FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CITY OF ALBUQUERQUE DRINKING WATER PROJECT

Prepared by: U.S. Department of the Interior, Bureau of Reclamation
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This Final Environmental Impact Statement (FEIS) analyzes the impacts of implementing a drinking water project for residents of the City of Albuquerque, New Mexico, that aims to use existing water resources and develop a safe and sustainable water supply to the year 2060. The proposed project would entail four elements: (1) diverting surface water from the Rio Grande, (2) transporting the raw water to a new water treatment plant, (3) treating the raw water to drinking water standards, and (4) distributing the treated, potable water to customers in the City's water service area. The FEIS evaluates four alternatives: a no action alternative and three action alternatives. Each of the three action alternatives would provide a means by which the City would fully consumptively use the City's San Juan – Chama project water to provide a sustainable water supply. Additional material and options evaluated in addition to those evaluated in the Draft Environmental Impact Statement include an enhanced conservation goal, a slight modification of the location of one diversion alternative and adding several potable water transmission line alternatives. These are environmentally favorable improvements.

This FEIS has been prepared in compliance with the National Environmental Policy Act and Reclamation procedures and is intended to serve environmental review and consultation requirements pursuant to Executive Order 11988 (Floodplain Management), Executive Order 11990 (Wetlands Protection), Executive Order 12898 (Environmental Justice), the National Historic Preservation Act (Section 106), Fish and Wildlife Coordination Act, Endangered Species Act (Section 7c) and Departmental and Reclamation Indian Trust Asset policies.

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LIST OF ACRONYMS AND ABBREVIATIONS

ac-ft	acre-feet
ac-ft/yr	acre-feet per year
AD	*anno domini*
AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
amsl	above mean sea level
AOP	Albuquerque Overbank Project
AQCR	air quality control region
ARMS	Archaeological Resource Management System
ASR	aquifer storage and recovery
AT&SF	Atchison, Topeka and Santa Fe [Railroad]
AWRMS	Albuquerque Water Resources Management Strategy
BBER	Bureau of Business and Economic Research
BC	before Christ
BEMP	Bosque Ecosystem Monitoring Program
BIA	Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BMP	best management practice
CAA	Clean Air Act of 1970
CAC	Customer Advisory Committee
CBC	Christmas bird count
CEQ	[President's] Council on Environmental Quality
cfs	cubic feet per second
cfu	coliform fecal units
City	City of Albuquerque
CSSC	City Staff Steering Committee
CO	carbon monoxide
CWA	Clean Water Act
dBA	decibels
Doc ID	document identification
DWP	Drinking Water Project
EA	environmental assessment
e.g.	*exempli gratia* (for example)
i.e.	*id est* (that is)
FEIS	draft environmental impact statement
EMI	Ecosystem Management, Inc.
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ºF	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
FR `	*Federal Register*
ft^2	square feet
ft/sec	feet per second

FWCA	Fish and Wildlife Coordination Act
GAC	granular activated carbon
gpcd	gallons per capita per day
HEC-RAS	Hydrologic Engineering Center – River Analysis System
I-	Interstate
IAWG	interagency workgroup
IO	isolated artifact occurrence
ISC	New Mexico Interstate Stream Commission
ITA	Indian Trust Asset
km	kilometer
kWH	kilowatt hour(s)
LA	University of New Mexico Laboratory of Anthropology
LF	linear feet
LFCC	Low-Flow Conveyance Channel
LUST	leaking underground storage tank
m^2	square meters
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
mgd	million gallons per day
mg/L	milligrams per liter
mi^2	square miles
mm	millimeters
MRGAA	Middle Rio Grande Administrative Area
MRGCD	Middle Rio Grande Conservancy District
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NDC	North Diversion Channel
NEPA	National Environmental Policy Act
NHPA	National Historical Preservation Act
NMAC	New Mexico Administrative Code
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMFRCD	New Mexico Forestry and Resources Conservation Division
NO_2	nitrogen dioxide
NPDES	National Pollutants Discharge Elimination System
NPV	net present value
NRHP	National Register of Historic Places
NW	northwest
NWR	National Wildlife Refuge
O_3	ozone
O&M	operations and maintenance
OSE	Office of the State Engineer
Pb	lead
PL	public law
PM_{10}	airborne particulate matter less than or equal to 10 microns in aerodynamic diameter

$PM_{2.5}$	airborne particulate matter less than or equal to 2.5 microns in aerodynamic diameter
PNM	Public Service Company of New Mexico
ppb	parts per billion
ppm	parts per million
Reclamation	U.S. Bureau of Reclamation
RGR	Rio Grande Restoration
RGSM	Rio Grande silvery minnow
RGVSP	Rio Grande Valley State Park
RM	river mile
ROD	record of decision
ROI	region of influence
ROW	right-of-way
SDC	South Diversion Channel
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Officer
SJC	San Juan-Chama
SO_2	sulfur dioxide
SO_x	sulfur oxides (as sulfur dioxide)
SWRP	Southside Water Reclamation Plant
TBD	to be determined
TDS	total dissolved solids
URGWOM	Upper Rio Grande Water Operations Model
U.S.	United States
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
WIFL	Southwestern Willow Flycatcher
WTP	water treatment plant
YOY	young-of-the-year

SECTION 1

PURPOSE AND NEED

1.1 INTRODUCTION

This Final Environmental Impact Statement (FEIS) examines the potential impacts on the environment that may result from the City of Albuquerque's (City or Albuquerque) proposed Drinking Water Project ("DWP" or "the project"). The purpose of and need for the project is to provide a sustainable water supply for Albuquerque through direct and full consumptive use of the City's San Juan-Chama (SJC) water for potable purposes in accordance with United States Environmental Protection Agency (EPA) regulations under the Safe Drinking Water Act. This FEIS is prepared to comply with the National Environmental Policy Act (NEPA) as a result of federal actions which may be taken by the United States Bureau of Reclamation (Reclamation) and the U.S. Army Corps of Engineers (USACE) in connection with the project.

The federal actions which may be undertaken in connection with the project which require NEPA compliance are: (1) issuance of a license by Reclamation to the City for the location of project facilities on Reclamation-owned property or right-of-way (ROW), or approval of a license between the City and the Middle Rio Grande Conservancy District (MRGCD) for the location of facilities within the Middle Rio Grande Project; (2) execution of a water carriage contract authorizing use of federal irrigation canals to convey non-project water (this action would be required only if there would be diversion of the City's San Juan-Chama Project water at the Angostura Diversion Dam and conveyance of the water through existing facilities of the Middle Rio Grande Project). Special legislation would be needed to authorize carriage of non-project water for municipal and industrial purposes through Middle Rio Grande project facilities; and (3) Clean Water Act Section 404 permitting from the U.S. Army Corps of Engineers in conjunction with construction of project facilities in waters of the United States. The U.S. Fish and Wildlife Service (USFWS) and the Environmental Protection Agency has provided consultation and review pursuant to their respective statutory authority under the Endangered Species Act, Clean Water Act, and NEPA. The New Mexico State Historic Preservation Office has provided consultation under the National Historic Preservation Act. Table 1.1-1 lists the required federal actions, permits and licenses for the project. The City is responsible for planning, design, construction, funding, mitigation measures and permitting of the project. There are no federal, state or local partners.

The project's region of influence (ROI) includes portions of the Rio Grande watershed from the outlet of Heron Reservoir on the Rio Chama, downstream to the headwaters of Elephant Butte Reservoir on the Rio Grande (Figure 1.1-1). Prominent surface-water

TABLE 1.1-1
REQUIRED ACTIONS, PERMITS, AND LICENSES

Agency or Organization	Actions, Permits, and Licenses	Description
U.S. Bureau of Reclamation (Reclamation)	National Environmental Policy Act (NEPA) compliance	Reclamation would need to issue a license to the City for location of project facilities on Reclamation owned property or right of way or approve a license between the City and the MRGCD for location of facilities within the Middle Rio Grande Project. Reclamation is responsible for ensuring compliance with NEPA, Warren Act and other environmental statutes and Executive Orders, overall coordination of the environmental review, and issuing the Record of Decision.
	Secretarial Order 3175 – Identification, Conservation, and Protection of Indian Trust Assets	Reclamation is responsible for government-to-government consultations with Tribal and Pueblo entities.
U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act (ESA) (Section 7 Consultation) (Section 10 Compliance)	Consultation under Section 7 of ESA is required to determine if the project will adversely affect threatened or endangered species or designated critical habitat.
	Fish and Wildlife Coordination Act (FWCA) Report	USFWS must prepare a FWCA report that determines effects on fish and wildlife populations and their habitats from water-resource developments and recommends ways to avoid or mitigate adverse effects.
U.S. Army Corps of Engineers (USACE)	Permit pursuant to Section 404 of the Clean Water Act (CWA)	USACE is a cooperating agency for the proposed project under NEPA, and would issue a CWA Section 404 Permit, which would be required for discharge of fill material into waters of the U.S., including wetlands.
Federal Executive Orders (EOs) [a/]	EO 11990 – Wetlands	Minimize destruction, loss, or degradation of wetlands.
	EO 11998 – Floodplains	Reduce the risk of flood loss, minimize flooding effects.
	EO 12898 – Environmental Justice	Avoid disproportionate adverse effects to minority and/or low income populations.
	EO 13077 – Native American Sacred Sites	Accommodate access to and avoid adversely affecting sites.
	EO 11593 – Protection and Enhancement of the Cultural Environment	Leadership role in surveying and preservation of the cultural environment.
U.S. Environmental Protection Agency (EPA)	Oversight authority for CWA Section 404 Permits.	EPA provides review comments to the USACE on Section 404 permit applications during the public process. EPA has veto authority of USACE permit decisions under Section 404(c) of the Clean Water Act.
	EPA Review of FEIS Section 309 of the Clean Air Act	EPA will review the FEIS for environmental impact of the project, and will rate the adequacy of the FEIS when it is filed with EPA.
	National Pollutant Discharge Elimination System (NPDES)	Appropriate NPDES permit coverage for the contractors will be required.

TABLE 1.1-1 (Continued)
REQUIRED ACTIONS, PERMITS, AND LICENSES

Agency or Organization	Actions, Permits, and Licenses	Description
EPA (Cont.)	Section 402 of the Clean Water Act	A surface water pollution prevention plan (SWPPP) will be required for the project.
Sandia Pueblo	Section 401, Certification Authority under the Clean Water Act	If Angostura Alternative were selected, this certification would be required.
New Mexico Department of Game and Fish (NMDGF)	Management of fish and wildlife in New Mexico with concurrent responsibility for the USFWS FWCA report	NMDGF would comment on the FWCA Report. If the Department does not concur with USFWS findings, it may prepare its own FWCA report.
New Mexico Environment Department (NMED) or Water Quality Certification Agency	Section 401 Water Quality Certificate (CWA)	NMED or Water Quality Agency Section 401 certification is required prior to USACE issuance of individual Section 404 permit.
	Ground Water Discharge Plan	NMED would review the plan to ensure compliance with discharge and compliance limitations.
	20 NMAC 7.1.502 approval	Two copies of plans and specifications to be provided to the NMED prior to bidding on construction.
New Mexico Historic Preservation Division, State Historic Preservation Officer (SHPO)	National Historic Preservation Act Compliance	Reclamation is required to consult with SHPO regarding the effects of the project on historic and archeological sites (sites eligible for listing on the National Register of Historic Places) and to mitigate any adverse effects to these sites.
Office of the State Engineer (OSE)	Surface Water Diversion Permit	State Engineer approval of permit to divert water from the Rio Grande.
Middle Rio Grande Conservancy District (MRGCD)	License Agreement	For construction of project facilities within existing MRG Project property.
Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA)	License Agreement	For construction of project facilities within existing AMAFCA property.
City of Albuquerque	Open Space Division Permit	City permit required by Open Space to build and operate extraordinary facilities within bosque areas.
County of Bernalillo	County Flood Control Regulations (Chapter 38)	Compliance necessary to construct facility in the floodplain.

[a/] Reclamation must ensure compliance with these pertinent Executive Orders.

storage, transport, and regulating features within the project ROI are the Rio Chama and Rio Grande, and Heron, El Vado, Abiquiu, and Cochiti Reservoirs. The City takes delivery of its SJC water at the outlet of Heron Reservoir, which defines the upstream boundary of the Upper Project Subarea of the ROI. The Middle Project Subarea of the ROI begins at the City's proposed diversion at the existing MRG Project's Angostura Diversion or near Paseo del Norte in Albuquerque and extends to the City Southside Water Reclamation Plant (SWRP). The Lower Project Subarea begins at the SWRP and extends through the riverine system downstream of the City to the headwaters of Elephant Butte Reservoir. Project construction of the diversion and conveyance facilities would occur in Sandoval and/or Bernalillo Counties in the Middle Project Subarea. All other construction elements would occur in Bernalillo County.

Ten Pueblos are located along the main stem of the Rio Grande: San Juan, Santa Clara, San Ildefonso, Cochiti, Santa Domingo, San Felipe, Santa Ana, Sandia, Isleta, and Ysleta del Sur, in El Paso, TX.

1.2 BACKGROUND

1.2.1 Technical Studies – Albuquerque Aquifer

Historically, the City has relied solely on ground water for drinking water and related municipal purposes such as industrial or turf irrigation. The City's existing water service area based on customer billing information and location of its existing wells is shown in Figure 1.2-1. The City's water source has been exclusively from the regional aquifer, which is a part of the sedimentary deposits known as the Santa Fe Group, Albuquerque Basin Aquifer ("Albuquerque Aquifer" or "Aquifer"). Aquifer characterization and water supply studies conducted during the 1950s and 1960s indicated the aquifer was extensive, and that flows in the Rio Grande recharged the aquifer sufficiently to allow ground water withdrawals without affecting the aquifer's long-term ability to supply water.

Based on the 1960s understanding of the relationship between the Rio Grande and the aquifer, the City's water supply plan was as follows: the City would pump water from the aquifer; the aquifer would be replenished by the Rio Grande; and the City would re-supply the Rio Grande through return flows, native water rights, and releases of water imported from the Colorado River system via the San Juan-Chama (SJC) Project.

Studies by the New Mexico Bureau of Mines and Mineral Resources (1992) and the U.S. Geological Survey (USGS, 1993 and 1995) have concluded that the volume of the water-producing zone within the Albuquerque Aquifer is much less than earlier studies had estimated. Work by Reclamation (1997a) shows the hydrologic connection between the Albuquerque Aquifer and the Rio Grande is not as transmissive as previously assumed. USGS (1995) estimated the aquifer is being depleted at a rate that is twice that of the recharge to the aquifer from the Rio Grande and other sources. In addition, the imbalance between limited and declining recharge and increasing withdrawals has caused ground water levels around the City pumping centers to drop by up to 150 feet (Reclamation, 1997a). As a result, reliance on the regional Albuquerque aquifer as the sole source of drinking water for the City is unsustainable.

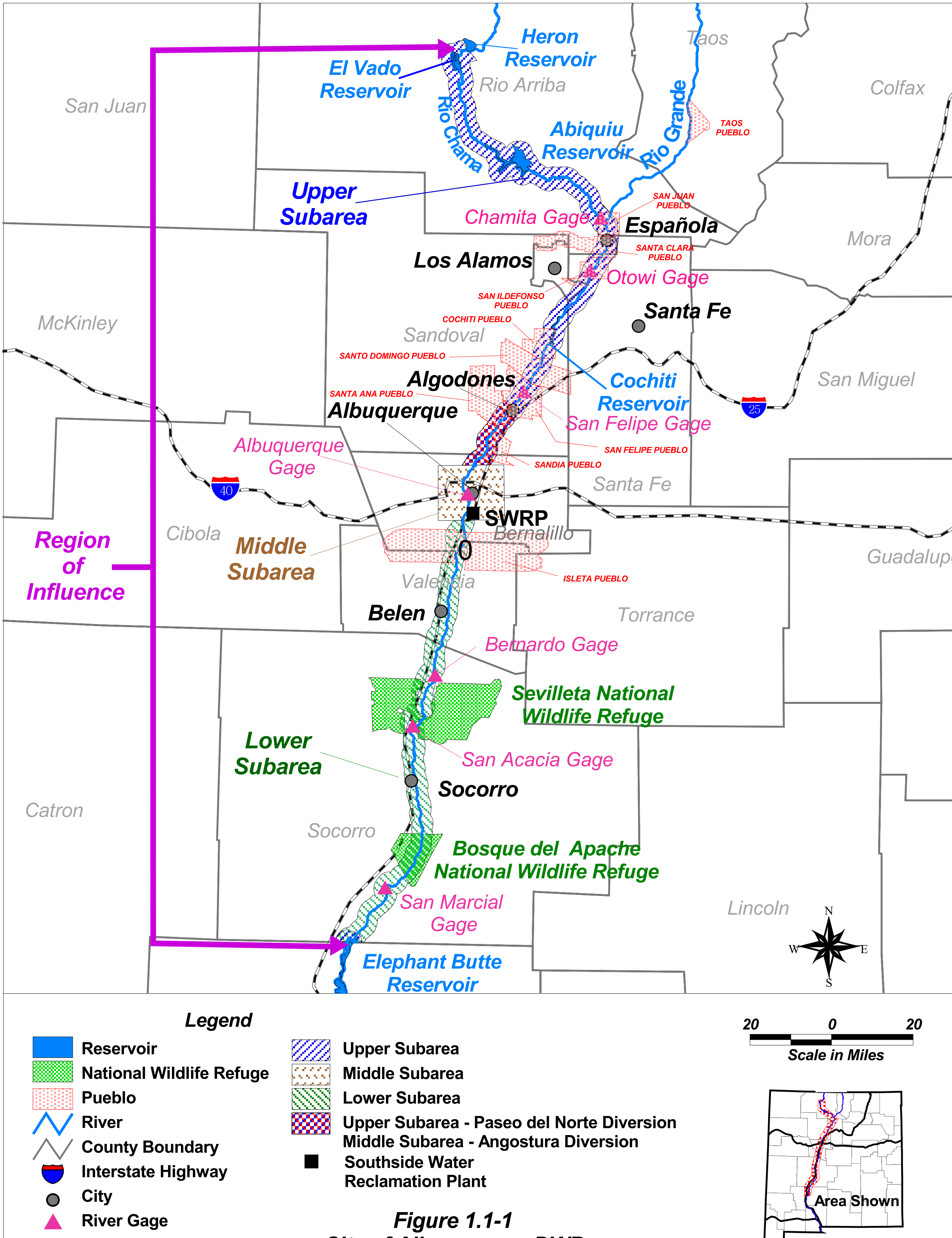

Figure 1.1-1
City of Albuquerque DWP
Region of Influence

Note: Riverine corridor not to scale

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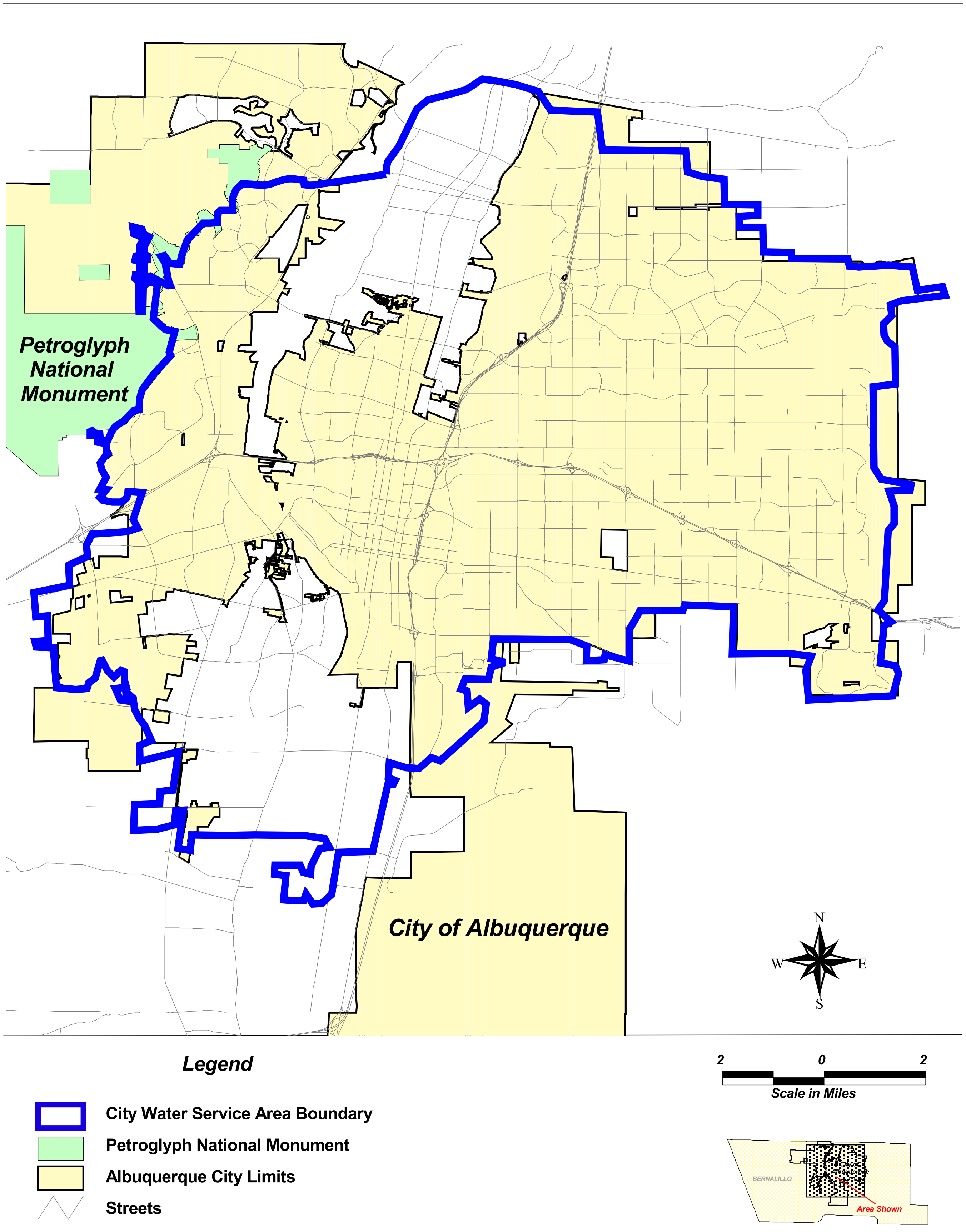

Figure 1.2-1
Existing Water Service Area

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The proposed diversion and direct use of the City's SJC water for a drinking water supply is in response to these more recent studies and recognition that the City's current exclusive reliance on ground water is not sustainable. The City has an established water conservation program and other reuse and recycling projects ongoing. Full consumptive use of the SJC renewable water supply is the only means available to provide a sustainable supply and allow ground water levels in the aquifer to recover and serve as a drought reserve. Continued sole reliance on ground water resources would lead to serious environmental problems in the region, including water quality degradation, irreversible damage to the aquifer, and land surface subsidence.

1.2.2 San Juan-Chama Project

The SJC Project was authorized by Congress on June 13, 1962 under PL87-483, Colorado River Storage Project Act of April 11, 1956. The SJC Project consists of facilities that divert water from the San Juan Basin (Colorado River Basin) in southern Colorado through 26 miles of tunnels beneath the Continental Divide to Willow Creek, a tributary of the Rio Chama in the Rio Grande Basin, in New Mexico. In 1963, the City contracted for 53,200 acre-feet per year (ac-ft/yr) of SJC water. Subsequently, the contract amount was reduced to 48,200 ac-ft/yr in 1965, pursuant to an agreement by the City to relinquish 5,000 acre-feet (ac-ft) in order to establish a permanent recreational pool at Cochiti. The project has a firm yield of 96,200 ac-ft/yr, based on a hydrologic analysis performed by the BOR and updated in 1989. After transit losses, as determined by the Rio Grande Compact Commission, the amount of the City's SJC water available for beneficial use is 47,000 ac-ft/yr. Under the terms of the 1963 contract, the City owns the 48,200 ac-ft/yr in perpetuity. The City is obligated to repay the full cost of construction, with interest, for SJC water allocated to municipal and industrial purposes and for its proportional share of operation and maintenance costs for the project. To date, the City has invested more than $46 million in construction repayment (principal and interest), operation, and maintenance costs for its SJC water.

Since the SJC became operational in 1971, the City has taken full delivery of its SJC water, a total of 0.94 million ac-ft of water through 1998. The only exceptions were the wet years of 1985 and 1987 when there was insufficient storage space to take delivery. Approximately 0.57 million ac-ft of the City's SJC water has passed through the Otowi gage. This represents approximately 2 percent of the more than 30 million ac-ft of native water passing through the Otowi gage during the same period. Rio Grande Compact Commission records from 1972 to 1998 indicate that an average of 53,000 ac-ft/yr of SJC water from all sources have passed the Otowi gage. Upon implementation of the project, due to Albuquerque's release of SJC water, there will be a net increase in the flow at the Otowi gage of approximately 25,000 ac-ft/yr.

1.2.3 Arsenic Rule Compliance

The EPA promulgated a new rule for arsenic on February 22, 2002 and set a maximum contaminant level (MCL) for arsenic at 10 micrograms per liter (µg/L). This new arsenic standard will have significant ramifications for the City of Albuquerque. The EPA has given water systems until January 23, 2006 to be in compliance. The City operates approximately 92 production wells. Of these, it is expected that 40 wells will not be in compliance with the 10 µg/L arsenic standard. The City system wide arsenic concentration is around 13 µg/L. However, some wells have arsenic levels approaching 50 µg/L. Additional arsenic information is provided in Section 3.27, Water Quality.

1.2.4 Public Process

As a first step towards achieving a sustainable water supply, the Albuquerque City Council adopted the following policies in 1995:

1. Water Conservation: Water conservation is an integral component of the Albuquerque Water Resource Management Strategy (AWRMS). Conservation measures are incorporated in both the No Action and action alternatives. Both the No Action and the action alternatives include the continuation of the City's current conservation program and the reduction of per capita water use from 250 gallons per capita per day (gpcd) to 175 gpcd by the end of calendar year 2004. The City is part way through this program of reducing per capita water use and current per capita usage is approximately 197 gpcd, a 26 percent reduction since 1995. The 175 gpcd goal has been modified to include an enhanced goal of 150 gpcd by 2014.

   While working towards this goal, the City is evaluating other mechanisms to improve water conservation. The City is setting an example in new City facilities and in the development of alternative supplies to meet non-potable uses. Retrofitting and/or redesign to enhance water conservation of existing facilities will take a period of years.

   Water conservation alone cannot meet the policies of the AWRMS or the purpose and need of the proposed project. If policies approved in the AWRMS are met, the City's rate of ground water pumping would still be greater than the amount that can be replenished naturally. The project will help protect the aquifer while providing a greater range of necessary options to water managers.

2. In 1997, the AWRMS was adopted. This strategy is based on optimizing the City's use of existing water resources and developing new renewable water supplies. The AWRMS is intended to provide a safe and sustainable drinking-water supply for the City by minimizing continued ground water pumping and exclusive reliance on ground water resources. Albuquerque's current use of ground water is not sustainable because the City is mining the aquifer in a manner which by definition is drawing on a non-renewable resource, i.e., more is taken out than can be replaced through natural processes. The focus of the DWP is conjunctive use to provide a sustainable supply through use of renewable surface water and use of ground water in a manner which allows recharge of the aquifer. Additionally, a focus of the AWRMS is reduced usage through a target goal of 40 percent reduction over 20 years.

3. Policies adopted by the City Council as set forth in the AWRMS include the following:

- Proceed with dispatch to develop and fully use the City's existing surface water supplies (i.e., the City's SJC water),
- Establish a ground water drought reserve,
- Support regional water resources planning and management,
- Pursue the conjunctive use of available water resources,
- Pursue acquisition of new water supplies as needed,
- Fully implement the water conservation strategy,
- Fully implement the Ground Water Protection Policy and Action Plan,
- Equitably incorporate the costs of providing a safe and sustainable water supply into water rates,
- Protect valued environmental resources,
- Preserve and enhance the quality of life in the region,
- Encourage and facilitate public involvement and support,
- Update the City/County Comprehensive Plan and other City plans,
- Drought management strategy adopted 2002, and
- New water conservation goal – 2003.

The first project implemented under the AWRMS was the construction and operation of an industrial water-recycling project in the North I-25 area. Under this project at full build-out, substitution of recycled water for uses previously met by ground water pumping reduced ground water pumping by 896 ac-ft/yr. The Non-potable Surface Water Reclamation Project is operational, but not fully operational (July 1, 2003), and the Southside Water Reclamation Plant Reuse Project, is in the design stage. These projects will provide non-potable water for turf irrigation and industrial uses in areas of the City (Reclamation, 1999 and 2001a). Through use of reclaimed water and a portion of the City's SJC water, these two projects are expected to reduce ground water pumping by a total of 3,038 and 2,455 ac-ft/yr, respectively. The sum of these projects, 6,389 ac-ft/yr, represents approximately 6 percent of the City's current (2000) demands.

The City's DWP, which is the subject project of this FEIS, is the major feature of the AWRMS. Together with water conservation and the non-potable water projects, it will reduce the rate of water withdrawn from the deep aquifer, and extend the life of the existing ground water supply.

The approach to divert and directly use the City's SJC water was formulated over many years of planning, evaluation of alternatives, and public involvement. By actively engaging the public from the initial inception of the AWRMS planning process, the City has focused and educated the community on the need to conserve, preserve, and protect the aquifer. The public education, information, and involvement program has included over 100 meetings with agency officials, public and civic groups, City customers, residents, neighborhood associations, and elected regional officials. The Mayor and City Council also established a Water Resources Customer Advisory Committee (CAC) in 1996 to provide community policy direction and input as the strategy was developed and implemented. The CAC is made up of 10 members representing environmental, business, community, and neighborhood interests who meet monthly to discuss and provide City staff direction. With the public's technical and policy input, the City evaluated 32 water supply alternatives. Evaluation of the alternatives was based on the following criteria: environmental protection; implementability; reliability and sustainability; effect on the quality of life; and financial feasibility. After evaluating 32 alternatives using these criteria, the interdisciplinary team, through further public process and screening criteria, refined the analysis of 14 options. In 1997, the City adopted the AWRMS. Continued detailed study led to the formulation of 9 raw water diversion options. Finally, three action alternatives (including the preferred) were brought forward for evaluation in the FEIS. The process for the evaluation and selection of alternatives is more fully described in Section 2.

1.2.5 Current Conservation Goal

In 1994, the City called for a 30 percent reduction in gpcd. This amounts to a reduction from 250 gpcd to 175 gpcd within 10 years. The percent analysis in 2002 showed a reduction of 27 percent. When unaccounted-for water was deducted, usage actually drops to 175 gpcd. In 2003, the City established a new goal to reduce use 40 percent by 2014 reaching 150 gpcd.

This change reduces the overall supply required and therefore reduces the amount of pumping required to meet demands, particularly in the late years for the DWP or the No Action Alternative.

1.3 PURPOSE OF AND NEED FOR THE PROJECT

The purpose of and need for the project is to provide a sustainable water supply for the City of Albuquerque through direct and full consumptive use of City San Juan-Chama water for potable purposes in accordance with EPA regulations under the Safe Drinking Water Act. The proposed DWP, as set forth in the three action alternatives in this FEIS, would meet the stated purpose and need. The following project components are required to meet the purpose and need of the project:

- Diversion of 94,000 ac-ft/yr (47,000 ac-ft/yr of City SJC water and 47,000 ac-ft/yr of native Rio Grande water) to fully consume the City's SJC water (47,000 ac-ft/yr), with the native Rio Grande water (47,000 ac-ft/yr) returned after treatment at the SWRP;
- Construction and operation of a surface water treatment plant (WTP) to provide potable water for municipal and industrial use;
- Construction of transmission pipelines to convey potable surface water to the City's water service area;
- Continued use of ground water pumped from City wells during periods of drought and to meet peak demands;
- Development of a program to demonstrate and implement aquifer storage and recovery technologies at appropriate City well fields; and

- Use of vested and native surface-water rights to offset pumping effects on river flows.

The DWP would fully utilize the City's existing water resources, protect and replenish the local aquifer for use as a drought reserve, and facilitate the conjunctive use of ground and surface water. The DWP would result in a reduction of pumping within the City well fields of 94,000 ac-ft/yr. Reduced pumping also would lower the risk of subsidence. Additionally, implementation of the DWP as proposed in this FEIS is the sole economically viable method for the City to comply with the SDWA standard for arsenic by the compliance deadline of 2006. Implementation of the DWP would reduce the need for arsenic treatment of ground water for impacted wells.

Compliance with the Arsenic Rule will require the construction of the DWP to supply low arsenic water in place of the higher arsenic well water. Without the DWP, the City would be required to spend an estimated $150 million to provide arsenic treatment for the impacted wells.

The DWP is essential to meet current and projected water demands. The project is needed to provide a sustainable water supply for the City's citizens, even if population does not increase. Moreover, the project is needed to preserve the aquifer and create a ground water drought reserve. As can be seen in Figure 1.3-1 and Table 1.3-1 the City currently uses both renewable and non-renewable ground water supplies to meet its demand. Conservation programs in effect from 1995 have reduced overall water demand.

Additionally, a focus of the AWRMS is reduced usage through a target goal of 40 percent reduction over 20 years. However, water conservation is not enough to meet the goals of the AWRMS. If conservation goals (i.e., reducing water use on a per capita basis by 40 percent) are met, the City's rate of ground water pumping would still be substantially greater than the amount that can be naturally replenished. Therefore, conservation alone cannot provide a sustainable supply without direct, diversion, and full use of City SJC water.

The recently permitted recycling projects will also contribute to meeting the City's water demand. While the DWP does fully consume the City's annual supply of SJC water, water for the non-potable project is supplied through the City's storage and through unused supply during drought years.

The DWP would replace the use of non-renewable ground water with sustainable water supplies. These sources would meet all the City's demands through approximately 2060 when new sources of water supply will be required.

1.4 RELEVANT ISSUES IDENTIFIED DURING SCOPING

The issues-identification process inherent to the NEPA analysis involved extensive public and agency involvement using various techniques, including meetings, scoping sessions, workshops, technical work groups, and town hall meetings. Several relevant issues were identified through both an ongoing City scoping program (multi-agency and stakeholder work group sessions), and the public scoping meetings that were held during September, 1999 in Albuquerque, Socorro, and Española, New Mexico.

At the Albuquerque public scoping meeting, the issues of primary concern to the public were water treatment plant site selection, the quality and taste of river water, aquifer storage and recovery, water diversion methods and impacts on the bosque (i.e., riparian woodlands), potential effects on farmers and irrigation waters, and the potential effects on residential wells.

At the Socorro public scoping meeting, issues of concern to the public were the potential for decreased flows downstream in the Rio Grande, water quality, general environmental concerns as reflected by concern for the endangered Rio Grande silvery minnow (RGSM) and sensitive cultural resources, and the effects of population growth on New Mexico water supplies.

At the public scoping meeting at Española, issues of primary concern to the public were effects on Heron and Abiquiu Reservoirs, and effects on river flows. Additional issues were farming and irrigation water concerns, general cultural and environmental concerns, and population growth in Albuquerque.

Agency scoping and the identification of relevant issues and other concerns have been ongoing since the first agency workshop was held in December, 1998. Categories to be addressed in environmental documentation include Indian Trust Assets; biological resources, including in particular the RGSM and the southwestern willow flycatcher; and a cumulative effects analysis. Additional relevant issues identified through agency scoping and workshops are downstream water quality, matching water supply and population growth, and drawdowns at Abiquiu Reservoir. These issues are briefly reviewed below by resource category.

1.4.1 Human Health and Safety

Opposition to selection of a South Valley site for the drinking water treatment plant was expressed during the Albuquerque public scoping meeting. Comments included questions about water taste, the risk of contamination, and noise and odors associated with drinking water treatment plant operation.

1.4.2 Water Quality

Concerns expressed at the Socorro public meeting were related to water quality changes associated with any project effects on downstream surface water quality. Agency scoping identified some Native American concerns about impacts on water quality in the Rio Grande. Additional issues raised at the Albuquerque public meeting were background water quality of the Rio Grande, and the potential effects that using the river water might have on the ground water in the aquifer. The Isleta Pueblo expressed some concerns about water quality below the City's proposed water diversion structure and below the existing SWRP. Potential effects on residential wells and agricultural use of water were also identified as issues.

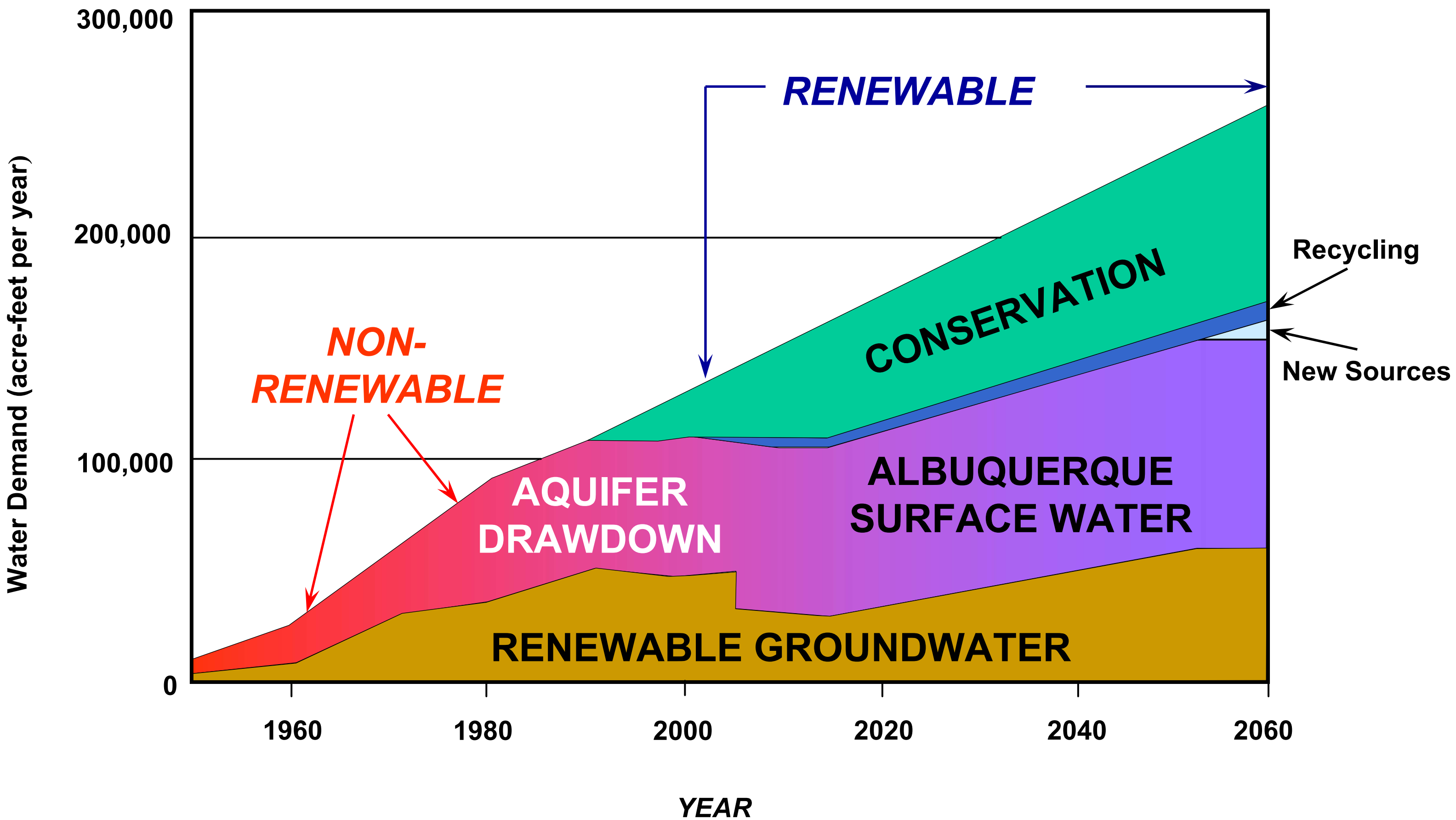

Figure 1.3-1
Projected Water Demand and Sources of Supply

Source: CH2M Hill

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TABLE 1.3-1. SUMMARY OF WATER SUPPLY FOR THE CITY OF ALBUQUERQUE FROM 2000 TO 2060 (CH2M HILL, 2003)

Year	Aquifer Pumping (afy[a/])	Total Non-potable Water Use [c/] (afy)	DWP River Supply (afy)	New Sources of Water [b/] (afy)	Total Demands After Conservation (afy)
2000	115,500	0	0	--	115,500
2006	30,000	7,000	94,000	--	111,000
2010	8,660	9,400	94,000	--	111,400
2020	14,600	9,400	94,000	--	110,660
2030	29,600	9,400	94,000	--	133,100
2040	67,500	9,400	94,000	--	148,300
2050	67,500	9,400	94,000	--	162,200
2060	67,500	9,400	94,000	5,300	176,200

[a/] afy = ac-ft/yr.

[b/] New sources of water were calculated by limiting the aquifer pumping to 67,500 ac-ft/yr. This 67,500 ac-ft/yr is an estimate of the sustainable yield of the aquifer. These new sources have not been identified and are required to be in place by the year 2060.

[c/] Includes future shallow ground water and Mesa del Sol reclaimed effluent projects of 3,025 ac-ft/yr.

1.4.3 Water Quantity

Concerns regarding issues related to defining a hydrologic baseline were documented during agency and public scoping. Hydrologic baseline definition is important in gaining agency and public acceptance of modeling simulations, which are proposed to be used as the basis for determining environmental effects of the DWP on the Rio Grande and the local ground water aquifers. There also have been issues raised about potential effects of diverting the City's SJC water on downstream river flows. Concerns were also expressed about the river drying up, and the integrity of channels and subsequent effects on channel capacity. Some concern was expressed at the Española public meeting about the effects of the project on Heron and Abiquiu reservoirs, especially the recreational aspects of reservoir operations. Concern over proposed diversion methods, and which one would be most suitable, was expressed at the public meetings. The potential effects from diversion include depletion of river flows and impacts on the RGSM and its habitat.

1.4.4 Biological Resources

The RGSM and its habitat are of environmental concern within the project ROI, and are the subject of considerable analysis within this document. While the exact effects on the bosque were not yet clearly defined during scoping, substantial public concern regarding potential effects on the bosque was expressed. Construction effects and overall short- and long-term effects on the bosque and surrounding fish habitats have been evaluated. Construction effects and operational effects causing potential lowering of the ground water table within the bosque have been identified as agency concerns. In addition to the RGSM, two birds, the endangered southwestern willow flycatcher and the threatened bald eagle, may be potentially present in the bosque areas near the project.

1.4.5 Cultural Resources

Cultural resource concerns were raised at the Española and Socorro meetings. The need for field surveys to assess cultural resources, particularly in the area of Sandia Pueblo, was identified as a concern. Potential effects on cultural resources likely would be a result of project construction rather than project operation.

1.4.6 Indian Trust Assets and Other Tribal Resources

As the lead federal agency, Reclamation has primary responsibility for identifying and determining effects to Indian Trust Assets (ITAs). Although no potentially affected ITAs have been formally identified by Tribes, Pueblos, or Bureau of Indian Affairs (BIA), Reclamation has determined that ITAs could include Indian water rights and any trust land and natural resources. Scoping input identified concerns regarding effects of flow reduction on traditional uses of the river, water quality, water rights, and the environment.

1.4.7 Socioeconomics

The effects of population growth in Albuquerque were identified as a concern at the public meetings outside of Albuquerque. Specific concerns relate to potential impacts on the regional water supply for neighboring communities from implementation of the AWRMS and as a consequence of growth in the Albuquerque metropolitan area.

Table 1.4-1 lists the resource categories and the associated relevant issues identified during public scoping. Also provided in Table 1.4-1 are cross references to sections of this document where these issues are addressed.

1.5 RELATION TO OTHER RECLAMATION PROJECTS

In addition to the proposed DWP, the City of Albuquerque, in cooperation with Reclamation, recently completed the North I-25 Industrial Recycling Project. This project uses water recycled from local industrial processes for turf irrigation and other uses that do not require potable water. Based on an environmental assessment (EA) performed under NEPA, a Finding of No Significant Impact (FONSI) was issued for the North I-25 Industrial Recycling Project (Reclamation, 1999). This project is a component of the City of Albuquerque AWRMS.

An EA was also completed, and a FONSI issued, for the Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque Project (Reclamation, 2001a). This component of the AWRMS replaces the use of high-quality drinking water from the aquifer for turf irrigation and some industrial uses with a small amount of the City's SJC supply and reclaimed effluent from the City's wastewater treatment plant.

TABLE 1.4-1
SUMMARY OF ISSUES IDENTIFIED DURING PUBLIC SCOPING

Resource Category	Related Issues	Addressed in Section/Appendix of FEIS
Human Health and Safety	Opposition to a Southwest Valley water treatment plant location	2.2.1, Appendix B
	Taste of water	3.15, 3.27
Water Quality	Effects on downstream uses	3.27
	Native American concerns with downstream water quality	3.17, 3.27 Appendix F
	Effects on residential wells and agricultural uses	3.16, 3.27
	Effects on ground water	3.16, 3.27
	Project hydrology	3.16, Appendix L
	Drying or alteration of river channel	3.16
	Effects on downstream reservoirs	3.16
	River diversion	3.16
	Selection of diversion method	2.2
Biological Resources	Effects on endangered species	3.7, 3.8, 3.24, Appendices H, I, J
	Effects on bosque or riparian areas	3.7, 3.21, 3.28
	Ground water effects on the bosque	3.21, 3.28, 3.16
	Ecosystem approach to cumulative effects analysis	3.30
Cultural Resources	Identification and consideration of cultural resources	3.9, Appendix G
Indian Trust Assets	Sandia Pueblo concern with reduction of flows for traditional uses of the river	3.16, 3.17, Appendices F, G
Socioeconomics	Effects of population growth	3.10, 3.18, 3.22, 3.25
	Albuquerque growth effects on neighbors	3.6, 3.10, 3.16, 3.18, 3.22

The impacts of the City projects for which FONSIs have been issued are evaluated in this FEIS in combination with the effects of other ongoing projects being undertaken within the Rio Grande basin by the City, other municipalities, Reclamation, USACE, MRGCD, and other agencies.

The USFWS' Biological and Conference Opinions on the Effects of Actions Associated with the Programmatic Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operation, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico (USFWS, 2003) was issued on March 17, 2003. This document included the SJC Project, Middle Rio Grande Project, State of New Mexico Cooperative Program, and annual operating plan. In New Mexico, Reclamation maintains the river channel for the Middle

Rio Grande Project from Velarde to Caballo Dam. River maintenance activities include bank stabilization, habitat enhancements, river training works, sediment removal, levee maintenance, and other access and construction requirements. Current projects include activities to conserve threatened and endangered species, maintain bosque functions and values, minimize adverse water quality effects, and allow fluvial processes to occur to the extent possible. Reclamation is also acquiring supplemental water for the conservation and recovery of the RGSM. SJC Project water has been provided to supplement flows in the middle reach of the Rio Grande, thereby allowing the MRGCD to augment native flows to maintain RGSM habitat. Reclamation (2000a) continues to pursue other means to acquire water to supplement stream flow.

Reclamation and USACE are completing the Upper Rio Grande Basin Water Operations Review FEIS (Reclamation, 2001d). Reclamation and USACE, in partnership with the State of New Mexico, will review water storage and delivery operations, and may modify operations of federal river and reservoir facilities within the Upper Rio Grande Basin and develop an integrated management plan. USACE also has planned for ongoing levee-maintenance construction activities in the project area. There is a requirement for updated NEPA and ESA compliance, and a need to define procedures and protocols for review, coordination, and public involvement in water operations decisions. A decision document for the Upper Rio Grande Basin water operations is scheduled for 2004.

There are other agencies and municipalities with planned or on-going construction and operational activities within the Middle Rio Grande area. Cumulative effects analyses of these activities and related projects, including the additive effects of the proposed project, are considered in Section 3 of this FEIS (see Section 3.30).

SECTION 2

SELECTION AND DESCRIPTION OF ALTERNATIVES

2.1 INTRODUCTION

The process of formulating the DWP alternatives proposed in this FEIS began with the City Council's adoption of the AWRMS in 1997. Extensive public involvement, beyond the NEPA requirement for public scoping meetings, has occurred. Three public scoping meetings for development of public comment under NEPA were held in September, 1999. The results of these public scoping meetings are summarized in Appendices B through D. Figure 2.1-1 shows a general chronology of the DWP alternatives development. Other public involvement has included numerous public meetings with stakeholder groups, periodic agency scoping meetings, town hall meetings, and the use of media events and media reports.

The four alternatives selected for detailed analysis are:

- No Action Alternative, which would involve continued reliance on ground water for current and future drinking-water demand, with implementation of conservation measures, development of non-potable supplies, and attendant system expansion.
- Angostura Diversion Alternative, which would involve diversion of the City's SJC water at the existing Angostura Diversion, with conveyance of raw water to a new water treatment plant via two existing Middle Rio Grande Project facilities, pump station and conveyance pipeline, and distribution of treated potable water to consumers for full consumptive use in the Albuquerque metropolitan area with implementation of conservation measures, development of non-potable supplies, and attendant system expansion.
- Paseo del Norte Diversion Alternative, which would involve diversion of the City's SJC water at a new diversion to be constructed north of Paseo del Norte, with conveyance of raw water to a new treatment plant via a new pipeline, and distribution of treated potable water to consumers for full consumptive use in the Albuquerque metropolitan area with implementation of conservation measures, development of non-potable supplies, and attendant system expansion. This alternative is both the preferred alternative and the environmentally preferred alternative.
- Subsurface Diversion Alternative, which would involve diversion of the City's SJC water via new subsurface collectors to be constructed near Paseo del Norte, with conveyance of raw water to a new treatment plant via a new pipeline, and distribution of treated potable water to consumers for full consumptive use in the Albuquerque metropolitan area with implementation of conservation measures, development of non-potable supplies, and attendant system expansion.

This section reviews the planning process used by the City to identify and evaluate water-supply options, provides an overview of the formulation and selection process for the action alternatives, and describes the No Action Alternative, the three action alternatives, and the alternatives eliminated from detailed evaluation. A summary of the environmental consequences of the four alternatives retained for detailed analysis is also provided.

2.2 WATER-SUPPLY ALTERNATIVES EVALUATION

2.2.1 Background Studies

In the 1980s the City undertook studies of the aquifer in conjunction with water resources and planning efforts. Based on these studies the City determined the prevailing hydrogeologic model regarding the interaction between the basin surface and ground water was flawed. The conceptual model developed by the City and others showed that instead of being rapidly replenished by recharge from the river, the aquifer was showing a net loss in the form of declining water tables. In addition, as water levels declined, so did water quality. Higher concentrations of naturally occurring arsenic were found as supply wells were drilled deeper into the aquifer. Water quality was generally poorer on the west side where two City wells were taken out of service due to high arsenic levels.

In 1988, the City initiated a series of hydrogeologic studies by qualified experts from federal and state agencies, academia, and the private sector. Using data collected during these studies, and advances in computer modeling and other technological advances, a dramatically different interpretation of the surface water and ground water regime of the Middle Rio Grande Basin emerged. Some of the key studies interpreting the aquifer are:

- Deep-Hole Test Drilling Program (City, 1988-1991);
- Hydrogeologic Framework of the Northern Albuquerque Basin (New Mexico Bureau of Mines and Mineral Resources, 1992);
- Geohydrologic Framework and Hydrologic Conditions in the Albuquerque Basin, Central New Mexico (USGS, 1993);
- Simulation of Flow in the Albuquerque Ground-water Basin, New Mexico, 1901-1994, with Projections to the Year 2020 (USGS, 1995); and
- Middle Rio Grande Water Assessment (Reclamation, 1997).

USGS (1993 and 1995) developed a three-dimensional ground water flow model that calculates the effects of ground water withdrawals on the surface flows of the Rio Grande. The USGS simulation characterizes the aquifer as smaller and less unified than was inferred by the 1950s model. The new model shows the most productive layers of the aquifer are thinner and less extensive than was previously believed. While the regional aquifer is very large, much of it consists of low-permeability materials from which it is difficult to extract water. Moreover, the hydraulic connection between the

Devise 32 Provisional Alternatives

Ground water only

1. Continued current trends
2. Local ground water development, with conservation
3. Relocation of wells

Diversion and recharge

4. Injection of San Juan-Chama (SJC) water
5. Aquifer storage and recovery (ASR) of SJC
6. Spreading basins recharge
7. ASR/Infiltration
8. Enhanced surface recharge
9. Enhanced surface recharge and recreation

Direct use of SJC

10. Infiltration
11. MRGCD delivery
12. Maximized
13. Modular Treatment
14. Maximize surface water use

Wastewater reclamation and recharge

15. SWRP and westside
16. Zero discharge
17. Current unencumbered SJC

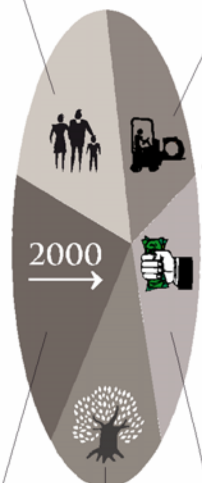
Nonpotable reuse

18. Citywide
19. Focused
20. Focused, with constructed wetlands
21. Constructed wetlands
22. Distributed wastewater treatment facilities for reclamation

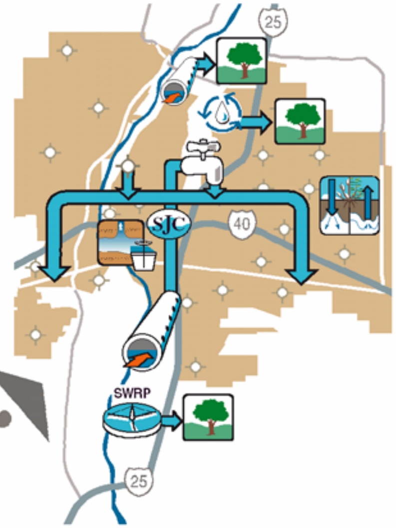
Multicomponent

23. With ASR, valley enhancements and modified nonpotable reuse
24. And Modified nonpotable reuse
25. Nonpotable surface water
26. Shallow ground water for nonpotable uses
27. With ASR, focused nonpotable reuse
28. Westside recharge and remediation
29. Focused nonpotable reuse with Constructed wetlands
30. With recharge
31. Direct use, focused reuse with constructed wetlands, ASR and shallow ground water
32. Direct use with Callabacillas

Screening Criteria

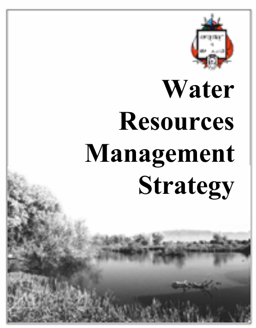


Alternatives



Refined Analysis Of 14 Options

Strategy Adopted by Mayor & Council Spring 1997



Supported by the entire community

- Business
- Civic
- Environmental
- Public Interest

Detailed Study

- **Computer Modeling**
- **Cost Estimates**
- **Stakeholder Meetings**
- **Field Studies**
- **Site Review and selection – 18 potential water treatment plant sites**
- **Transmission Pipeline Routing**
- **NEPA Public Scoping Meetings**

Diversion Options

Angostura Dam with

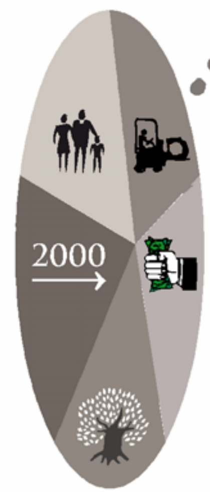
- Albuquerque Main Canal
- Pipeline
- Dual Canal

New Surface Diversion, adjustable-height dam

- North of Alameda
- North of Alameda, with wastewater augmentation
- South of Rio Bravo Bridge

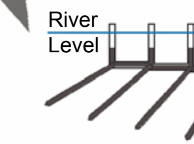
Subsurface Diversion

- Radial Collector
- Horizontal Collectors
- Horizontal Collectors, with wastewater augmentation



Screen & Evaluate

New Surface Adjustable-H



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aquifer and the Rio Grande is more complex and less direct than was assumed and approximately half of the ground water pumped from the aquifer is not readily replenished.

Based on the physical water table declines, some in excess of 180 feet, and the technical studies and extensive field data collected, the City determined that continued exclusive reliance on ground water was not a sustainable water supply strategy. The City initiated additional studies, (CH2M Hill, 1997a), to address the following issues:

- The ground water supply is limited and can be exhausted if long-term mining of the aquifer continues. Only about half of the amount the City now pumps is being replenished by the river.

- The City's current programs to implement the City/County Ground Water Protection Policy and Action Plan and to achieve conservation goals are important aspects of an overall management strategy.

- Continuing past ground water pumping practices will inevitably lead to such severe water table declines that the aquifer will become compacted, causing subsidence of the land surface and permanent damage to the water-bearing capacity of the aquifer.

- To provide a safe and sustainable water supply, the City must begin to directly use its SJC water to supplement ground water supplies.

- Administrative rules and institutional frameworks play a large role in determining what beneficial-use and water-management options are available to the City. Therefore, viable DWP alternatives must provide engineering solutions while complying with legal, administrative, and institutional requirements.

- While all studies indicate that using water the City already owns is the surest and least expensive, and environmentally preferred way to achieve a safe and sustainable drinking-water supply, other sources of water are potentially available and merit investigation.

- The hydrogeologic information now available must be disseminated among all users of the aquifer and those with authority over Middle Rio Grande Valley water issues.

Concurrent with its investigation of additional water supply alternatives, the City developed and implemented a rigorous conservation plan that is proving effective. The City also participates in and funds regional water planning efforts.

2.2.2 Planning Process and Formulation of Water-Supply Alternatives

Figure 2.1-1 shows a general chronology of the DWP alternatives development and phased evaluation process that the City has used, culminating in the decision to use the City's 48,200-ac-ft/yr of SJC surface water to supplement ground water sources via direct diversion from the Rio Grande, conveyance, and treatment, with subsequent distribution to consumers as drinking water.

The process began in 1995 with the identification of five broad options for the diversion of City SJC water (CH2M Hill, 1995a):

- Diversion at Cochiti Lake, with transmission to Albuquerque through a new pipeline;
- Diversion at the Middle Rio Grande Project Angostura Diversion structure, with transmission to Albuquerque through a new pipeline;
- Diversion using Middle Rio Grande Project facilities (e.g., the Angostura Diversion), with transmission to Albuquerque via existing Middle Rio Grande Project facilities;
- Construction of a new local diversion structure; and
- Construction of local, underground infiltration galleries to divert water from the Rio Grande.

The alternatives evaluation process reflects the advice and counsel of a City Staff Steering Committee (CSSC), with participants from the City Council, the Public Works Department, the Environmental Health Department, the Planning Department, the Department of Finance and Management, and Open Space Division. The process has incorporated advice and comments received from the CSSC at workshops in August and December, 1996, comments from the City Administration, a Customer Advisory Committee (CAC), agency stakeholders, and the general public at two public forums. The review and discussion with stakeholders and the general public occurred during September through December, 1996. The CAC was formed, as called for by the Mayor and authorized by the City Council. The CAC has played a critical role throughout the planning process and continues to provide vital oversight, review and public education assistance.

During the DWP alternatives development phase of the AWRMS, 32 water-supply alternatives were considered, evaluated, and ranked. Based on this analysis, 14 were retained for further analysis. A multi-component alternative was selected and adopted by City Council in the Spring of 1997.

After the WRMS was adopted, additional detailed studies by the interdisciplinary NEPA team led to the development of eight diversion alternatives. From these eight options, three alternatives were selected for evaluation at a public workshop in March, 2000. Three variations were evaluated with each one of the three alternatives for surface water diversion, making nine alternatives. From this group of nine alternatives presented at the public workshop, three action alternatives were developed. These three action alternatives and the No Action Alternative are further evaluated for environmental and socioeconomic effects in Section 3 of this FEIS.

Comments and suggestions received during the process were taken into account, and a preliminary prioritization scheme was refined. In addition, the project team, consisting of the City and its consultants, assessed key uncertainties, such as pending Isleta and federal water-quality stream standards and future revision of the federal arsenic drinking-water standards. Based on a refined analysis, the project team presented its recommended preferred alternative to CSSC at a workshop in December, 1996. Based on CSSC input, a draft water-resources management plan, along with implementation and financing plans, was formulated. The CSSC and City Administration reviewed these plans in January and February, 1997, and the AWRMS (CH2M Hill, 1997a) was submitted to and approved by the City Council in February, 1997. In April, 1997, the Council sponsored a Town Hall meeting to hear additional public input. Broad based support for the proposed Strategy was expressed by a diverse group of speakers representing the Albuquerque Economic Forum, USFWS, the Sierra Club, neighborhood associations, and water-resources experts. The AWRMS was adopted by the Council in April 1997, and signed by the Mayor in May, 1997.

Extensive public involvement is ongoing. Since 1997, in addition to the three public scoping meetings in 1999, the City has conducted numerous other meetings and workshops with the public and other agencies. These have included a 2-day interagency workshop in 1998 attended by USFWS, Reclamation, the Bureau of Indian Affairs, and other agencies; public meetings in 1999 to determine a site location for the proposed water treatment plant; an alternatives-screening public workshop of diversion alternatives in March, 2000; public meetings in the spring of 2001 to help determine a preferred alternative; and a Town Hall meeting in April, 2001 to present the preferred alternative. The City has conducted eighteen interagency meetings since early 1999. There have been numerous meetings to present the AWRMS and its implementing projects, to neighborhood associations, Pueblos, individual agencies, and many others. Public hearings regarding the DEIS were conducted at three locations during September 2002.

2.2.3 Evaluation of Water-Supply Alternatives

Introduction

This was a broad conceptual approach, the primary element of which was the DWP. The keystone of the DWP was to fully and beneficially use the City's SJC water. The City recognized that many technical details remained to be worked out. Accordingly, the AWRMS included an implementation plan that called for additional work to find the best sites for the facilities and to further assess environmental impacts and technical and engineering details of the DWP. To accomplish this directive, the City considered options for the three main components of the DWP: diversion, treatment, and transmission.

The City's formulation of the AWRMS involved identification and evaluation of 32 water supply alternatives. The technical and public process associated with the AWRMS narrowed this field to 14 alternatives based on criteria reflecting environmental, implementation, sustainability and reliability, quality of life, and financial considerations (CH2M Hill, 1997a and 1997b). Alternative concepts originally developed included direct withdrawal of the City's SJC surface water for drinking water, possible aquifer recharge, recycling wastewater, the use of shallow ground water, further development of water conservation measures, and various combinations of concepts.

A thorough evaluation of WTP site options led to the selection of the Chappell Drive site. An evaluation of the options for treated-water transmission led to development of a set of preferred transmission corridors.

The City, working with the public and stakeholders, identified eight diversion alternatives for evaluation. This evaluation resulted in three viable diversion options. These diversion options were then combined with raw-water conveyance options, the WTP site, and treated-water transmission pipelines to formulate nine DWP alternatives. Additional evaluation led to the identification of the three action alternatives.

Development of 32 Water Supply Provisional Alternatives

The original 32 water-supply provisional alternatives were grouped into five general categories for evaluation as preliminary alternatives. These alternatives were screened against five basic criteria (environmental protection, sustainability and reliability of supply [i.e., technical feasibility], implementability, quality of life, and financial support) using specific measures of performance. The evaluation process was completed using mathematical decision-analysis techniques (CH2M Hill, 1997a and 1997b). The 32 alternatives initially considered were grouped as follows:

- Three ground water development options (i.e., ground water alternatives, denoted with a “GW” prefix during the screening evaluation, as summarized in Table 2.2-1);

- Six SJC-water-diversion and aquifer-recharge options (i.e., diversion/recharge alternatives, denoted with a “DR” prefix during the screening evaluation, as summarized in Table 2.2-2);

- Five options involving diversion of the City’s SJC water from the Rio Grande for direct use in the municipal water supply (i.e., diversion/direct-use alternatives, denoted with a “DD” prefix during the screening evaluation, as summarized in Table 2.2-3);

- Eight options involving the recycling of treated wastewater for either non-potable use or aquifer recharge (i.e., recycled-wastewater alternatives, denoted with a “RW” prefix during the screening evaluation, as summarized in Table 2.2-4); and

- Ten multicomponent options that combine concepts from the other four categories (i.e., multicomponent alternatives, denoted with an “MC” prefix during the screening evaluation, as summarized in Table 2.2-5).

Final rankings of conceptual alternatives from this initial phase of evaluation are listed in Tables 2.2-1 through 2.2-5.

TABLE 2.2-1
GROUND WATER DEVELOPMENT ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
GW0: Continued Current Trends	New wellfields and storage reservoirs, pump stations, and transmission lines to be located within Albuquerque's water service area	Baseline case assuming demands continue to increase at current rates	32
GW1: Continued Local Ground Water Development, with Conservation	New wellfields and storage reservoirs, pump stations, and transmission lines to be located within Albuquerque's water service area	Local ground water is likely to be a key element in any future water-resources strategy. This option describes the effects of continued complete reliance on local ground water sources.	31
GW2: Relocation of Ground Water Pumping	Construct a new wellfield and water-transmission facilities outside the local water service area to deliver 47,000 ac-ft/yr of the City's SJC water to Albuquerque	Would slow the local decline in ground water levels and increase Rio Grande stream-flow depletion, which could be offset by use of the City's SJC water	24

Ground water use alternatives ranked very low because continued exclusive or primary reliance on ground water, even with new wellfields, would not improve or stabilize the water supply, as required under the AWRMS. Subsidence, increased energy costs, and increasing water-quality problems also are likely under these three alternatives.

Among the SJC water diversion/aquifer recharge alternatives (Table 2.2-2), DR4 ranked fifth overall among the 32 original provisional alternatives. The infiltration-gallery approach for diverting water from the Rio Grande initially appeared promising, but was ultimately rejected as subsequent technical and environmental evaluation showed this technique would cause substantial adverse effects on bosque areas, could be difficult to construct, and has some hydrologic parameters that make it less technically feasible than originally thought.

TABLE 2.2-2
DIVERSION AND RECHARGE ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
DR1: Injection of SJC Water	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande using existing MRG Project facilities, treat to appropriate standards, and inject into the aquifer	Would use SJC water to recharge the aquifer, thereby restoring ground water levels and allowing continued use of local ground water with fewer negative impacts	18
DR2: Aquifer Storage and Recovery of SJC Water	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande with existing facilities and treat to drinking-water standards; inject "excess" capacity into the aquifer using existing wells; recover stored water via pumping wells to meet peak demands	Would use SJC water to recharge the aquifer, thereby restoring ground water levels and allowing continued use of local ground water with fewer negative impacts	12
DR3: Spreading Basins Recharge	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande near Albuquerque, pump to spreading basins for aquifer recharge	Would expedite use of SJC water to recharge the aquifer, thereby restoring ground water levels and allowing continued use of local ground water with fewer negative impacts	19
DR4: Aquifer Storage and Recovery (ASR)/ Infiltration	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande near Albuquerque using an infiltration gallery, and treat to drinking-water standards; inject "excess" water capacity into the aquifer using existing wells; recover stored water via pumping wells to meet peak demands	Would expedite use of SJC water to recharge the aquifer, thereby restoring ground water levels and allowing continued use of local ground water with fewer negative impacts; infiltration gallery potentially would have fewer adverse environmental effects than surface water diversion, and some treatment advantages	5
DR5: Enhanced Surface Recharge	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande using existing MRG Project facilities to transmit to treatment facility (filtration), then to spreading basins and Tijeras Arroyo; modify river-side drain check gates to enhance ground water recharge; maintain winter flows in highline canal using interior drains	Would maximize surface recharge of the aquifer with modest structural components	20

TABLE 2.2-2 (Continued)
DIVERSION AND RECHARGE ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
DR6: Enhanced Surface Recharge and Recreation	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande using existing MRG Project facilities to transmit to treatment facility (filtration), then to spreading basins and Tijeras Arroyo; modify river-side drain check gates to enhance ground water recharge, maintain winter flows in highline canal, interior drains, construct a river walk	Same as DR5 (effort to maximize surface recharge with modest structural components) plus a recreational river-walk component	21

TABLE 2.2-3
DIVERSION AND DIRECT-USE ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
DD1: Direct Use of SJC Water	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande using infiltration galleries near Albuquerque, treat to drinking-water standards, and distribute throughout the City	Would put SJC water to early use, and reduce local pumping, thereby reducing the difference between aquifer withdrawals and recharge	7
DD2: Direct Use of SJC Water — MRGCD Delivery	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande using existing MRG Project facilities, treat to drinking-water standards, and distribute throughout the City	Similar to DD1, but potentially would require fewer new facilities	11
DD3: Direct Use of SJC and Rio Grande Water	Divert 94,000 ac-ft/yr (84 mgd) of the City's SJC and native water from the Rio Grande using local infiltration galleries, treat to drinking-water standards, and distribute citywide	Assumes 50 percent of the diverted volume (47,000 ac-ft/yr) would be returned to river as treated effluent, for a net consumptive use of 47,000 ac-ft/yr	6

TABLE 2.2-3 (Continued)
DIVERSION AND DIRECT-USE ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
DD4: Direct use of SJC (Modular Treatment)	Divert 47,000 ac-ft/yr of the City's SJC water from the Rio Grande using MRGProjectfacilities, treat to drinking-water standards using two water treatment plants, one on each side of the river, and distribute throughout the City	Similar to DD2, but would use two water treatment plants to avoid the need for river crossings	9
DD5: Maximize Surface Water Use	Divert 112,000 ac-ft/yr of the City's SJC and native Rio Grande water using local infiltration galleries, treat to drinking-water standards, and supply citywide	Assumes return-flow calculation and existing water rights would allow diversion of greater amounts of surface water	10

TABLE 2.2-4
RECLAIMED WASTEWATER ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
RW1: Reclamation and Recharge—SWRP and West Side	Inject 33,600 ac-ft/yr of treated effluent from the SWRP into mid-aquifer injection zone; reclaim and recharge Intel's treated wastewater (5,000 ac-ft/yr) on the west side of the Rio Grande	Would use treated effluent to maintain ground water levels; minimizes National Pollutant Discharge Elimination System (NPDES) compliance concerns; the City's SJC water would be used directly to offset reduced effluent discharge levels	23
RW2: Reclamation and Recharge—Zero Discharge (Scenario 2)	Inject 85,000 ac-ft/yr of treated effluent from the SWRP into north and mid-aquifer injection zones	Would use the full capacity of the SWRP to recharge the aquifer; recharge would be distributed over a wider area than under RW1	25
RW3: Reclamation and Recharge (Scenario 3)	Inject 33,600 ac-ft/yr of treated effluent into mid-aquifer injection zone	Would recharge the aquifer in the amount of the City's currently unencumbered SJC water	22
RW4: Non-potable Reuse—Citywide	Provide enhanced effluent treatment of 10,000 ac-ft/yr and distribute through secondary water-distribution system to large turf and industrial user	Would reuse wastewater at potentially lower costs than the reclamation/recharge options	28

TABLE 2.2-4 (Continued)
RECLAIMED WASTEWATER ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
RW5: Focused Non-potable Reuse	Provide enhanced effluent treatment of about 1,800 ac-ft/yr and distribute through secondary water-distribution system to non-potable users in the south area, including golf courses, parks, and schools; provide enhanced effluent treatment of about 900 ac-ft/yr of industrial wastewater from the North I-25 area for nearby non-potable industrial reuse and landscape irrigation, including Balloon Fiesta Park; provide reclamation of Intel's wastewater for irrigation on the west side	A more limited option for reusing wastewater, but focusing on more cost-effective components	27
RW6: Focused Non-potable Reuse—Constructed Wetlands	Provide enhanced effluent treatment of about 3,900 ac-ft/yr using constructed wetlands and distribute to south area of City, including golf courses, parks, schools, and Journal Pavilion; provide enhanced effluent treatment of about 900 ac-ft/yr of industrial wastewater from the North I-25 area for nearby non-potable uses, including Balloon Fiesta Park; provide reclamation of Intel's wastewater for irrigation on the west side	Similar to RW5, but would use constructed wetlands in place of tertiary filtration for the reclaimed water	29
RW7: Constructed Wetlands	Provide constructed wetlands to polish the wastewater treatment effluent prior to discharge. In addition, construct wetlands at the north and south discharge points of the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) canals to capture wet-weather flows and minimize non-point source pollution	Wetlands would have the potential to enhance the quality of the discharged reclaimed water and enhance wildlife habitat; wetlands could provide benefits similar to those associated with recharge of stormwater flows	26

TABLE 2.2-4 (Continued)
RECLAIMED WASTEWATER ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
RW8: Distributed Wastewater Treatment Facilities for Reclamation	Construct small wastewater treatment facilities at strategic locations for the purpose of providing reclaimed water for the Ladera, Arroyo del Oso, and Los Altos golf courses; in addition, the SWRP would provide reclaimed water for irrigation in the south area of the City, including Journal Pavilion, and provide enhanced effluent treatment of about 900 ac-ft/yr of industrial wastewater from the North I-25 area for nearby non-potable uses, including Balloon Fiesta Park	Use of small, localized wastewater treatment plants would avoid the costs of pumping reclaimed water to users far removed from the SWRP	30

TABLE 2.2-5
MULTICOMPONENT ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
MC1: Direct Use with ASR, Valley Recharge Enhancements and Modified Non- potable Reuse	Divert 94,000 ac-ft/yr of the City's SJC and Rio Grande water from the Rio Grande for direct use and ASR using existing MRG Project facilities; reuse about 3,900 ac-ft/yr for southern parks and golf courses and about 900 ac-ft/yr for industrial reuse (Northeast Heights); work with MRGCD to implement valley recharge enhancements	Would combine direct-use features of DR2 and DD3 with more cost-effective non-potable reuse option	8
MC2: Direct Use and Modified Non-potable Reuse	Divert 94,000 ac-ft/yr of SJC and Rio Grande water from the Rio Grande using infiltration galleries near Albuquerque, treat to drinking-water standards, and supply areas throughout the City; reuse about 3,900 ac-ft/yr for south City turf irrigation and Journal Pavilion, and about 900 ac-ft/yr for industrial reuse in the north I-25 corridor	Would combine direct-use features of DD3 with modified, non-potable aspects of MC1	4

TABLE 2.2-5 (Continued)
MULTICOMPONENT ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
MC3: Direct Use of the City's SJC Water, Direct Non-potable Use of Surface Water	Divert 94,000 ac-ft/yr of the City's SJC and Rio Grande water from the Rio Grande using MRG Project facilities, treat to drinking-water standards, and supply areas throughout the City; divert an additional 2,100 ac-ft/yr for non-potable uses	Would combine the direct uses of DD3 with non-potable use of surface water to reduce treatment needs and offset demands on higher-quality deep aquifer	16
MC4: Direct Use of the City's SJC Water, Direct Non-potable Use of Shallow Ground Water	Divert 94,000 ac-ft/yr of the City's SJC and Rio Grande water from the Rio Grande using MRG Project facilities, treat to drinking-water standards, and supply areas throughout the City; produce about 6,000 ac-ft/yr of shallow ground water and provide for non-potable uses	Would combine the direct uses of DD3 with non-potable use of poorer-quality ground water to offset demands on higher-quality aquifer; shallow ground water system would become the "distribution" system, allowing a greater feasible service area	17
MC5: Direct Use of the City's SJC Water, ASR, Modified Non-potable Reuse	Divert 94,000 ac-ft/yr of the City's SJC and Rio Grande water from the Rio Grande using infiltration galleries near Albuquerque, treat to drinking-water standards, and supply areas throughout the City; include capacity for diversion (and aquifer storage) of up to an additional 47,000 ac-ft/yr; reuse about 3,900 ac-ft/yr for south City turf irrigation and about 900 ac-ft/yr for industrial reuse	Similar to MC1, but without the surface recharge component	2
MC6: Direct Use of the City's SJC Water, West-Side Recharge and Remediation	Divert 94,000 ac-ft/yr of the City's SJC and Rio Grande water from the Rio Grande using MRG Project facilities, treat to drinking-water standards, and supply areas throughout the City; integrate a pump-and-treat system for Coors Road ground water contamination into west-side supply needs; divert and recharge about 7,800 ac-ft/yr of surface water through the Calabacillas Arroyo recharge window	Would combine direct-use elements of DD3 with components designed to deal with west-side ground water contamination and aquifer draw downs	14

TABLE 2.2-5 (Continued)
MULTICOMPONENT ALTERNATIVES

Alternative	Description	Explanation	Final Ranking
MC7: Direct Use and Focused Non-potable Reuse with Constructed Wetlands	Divert 94,000 ac-ft/yr of the City's SJC and Rio Grande water from the Rio Grande using infiltration galleries near Albuquerque, treat to drinking-water standards, and supply areas throughout the City; treat SWRP effluent using constructed wetlands, and reuse for southern turf irrigation and industrial reuse	Same as MC2, but constructed wetlands are used to treat SWRP effluent	3
MC8: Direct Use of the City's SJC Water with Recharge	Divert 112,000 ac-ft/yr of SJC and Rio Grande water from the Rio Grande using MRG Project facilities, treat 103,000 ac-ft/yr to drinking-water standards, and supply areas throughout the City; work with MRGCD to enhance valley recharge with 9,000 ac-ft/yr	Adds enhanced valley-recharge component to direct uses of DD5	15
MC9: Direct Use and Focused Non-potable Reuse with Constructed Wetlands, ASR, Shallow Ground Water and Surface Water for Non-potable Irrigation	Divert 97,000 ac-ft/yr of the City's SJC and Rio Grande water from the Rio Grande using infiltration galleries, treat 94,000 ac-ft/yr to drinking-water standards, and supply areas throughout the City; retrofit 2 or 3 wellfields with ASR capability; work with MRGCD to enhance valley recharge; treat with constructed wetlands, and combine with about 1,900 ac-ft/yr of surface water for reuse for turf irrigation in the south and industrial reuse in the north	Small-project components are potentially more flexible and effective; an ASR component would be included, but would not be a principal emphasis	1
MC10: Direct Use of the City's SJC Water and Calabacillas Arroyo Recharge	Divert 94,000 ac-ft/yr of the City's SJC and Rio Grande water using infiltration galleries, treat to drinking-water standards, supply throughout the City; divert about 7,800 ac-ft/yr of surface water and recharge ground water through the Calabacillas Arroyo recharge window	Calabacillas Arroyo is potentially the best surface recharge opportunity	13

The alternatives calling for diversion and direct use of the City's SJC water via existing Middle Rio Grande Project facilities also were ranked fairly high in the screening evaluation (Table 2.2-3).

The reclaimed wastewater alternatives (Table 2.2-4) were ranked low because of environmental difficulties, poor public perception, financial consideration and regulatory issues. The use of reclaimed water is a component of the AWRMS, and the City has completed one recycling project and is designing and constructing two non-potable water reclamation projects to promote conjunctive use of available water resources. The ground water injection and wastewater-reuse alternatives were not as feasible as other alternatives, based on the five evaluation criteria.

Alternatives with multiple components or combinations of technologies and methods (Table 2.2-5) generally ranked higher than other alternatives in the preliminary evaluation. This is a reflection of the ability of these alternatives to meet more than one AWRMS objective while pursuing conjunctive use of available water resources.

Evaluation of 14 Alternatives Retained for Further Analysis

Fourteen alternatives were retained for further analysis from the evaluative phase set forth in Section 2.2.3: DR4, DD1, DD3 and DD5, and MC1 through MC10 (CH2M Hill, 1997b).

The 14 alternatives were further evaluated based on refined reliability and sustainability measures, environmental and financial performance, and implementability. All 14 alternatives scored well in the environmental performance area. Implementability scores favored the lower-volume diversion alternatives DD1 and DR4, but multicomponent alternatives MC7 and MC9 also scored well in this area.

The large-volume diversion alternatives scored highest in the sustainability and reliability category. They also scored high on the quality-of-life scale, especially with regard to socioeconomic benefits. The smaller, low-volume diversion alternatives scored higher than the larger projects with regard to project cost, although the cost range was not very great. Alternative MC9, on balance, best met the objectives of the City. It was the highest ranking alternative under all criteria except cost, and even in this category scored better than most of the other 14 alternatives.

Based on evaluations to this point, it was clear the City should undertake a large-volume, surface water diversion project that adds the City's SJC water to the municipal supply. The overall desirability of this solution was enhanced by inclusion of small-scale recycling and other small-project components. Because it ranked highest under the criteria used for the study and initial evaluations from 32 to 14 alternatives, and then under the more precise performance criteria, the MC9 alternative was adopted. The recommended strategy, using alternative MC9, comprised the following elements (Table 2.2-5):

- A drinking-water supply project that diverts, treats, and distributes 97,000 ac-ft/yr of water from the Rio Grande, making full use of the surface water supplies the City already owns. About half of the diverted volume would be returned to the Rio Grande.

- About 8 miles of subsurface infiltration galleries as the means for diverting water from the Rio Grande.

- A water treatment plant to treat the diverted raw water to meet drinking-water standards.

- Transmission pipelines to carry the water to users throughout the City's service area.

2.3 FORMULATION AND SELECTION OF ACTION ALTERNATIVES

2.3.1 Formulation of Treatment-Plant Site Alternatives

Under all diversion/direct-use alternatives, a new WTP would be used to treat surface water diverted from the Rio Grande to comply with federal and state water quality criteria for municipal drinking water uses. The treatment plant site must be large enough to accommodate construction and operation of the treatment plant. Based on previous experience and a review of projects with similar requirements, the project team determined that a land area of approximately 110 acres would be needed for the WTP site.

Initially, 18 potential WTP sites in the Albuquerque area were identified for consideration. Two sites were eliminated from consideration by the project team during screening activities because of their remoteness from the population center. Also, several sites initially identified were not large enough to meet the land-use requirements. Evaluation of the remaining plant sites considered environmental, public acceptability, technical feasibility, cost, and implementability criteria. This initial screening narrowed the sites to four sites that scored better than the other sites. These four sites are identified on Figure 2.3-1 as Site P–Chappell Drive Site, Site D–Barr Canal Site, Site O–Coors and Montaño Site, and Site C–Southwest Valley Site. The Chappell Drive Site scored above all other sites under the environmental, public acceptability, technical feasibility, and implementability evaluation criteria. The Chappell Drive Site also scored well under the cost criterion, with costs only slightly higher than those of the Barr Canal Site. Based on results of the evaluation and input received at public meetings, the Chappell Drive Site was selected as the preferred location for the WTP.

2.3.2 Formulation of Potable-Water Transmission Alternatives

Under all diversion/direct-use alternatives, new pipelines would be required to deliver treated potable water from the new WTP to customers in the Albuquerque metropolitan area. Once the Chappell Drive site was selected as the location of the proposed WTP, studies were undertaken to identify six potential pipeline alignments for the transmission of treated water from the WTP to the existing potable water distribution system. Three pipeline alignments for the West Side distribution system (west of the Rio Grande) and three pipeline alignments for the East Side distribution system (east of the Rio Grande) were identified.

The final proposed alignment was modified based upon *Drinking Water Project Conceptual Design Report* (CH2M Hill, 2001c). The City's existing water distribution system consists of a series of major trunk lines that transport ground water from higher-elevation to lower-elevation pressure zones. The trunks generally are arrayed in an east/west alignment. The proposed new transmission corridors were selected to permit the optimum use of existing hydraulic gradients and in-place City water lines. The new water-transmission pipeline to serve the west side would cross the Rio Grande near Campbell Road.

2.3.3 Formulation of Diversion/Conveyance Alternatives

Options considered for diverting the City's SJC water from the Rio Grande included the use of a new diversion structure, existing Middle Rio Grande Project diversion structures, existing dams, and new subsurface infiltration structures. Locations along the river that were considered for these diversion structures ranged from Cochiti Reservoir, upstream from Albuquerque, downstream to the Isleta diversion structure. Diversion refers to withdrawing raw water from the river, and conveyance refers to the pumping of this water from the point of diversion to a WTP site. The raw-water diversion and conveyance facilities would divert the City's SJC water from the Rio Grande and transport the water to a proposed water treatment facility. Concurrent with the evaluation of WTP sites, an initial evaluation of a series of diversion/conveyance concepts was undertaken for the DWP (CH2M Hill, 1995b). This evaluation considered environmental, technical, financial, and socioeconomic factors.

Eight diversion/conveyance alternatives were identified for evaluation (CH2M Hill, 2000a). Three alternatives involved diversion of surface-water using existing irrigation diversion dams; one alternative was based on construction of a new diversion dam; and four alternatives were based on subsurface (underground) diversion alternatives involving infiltration galleries or collector-well systems. In addition to river-water diversion facilities, each of these concepts included a means of conveying water from the river to the Chappell Drive WTP site. The required hydraulic capacity of each conceptual diversion/conveyance system was assumed to be 92 mgd (CH2M Hill, 2000a). The eight raw-water diversion and conveyance alternatives considered in the initial evaluation are set forth in Table 2.3-1.

TABLE 2.3-1
RAW WATER DIVERSION AND CONVEYANCE ALTERNATIVES

1. Angostura Dam	Diversion of raw water from the Rio Grande at the existing MRG Project's Angostura Diversion dam about 5 miles upstream from the Town of Bernalillo; conveyance to Albuquerque through the existing Albuquerque Main Canal and on to the Chappell Drive water treatment plant site. One of the three diversion/conveyance alternatives evaluated in this FEIS would use the existing Angostura Diversion structure. This conceptual diversion/conveyance system, combined with the Chappell Drive treatment plant site, was retained for detailed analysis, as described in Section 2.5.1.

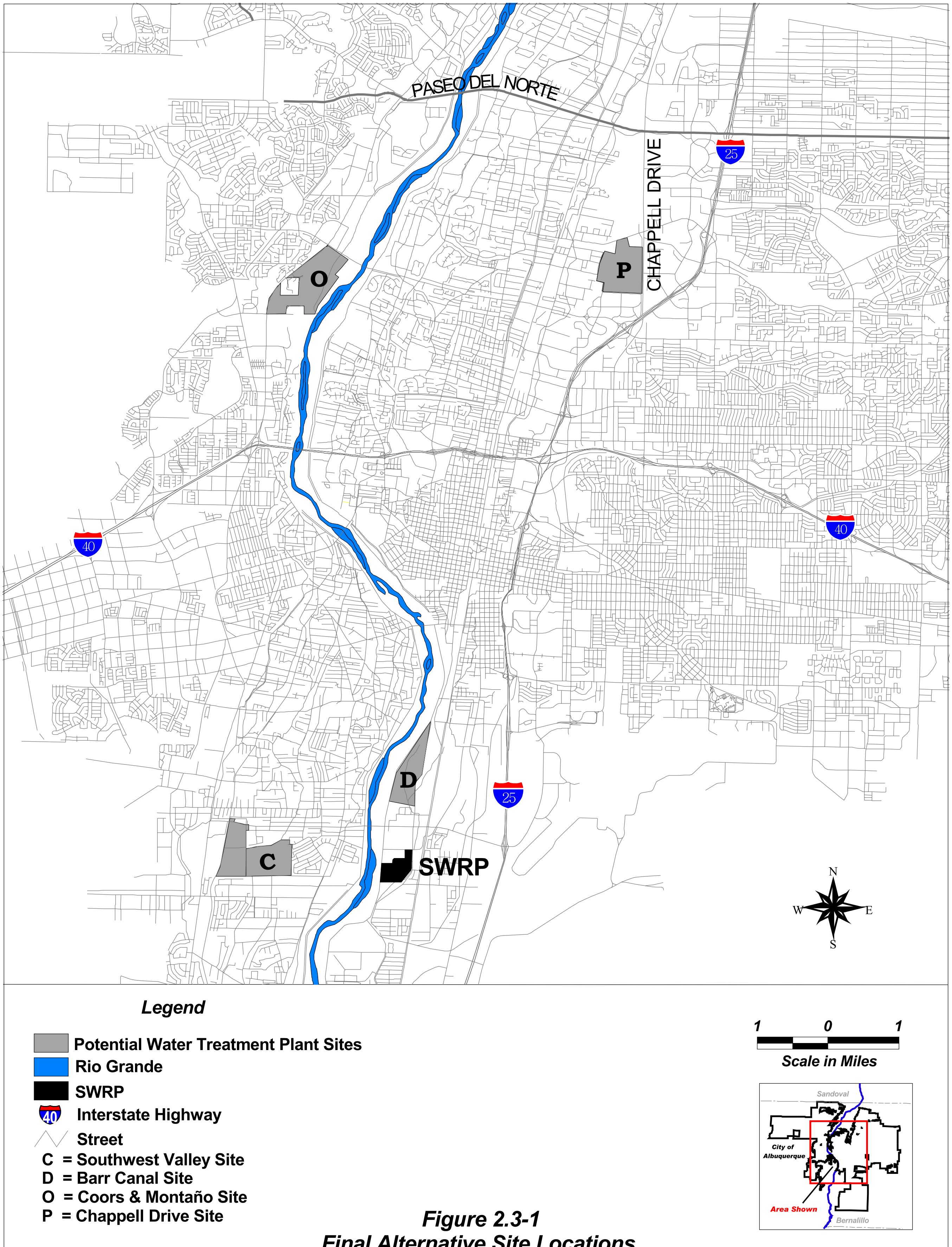

Figure 2.3-1
Final Alternative Site Locations for Water Treatment Plant

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TABLE 2.3-1 (Continued)
RAW WATER DIVERSION AND CONVEYANCE ALTERNATIVES

2. Atrisco Header	Reconstruction and operations of the abandoned Atrisco header (dam) diversion on the Rio Grande just north of Central Avenue in Albuquerque; conveyance would be via a new pipeline to a water treatment plant in the Southwest Valley. This diversion concept was eliminated as infeasible due to sedimentation problems and public opposition to a water treatment plant in the South Valley of Albuquerque. This MRG Project feature was abandoned when the Corrales Siphon was built.
3. Isleta Dam	Diversion at the existing MRG Project's Isleta diversion dam about 10 miles downstream from Albuquerque; conveyance to an Albuquerque water treatment plant would be via a new pipeline. This diversion concept was eliminated from detailed analysis because of the distance between the river diversion point and the water treatment plant sites (especially the preferred Chappell Drive site), which would result in high pumping and transmission-line construction costs. This diversion concept was eliminated as infeasible due to sedimentation problems and public opposition to a water treatment plant in the South Valley of Albuquerque.
4. New Dam	Diversion by means of a new low-head, adjustable-height dam to be constructed on the Rio Grande in the Albuquerque reach; conveyance would be by new buried pipeline to the Southwest Valley, Coors, Barr, Montaño, or Chappell Drive water treatment plant site (see Section 2.3.1). This conceptual diversion/conveyance system, combined with the Chappell Drive treatment plant site, was retained for detailed analysis, as described in Section 2.5.2.
5. Riverside Infiltration Gallery	Diversion using a subsurface infiltration gallery (up to 8 miles in length) located along the riverside drain-collector road, parallel to the river; conveyance would be by new pipeline. This diversion concept was eliminated because of construction and dewatering difficulties and possible impacts on riverside drain flows and the bosque and on the integrity of the flood-control levee.

TABLE 2.3-1 (Continued)
RAW WATER DIVERSION AND CONVEYANCE ALTERNATIVES

6. Radial-Collector Wells	Diversion using subsurface (underground) riverside radial-collector ('Ranney-type') horizontal wells extending beneath the riverbed from the floodplain; conveyance would be via new pipeline to the Southwest Valley, Coors, Barr, Montaño, or Chappell Drive water treatment plant site. Conceptual systems that relied on this diversion method were eliminated based on a screening analysis and public input.
7. Horizontal 'In-River' Collectors	Subsurface diversion using slotted collector pipes in trenches backfilled with gravel; the collectors would be buried beneath the riverbed; conveyance would be by pipeline to the Southwest Valley, Coors, Barr, Montaño, or Chappell Drive sites. This conceptual diversion/conveyance system, combined with the Chappell Drive treatment plant site, was retained for detailed analysis, as described in Section 2.5.3.
8. Horizontal Directional-Drilled Collectors	Subsurface diversion using slotted pipes installed in boreholes directionally drilled beneath the river; conveyance via new pipeline to the Southwest Valley, Coors, Barr, Montaño, or Chappell Drive water treatment plant site. Options relying on this method of diversion were eliminated due to high cost, construction difficulties, and the likelihood of insufficient yield.

2.3.4 Evaluation and Selection of Action Alternatives

Preliminary studies, public and agency input reduced the eight initially considered diversion/conveyance alternatives to four: Angostura Dam with Main Canal conveyance; a new adjustable-height dam with pipeline conveyance; radial collector wells with pipeline conveyance; and horizontal in-river collectors with pipeline conveyance.

Further evaluation led to grouping of the radial and horizontal in-river collector concepts, expansion of the Angostura Dam and new adjustable-height dam diversion options to include several new conveyance methods. Conceptual features also were added to include pumping of reclaimed wastewater from the SWRP to a discharge point just downstream from the proposed diversion locations to reduce the length of the river in the intervening reach between the point of diversion and the SWRP outfall that would experience depleted river flows. However, wastewater augmentation was not added to the Angostura Diversion alternatives because of the cost of a pump station and the nearly 25 miles of pipeline required. These facilities could add as much as $90 million to this alternative. Construction effects upon Kellner jetty jack fields will be coordinated with USACE and Reclamation for approval.

The nine diversion/conveyance alternatives that were formulated and evaluated in the public process are set forth in Table 2.3-2

TABLE 2.3-2
PUBLIC PROCESS DIVERSION/CONVEYANCE ALTERNATIVES

A-1—Angostura Diversion—Albuquerque Main Canal Conveyance	This alternative would involve enlarging and improving approximately 14 miles of MRG Project's Albuquerque Main Canal for conveyance of river water to a new pump station, to be located near the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) North Diversion Channel (NDC). Necessary permission and applicable permits from the Sandia Pueblo would also be required. A considerable reach of the improved Main Canal would be located on Sandia Pueblo land. Some of the diversion and canal improvements also would be on San Felipe and Santa Ana Pueblo lands. From the pump station, diverted water would be conveyed about 5 miles within the NDC ROW in a 72-inch-diameter pipe to the proposed Chappell Drive WTP site.
A-2—Angostura Diversion—Pipeline Conveyance	For this alternative, a pump station would be constructed adjacent to the Angostura Dam to convey river water in a 78-inch-diameter pipeline (primarily along New Mexico State Highway 313 ROW) approximately 14 miles through the Bernalillo area and Sandia Pueblo lands, then about 5 miles within the NDC ROW to the proposed Chappell Drive WTP site. Some of the diversion/conveyance facilities near Angostura would be located on lands of the San Felipe and Santa Ana Pueblos.
A-3—Angostura Diversion—Dual-Canal Conveyance	This alternative is similar to Alternative A-1, except that both the Main Canal and the Albuquerque Riverside Drain (also known as the Atrisco Feeder) would be used for conveyance. Improvements to the Riverside Drain would involve reshaping and enlarging in some reaches, removing vegetation, improving access roads, and improving hydraulic structures. From a pump station to be constructed in the vicinity of the NDC, (necessary permission and applicable permits from the Sandia Pueblo would also be required), water collected from the Main Canal and Riverside Drain would be conveyed about 5 miles within the NDC ROW in up to a 72-inch-diameter pipe to the proposed Chappell Drive WTP site.

TABLE 2.3-2 (Continued)
PUBLIC PROCESS DIVERSION/CONVEYANCE ALTERNATIVES

B-1—New Surface Diversion North of Alameda Bridge	This alternative would involve construction of a low-head, adjustable-height dam and pump station north of Alameda Bridge. A 72-inch-diameter conveyance pipeline would be built approximately 0.5 miles south along the drain road to Alameda Boulevard, then east about 2.5 miles along Alameda to the NDC, then south about 2.5 miles within the NDC ROW to the proposed WTP at Chappell Drive.
B-2—New Surface Diversion North of Alameda Bridge—Wastewater Augmentation	This alternative is the same as Alternative B-1 except that treated wastewater would be pumped approximately 15 miles from the wastewater treatment plant south of Rio Bravo Boulevard in a 54-inch pipeline to a point just below the dam. The treated wastewater would be discharged to the river to help maintain flows in the river reach between Alameda and Rio Bravo. The route of the treated wastewater pipeline has tentatively been selected along Rio Bravo east to Broadway, then north along Broadway and Edith to Alameda, then west along Alameda to a discharge point below the dam.
B-3—New Surface Diversion South of the Rio Bravo Bridge	This alternative would involve construction of a low-head (about 4 to 5 feet in height), adjustable-height dam and a pump station north of the Rio Bravo Bridge. A 78-inch-diameter pipeline also would be built to convey river water approximately 0.5 mile south along the levee to Rio Bravo Boulevard, then east along Rio Bravo to Broadway, north along Broadway and Edith to Osuna, east along Osuna to Chappell Drive, then south to the WTP site on Chappell Drive.

TABLE 2.3-2 (Continued)
PUBLIC PROCESS DIVERSION/CONVEYANCE ALTERNATIVES

C-1—Radial Collector Wells between Montaño Bridge and North Diversion Channel	This alternative would involve construction of approximately 30 Ranney-type radial collector wells and pump stations over a 5.5-mile reach of the Rio Grande north and south of Paseo del Norte Bridge along both sides of the river. Pumps located at each of the radial wells would pump the water through conveyance pipelines constructed along the Albuquerque and Corrales Riverside Drain access roads, located on the east and west sides of the river, respectively. An under-river pipeline would convey water from the west-side collectors to the east side near Paseo del Norte Bridge. A 72-inch-diameter pipeline would then convey the water approximately 5.5 miles, first east along Paseo del Norte, then south along the NDC ROW to the Chappell Drive WTP site.
C-2—Horizontal Collectors North of Alameda Bridge	This alternative would involve the construction of a horizontal collector system using slotted pipes (or well screen) buried 25 feet beneath the riverbed in trenches oriented perpendicular to the riverbank. The pipe trenches would be backfilled with gravel, and would extend about 500 feet into and beneath the active river channel. Three collector systems would be constructed along a 1.5-mile reach of the river north of the Alameda Bridge. Each of the three systems would have 11 ‘arms’ of 20-inch-diameter slotted pipes manifolded to a common header connected to a pump station. From the pump stations, water would be pumped south in a 72-inch-diameter pipeline along the Albuquerque Riverside Drain access road to Alameda Boulevard, then east on Alameda approximately 2.5 miles to the NDC, then south about 2.5 miles within the NDC ROW to the proposed Chappell Drive WTP site.
C-3—Horizontal Collectors North of Alameda Bridge—Wastewater Augmentation	This alternative is similar to Alternative C-2, but includes pumping reclaimed wastewater approximately 15 miles from the wastewater treatment plant at Rio Bravo in a 54-inch pipeline to a point just below the collector systems. The treated wastewater would be discharged to the river to help maintain flows in the river reach between the point of collection at Alameda and the wastewater treatment plant outfall at Rio Bravo. The route of the reclaimed wastewater pipeline has tentatively been selected along Rio Bravo east to Broadway, north along Broadway and Edith to Alameda, then west along Alameda to a point downstream from the southernmost collector system.

Table 2.3-3 shows sensitivity analysis screening summary scores for the nine diversion alternatives. The analysis varied the weights of objectives to obtain ranking of the nine alternatives. The analysis was used to compare alternatives with differing emphasis placed on each objective. Table 2.3-4 gives the overall summary of the weighted evaluation scores used to evaluate the nine diversion alternatives. General screening and methodology, relative importance of general criteria and performance measures, scoring methods, sensitivity analysis and recommendations are detailed in *Summary of Drinking Water Project Alternatives Planning and Screening* (CH2M Hill, 2001b). Comments received at the workshop are documented in the *Report on the City of Albuquerque Drinking Water Projects Alternatives Screening Workshop* (The Hirst Company, 2000).

Alternative A-3 (Angostura Diversion – Dual Canal Conveyance) typically had the best overall score, followed by Alternatives B-1 (New Surface Diversion North of Alameda Bridge), A-1 (Angostura Diversion – Albuquerque Main Canal Conveyance), and C-2 (Horizontal Collectors North of Alameda Bridge).

Alternative A-2 (Angostura Diversion – Pipeline Conveyance) ranked slightly higher than Alternative C-2 (Horizontal Collectors North of Alameda Bridge) when emphasis was placed on quality of life, but ranked below Alternative C-2 when emphasis was placed on the team weighting, environmental protection, implementability, technical feasibility/reliability, financial considerations, and equal weights.

Alternative A-1 (Angostura Diversion – Albuquerque Main Canal Conveyance) includes many of the same advantages as Alternative A-3 (Angostura Diversion – Dual Canal Conveyance). However, upon reviewing the features and final ranking of the alternatives, the project team concluded that Alternative A-1 should be considered a variation of Alternative A-3 rather than a separate alternative because Alternative A-3 included an evaluation of both the Albuquerque Main Canal (the A-1 conveyance) and the Riverside Drain (Atrisco Feeder). Therefore, Alternative A-1 was not evaluated as a separate alternative in the NEPA process.

Following the alternatives evaluation workshop, additional analysis was undertaken regarding a new surface diversion dam and subsurface horizontal collectors. Alternatives evaluated included locations near Alameda, Paseo del Norte, and Montaño. The alternatives were evaluated using environmental, technical feasibility, implementability, and quality of life criteria. As a result of this option the Paseo del Norte site was selected (CH2M Hill, 2001b).

Based on the evaluations by the project team, the following alternatives were carried forward as the "action alternatives" for detailed evaluation in this FEIS, in accordance with NEPA.

2.4 NO ACTION ALTERNATIVE

The No Action Alternative serves as the conditions against which action alternatives can be evaluated. The No Action Alternative is a prediction of conditions that could

TABLE 2.3-3
SENSITIVITY ANALYSIS

EMPHASIS PLACED ON:

Objective	Team Weights	Equal Weights	Environmental Protection	Technical Feasibility/ Reliability	Implementability	Quality Of Life	Financial Considerations
Environmental Protection	20%	20%	40%	15%	15%	15%	15%
Technical Feasibility	20%	20%	15%	40%	15%	15%	15%
Implementability	25%	20%	15%	15%	40%	15%	15%
Quality of Life	15%	20%	15%	15%	15%	40%	15%
Financial Considerations	20%	20%	15%	15%	15%	15%	40%

Alternative Scores by Weighting Category (0 = Worst, 1 = Best)

Rank	Team Weights		Equal Weights		Environmental Protection		Technical Feasibility/ Reliability		Implementability		Quality Of Life		Financial Considerations	
1	A-3	0.621	A-3	0.623	A-3	0.596	B-1	0.623	A-3	0.611	A-3	0.622	B-1	0.707
2	B-1	0.605	B-1	0.609	B-1	0.577	A-3	0.582	A-1	0.575	A-1	0.581	A-3	0.705
3	A-1	0.568	A-1	0.570	A-1	0.556	A-1	0.521	B-1	0.560	B-1	0.578	A-1	0.615
4	C-2	0.498	C-2	0.496	C-2	0.489	C-2	0.482	C-2	0.465	A-2	0.474	C-2	0.591
5	A-2	0.431	A-2	0.443	A-2	0.457	A-2	0.478	A-2	0.417	C-2	0.456	B-3	0.402
6	B-3	0.422	B-3	0.428	B-3	0.447	B-3	0.446	B-3	0.408	B-3	0.438	A-2	0.388
7	B-2	0.354	B-2	0.358	B-2	0.384	B-2	0.383	B-2	0.339	B-2	0.361	B-2	0.325
8	C-3	0.276	C-3	0.274	C-3	0.324	C-3	0.278	C-1	0.280	C-3	0.259	C-3	0.236
9	C-1	0.259	C-1	0.248	C-1	0.292	C-1	0.259	C-3	0.270	C-1	0.223	C-1	0.186

TABLE 2.3-4
OVERALL SUMMARY OF WEIGHTED EVALUATION SCORES

(0=worst, 1=best)

General Criteria	Alternatives								
Performance Measures	**A-1**	**A-2**	**A-3**	**B-1**	**B-2**	**B-3**	**C-1**	**C-2**	**C-3**
Environmental Protection									
Biological Resources	0.062	0.057	0.062	0.044	0.046	0.046	0.037	0.041	0.045
Cultural Resources	0.021	0.024	0.021	0.032	0.026	0.034	0.028	0.032	0.030
Historical and Current Land Uses	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Subtotal	0.103	0.100	0.103	0.096	0.092	0.101	0.084	0.093	0.095
Technical Feasibility/Reliability									
Constructability	0.025	0.042	0.042	0.050	0.025	0.025	0.008	0.029	0.008
Water Quality	0.017	0.033	0.017	0.033	0.033	0.033	0.050	0.050	0.050
Operational Reliability	0.033	0.042	0.033	0.050	0.033	0.042	0.000	0.008	0.000
Subtotal	0.075	0.117	0.092	0.133	0.092	0.100	0.058	0.088	0.058
Implementability									
Permitting & Agency Coordination	0.085	0.085	0.081	0.083	0.071	0.087	0.073	0.072	0.064
Public Support	0.063	0.000	0.063	0.021	0.000	0.000	0.021	0.021	0.000
Subtotal	0.148	0.085	0.144	0.103	0.071	0.087	0.094	0.093	0.064
Quality of Life									
Compatibility with Existing Assets and Amenities	0.045	0.023	0.045	0.023	0.023	0.023	0.000	0.015	0.015
Adjacent Land Use Impacts	0.048	0.063	0.048	0.050	0.033	0.048	0.023	0.035	0.018
Subtotal	0.093	0.085	0.093	0.073	0.055	0.070	0.023	0.050	0.033
Financial Considerations									
Present Worth Costs	0.150	0.045	0.190	0.200	0.045	0.065	0.000	0.175	0.025
Subtotal	0.150	0.045	0.190	0.200	0.045	0.065	0.000	0.175	0.025
Total Evaluation Score	**0.568**	**0.431**	**0.621**	**0.605**	**0.354**	**0.422**	**0.259**	**0.498**	**0.276**

reasonably be expected to occur during a specified period of time if no new actions are undertaken to address project concerns. The No Action Alternative does not assume no actions are undertaken. Rather, it describes conditions expected to occur with reasonable certainty if the present course of action is maintained.

In the subject case, the No Action Alternative assumes the City would continue, and eventually increase, its ground water pumping and mining of the aquifer in accordance with established practices and accommodations for planned growth. The City's current system of 92 production wells, reservoirs, and distribution lines would be expanded to meet all future demands. The No Action Alternative assumes the City's conservation plan would be fully implemented as scheduled (i.e., 40 percent reduction by 2015, and 150 gpcd thereafter).

The No Action Alternative represents what the City would need to do if the Drinking Water Project is not constructed – in other words, how the City would attempt to meet customer water demands if the project to use its SJC water cannot be built. It basically consists of the status quo – i.e., a continuation of groundwater pumping into the foreseeable future. The City's system of some 90+ production wells, reservoirs, and distribution lines would be expanded to meet all future demands.

The No Action Alternative assumes that the City's most recent conservation plans and goals are fully implemented as scheduled – i.e., 40 percent reduction in peak demand from 250 to 150 gpcd by 2015, and 150 gpcd thereafter. In the No Action Alternative, the City will not be able to build the facilities needed to use its SJC water and will be forced to find other uses consistent with the original three SJC project priorities – i.e., municipal and industrial supply, irrigation uses in depressed areas of northern New Mexico, or supplemental irrigation – and consistent with the governing Law of the River, which requires beneficial consumptive use. Because actual users cannot be determined at this time, and speculation of alternative projects for other users is not appropriate for this analysis, the City's SJC water is not in the No Action hydrologic baseline, except for minor amounts already committed to lessees and 3,000 ac-ft/yr committed to the City's Non-potable Water Reclamation Project scheduled to begin operation in 2003.

Groundwater pumpage, based on a scenario of continued growth trends with conservation (CH2M Hill, 1995a, 1995b; Appendix A), is expected to increase from about 108,000 ac-ft/yr in 2006 to nearly 167,000 ac-ft/yr in 2060. As presented in Appendix L, such pumpage will result in increasing quantities of river water seeping into the Albuquerque basin aquifer and more ground water returned to the river at the City's SWRP outfall near Rio Bravo Bridge. The 'net effect' of the river seepage and return flows will be a loss of flow in the river in the Albuquerque reach.

Based on groundwater modeling investigations originally done by CH2M Hill (1997b), a number of negative consequences will result from the No Action Alternative. Estimates are that about 40 new wells would be needed by 2025 and up to 130 through the 2060 planning period. The need for the new wells is based on replacement of old wells, meeting projected increases in demand and replacing the anticipated reduction in well capacity due to declines in water levels. Regarding the latter, a number of existing wells will require modification to "blank off" section of well screen as pumping water levels fall below the top of screened intervals.

Moreover, under No Action, ground subsidence potential is estimated to be substantial for up to 26 square miles of land surface because of pumpage-induced water level drawdown of more than 250 feet by the year 2060. A 2060 cost of $1.0 million per acre of potential subsidence damage was assumed. This is roughly equivalent to $0.1 million per acre in 2005 dollars at a 4% discount rate. Moreover, a 10 percent probability of damages actually occurring in any one acre affected by >250 feet of drawdown was assumed. This led to a present worth estimate of potential subsidence-related costs over 26 square miles amount of about $166 million (0.10 x $0.1 million x 26 x 640).

The ground water in the aquifer beneath the Albuquerque metropolitan area contains naturally occurring arsenic. The present mean concentration of arsenic is about 13 parts per billion (ppb), with ranges from 2 ppb to over 50 ppb. Although there are not clear-cut trends in all wells, recent evidence compiled by the USGS for wells on the east and west side of the Albuquerque basin suggests a tendency for arsenic levels to increase with depth. Thus, the results of the large water declines in the aquifer under No Action are likely to result in production of water with increasingly higher arsenic concentrations. The new EPA standard for arsenic in drinking water is 10 ppb. Preliminary estimates of treatment costs prepared by CH2M Hill (2003) indicate that the 20-year present worth cost (e.g., 2005-2025) for treatment to reach the 10 ppb standard under No Action could be on the order of $150 million (based on present concentrations).

Another potential cost relates to deteriorating groundwater quality, particularly total dissolved solids (TDS). This could necessitate the need for expensive desalination in the post 2040 period (assumed by 2050). At present it is not possible to accurately determine the extent of desalination treatment necessary as poorer-quality ground water is drawn into the City well fields due to ever increasing pumpage under the No Action Alternative. But even now, some monitoring wells and water supply wells on the west side of the basin show TDS levels above drinking water standard of 500 milligrams per liter (mg/L). Currently, the average TDS in City wells is around 300 mg/L.

In the year 2060, the average day demand is estimated to be around 167,000 ac-ft/yr (about 150 mgd) with a maximum day demand of around 300 mgd. It was assumed that in the No Action Alternative, approximately one third of the City's future maximum demand (0.33 x 300 mgd = 100 mgd) would require desalination by 2050. The 2050 capital cost of a 100-mgd desalination facility is roughly estimated at $100 million (approximately $1 per mgd). It was assumed that the cost of a desalination facility constructed in 2050 will increase at a rate similar to the interest rate.

In addition to the potential costs of subsidence and desalination, there could be further economic costs associated with the state's largest City lacking a safe and sustainable water supply. Recent groundwater modeling updates (CH2M Hill, 2003) indicate that total cumulative pumpage under the No Action Alternative will be about 7.1 million ac-ft by 2060. Roughly a third of this quantity (more than 2 million ac-ft [CH2M Hill, 2003]) will come from aquifer storage, thus causing a serious depletion in the groundwater drought reserve. Without a sufficient drought reserve, a severe, prolonged drought would cause serious damage to turfed and landscaped areas due to the need to curtail water use for all but essential domestic needs. The attendant loss of economic vitality within Albuquerque and throughout the state would no doubt be costly.

The establishment of a No Action comparative baseline requires determining what future conditions without the project will be, based on what is predictable with some reasonable certainty. The historic use of the City's SJC water cannot reasonably be used to predict a future without the project. Moreover, with limited exceptions, possible future uses are similarly unpredictable. Given future legal and other uncertainties, the appropriate No Action baseline includes the City's SJC water which will be used directly by the City for the purpose of satisfying legally mandated offset requirements (pursuant to New Mexico State Engineer Permit RG-960 et. al), to satisfy outstanding City SJC contracts of approximately 2,600 ac-ft/yr through 2011, and to provide water to the Non-potable Surface Water Reclamation Project (about 3,000 ac-ft/yr). The amount of water for these three purposes is about 5,600 ac-ft/yr until 2011, and about 3,000 ac-ft/yr until 2060. See Table E-1, in the Hydrology Report, Appendix L. Regardless of the amount of water included in the comparative baseline, the hydrologic analysis demonstrates that any City SJC water in the river historically did not contribute substantively to annual river flow (CH2M Hill, 2003).

As discussed above in Section 1, varying amounts of the City's SJC water have historically been below Abiquiu from time to time. Generally, the City has taken delivery of all of its water since 1971. However, the historic presence of some City SJC water in the system cannot serve as the basis for the No Action Alternative because: 1) the authorizing legislation for the SJC project established limited parameters for use of SJC water; 2) the water was in the system pursuant to limited interim agreements with no basis for continued implementation of these agreements into the future; and 3) the basis for the City's limited historic use (through third party agreements) of its SJC water, that it would someday fully utilize the water, will not serve as a basis for continued similar usage into the future if the City is unable to secure approval for the DWP.

Similarly, future uses cannot be predicted with any reasonable certainty. The City's goal since executing its San Juan-Chama contract in 1963 has been to fully consumptively use the water. The future without the DWP represents a scenario unanticipated by the City and for which it has no current plan or policy with regard to SJC water other than the three uses noted above. Accordingly, any uses other than the three uses noted above would likely be ad hoc and limited until such time as the City determined how to use the water on a more permanent basis. The interim, ad hoc uses to which the City's water could be put are virtually infinite, involve possible agreements of unknown tenure with third parties, and accordingly lack sufficient predictability to allow for inclusion in the comparative baseline. Moreover, because the amount of water at issue is of such a small quantity that given the uncertainty as to when, where, or if such water may be present in the system, except for the above noted uses, any future uses are not included in the comparative baseline.

The uses of City SJC for the specified purposes are subject to the limitation of applicable interstate compacts, which limit the use of the SJC water to consumptive beneficial uses in New Mexico. The authorizing legislation specifically provided that the

City's allocation of SJC water was for full consumptive use by the City for municipal and industrial purposes. It was contemplated that full consumptive use would occur through use of the SJC water (48,200 ac-ft/yr, by contract) to offset the ground water pumping or through direct diversion.

The administration of the Middle Rio Grande, and the City's RG- 960 permit, require the City to offset the effect of the City's pumping on Middle Rio Grande stream flow. The City satisfies any offset requirement by utilizing: first, native water rights; second, return flows; and third, City SJC water. The State Engineer's analysis indicated that City well pumpage, minus credits given for wastewater return flows and native Rio Grande rights held by the City, would begin depleting river flows some time in the mid-1990s. Consequently, it was not necessary for the City to use its SJC water for offsetting river depletions during the 1971 to 1998 period. Because the City has not needed the majority of its SJC water for municipal purposes, some of its SJC allocation not stored in reservoirs has been made available for other users since 1972. Consequently, as an historic matter, the City has entered into formal and informal borrowing, trading and payback agreements on an ad hoc interim basis with a number of entities. However, the historical agreements have been based solely on the premise that the City would someday need, and in fact utilize, its full allocation of SJC water to satisfy its own municipal needs.

Agreements regarding these special uses were handled on an ad hoc basis, depending on unique annual and seasonal conditions. Later, ad hoc arrangements were formalized in contracts and letter agreements. No user wanted to pay for more water than it estimated it needed in its immediate and foreseeable circumstances. Each of these was unique to the circumstances necessitating the agreement for the use of the City's SJC water. The need for third party irrigation water often resulted in seasonal, annual and multiple-year agreements for use of the City's SJC water. Each of these agreements was negotiated and consummated in a unique transaction, with no guarantee that the agreement would be extended or continued once expired. Indeed, in 1985, the City Council passed a resolution limiting any sales to 1,000 acre-feet per annum with all terms expiring in 2010. Agricultural leases were further limited to a maximum of five-year terms. These explicit limitations underscore the fact that these historic uses were only temporary in nature and that the City's ultimate goal was to put its full allocation of SJC water to direct use for municipal purposes.

Under the assumption that the City would ultimately use all of its SJC water to offset ground water pumping, it was reasonable for the City to maintain its rights to SJC water and apply it to what uses it could through third party agreements until it needed the water itself for long-term municipal supply. The use of the water in the years before the City needed it served a valuable placeholder function that was worth the price the City paid for its SJC water each year to Reclamation. When it became clear with updated ground water modeling that the assumption underlying this approach was in error, the City developed the DWP in order to put its SJC water to use in the future.

In a future without the project, the City will be in the unique position of having no designated use for all its SJC water. Any use of this water always has been geared to eventual full consumptive use through use as offsets or through direct diversion. Absent the project, there is perhaps an infinite range of end uses for the City's SJC water, none of which are more reasonable or predictable than the next. These possibilities range from maintenance of a recreational pool in Abiquiu (resulting in no City SJC water in the system), some possible agreements with unknown third parties, and continued use of City SJC water for purposes of offsetting ground water effects on the river. With the exception of satisfying offset requirements, these uses would all be ad hoc and interim in nature and limited by the legal constraints of the SJC project authorizing legislation. There is no way to predict whether the City would enter into any agreements in the future, when agreements for use of water would occur, where the water would be put to use in the system, or how much water would be involved. Given the lack of a designated use absent the project, no one option for use of City SJC water is more predictable than the next. Moreover, significantly, even if such agreements occurred, making SJC water available in the system, the quantity of water is so small that the hydrologic analysis demonstrates there is no significant contribution to river flow (CH2M Hill, 2002a). Given the legal and factual uncertainty regarding whether agreements would occur, and the very small quantity even if such water were present in the system, the future without the project comparative baseline does not include these unpredictable amounts.

Rather, the only amounts of City SJC water that are properly included in the No Action Alternative are amounts required to satisfy legally mandated offset requirements, to fulfill existing City contracts, and that amount provided to the non-potable project. These future uses are reasonable and predictable in terms of use, amount, place of use and duration of use. Additionally, No Action assumes the City's SJC allotment of 48,200 ac-ft/yr is taken from Heron Reservoir each year. Because timing, amount, and destination of deliveries from Heron, and ultimate uses for most of the City's SJC water (other than the listed quantities) cannot be predicted, the hydrologic evaluation for the river above and below Abiquiu addresses only the amounts specified above.

2.5 DESCRIPTION OF ACTION ALTERNATIVES

The three DWP action alternatives for river-water diversion and conveyance to the WTP that are evaluated in detail in this FEIS are Angostura Diversion Alternative (Angostura Diversion with dual-canal conveyance), Paseo del Norte Diversion Alternative (a surface diversion north of Paseo del Norte with pipeline conveyance), and Subsurface Diversion Alternative (a subsurface diversion north and south of Paseo del Norte with pipeline conveyance). Each alternative would use the Chappell Drive WTP (Section 2.5.7). Each action alternative also would use the east and west transmission corridor lines to deliver the drinking water from the WTP to users within the Albuquerque metropolitan area (Section 2.5.8). Paseo del Norte Diversion (Section 2.5.2) is the preferred alternative. A 20-year cost analysis was performed for the action alternatives following industry standards. Beyond this period, uncertainty exists regarding additional operation, maintenance and replacement costs that will occur.

2.5.1 Angostura Diversion

The Angostura Diversion facility would divert a total of 94,000 ac-ft/yr of water from the Rio Grande (47,000 ac-ft/yr of City SJC water and 47,000 ac-ft/yr of native water). Figure 2.5-1 shows the diversion dam, fish screen, return flow by-pass pipe, and fishway. Figure 2.5-2 shows the raw-water conveyance route from the Angostura Diversion to the

Chappell Drive WTP site. Water would be diverted continuously even during the non-irrigation season, although there would be some seasonal variations in diversion volumes. This alternative would use the existing MRG Project Angostura Diversion Dam located approximately 18 miles north of the City. Flows in the MRG Project system would increase from an approximate range of 250 cubic feet per second (cfs) to 500 cfs to a range of 380 cfs to 630 cfs during the irrigation season. With the improvements to the canal system there should be no potential flood impact from the DWP.

The facility would be rehabilitated by repairing concrete and existing structures; constructing new motorized operators and gates (and installing new electrical service), a fish screen, and a fishway; removing sediment and debris; and improving the concrete-lined settling channel immediately downstream from the diversion gates that lead to the MRG Project irrigation canal system. Operational and conceptual design specifications are listed in Table 2.5-1. Estimates of the total cost of the Angostura Diversion including the 20-year present-worth cost (e.g., from 2005 through 2025) including the $36 million for the cost of arsenic treatment and $26 million for potential damage caused by subsidence are $538 million. A Section 404 permit is required for the in-river construction necessary for this alternative.

TABLE 2.5-1
CONCEPTUAL DESIGN AND OPERATIONAL SPECIFICATIONS FOR THE ANGOSTURA DIVERSION

Item	Design Specifications	Operating Requirements
River Location	Angostura Dam; 5 river-miles north of the Town of Bernalillo	---
Length of Conveyance Corridor to WTP	Approximately 17 miles	---
Distance to Return	Approximately 33 miles	---
Delivery Capabilities	---	94,000 ac-ft/yr (or 130 cfs)
Area of Pump Station at the North Diversion Channel (NDC) Outfall	2.9 acres	1.5 acres
Fishway Area	5.5 acres	1.7 acres
Fishway Flow Rate	---	50 cfs
Pipeline Conveyance Depth	4 feet to top of crown	---
Diversion Dam	Constructed in 1930s – may need concrete rehabilitation	Length 940 feet, Sluiceway 100 feet wide
Fish Screen Area	1.2 acres	0.3 acres
Cost of Fish Screen	$6.5 million	
Fish By-pass Area	2.7 acres	0.1 acres
Cost of Fishway	$4.1 million	

*Cost does not include MRGCD O&M costs

Figure 2.5-1
Angostura Diversion
Site Plan

Source: CH2M Hill Scale is approximate

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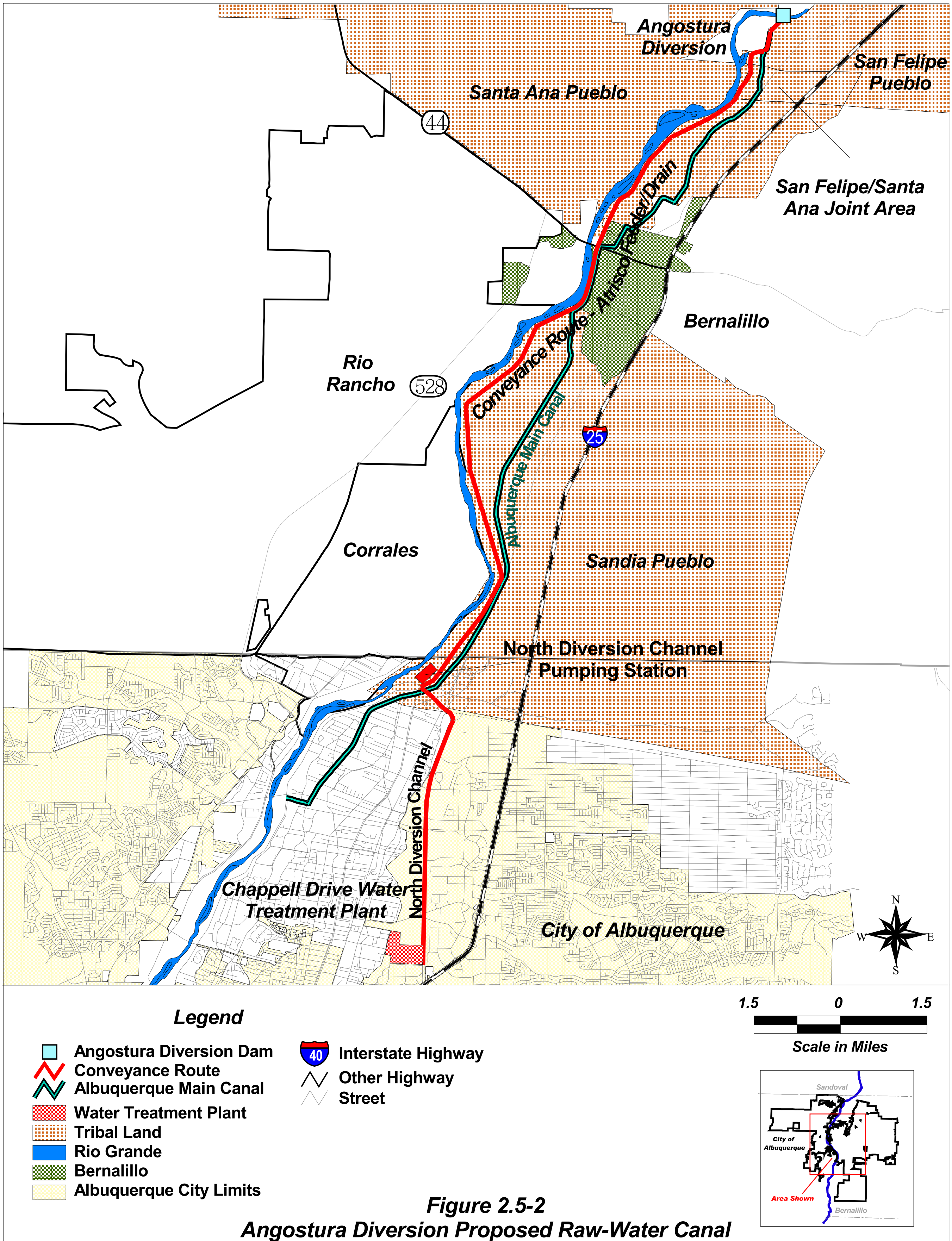

Figure 2.5-2
Angostura Diversion Proposed Raw-Water Canal and Pipeline to Chappell Drive Water Treatment Plant

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This alternative would use the Albuquerque Riverside Drain (also known as the Atrisco Feeder) as the primary conveyance route, with the Albuquerque Main Canal available for emergency use. Improvements to the Riverside Drain would involve reshaping and enlarging the channel along some reaches, removing vegetation, improving access roads, and improving hydraulic structures. This would include the need to remove some of the vegetation and obstructions from side slopes of the canal, removal of about 1 foot of accumulated sediment on the bottom and a widening of about 8 feet in most reaches. Total earthwork over the 14.5 mile length of the channel could be on the order of 0.3 million cubic yards. The access road on at least one side will require reconstruction. In addition, improvements would be needed for at least six existing bridge crossings, one wasteway to the river, at the Corrales Siphon south of the Town of Bernalillo, and at under crossing of the NM-44 Bridge at Bernalillo. There are also a number of drainage inlet pipes that empty into the Atrisco Feeder (approximately 10) that would require replacement during channel excavation. From a pump station in the vicinity of the NDC on Sandia Pueblo property, water from the Main Canal and Riverside Drain would be conveyed about 5 miles to the proposed Chappell Drive WTP site via a new 60 to 72-inch-diameter pipe to be constructed within the NDC ROW. Distribution of treated potable water from the treatment plant would be via the distribution system described in Section 2.5.8.

2.5.2 Paseo del Norte Diversion (Preferred Alternative)

Under Paseo del Norte Diversion, a new surface diversion structure would divert a total of 94,000 ac-ft/yr of water from the Rio Grande (47,000 ac-ft/yr of the City's SJC water and 47,000 ac-ft/yr of native Rio Grande water). Water would be diverted continuously, although there would be seasonal fluctuations in volume. The new surface diversion facility would consist of a low-head (approximately 2.5 to 3.5 feet in height), adjustable-height dam to be constructed in the Albuquerque reach of the river. The approximately 600-foot-long dam would consist of inflatable bladder structures mounted in a concrete base across the active river channel. Gates on the east side of the dam would route water to an inlet structure, on top of which would be a pump station. The new diversion dam would include fish screen and fishway facilities. Operational and construction details for this alternative are presented in Table 2.5-2. Estimates of the total cost of the Paseo del Norte Diversion including the 20-year present-worth cost (e.g., from 2005 through 2025) include the \$36 million for the cost of arsenic treatment, and the \$26 million for potential damage caused by subsidence.

This alternative would involve the construction of a low-head, adjustable-height dam and pump station on the Rio Grande approximately 0.7 miles north of Paseo del Norte. An aerial photograph of the area associated with this alternative, with the conceptual diversion components near Paseo del Norte indicated, is shown on Figure 2.5-3. This alternative would require construction of a new raw-water pump station near the adjustable-height dam, and a new pipeline to convey the water to the WTP. As shown on Figure 2.5-4, the conveyance pipeline would be constructed from the pump station south to Paseo del Norte, east about 2.5 miles along Paseo del Norte to the Albuquerque NDC, then south about 2.5 miles along the NDC to the Chappell Drive WTP. After treatment, the potable water would be provided for distribution through the same transmission corridors as described for Angostura Diversion (Section 2.5.8). A Section 404 permit is required for the in-river construction necessary for this alternative.

TABLE 2.5-2
CONCEPTUAL DESIGN AND OPERATIONAL SPECIFICATIONS FOR THE PASEO DEL NORTE DIVERSION

Item	Design Specifications	Operating Requirements
River Location	Between Alameda/Paseo del Norte – Albuquerque Reach	---
Length of Conveyance Corridor to WTP	Approximately 5.5 miles	---
Distance to SWRP outfall	Approximately 15 miles	---
Delivery Capabilities	---	94,000 ac-ft/yr (or 130 cfs)
Fishway Area	5.5 acres	1.7 acres
Fishway Flow Rate	---	50 cfs
Cost of Fishway	$2.6 million	--
Fish Screen Area	0.8 acres	0.2 acres
Fish Screen Flow Rate	--	0.2 ft/sec
Cost of Fish Screen	$1.6 million	--
Conveyance Pipeline Depth	4 feet to top of crown	---
Low-Head Adjustable Height Diversion Dam Area	1.8 acres	0.2 acre
Pumping Station Area	4 acres	2.3 acres

Scientific studies to provide a basis for the design of a fishway that would allow upstream movement of fish, particularly silvery minnow, past the diversion are being completed. The effectiveness of the proposed fishway will be monitored. As a result there is a continuing effort to develop the knowledge necessary to finalize designs for effective fishways. The fish passageway facility may also be moved to the east side of the river during final design.

2.5.3 Subsurface Diversion

Under the Subsurface Diversion, a total of 94,000 ac-ft/yr (47,000 ac-ft/yr of the City's SJC water and 47,000 ac-ft/yr of native water from the Rio Grande) would be diverted. Water would be withdrawn continuously, although withdrawal volumes could vary seasonally. This alternative would involve construction of below-grade collector systems installed in trenches beneath the river. Each collector system would collect and divert water to a dedicated pump station located either within or adjacent to the bosque and floodplain (as bounded by the existing flood-control levees). Operational and conceptual design details for this alternative are provided in Table 2.5-3. Estimates of the total cost of the Subsurface Diversion including the 20-year present-worth cost (e.g., from 2005 through 2025) include the $36 million for the cost of arsenic treatment, and the $26 million for potential damage caused by subsidence.

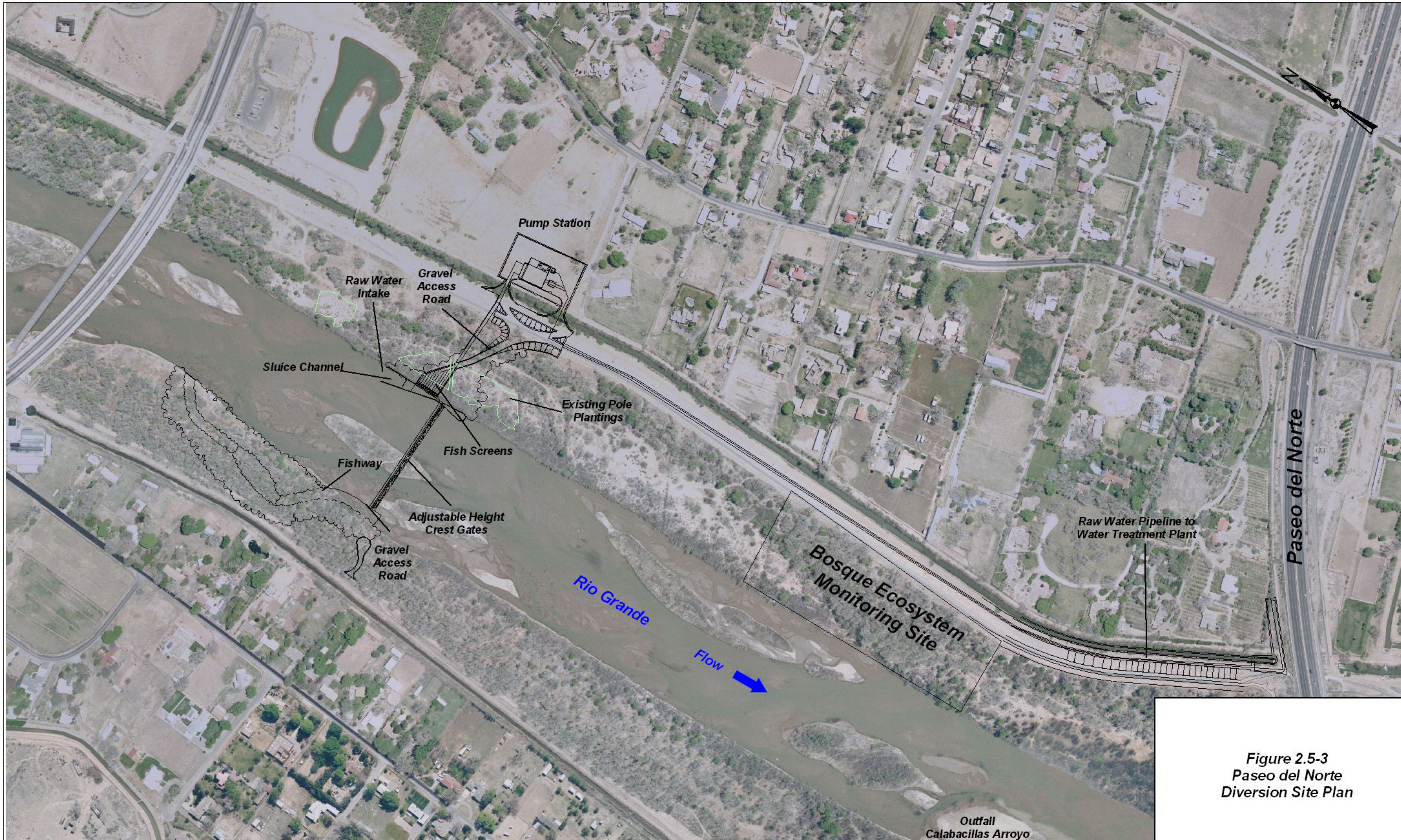

Figure 2.5-3
Paseo del Norte Diversion Site Plan

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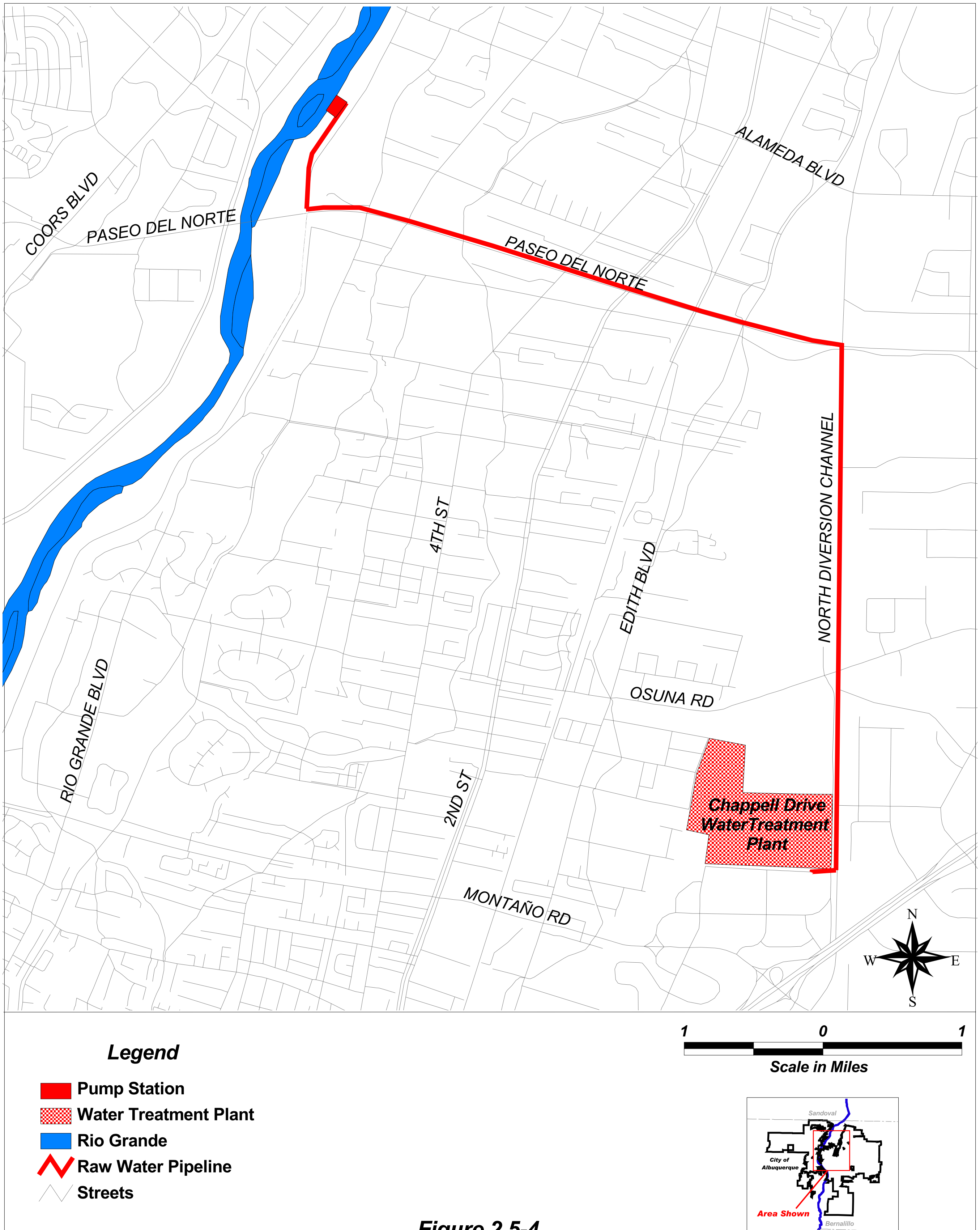

Figure 2.5-4
Paseo del Norte Diversion Proposed Raw-Water Pipeline to Chappell Drive Water Treatment Plant

Schematic of Pumpstation Not to Scale

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TABLE 2.5-3
CONCEPTUAL DESIGN AND OPERATIONAL SPECIFICATIONS FOR THE SUBSURFACE DIVERSION

Item	Design Specifications	Operating Requirements
River Location	Between Alameda/Paseo del Norte – Albuquerque Reach	---
Length of Conveyance Corridor to WTP	Approximately 5.5 miles	---
Distance to SWRP outfall	Approximately 15 miles	---
Delivery Capabilities	---	94,000 ac-ft/yr (or 130 cfs)
Conveyance Pipeline Burial Depth	4 feet to top of crown	---
Number of Horizontal Collector Arms	3 groups of 11 (33 total)	---
Collector-Arm Length	500 feet (each)	---
Collector-Arm Depth	20 feet below riverbed	---
Length of Riverbed Affected	1.3 miles	1.3 miles
Number of Pumping Stations	3	3
Area of Riverbed Disturbed	78 acres	Limited to general maintenance

This alternative would involve the construction of three subsurface water-collection systems, each with 11 horizontal arms constructed of 20-inch-diameter slotted pipes (well screen) buried 20 feet beneath the riverbed, perpendicular to the riverbank (Figure 2.5-5). The pipe trenches would be backfilled with gravel and would extend about 500 feet beneath the active river channel. The three collector systems would be constructed along a 1.5-mile reach of the Rio Grande, north and south of the Paseo del Norte Bridge. The collector arms of each system would be manifolded to a common header, which would be connected to a pump station. A dedicated pump station would be constructed at each of the three collector systems. A Section 404 permit is required for the in-river construction necessary for this alternative.

An aerial photograph of the area north and south of the Paseo del Norte Bridge, with the conceptual diversion components superimposed, is shown on Figure 2.5-5. A new raw-water conveyance pipeline would be constructed from the pump stations east about 2.5 miles along Paseo del Norte, then south within the NDC ROW to the Chappell Drive treatment plant site (Figure 2.5-6). From the WTP, treated water would be delivered to customers using the transmission system described in Section 2.5.8.

2.5.4 River Diversion Sizing and Scheduling

Figure 2.5-7 shows a general description of the movement of water from Heron Reservoir to the point of diversion and the return flows below the SWRP. Under the Angostura Diversion, the City's SJC water would be released in most years at a constant rate of about 66 cfs from Abiquiu Reservoir. After incurring conveyance losses between

Abiquiu and Albuquerque, approximately 65 cfs of the City's SJC water (on average) would reach the diversion facility. As a result of consultations with the USFWS as described in Appendices H and I, the curtailment flows described in the FEIS have been increased by 60 cfs. On October 21, 2002, flow at the Central Gage was 106 cfs. To allow for seepage losses from the preferred alternative at Paseo del Norte, the amount of flow by-passed due to curtailment was increased to 130 cfs. This 60 cfs increase in the curtailment rate also applies to the other action alternatives of the FEIS. The curtailment flow, where the City would have the diversion shut down completely, is the result of Section 7 consultation with the USFWS revised to a total river flow of 560 cfs from the previous 500 cfs at Angostura, above the diversion and at 260 cfs from the previous 200 cfs total river flow for the other two diversion alternatives. If river flow above the diversion point falls below the thresholds for either alternative, the diversion flow rate would be 'curtailed' to ensure proper operation of the sluiceway and fishway facilities, and to eliminate depletion effects in the reach between the diversion and the SWRP outfall (CH2M Hill, 2003).

When flows just above the diversion point for Angostura Diversion fall below 560 cfs the City would begin curtailing the quantity of the diversion, but would continue to release and divert the full 65 cfs of its SJC water. As native flow continues to drop, raw-water diversion would be reduced accordingly. When native flow reaches 430 cfs (250 cfs MRGCD diversion + 120 cfs fishway and sluiceway flow plus 60 cfs additional curtailment threshold flow) just above the diversion, all raw-water diversions and SJC water releases would be suspended (100-percent curtailment). During periods of curtailment, the City would offset decreases in the amount of raw water diverted by increasing the amounts of ground water pumped for potable use. During periods of complete shut down of river diversions, the City would rely entirely on ground water (CH2M Hill, 2003).

When flows just above the diversions for the Paseo del Norte Diversion or the Subsurface Diversion fall below 260 cfs, the City would begin curtailing the quantity of the diversion but would continue to release and divert the full 65 cfs of its SJC water. As native flow continues to drop, raw-water diversion would be reduced. When native flow reaches 130 cfs just above the diversion, all raw-water diversions and SJC water releases would be suspended (100-percent curtailment). During periods of curtailment, the City would offset decreases in the amount of raw water diverted by increasing the amounts of ground water pumped for potable use. During periods of complete shut down of river diversions, the City would rely entirely on ground water.

At the point of diversion (Angostura Diversion), water would be diverted at a constant flow rate of 130 cfs throughout the year, as long as flows are at or above a specified 'threshold flow' of 560 cfs (about 250 cfs after MRGCD diversion) at the diversion point. The 130-cfs diversion would include 65 cfs of the City's SJC water and 65 cfs of native Rio Grande water. The 65 cfs of SJC water would be consumptively used within the City's water service area, and the 65 cfs of native water would be returned to the river at the SWRP outfall below Rio Bravo (CH2M Hill, 2003). See Section 3.16 Hydrology for further discussion and explanation of threshold flows.

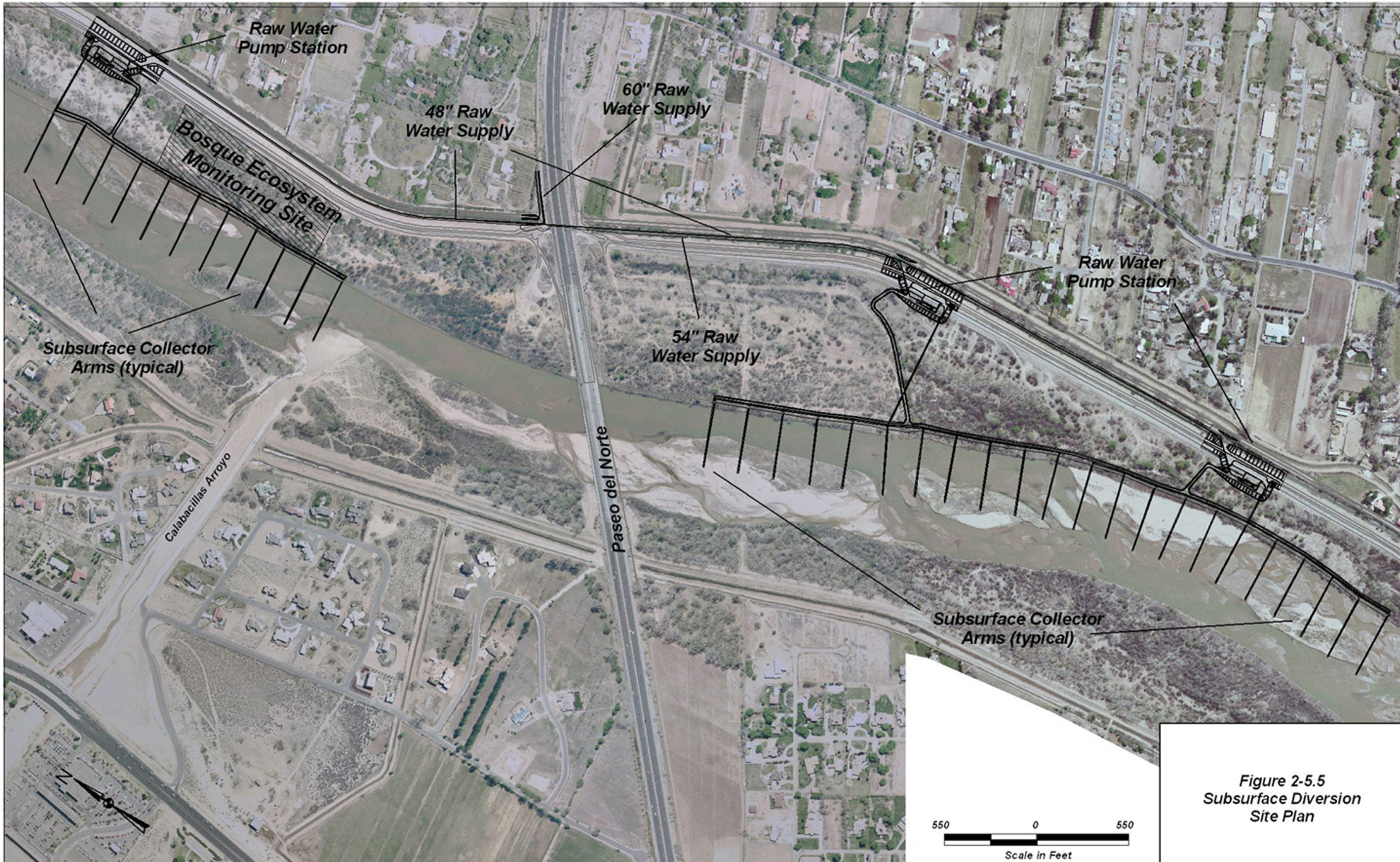

Figure 2-5.5
Subsurface Diversion
Site Plan

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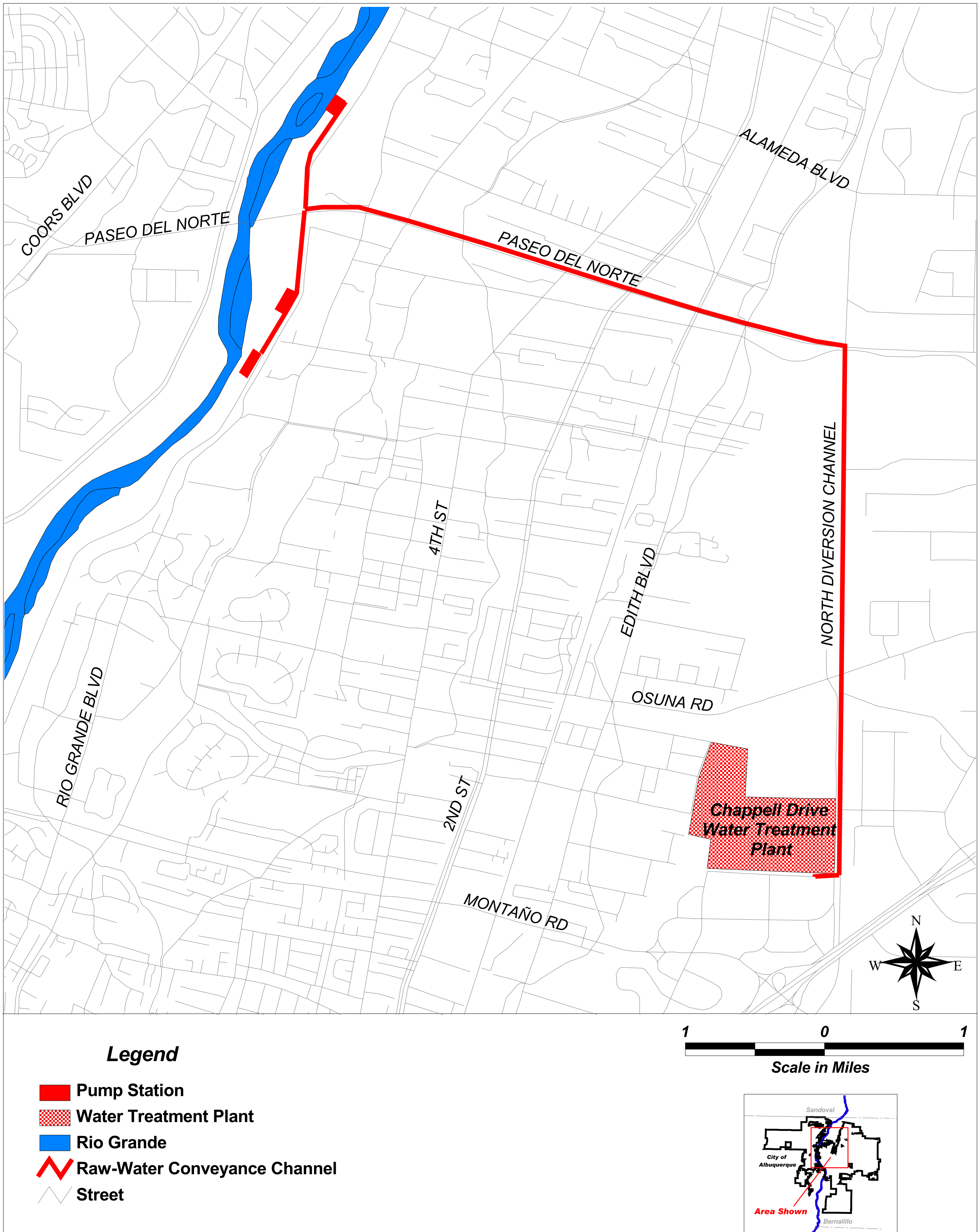

Figure 2.5-6
Subsurface Diversion Proposed Raw-Water Pipeline to Chappell Drive Water Treatment Plant

Schematic of Pumpstation Not to Scale

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Heron to Abiquiu Reservoir - City SJC water. Averages 67 cfs over year.

Abiquiu through Cochiti to City Diversion - City SJC water released at 66 cfs, diverted at 65 cfs.

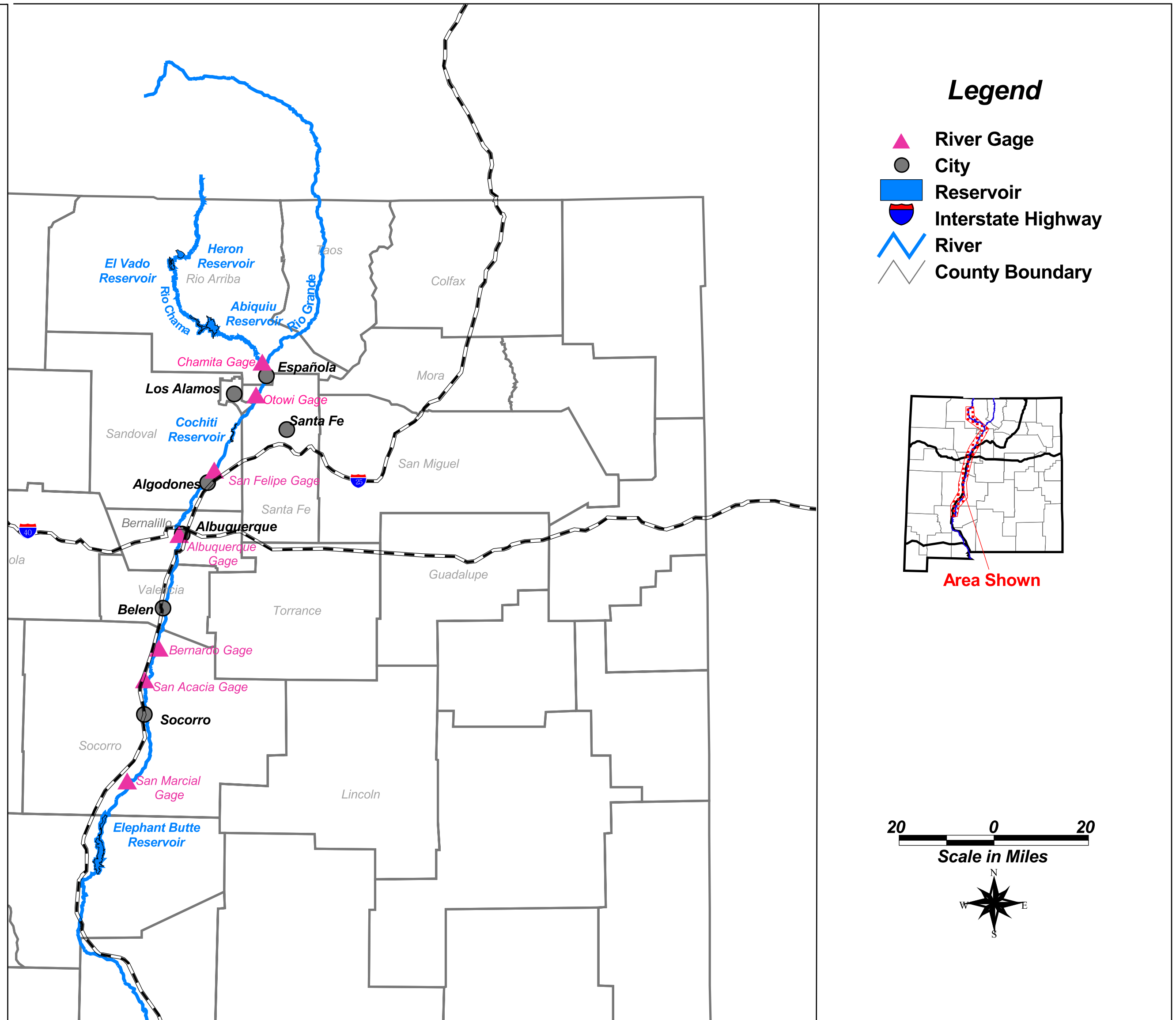

Figure 2.5-7
Drinking Water Project
General Description of
Water Operations

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Under the Paseo del Norte and Subsurface Diversions, the City's SJC water would be released in most years at a constant rate of about 66 cfs from Abiquiu Reservoir. After incurring conveyance losses between Abiquiu and Albuquerque, approximately 65 cfs of the City's SJC water (on average) would reach the diversion facility. At the point of diversion, water would be diverted at a constant flow rate of 130 cfs throughout the year, as long as flows are at or above a specified 'threshold flow' of 260 cfs at the diversion point. The 130-cfs diversion would include 65 cfs of the City's SJC water and 65 cfs of native Rio Grande water. The 65 cfs of SJC water would be consumptively used within the City's water service area, and the 65 cfs of native water would be returned to the river at the SWRP outfall below Rio Bravo (CH2M Hill, 2003). See Section 3.16 Hydrology for further discussion. Under this operating plan, there would be a reach of the Rio Grande between the point of diversion and point of return in which native flows would be depleted by 10 to 30 cfs at the Central gage (on average) relative to No Action (CH2M Hill, 2003). Under the No Action Alternative, losses of river water by seepage through the riverbed continue and increase through time. With continued ground water pumping under No Action there is no control over these river losses.

To ensure DWP diversions do not adversely affect the riverine ecology between the diversion point and return flow points, the City would implement a curtailment strategy. For full operation of the DWP under a constant-release/diversion scenario, the flow at the diversion point and the Paseo del Norte Diversion must be at least 260 cfs, at least 560 cfs for Angostura Diversion based on the following operating assumptions:

- Angostura Diversion Alternative rate of 130 cfs, consisting of 65 cfs of the City's SJC water and 65 cfs of native water plus the diversion of approximately 250 cfs for the MRGCD water;

- Angostura Diversion would have a fishway flow of 70 cfs on the west side of the river;

- Angostura Diversion would have a flow of 50 cfs at the outlet of the sluiceway on the east side of the river to provide for downstream movement of sediment and fish past the diversion intake screens;

- Paseo del Norte Diversion would have a fishway flow of 50 cfs on the west side of the river;

- Paseo del Norte Diversion rate of 130 cfs, consisting of 65 cfs of the City's SJC water and 65 cfs of native water; and

- Paseo del Norte Diversion would have a flow of 20 cfs at the outlet of the sluiceway on the east side of the river to provide for downstream movement of sediment and fish past the diversion intake screens.

During curtailment years, the City may be releasing and diverting additional San Juan-Chama water for an Aquifer Storage and Recovery program. For example, if the City were to curtail diversions during the months of July and August, the City will increase diversions from 130-142 cfs during the months of November through March. The additional 12 cfs of the City's San Juan-Chama water released during peak diversion will be stored in the aquifer to restore the additional groundwater taken during the curtailment period of July and August. Another example of the City increasing the diversion for peak operations will be during a wet year. During a wet year, the City may divert 142 cfs throughout the entire year. The add ional San Juan-Chama water that will be released and diverted will be water the City leases, payback from other San Juan-Chama contractors or San Juan-Chama water stored by the City in Abiquiu Reservoir. During that wet year, the maximum amount diverted will be 142 cfs, comprised of 71 cfs or native water and 71 cfs of San Juan-Chama water. An alternative operation scenario may be that the City diverts 65 cfs native water and 77 cfs San Juan-Chama water to meet demands and provide for aquifer storage and recovery. As with all operational scenarios, the native water will be returned to the river at the Southside Water Reclamation Plant.

2.5.5 Aquifer Storage and Recovery

The AWRMS DWP will have an aquifer storage and recovery (ASR) program intended to supplement the aquifer for peak demands and drought reserve and to improve the possibilities for conjunctive use of surface and ground water resources. The WTP will run at an essentially constant rate of 84 million gallons per day (mgd) or 130 cfs, with a peaking capacity of 92 mgd or 142 cfs. In early years of the project (e.g., 2006 to 2010) peak summer City water demands should be about 200 mgd. Thus, during summer months a number of existing City wells would be utilized to help meet demands. During low demand periods, typically October through March, the WTP would be producing sufficient water to allow the wells to be turned off. During such low demand periods, recharge to the aquifer would be done by transmission of treated City water in the existing distribution system for injection into existing (and possibly some new) City wells. The overall layout of the ASR program awaits a demonstration project and an evaluation to select optimal wells for recharge. Because many of the existing City wells produce water that is relatively high in arsenic, the new EPA arsenic standard and possible need for blending low arsenic river water with well water will also be a factor in the selection of ASR wells. Consequently, it is likely that the details of the ASR program will not be known until early or mid-2004. This recharge program does not use wastewater.

Preliminary water budget calculations, based on projected population and water demand figures and various supply assumptions, suggest that the quantities of water actually available for ASR will be about 10,000 to 15,000 ac-ft/yr in early (2006-2010) project years and gradually decline thereafter. Perhaps 15 to 20 existing wells would be required. Although small relative to overall City water demands, the ASR water could accumulate over time and provide a 'banked' reserve important in drought or emergency situations.

2.5.6 Other AWRMS Project Components Evaluated

During development of the DWP, and pursuant to implementation of the AWRMS, several other projects were evaluated. These projects are described in the following subsections.

North I-25 Industrial Recycling Project

The purpose of the North I-25 Industrial Recycling Project is to reduce the City's reliance on ground water supplies by developing a City-owned and -operated, reclaimed, non-potable water collection, storage, disinfection, and distribution system in the North Interstate 25 (I-25) area near Alameda Boulevard. A FONSI for this project has been completed (Reclamation, 1999). This system provides a portion of the City with 896 ac-ft/yr of non-potable water (reclaimed from industrial uses) at full build-out for turf irrigation and industrial processes and has been online since April 2000. The use of the reclaimed water for non-potable, low-quality purposes would offset the need to withdraw an equivalent net amount of high-quality ground water from the deep aquifer. The federal action for this project provides cost-sharing as authorized by Reclamation's Title XVI program.

Non-Potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque

The Non-Potable Surface Water Reclamation Project (Reclamation, 2001a) would provide approximately 3,038 ac-ft/yr to irrigate approximately 900 acres of parks, golf courses, and greenbelts in the Northeast Heights area. This project would use some of the City's allotment of SJC surface water. The City's SJC water would be diverted from the Rio Grande and mixed with treated industrial wastewater as part of a separate project in the North I-25 area.

The Southside Water Reclamation Plant Reuse Project would provide 2,455 ac-ft/yr at full build-out to irrigate about 700 acres of parks, golf courses, and greenbelts in an area east of the SWRP. This project would also provide 93 ac-ft/yr for industrial purposes. This entire volume of water would consist of treated wastewater effluent from the SWRP. A FONSI has been completed for this project (Reclamation, 2001a).

2.5.7 Treatment Works

The Chappell Drive site was selected as the location for the proposed WTP based on results of the plant siting evaluation and input received at the public meetings (CH2M Hill, 1999a). The Chappell Drive site, located near the southwest corner of Osuna Road and Chappell Drive, is the location of the WTP for each of the three action alternatives described above (Sections 2.5.1 through 2.5.3). An aerial photograph of the Chappell Drive WTP site is shown on Figure 2.5-8. Operational and construction design details for the WTP are summarized in Table 2.5-4. Water-treatment processes for the new WTP proposed for the DWP would be designed to produce drinking water that complies with all current and anticipated drinking-water regulations. The treatment sequence at the proposed Chappell Drive plant would consist of several processes designed to remove suspended solids and organic materials from the diverted Rio Grande water (CH2M Hill, 2001a). Solid plant wastes would be taken off site for land disposal, and liquid wastes would be discharged to the sewer system for treatment at the SWRP, or returned to pre-sedimentation ponds. The treatment system would consist of the following major components:

- **Screening and Raw-Water Pump Station**—For surface-water diversion alternatives, screens at the point of diversion would be constructed to prevent fish and large debris from entering the pump station from the river. The subsurface diversion option would not require screening facilities. The pump station would then pump the water from the diversion/collection site via the raw-water conveyance system to pre-sedimentation ponds at the WTP site.

- **Pre-Sedimentation Ponds and Settled-Water Pump Station**—Pre-sedimentation ponds at the WTP would be used to reduce gross turbidity attributable to coarse fines (e.g., sand and silt), and would provide emergency raw-water storage. Settled water would then be pumped from the ponds into the treatment system.

- **Ferric Chloride and Sulfuric Acid Addition**—Ferric chloride is a coagulant used to destabilize suspended particles and natural organic matter for removal downstream. Sulfuric acid would be added to lower the pH, which would enhance coagulation for removal of total organic carbon. The coagulants would be mixed into the water at a rapid-mixing basin.

- **Flocculation/Clarification**—The purpose of the flocculation step is to provide gentle mixing to allow the destabilized particles to agglomerate into larger floc particles that will settle from the water. The flocculated water is conveyed to a sedimentation process, where the majority of particles would be removed.

- **Ozone Generation, Dissolution, Contacting, and Off Gas Destruction**—Ozone is the most powerful oxidant used in conventional water treatment. Ozone would be used as a primary water disinfectant, would remove color, and would provide taste and odor control. Ozone also breaks down large, long-chain organic molecules into smaller molecules that can be removed by bacteria in the granular activated-carbon (GAC) filters. Components of the ozone treatment process would include ozone generators; ozone-diffuser grids located within contact basins; ozone off gas collection and destruction; and a diffused-bubble aeration system of effluent end of ozone contact basin to control residual ozone and provide carbon dioxide stripping for pH control.

- **Hydrogen Peroxide Addition to Ozone Contactors**—Hydrogen peroxide feed facilities would be provided to generate hydroxyl radicals for potential bromate control and for enhanced taste and odor control.

- **GAC Filtration**—Treated water would be passed through GAC filters as a polishing step. The GAC filters would provide a place for beneficial bacteria to grow and would adsorb organic compounds from the water. The filters would remove any remaining suspended solid particles, taste and odor compounds, biodegradable dissolved organic carbon, and residual iron and manganese.

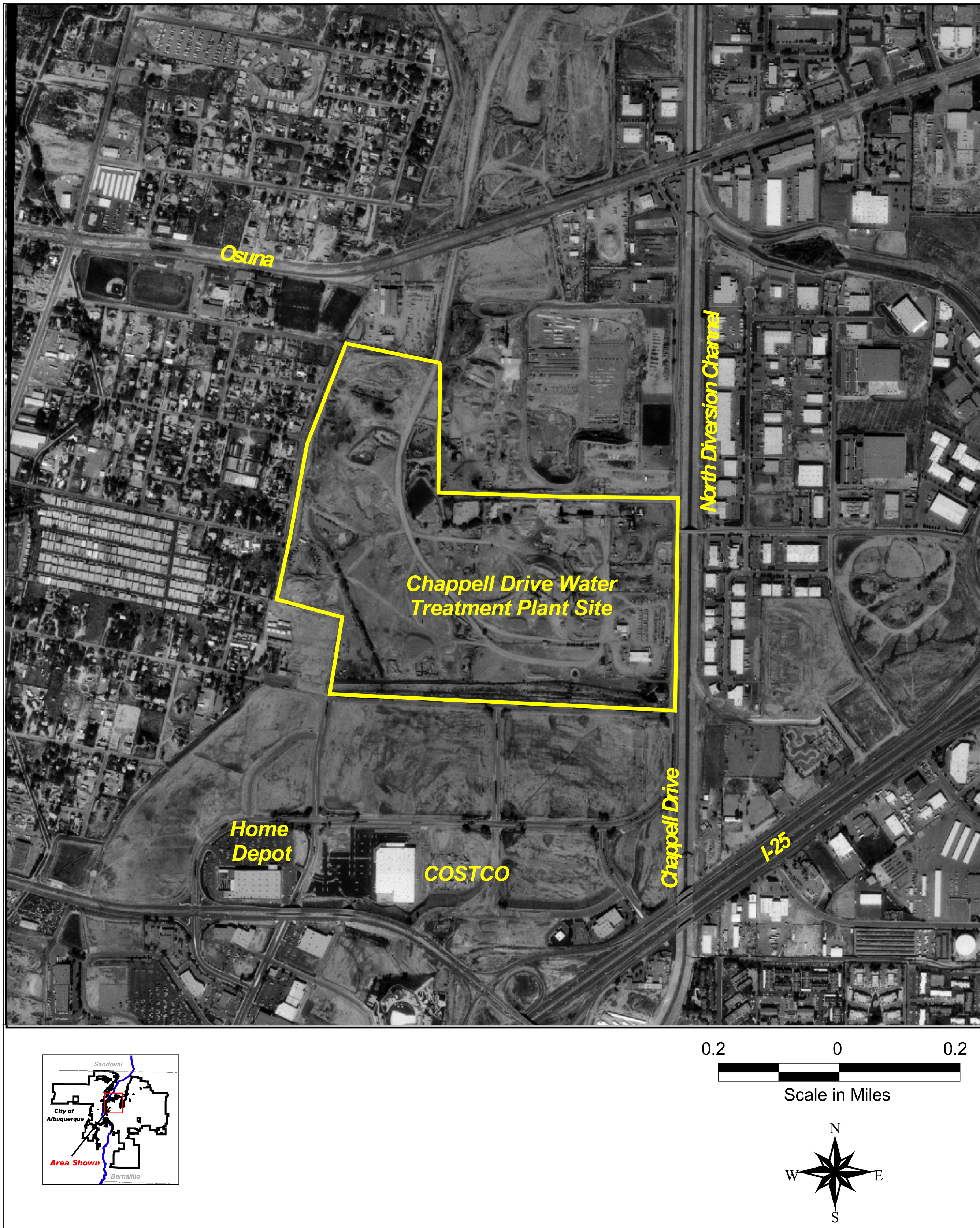

Figure 2.5-8
Chappell Drive Water Treatment Plant Site

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TABLE 2.5-4
CONCEPTUAL DESIGN AND OPERATIONAL SPECIFICATIONS FOR THE PROPOSED DRINKING WATER TREATMENT PLANT

Item	Design Specifications	Operating Requirements
Water Treatment Capacity	---	92 mgd
Ozone Generation	---	5,000 lbs/day
Chemical Storage	---	30-day chemical storage inventory
Administration Office Space	---	20,000 ft^2
Operational Plant	---	20,000 ft^2
Total Pond Water Area	36 acres	28 acres
Number of Ponds	4	4
Water Capacity/Pond (each)	---	30 million gallons
Maximum Ozone Usage	---	5,000 lbs/day
Maximum Daily Solids Production	---	35,000 lbs/day
Annual Volume of 5-percent Solids Wet Sludge in Lagoons	---	30,000,000 gallons
Total Operating Volume/Lagoon	---	60,000,000 gallons
Number of Lagoons	2	2

- **Clearwell and High Service Pumps**—Following treatment, the water would be conveyed to a clearwell storage tank. The treated water would be pumped from this tank to the distribution system. The clearwell would provide operational storage, filter backwash-supply storage, and contact volume for standby primary disinfection with chlorine.

- **Chlorine, Fluoride, and Hydrated Lime Addition to the Finished Water**—Chlorine addition would provide secondary disinfection by maintaining a chlorine residual. Fluoride would be added to help prevent tooth decay and to match the quality of the ground water supply. Hydrated lime may be added to the water for corrosion control and stability matching ground water supply by increasing the level of calcium and the pH of the finished water.

- **Residuals Dewatering**—Secondary (residual) wastes would be produced from the sedimentation and filter backwash processes. The sludges would be dewatered either in a drying pond or with mechanical processes such as centrifuges prior to disposal. Decant water from the dewatering process could be cycled back to the pre-sedimentation ponds, discharged to the sanitary sewer, or used as a reclaimed water source. The dewatered solids would be trucked to a landfill for disposal.

2.5.8 Potable-Water Transmission Lines

Based on the evaluation discussed in Section 2.2.2, potable water transmission-line corridors were selected to deliver treated potable water from the Chappell Drive WTP to

Albuquerque metropolitan-area consumers on the east and west sides of the Rio Grande (CH2M Hill, 2000b). The selected transmission corridors are shown on Figure 2.5-9. The route for the east-side transmission corridor would generally run southeast from the WTP, then east to Jefferson near Pinata. At this point, the pipeline would branch into two lines, with the northern segment terminating at Coronado Reservoir and the southern branch would run generally south-southwest, beneath I-40, to the two Burton reservoirs (Figure 2.5-8).

As shown on the figure, the route for the west-side transmission corridor would run generally southwest to Griegos, then west beneath the Atchison, Topeka, and Santa Fe (AT&SF) Railroad to a river crossing open cut, and across the Rio Grande. The Drinking Water Project will require a potable water line crossing of the Rio Grande to provide water to the west side of the City. "Open-cut" refers to the trench excavation method anticipated for the transmission pipeline crossing of the Rio Grande. Other methods, for example bore and jack, will be considered. It is estimated that to install the pipeline across the Rio Grande, the contractor will construct a temporary coffer dam half way across the river. The contractor will then dewater the soil, excavate a trench (open-cut) using an excavator or hoe, install the pipeline, backfill the trench, and remove the temporary coffer dam. The contractor will then repeat the process on the second half of the river crossing – construct a temporary coffer dam, dewater the soil, excavate a trench (open-cut) using an excavator or hoe, install the pipeline, backfill the trench, and remove the temporary coffer dam. From here, the line would follow either Western or St. Joseph, and continue west from Western (Option 1) or St. Joseph (Option 2), to Atrisco and/or to Ladera Drive, and then west along the Mirehaven Diversion, and south on 110th. The line would then cross beneath I-40 to Avalon, then go west to 118th, and south to 118th and Central Avenue.

The following paragraphs describe alternatives for potable water transmission lines throughout the system. The first describes alternatives in the northwest portions of the potable transmission lines. The segment of transmission line connecting the Don and Volcano Cliffs Reservoirs, for clarity will be referred to as "Don – Volcano Transmission Line," or "DVTL."

The alignment of the DVTL generally runs from its beginning at the intersection of Montaño Rd. and Unser Blvd. from its connection toward the Volcano Cliffs Reservoir, south on Unser to its connection to the western terminus of the WTP-DVTL transmission line at one of three alternate locations described later, then south and west to connect to the existing College Reservoir, continuing south and west to cross I-40, and then connects to the existing Don Reservoir located near the intersection of Central Ave. and 116th St. The total length of transmission line for this portion of the project is approximately 9 miles (46,000 linear feet [lf]) and will be relatively large-diameter pipe ranging between 30 inches and 48 inches. The majority of the proposed transmission line will lie within existing rights-of-way (ROWs) and easements; the proposed action does not include any ROWs or easements into or through Petroglyth National Monument.

The Osuna Alternate proceeds southerly from the Bear Canyon Arroyo outlet along the east side of Interstate 25 Frontage Road to the westbound driving lanes of Osuna Road NE, then it proceeds easterly along the westbound driving lanes of Osuna Road NE

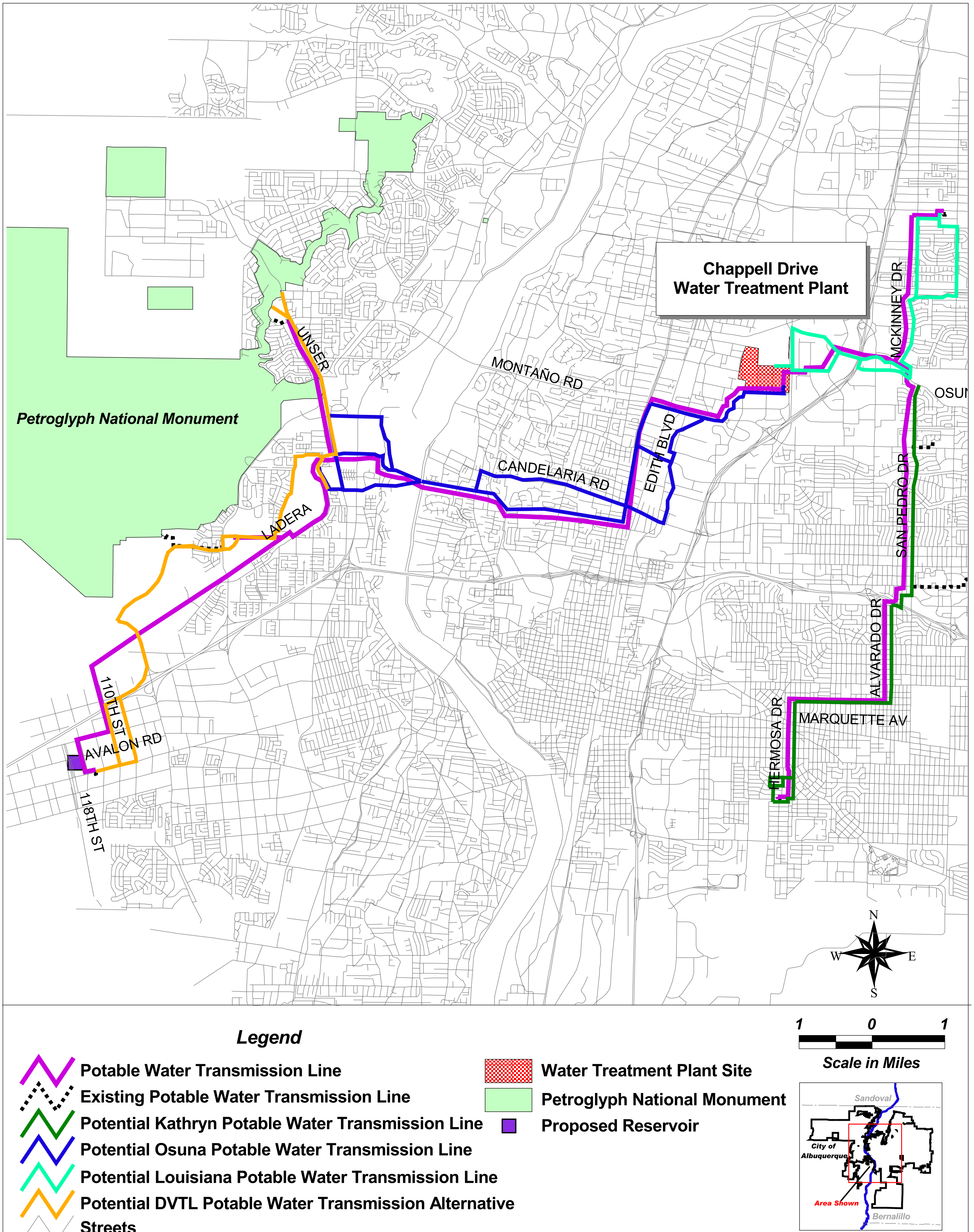

Figure 2.5-9
Potable Water Transmission Pipeline Alignment and Alternatives

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to near the southwest corner of the Arroyo del Oso Golf Course. The pipe diameter increased from 56” to 66”.

The Louisiana Alternate proceeds easterly along Forrest Hills Dr. from San Pedro to Louisiana Blvd. NE, then north on Louisiana to the Domingo Baca Arroyo, then westerly along the south side of the Domingo Baca Arroyo to the drainage easement between Edmund G. Ross and Hope Christian School, then north under the arroyo and along the easement to Palomas Avenue and into Coronado Reservoir. The pipe diameter may vary.

These Kathyrn alternatives are proposed editions within the southeast area of the potable transmission lines. The original alignment consists of exiting the reservoirs and Burton park on Kathryn Ave., proceeding east to Carlisle Blvd., north to Parkland Place, east to Parkland Circle and north on Parkland circle to Ridgecrest Blvd. The original alignment does not appear to allow full utilization of the reservoir capacities because the reservoirs are constructed mainly below grade, with the reservoir floors located approximately 18 feet below existing grade. Due to the topography of the immediate area, the transmission pipeline would need to be installed within 15 feet of cover or more, for a distance of approximately 2,000 feet.

Alignment Option B consists of exiting the pump station on Wellesley Drive, proceeding north to Santa Clara Avenue, east to Amherst Drive, north to Pershing Avenue and east on Pershing to Parkland Circle. This alignment was developed to allow connection to the existing 42-inch transmission line from Miles Pump Station (immediately west of the Burton Pump Station building) and to keep the pipeline generally with a shallow 4 feet of cover. The 42-inch transmission line has an approximate invert elevation of 5,300 feet and also has an abandoned 30-inch butterfly valve that is suitable for connection.

Alignment Option B is congested with existing utilities along Wellesley and Amherst Drives. To ascertain the availability of a suitable alignment corridor, it is recommended that specific utility potholing be performed on these streets prior to preliminary design.

Alignment Option C consists of exiting the pump station on Wellesley Drive, proceeding north to Santa Clara Avenue, west to the continuation of Wellesley Drive, north to Pershing Avenue and east on Pershing to Parkland Circle. This alignment was developed as an alternative to Option B if the existing large diameter utilities on Amherst Drive do not allow for a clear pipeline corridor for the installation of the 36-inch transmission line.

Alignment Option C is less congested with existing utilities because it avoids Amherst Drive. To ascertain the availability of a suitable alignment corridor, it is recommended that specific utility potholing be performed on these streets prior to preliminary design.

At this time, Alignment Option B is the preferred alignment to allow full utilization of the Burton Reservoirs and to decrease the bury depth of the transmission line. However, Option C alignment may need to be utilized if exploratory work on existing utilities indicates that Amherst Drive is too congested.

The pipeline alignment starts at Burton Pump Station and exits the site through the existing driveway and proceeds north on Wellesley Drive to Santa Clara Avenue, east to Amherst Drive, north to Pershing Avenue, east to Parkland Circle north to Hermosa Drive across Lomas Blvd., east on Indian School and across Interstate 40 in a northerly direction to a private parking lot north of the freeway, north on Cardenas Drive east on Taylor Road, north on San Pedro crossing Menaul Blvd., Candelaria Road, Comanche Road and Montgomery Blvd. to Osuna Road, proceeding west on Osuna for approximately 600 feet and connecting to a new 66-inch transmission line that originates at the Water Treatment Plant. Along the route, the transmission line will connect to Charles Wells and Leyendecker reservoirs in a manner yet to be formalized.

The following options are for the portions of the potable transmission lines from the water treatment plant to the river crossing at Campbell. The additions are:

- Continue to include the route from Montaño west to 2nd St. and 2nd St. south to the intersection of Candelaria and 2nd Street.
- Continue to include the route from Montaño, then southwest on Alameda Lateral to Edith and south on Edith to Griegos, then west on Griegos to 2nd Street.
- Continue to include the route from Montaño, then south on Alameda Lateral all the way to Candelaria and west on Candelaria to 2nd Street.
- Add a route from Montaño, the southwest on Alameda Lateral all the way to Griegos, then south on Edith Blvd. to Candelaria and west on Candelaria to 2nd Street.

The preliminary design drawings for these additional potential options for the transmission line alternatives are located in Appendix K. The proposed action does not include any facilities, access, or portions of Petroglyth National Monument.

2.6 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Based on results of the in-depth DWP alternatives engineering, environmental, and cost analyses and comments received from the public, agencies, and other stakeholders during the scoping process, many of the originally identified diversion/conveyance concepts were eliminated from detailed consideration because they failed to meet the stated purpose and need of the project. These concepts, and the reasons for their elimination, are reviewed in this subsection. In addition, other alternatives were eliminated from detailed study because they were not found to be technically feasible or reasonable.

The 1996-1997 Alternatives Formulation and Evaluation project team worked with community and expert groups to develop and apply evaluation criteria to more than 30 facilities alternatives. This process, and a comparison of the alternatives considered, are detailed in the document entitled *Alternative Descriptions and Opinions of Cost* (CH2M Hill, 1997c). Various approaches to providing a reliable long-term drinking-water supply were explored, including aquifer recharge, purchasing additional water rights, several beneficial-use options for the City's SJC Project water, and seeking legislative and administrative changes. Broad concepts of water use that were considered during this time included:

- Diverting the City's SJC water and other surface water for use in recharging the aquifer, either by means of surface-recharge facilities or through injection wells. Recycling wastewater by treating it for non-potable use, and using it either to recharge the aquifer or for non-potable applications such as landscape irrigation or industrial processing. The scope of this approach ranged from small, localized projects to recycling virtually all the City's wastewater.

- Enhancing recharge of the shallow aquifer, through natural or engineered means, and withdrawing shallow ground water for non-potable uses.

- Continuing the City's traditional strategy of relying solely on the local deep aquifer, with separate scenarios considered to account for varying success in achieving water-conservation goals.

- Combinations or "packages" of the above-listed strategies.

2.6.1 Cochiti Pipeline

In 1995, a water-supply option involving construction of a pipeline from Cochiti Reservoir to Albuquerque was studied. The concept called for construction of an outlet structure at the Cochiti Dam by boring a new tunnel through the dam, and construction of a control-gate facility upstream from the dam. A pipeline would convey water the 43 miles from the dam outlet works to Albuquerque (13 miles through the Cochiti and Santa Domingo Pueblos, then 30 miles along the I-25 easement). A 66-inch-diameter pipeline could convey 42 mgd, and an 84-inch-diameter pipeline could convey 92 mgd. The estimated cost for this 43-mile conveyance pipeline ranged from $70 million to $90 million (in 1995 dollars).

This concept was rejected as infeasible due to several factors, including:

- The high capital and operations and maintenance (O&M) cost of this conveyance facility.

- The need to tunnel into an existing dam structure to construct new outlet works, which would have significant permitting and dam-safety requirements; and would incur added cost and liability.

- The need to construct a pipeline along 30 miles of the I-25 ROW, which would pose access problems and require extensive permitting by the New Mexico State Highway and Transportation Department.

- Obtaining easements from Pueblos.

2.6.2 Diverting the City's SJC Water for Aquifer Recharge

Wastewater aquifer-recharge alternatives would require construction of diversion and treatment facilities, as well as selecting appropriate locations for recharge. This concept was eliminated from further consideration because recharge potential would be limited by a lack of suitable recharge areas and the requirements to divert and treat the water prior to recharge or injection. The complicated geology and hydrology of the Santa Fe Group within the Albuquerque Basin would likely require further study in order to optimize this type of approach. The aquifer-recharge alternative also would require the installation and maintenance of additional pumping wells to recapture the water for drinking-water purposes.

A modified aquifer-recharge proposal, along with other proposals, was presented by Rio Grande Restoration (RGR) at the April 20, 2001 Town Hall meeting in Albuquerque (Shared Vision, 2001). RGR proposed to use treated wastewater effluent for surface recharge (infiltration) of the shallow aquifer in an area near Tijeras Arroyo.

The RGR proposals involve repackaging and re-combinations of alternatives already considered but eliminated. The three proposals were: 1) aquifer recharge; 2) small scale diversion; and 3) a combination of 1 and 2. The aquifer recharge proposal involves treatment of 60,000 ac-ft/yr of effluent and recharge using surface-water spreading facilities in the Tijeras Arroyo. Based on the work undertaken during AWRMS formulation and the scoping process, this is not a reasonable proposal, as discussed below (CH2M Hill, 2001f).

The RGR aquifer-recharge proposal would not satisfy the purpose and need of the project and the over-arching objective of the AWRMS—a safe and sustainable drinking-water supply—because it would not fully utilize the City's San Juan-Chama water. The recharged water would take many years to reach the aquifer, with much of the water lost to evaporation, and rendered unusable in the unsaturated zone. Once reaching the water table, significant amounts would be lost to the shallow ground water system, which flows in part to the Middle Rio Grande Project drains. Water not lost to evaporation, the unsaturated zone, or drains would not reach the areas of the aquifer where historical water-level declines have been the greatest, and it might be decades before any measurable benefit could be seen in many existing City wells. Additionally, the safety of the water supply would be in question because ground water contamination exists in this area. Moreover, quality-of-life concerns would not be adequately addressed under this proposal, as it violates a fundamental precept of the public water-supply industry that public drinking water supplies should be taken from the highest-quality source (AWWA, 2000). Finally, from a financial perspective, this alternative would have a construction cost of more than $300 million, or 50 percent more than the preferred alternative, while producing a water supply around 30 to 50 percent smaller than the preferred alternative.

The second proposal involves diversion and direct use of 47,000 ac-ft/yr of the City's SJC water, with diversion at Angostura and delivery to the west side of Albuquerque. This essentially is similar to AWRMS alternative "DD2," except that DD2 delivered water throughout the City. This second proposal has all of the shortcomings of the considered-but-eliminated DD2 (i.e., it is not sustainable, would not fully use City SJC water, and would lead to greater potential for aquifer subsidence), plus the added shortcoming of failing to address east-side water-supply needs.

The RGR proposal also suggested a combination of the above two proposals. The combined RGR proposal also is not a reasonable alternative because the estimated construction cost of the combined alternative is over $430 million, more than double the cost of the preferred alternative. Moreover, the annual O&M costs of this combined alternative would be >$40 million, or more than three times the annual O&M cost of the preferred alternative. The combined alternative also suffers the additional drawback of not using water from the highest-quality source. Finally, the proposal, as with the recharge and diversion only, results in greater drawdowns and less of a drought reserve than the preferred alternative.

The proposed RGR scenarios were simulated with the New Mexico Office of the State Engineer Interim Middle Rio Grande Management Area Model. Both were found to produce more drawdown and therefore a smaller to non-existent drought reserve over the planning period and a greater potential for subsidence than the preferred alternative. The recharge only scenario resulted in the City pumping current permitted limits. The diversion only scenario results in drawdowns on the east side 60 to 80 feet greater than the preferred alternative. The combined scenario results in smaller drawdowns than either of the other scenarios but still far greater drawdowns than the preferred alternative.

Water balances also were constructed from the OSE model results. The recharge only scenario assumes City SJC will be used to offset net effects from pumping. However, it is clear from the water balance that only a small portion of SJC would be used and that the City would continue to mine ground water. In the diversion only scenario, it was assumed SJC water would be released to offset project diversions. SJC water is therefore "consumed." However, the diversion only scenario does not fully use SJC water. The combined scenario results in the complete depletion of surface water storage and an enormous need for additional water rights to offset surface water effects.

2.6.3 Recycle Wastewater

Recycling wastewater is most feasible for small-scale projects that would distribute treated wastewater for turf irrigation or other non-potable uses. While the potential exists to use wastewater and reclaimed water directly for aquifer recharge, there are serious concerns about public health and possible contamination of the aquifer by the introduction of wastewater effluent into the aquifer. The costs associated with treatment of injected water to meet the new arsenic drinking-water standard also would increase, and a substantial number of new aquifer-injection wells would be required. Injection of water into aquifers is regulated by NMED (State of New Mexico, 2001) and governed by the Underground Injection Control Section of the SDWA. ASR regulations prohibit the injection of wastewater into ground water aquifers unless it is treated to potable conditions.

2.6.4 Use of Shallow Ground Water

This type of alternative would increase the recharge and use of ground water from shallow aquifers in the Albuquerque area for non-potable uses. Within many areas of Bernalillo County, shallow aquifers that could be effectively pumped are located near the Rio Grande. Contamination events that have previously impacted the shallow aquifers in many of these areas could pose human health and safety concerns (City, 1995). Also, because the amount of water within the shallow aquifers is variable, this resource could be unreliable.

2.6.5 Continued Traditional Ground Water Pumping with Conservation

This type of alternative would require construction of new wellfields, storage reservoirs, pump stations, and transmission lines within the Albuquerque water service area. Conservation efforts would continue, and likely be expanded, with this type of alternative. This approach would continue the depletion of the deep aquifer, and would not incorporate optimum beneficial use of the City's available surface-water resources. Increased arsenic levels with ground water depth is possible.

2.6.6 Combinations of Alternatives

Ten combinations of water-supply options also were considered. Most of these involved combination of direct use of the City's SJC water with various schemes and locations for ASR, direct recharge, and the possible use of constructed wetlands and reclaimed/recycled water for non-potable uses. Combining alternatives and methods would increase the complexity of permitting and environmental assessment. Constructability and operational reliability also would be difficult to assess for some combinations of the alternatives.

2.7 ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

Table 2.7-1 summarizes the environmental effects of the DWP action alternatives, and the No Action Alternative, on the affected environment. Detailed descriptions of environmental effects are presented in Section 3, Affected Environment/Environmental Consequences. The effects summarized in Table 2.7-1 represent expected changes with mitigation programs fully implemented. The three action alternatives would use the same WTP site and treated-water transmission pipeline system. Angostura Diversion would divert water from the Rio Grande near Algodones, New Mexico. Paseo del Norte Diversion (new surface diversion) and Subsurface Diversion (new subsurface diversion) would divert water from the Rio Grande near Paseo del Norte.

TABLE 2.7-1
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Aesthetics and Visual Resources				
Location and size of project facilities that would block most of an existing viewshed	Potential structures, located primarily in urban areas; no disruption of existing viewsheds	An existing diversion dam and new, slightly visible fish screens; no disruption of existing views	A new, low-profile diversion dam, visible from roads and bosque, and one pump station in the bosque	Three pump stations, visible from within the bosque
Air Quality				
Emissions from construction equipment causing violations of standards	Some non-DWP-related construction of pump houses, wells, and other facilities may be required; no violations likely	With mitigation, no air emissions would exceed standards	With mitigation, no air emissions would exceed standards	With mitigation, no air emissions would exceed standards
Emissions that result in non-attainment of NAAQS	Some non-DWP-related construction of pump houses, wells, and other facilities may be required; no violations likely	With mitigation and construction management practices, no non-attainment violations	With mitigation and construction management practices, no non-attainment violations	With mitigation and construction management practices, no non-attainment violations
Generation of dust or other emissions that degrade air quality	Some non-DWP-related construction of pump houses, wells, and other facilities may be required; no violations likely	Dust likely in unpaved areas during construction; amount depends upon climate and moisture conditions; to be controlled by best management practices (BMPs)	Dust likely in unpaved areas during construction; amount depends upon climate and moisture conditions; to be controlled by BMPs	Dust likely in unpaved areas during construction; amount depends upon climate and moisture conditions; to be controlled by BMPs

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Emission of objectionable odors	Some non-DWP-related construction of pump houses, wells, and other facilities may be required; no violations likely	Off gas from WTP operations would be filtered, and would not pose an odor nuisance	Off gas from WTP operations would be filtered, and would not pose an odor nuisance	Off gas from WTP operations would be filtered, and would not pose an odor nuisance
Aquatic Life				
Reservoir level changes that lead to fish kills	None	No substantive change in historic maximum and minimum reservoir levels as a result of project operations; increase of 65 cfs in flow-through volume in reservoirs of Upper Project Subarea	No substantive change in historic maximum and minimum reservoir levels as a result of project operations; increase of 65 cfs in flow-through volume in reservoirs of Upper Project Subarea	No substantive change in historic maximum and minimum reservoir levels as a result of project operations; increase of 65 cfs in flow-through volume in reservoirs of Upper Project Subarea
Lowered water table that reduces fishery quality	Indirect effect on water table due to ground water pumping of approximately 373 acres of riparian vegetation in Middle Project Area would be affected by lowered water table, which could modify streamside habitats	Increased flows from the City's SJC water would support current water table in Upper Project Subarea; no effect on water table in Middle or Lower Project Subareas	Increased flows from the City's SJC water would support current water table in Upper Project Subarea; no effect on water table in Middle or Lower Project Subareas	Increased flows from the City's SJC water would support current water table in Upper Project Subarea; approximately 552 acres of riparian vegetation in Middle Project Area would be affected by lowered water table, which could modify streamside habitats

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Habitat modification	None	No substantive changes in flow velocity or river width or depth in any Project Subarea. 0.5 acres of aquatic habitat temporarily lost during in-river construction near the existing dam and ends of fishway to connect to the river. 1.5 acres of aquatic habitat temporarily lost by in-river construction for the potable water transmission line crossing.	No substantive changes in flow velocity or river width or depth in any Project Subarea. 0.2 acres of aquatic habitat lost to dam construction. 1.8 acres temporarily lost due to construction of dam, access roads, backfill areas during in-river construction. 1.5 acres of aquatic habitat temporarily lost by in-river construction for the potable water transmission line crossing.	No substantive changes in flow velocity or river width or depth in any Project Subarea. 1.5 acres of aquatic habitat temporarily lost by in-river construction for the potable water transmission line crossing. 100 acres temporarily lost due to construction of subsurface collectors, access roads, backfill areas, etc. during in-river construction.
Cultural Resources				
NRHP-eligible or –listed resources to be damaged or destroyed	Subsidence could affect historic structures if unabated.	Temporary construction impacts on < 1% of other historic acequias. Adverse effects to the Angostura Dam and the Atrisco Feeder.	Temporary construction impacts on < 1% of historic acequias.	Temporary construction impacts on < 1% of historic acequias.
Traditional Cultural Properties	At Isleta Pueblo Rio Grande flow changes could potentially affect traditional cultural use of the river.	At San Felipe, Santa Ana, Sandia, and Isleta Rio Grande flow changes could potentially affect traditional cultural use of the river by Pueblos.	None	None

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Known burial sites or human remains to be disturbed	None	None; if human remains are encountered during construction, NAGPRA compliance or New Mexico state burial law compliance would be enforced.	None; if human remains are encountered during construction, NAGPRA compliance or New Mexico state burial law compliance would be enforced.	None; if human remains are encountered during construction, NAGPRA compliance or New Mexico state burial law compliance would be enforced.
Energy				
Energy requirement for diversion-system operations (kWH/Yr)	Not Applicable	13,500,000	12,500,000	13,000,000
Energy requirement for pumping and treatment plant operations (kWH/Yr)	Not Applicable	55,500,000	55,500,000	55,500,000
Energy requirement from wells (kWH/yr)	182,000,000	60,000,000	60,000,000	60,000,000
Total energy requirement of alternatives (kWH/yr)	182,000,000	129,000,000	128,000,000	128,500,000
Additions to power infrastructure or changes in power availability	None	None	None	None
Environmental Justice				
Minority or low-income neighborhoods disproportionately affected by project implementation	None	Construction and flow depletion in the Sandia, San Felipe, and Santa Ana Pueblo areas.	None	None

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS
ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Floodplains				
Increase in the water surface elevation of the 100-year flood between Abiquiu Reservoir and the diversion point (inches)	0	Less than 1	Less than 1	Less than 1
Area within the 100-year floodplain occupied by permanent structures (acres)	0	3.6	6.8	9.3
Increase in the Rio Grande water-surface elevation of the 100-year flood at the location experiencing the largest change in water levels (inches)	0	0	3.5	Less than 0.5

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Geology				
Loss of unique mineral-recovery operations	None	None	None	None
Project structural facilities located in areas of shallow ground water constraints, or severe (greater than 30-degree) slopes	None	None	None	None
Contribution to land subsidence	Subsidence risk would increase as a result of increased pumping to meet City requirements.	Subsidence risk should decrease as a result of reduced ground water pumping.	Subsidence risk should decrease as a result of reduced ground water pumping.	Subsidence risk should decrease as a result of reduced ground water pumping.
Hazardous Materials				
Number of known hazardous waste sites disturbed by project construction or operation	None	None	None	None

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Risk of hazardous materials exposure from routine transport and project operations	None	Low	Low	Low
Human Health and Safety				
Number of untreated/potable water-line cross-connections likely to be implemented during construction activities	None	None	None	None
Primary and secondary drinking-water-quality parameters that would be exceeded in treated water	None	None	None	None
Uncontrollable public safety hazards during project construction	None	None	None	None
Maximum drawdown from pre-development conditions within the critical management area boundary in the year 2040	250-400	100-150	100-150	100-150

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Hydrology				
Maximum drawdown from pre-development conditions within the critical management area boundary in the year 2060 (feet below ground surface)	200-260	100-130	100-130	100-130
Total ground water pumping (million ac-ft)	7.1	2.3	2.3	2.3
Total length of river channel likely to experience average annual water flow increase of 65 cfs (miles) relative to the No Action Alternative	0	171.3	189	189

**TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS
ON ALL EVALUATED RESOURCE CATEGORIES [a/]**

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Total length of river channel where flows would be depleted by project operations (miles)	15	32.7	15	15
Total annual reduction in water from City's SWRP discharged to Rio Grande (ac-ft/yr)	0	0	0	0
Length of river in which future operational reservoir releases would exceed the capacity of the active channel or cause river bank erosion (miles)	0	0	0	0
Average annual flow reduction in Rio Grande in an average water year between the SWRP outfall and Isleta Diversion Dam (percent)	0	0	0	0

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Average annual reduction in mean annual flow for a typical year midway through the project in the Rio Grande at the Albuquerque gage (percent)	5.0	7.0	7.0	7.0
Reduction in flow in the Rio Grande downstream of the SWRP outfall during low flow periods as a result of diverting surface water (percent)	0	0	0	0
Simulated zero flows (modeled over 2006 at the ABQ gage)	23	16	16	16
Number of modeled years without waivers in which winter minimum fisheries releases could be met (maximum = 54)	54	54	54	54
Number of modeled years without waivers in which rafting releases could be met (maximum = 54)	48	54	54	54

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Maximum change in shallow water table elevation in the vicinity of the Paseo del Norte Bridge (feet)	1 to 3	0	0	3 to 3.5
Indian Trust Assets and Other Tribal Resources				
Number and location of affected Indian Trust Assets and other tribal resources	Possible indirect effects to ground water supply.	Construction effects of modification of canal and construction of pump station on Sandia Pueblo. Flow depletion through pueblos of Santa Ana, Sandia and a portion of San Felipe.	None	None
Land Use				
Area that would change from private to City ownership (acres)	None	~110 for Chappell Drive WTP.	~110 for Chappell Drive WTP.	~110 for Chappell Drive WTP.
Areas that would require a change in land use designation/ zoning (acres)	None	Lease of ~5 acres of Sandia Pueblo lands for pump station.	None	None
Designated prime or unique farmland to be withdrawn (acres)	None	None	None	None

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Noise and Vibration				
Number of expected cases when operation of DWP facilities would exceed City noise or vibration standards	None	None	None	None
Number of expected cases when construction of project facilities exceeds City noise or vibration standards	None	None	None	None
Recreation				
Number of reservoir angling days that would be lost because of project operations or construction (Upper Project Subarea)	None	None	None	None
Loss or diminished quality of river-based recreation caused by project construction or operations (all Project Subareas)	None	None; possible positive effect from periodic additions of City's SJC flow below reservoirs.	None; possible positive effect from periodic additions of City's SJC flow below reservoirs.	None; possible positive effect from periodic additions of City's SJC flow below reservoirs.

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Loss or diminished quality of bosque recreational activity (Middle Project Subarea)	None	Temporary modification of hiking trails and visual/auditory experience during construction; loss of about 8.2 acres of bosque due to construction of permanent facilities.	Temporary modification of hiking trails and diminished visual/auditory experience during construction; loss of 14.7 acres of bosque due to construction of permanent facilities.	Temporary modification of hiking trails and diminished visual/auditory experience during construction; loss of 23.1 acres of bosque due to construction of permanent facilities.
Riparian Areas				
Total length of riparian corridor likely to experience substantial changes in existing dominant plant structural composition (miles)	0	0	0.5	1.0
Riparian area temporarily lost due to diversion construction activities (acres)	0	8.2	14.7	23.1
Riparian area temporarily lost due to transmission pipeline construction (acres)	0	2.4	2.4	2.4

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS
ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Riparian area permanently lost due to construction of new facilities (acres)	0	1.8	4.2	10.6
Riparian areas lost due to ground water elevation drawdown of > 3 feet below the existing average ground water depth for at least 1 month each year during the growing season (acres)	373	0	0	27
Riparian areas that would experience substantial changes in overall plant-community structural composition due to a ground water decline of 1 to 3 feet for at least 1 month per year (acres)	607	0	0	552

**TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS
ON ALL EVALUATED RESOURCE CATEGORIES [a/]**

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Socioeconomic				
Total number of permanent new jobs gained because of DWP	0	15 to 20	15 to 20	15 to 20
Total number of temporary or seasonal new jobs gained because of DWP	0	420	380	446
Average number of construction jobs gained during the period of DWP construction	0	250	220	263

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Soils				
Loss or degradation of prime farmland or unique soils (acres)	None	None	None	None
Creation of long-term uncontrolled erosion or unstable soil conditions	Potential for unstable soils due to subsidence related to aquifer depletion.	None	None	None
Threatened and Endangered Species				
Loss of individual members of a population of a listed species	None	No bald eagle or southwestern willow flycatcher would be lost. Individual Rio Grande silvery minnow eggs and larvae would be impinged on or entrained thru fish screens.	No bald eagle or southwestern willow flycatcher would be lost. Individual Rio Grande silvery minnow eggs and larvae would be impinged on or entrained thru fish screens.	None

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Loss or substantial degradation of supporting habitat	373 acres riparian habitat would be lost; due to ground water elevation drawdown.	1.8 acres of riparian habitat would be lost; no Rio Grande silvery minnow habitat would be lost or substantially degraded.	0.2 acres riparian habitat would be lost; 1 acre of Rio Grande silvery minnow habitat would be lost or substantially degraded.	27 acres riparian habitat would be lost; due to ground water elevation drawdown Rio Grande silvery minnow habitat would be lost or substantially degraded.
Loss or modification of RGSM critical habitat (acres)	0	0	0.2 acres of critical habitat lost or modified	0
Traffic and Circulation				
Number of street/highway/railroad intersection crossings (constructed or bored).	Some possible	19	19	19
Length of pipeline to be installed in 2-lane streets (linear feet).	Some possible	56,600	56,600	56,600
Length of pipeline to be installed in 4+-lane streets (linear feet).	Some possible	37,800	37,800	37,800
Upland Vegetation				
Number of unique upland plant communities affected by construction or operation of the DWP	0	0	0	0

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Number of rare or sensitive upland plant species affected by construction or operation of the DWP	0	0	0	0
Upland vegetated areas to be permanently converted to non-vegetated areas (acres)	0	2	2	2
Total length of unpaved route with upland vegetation to be disturbed by construction (approximate linear feet)	0	26,000	26,000	26,000
Total length of ditch corridor of mixed riparian/upland vegetation disturbed by construction (linear feet)	0	76,600	Minimal	Minimal
Water Quality				
Degradation of water quality in the Rio Grande due to in-river construction	None	Temporary turbidity effects downstream from construction sites.	Temporary turbidity effects downstream from construction sites.	Temporary turbidity effects downstream from construction sites.
Degradation of water quality in the Rio Grande due to DWP operations	None	None	None	None

TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS
ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Reduction in the quality or taste of potable water treated at the proposed WTP	--	None	None	None
Wetlands/Non-wetland Waters				
Number of jurisdictional wetlands affected by construction or operation of the DWP	0	0	0	0

**TABLE 2.7-1 (Continued)
SUMMARY OF DRINKING WATER PROJECT EFFECTS
ON ALL EVALUATED RESOURCE CATEGORIES [a/]**

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Wildlife				
Number of high-use waterfowl areas that would be lost due to project operations	0	0	0	0
Productive songbird riparian habitat that would be permanently lost due to project construction (acres)	0	1.8	6.6	10.6
Number of active raptor nests that would be lost because of project construction	0	0	1	3
Number of active raptor nests that would be lost because of the close proximity of project structural facilities and associated human presence	0	0	1	3

TABLE 2.7-1 (Concluded)
SUMMARY OF DRINKING WATER PROJECT EFFECTS ON ALL EVALUATED RESOURCE CATEGORIES [a/]

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Amount of riparian wildlife habitat that would be permanently altered due to project operations (acres)	373	0	0	552
Number of birds protected under the Migratory Bird Treaty Act that would be lost as a direct result of project construction or operations	0	0	0	0

[a/] ac-ft/yr = acre-feet per year; AWRMS = Albuquerque Water Resources Management Strategy; BMP = best management practices; cfs = cubic feet per second; DWP = Drinking Water Project; kWH/yr = kilowatt hours per year; NAAQS = National Ambient Air Quality Standards; NAGPRA = Native American Graves Protection and Repatriation Act; SJC = San Juan-Chama; SWRP = Southside Water Reclamation Plant; WTP = water treatment plant.

SECTION 3

AFFECTED ENVIRONMENT/ENVIRONMENTAL CONSEQUENCES

This section develops the scientific and analytical basis for comparison of the four alternatives, including the No Action Alternative, and describes the probable consequences of each alternative on environmental resources. The discussions are organized as follows:

- The environmental setting of the Rio Grande Basin is described in Section 3.1;
- The DWP area evaluated in this FEIS is reviewed in Section 3.2;
- Major water-management projects and features in the project Region of Influence (ROI) are described in Section 3.3;
- Baseline environmental conditions, and the environmental consequences of the alternatives, are discussed for each evaluated resource category in Sections 3.4 through 3.29 (resources issues identified during scoping are presented in Appendices B through D); and
- Cumulative, unavoidable, irreversible, and irretrievable effects of the alternatives are reviewed and summarized in Sections 3.30 through 3.33.

3.1 ENVIRONMENTAL AND HYDROLOGIC SETTING – RIO GRANDE BASIN, NEW MEXICO

The Rio Grande is approximately 2,000 miles long, making it the 24th longest river in the world. Its extensive watershed drains 355,500 square miles (mi^2), and is the 5th largest watershed in North America. From its headwaters in the San Juan Mountain Range in southern Colorado, the river flows through New Mexico and into Texas, then along the international border between the United States and the Republic of Mexico. The Rio Grande discharges into the Gulf of Mexico near Brownsville, Texas.

In New Mexico, the Rio Grande is divided into three reaches: the Upper, Middle, and Lower Rio Grande. The Middle Rio Grande corresponds to the 130202 Hydrologic Unit in New Mexico ([USGS], 1974 and 2000). Five physiographic regions make up portions of the Rio Grande Drainage: the Coastal Plain, the Great Plains, the Basin and Range, the Colorado Plateau, and the Southern Rocky Mountains. The Middle Rio Grande and its tributaries are located within the latter three regions.

From its origin in Colorado north of Santa Fe, New Mexico, the Rio Grande Basin is located within the Southern Rocky Mountains physiographic province. Within the Colorado Plateau province, broad, generally low-relief plateaus, with horizontal or gently deformed Paleozoic, Mesozoic, and Cenozoic rock strata, characterize the area of the Middle Rio Grande Basin. The Rio Puerco and Rio Salado are two major tributaries to the Rio Grande that have the majority of their drainage basins in this region (Bullard and Wells, 1992).

3.1.1 Hydrology

Physically, the nature of the Rio Grande and its tributaries varies with the location within the drainage basin. Topographic relief is greatest in headwater regions, and from Velarde to Cochiti Reservoir, the river gradient drops at a rate of about 10 feet per mile. From Cochiti Dam to Elephant Butte, where the topographic relief is low, the gradient is about 4 feet per mile (Bullard and Wells, 1992).

River channel characteristics such as width and sinuosity are strongly influenced by position within the drainage basin. The width of the Rio Grande Valley ranges from less than 700 feet in the Rio Grande Gorge to 1 to 6 miles from Velarde to Elephant Butte, with the exception of White Rock Canyon at river mile (RM) 252 and the San Marcial Constriction at RM 69. Floodway widths (based on 1977 Reclamation cleared widths) in the Velarde to Elephant Butte Reservoir portion of the river are noted in Table 3.1-1.

TABLE 3.1-1
RIO GRANDE FLOODWAY WIDTHS IN NEW MEXICO FROM VELARDE TO ELEPHANT BUTTE RESERVOIR

Reach	Period of Clearing	Range of Cleared Floodway Widths (feet)	Estimated Range of Entire Floodway Widths (feet)
Española	1956-1958	344-459	1,640-2,624
Cochiti	1953-1974	164-1,476	229-4,723
Albuquerque	1953-1974	360-1,476	246-3,017
Belen	1953-1974	344-2,361	492-3,050
Socorro	1951-1974	295-1,705	787-4,920
San Marcial	1951-1974	426-1,541	688-2,214

Source: Bullard and Wells, 1992.

Most of the discharge of the Rio Grande results from late spring snowmelt and rainstorms. Summer convective storms produce runoff in isolated parts of the basin. These storms may alter river hydrology in portions of the watershed for brief periods. Most of the annual flow and discharge of the Rio Grande is generated in the headwaters of the river basin in Colorado and from the Rio Chama, its major tributary in New Mexico (Figure 1.1-1). Average annual discharge of the Rio Grande into the Gulf of Mexico is about 9,000,000 ac-ft. Annual runoff north of the Colorado–New Mexico state line is 425,680 ac-ft at Lobatos, Colorado (gage 08251500) (USGS, 2000). In the entire

Rio Grande headwater region, the annual runoff ranges from 215,000 to 1,100,000 ac-ft/yr, with an average of 660,000 ac-ft/yr (Bullard and Wells, 1992).

Flow in the Rio Chama is a combination of native water and transmountain diversions from the SJC Project. As described in Section 3.3.1, this Reclamation project transfers New Mexico water rights in the Colorado River from that drainage to the Rio Grande Basin via a series of dams and tunnels under the Continental Divide (Bullard and Wells, 1992).

3.1.2 Climate

Most of the region considered in this DWP FEIS is a continental plateau with an arid to semi-arid climate. Climate characteristics include average annual precipitation of less than 15 inches, high solar radiation, low relative humidity, high evaporation and transpiration rates, and a wide range of diurnal/nocturnal and seasonal temperatures. In the higher mountain ranges flanking the river valley, adjacent mesas, and foothills, sub-humid and humid climatic conditions prevail.

Two factors that exert major influences on the climate of the Rio Grande region are topography and atmospheric circulation patterns, which combine to cause wet and dry years. In areas such as the Middle Rio Grande, dry years and their persistence are important considerations in the storage and operation of water facilities in the region. The relationship between these manifestations of climate and other natural and human disturbances may be among the most significant factors influencing ecological systems in New Mexico (Finch and Tainter, 1995).

The Middle Rio Grande Basin lies within three climatic subtypes: the valley reach and lowlands (less than 5,000 feet above mean sea level [amsl]) from Town of Bernalillo to Elephant Butte Reservoir have an arid climate; the adjacent uplands (to 9,000 feet amsl) to the east, west and north of Albuquerque have a semi-arid climate; and the mountains (above 9,000 feet amsl) have a sub-humid climate. In the arid areas, temperatures and evaporation are high, and annual precipitation is less than 10 inches. The frost-free season ranges from 180 to 200 days. The average annual rainfall at the Albuquerque airport is 8.70 inches.

The semi-arid portions of the region, sometimes referred to as grasslands, have average temperatures in the warmest months in the 70s in degrees Fahrenheit (°F) and in the coolest months around 32°F. Annual precipitation ranges from near 11 to 18 inches; the average is 15 inches. The semi-arid climate extends over most of the region. Temperatures are somewhat lower than in the arid subtype. The annual moisture deficiency is between 10 and 21 inches. Spring winds with blowing dust are annual events (Tuan *et al*., 1973). Temperatures generally decrease 5 °F for every 1,000 feet in elevation gain.

In the Middle Rio Grande Basin, precipitation falls during two distinct periods – winter and summer (early July to late September). The principal sources of moisture for this precipitation are the Gulf of Mexico and the Pacific Ocean. About 50 percent of the annual precipitation falls in summer from thunderstorms, which are uplifted over high mountains by convection-heated air. Snowfall derives mostly from cyclonic storms of moist Pacific air masses, generally moving eastward over the mountains. November and May or June receive the least amounts of precipitation.

3.2 PROJECT AREA EVALUATED IN THE FEIS

The project ROI was evaluated to determine the potential environmental effects of implementing the four alternatives. To facilitate data collection, focus assessment efforts, and ensure that the areas most likely to be potentially affected by components of the DWP were thoroughly and comprehensively evaluated, the ROI was divided into three subareas along the Rio Grande Basin. The boundaries of the subareas are based on key water conveyance sites relevant to the DWP: a) point at which the City takes delivery of it SJC water; b) point at which the City would divert imported and native water; and c) point at which the City would return native water. From north to south, the following subareas comprise the FEIS evaluation area or ROI:

- **Upper Project Subarea – (Figure 3.2-1)** From the outlet works of Heron Reservoir to the proposed Angostura Diversion (at RM 209.7) (approximately 145 river miles), or from the outlet works of Heron Reservoir to the proposed Paseo del Norte Diversion or Subsurface Diversion (at RM 192) (approximately 165 river miles).

- **Middle Project Subarea – (Figure 3.2-2)** The approximately 33 river miles from the Angostura Diversion facility (RM 209.7) to the Albuquerque SWRP outfall (RM 177) or 15 river miles from Paseo del Norte Diversion or Subsurface Diversion (RM 192) to the SWRP outfall (at RM 177).

- **Lower Project Subarea – (Figure 3.2-3)** The approximately 120 river miles from the SWRP outfall (at RM 177) to the headwaters of Elephant Butte Reservoir (at RM 57).

These subareas are further described below.

3.2.1 Upper Project Subarea

The Upper Project Subarea begins at the outlet works of Heron Reservoir where the City takes delivery of its SJC water. The Upper Project Subarea ends at the point of diversion at Angostura for Angostura Diversion or Paseo del Norte for Paseo del Norte Diversion and Subsurface Diversion.

The Upper Project Subarea includes the Rio Chama channel and associated riparian corridor from the outlet works of Heron Reservoir to the confluence of the Rio Chama with the Rio Grande, and the Rio Grande corridor from the confluence to a point immediately upstream from the proposed diversion facilities in the Middle Rio Grande (Figure 3.2-1). This subarea comprises approximately half of the total length of the river corridor evaluated in this FEIS. Approximately 84 river miles of the Rio Chama lies within the Upper Project Subarea. From the confluence of the Rio Chama and Rio

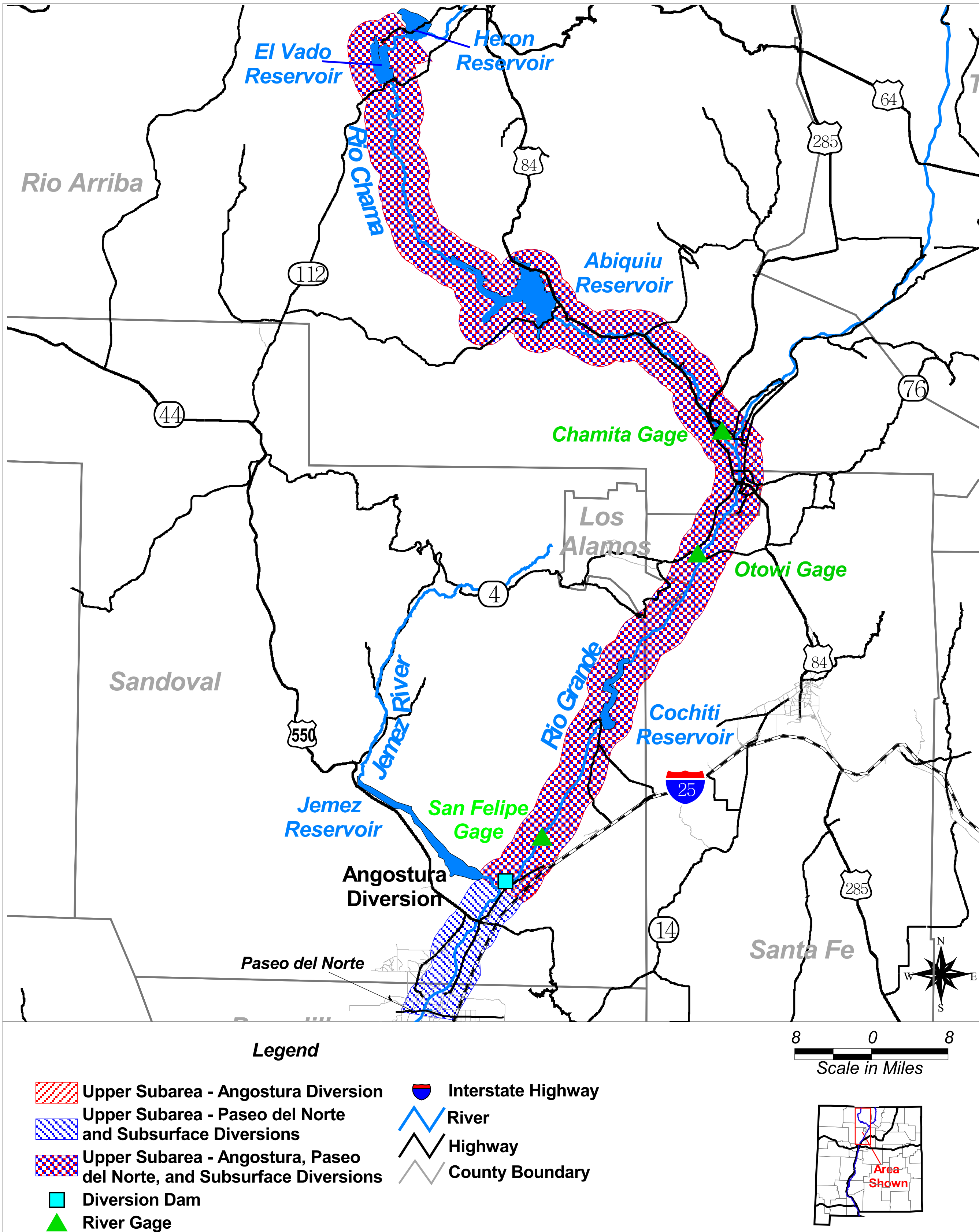

Figure 3.2-1
Upper Project Subarea

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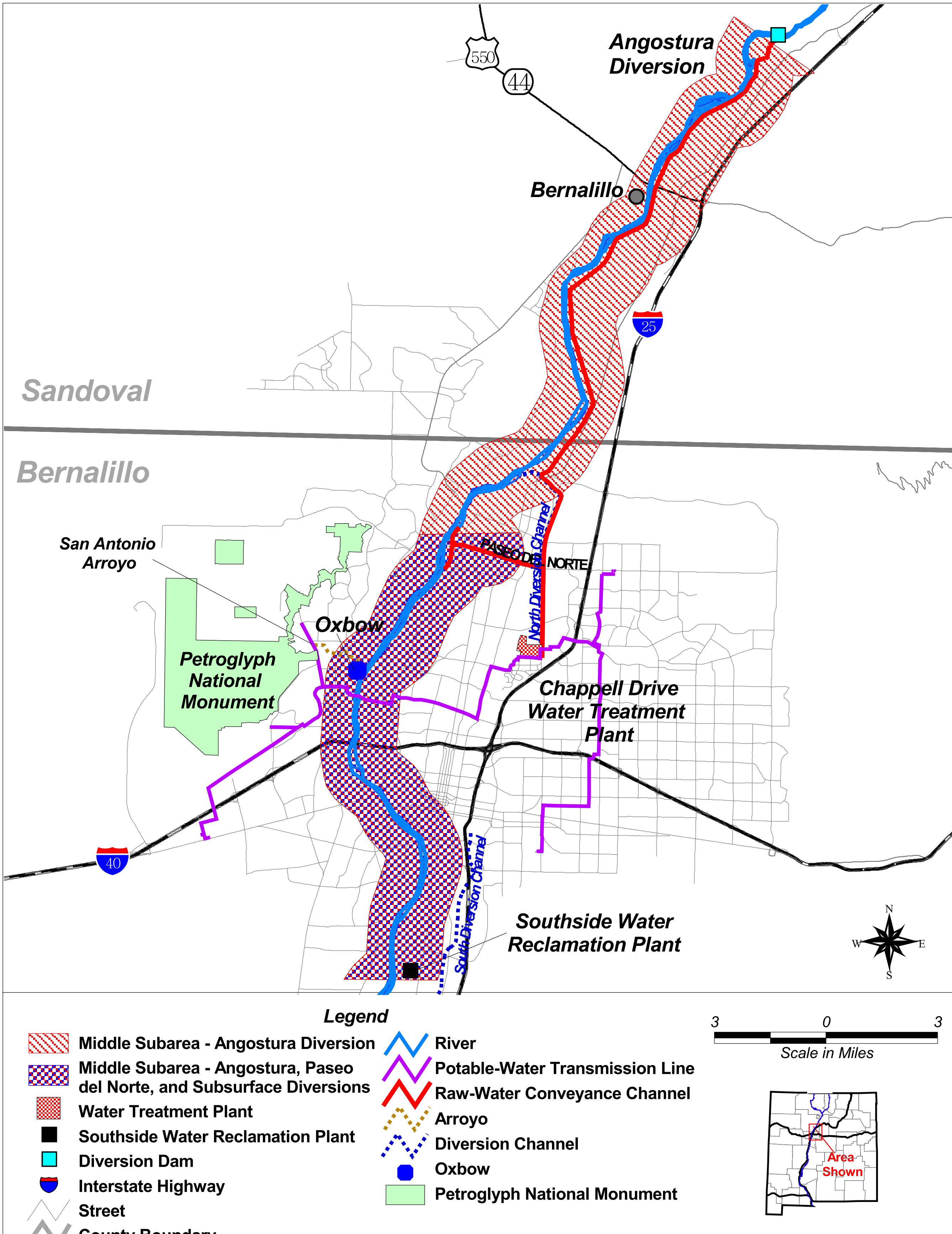

Figure 3.2-2
Middle Project Subarea

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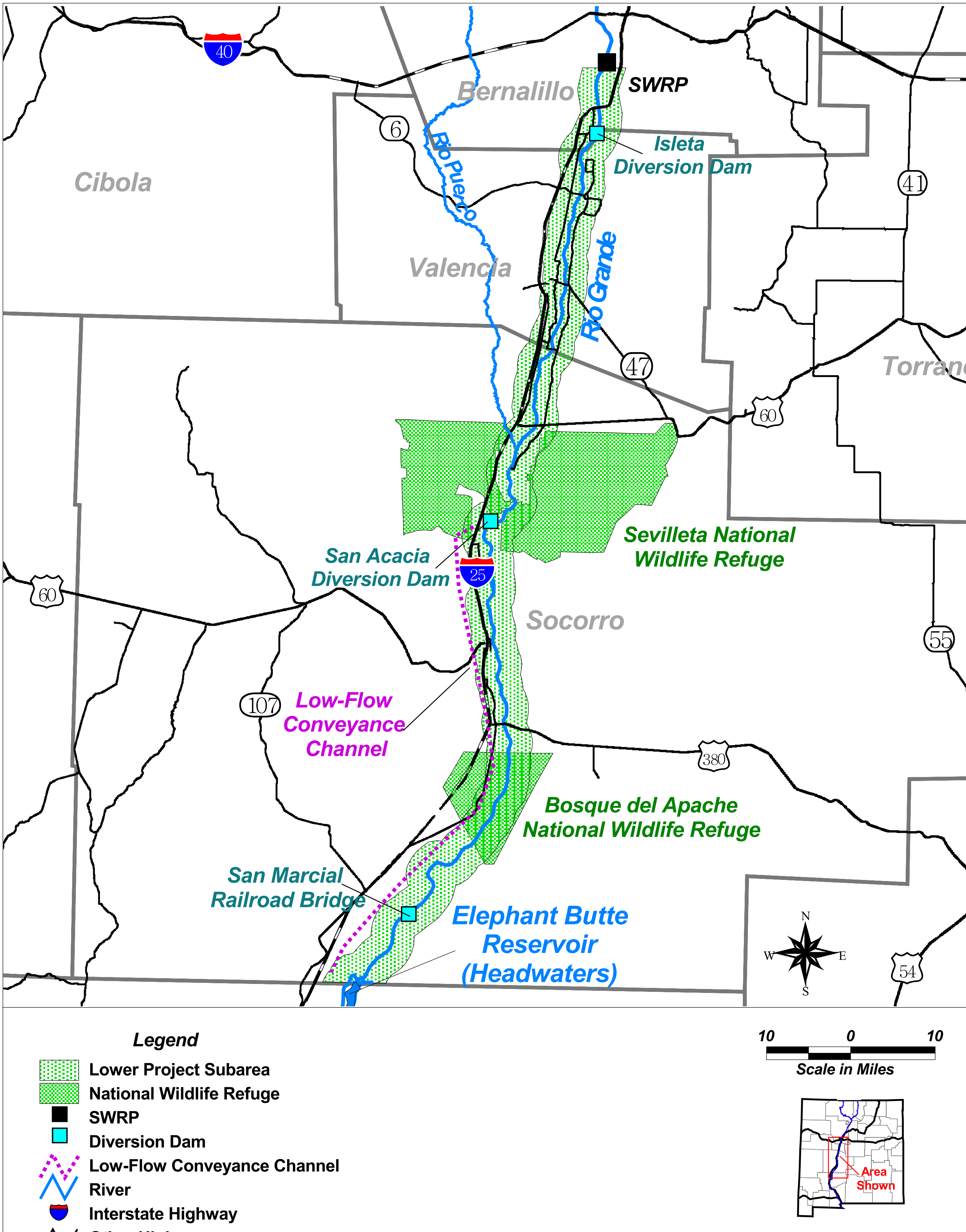

Figure 3.2-3
Lower Project Subarea

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Grande to the proposed Angostura diversion facility is approximately 61 river miles, and from the confluence to the proposed Paseo del Norte diversion facilities (Paseo del Norte Diversion or Subsurface Diversion) is approximately 80 river miles. Heron, El Vado, and Abiquiu Reservoirs are located along this reach of the Rio Chama, and Cochiti Reservoir is located in this reach of the Rio Grande (see Section 3.3.1). Parts of Rio Arriba, Santa Fe, Los Alamos, Sandoval, and northern Bernalillo Counties fall within this subarea.

3.2.2 Middle Project Subarea

The Middle Project Subarea begins at the point of diversion and ends at the SWRP. The Middle Project Subarea also includes areas in Bernalillo and/or Sandoval Counties in which construction and operation of project facilities would occur.

Figure 3.2-2 shows the extent of the Middle Project Subarea from the proposed diversion-facility sites to the SWRP. The existing MRG Project Angostura Diversion Dam is located along this reach of the Rio Grande (see Section 3.3.2). This area represents approximately 33 river miles (from the Angostura Diversion Dam to SWRP), and 15 river miles for Paseo del Norte Diversion and Subsurface Diversion (from Paseo del Norte to the SWRP); or 4 to 10 percent of the total length of river corridor evaluated. All of the construction areas, which are within Bernalillo County, are included in this evaluation subarea. Southern Sandoval County also is within this subarea.

3.2.3 Lower Project Subarea

The Lower Project Subarea begins at the SWRP and ends at the headwaters of Elephant Butte Reservoir.

The Lower Project Subarea extends 120 river miles from the SWRP outfall in Bernalillo County to the headwaters of Elephant Butte Reservoir (Figure 3.2-3). The Isleta and San Acacia diversion dams are located along this reach of the Rio Grande (Section 3.3.3). This reach of the Rio Grande represents approximately 35 percent of the total length of river corridor evaluated in this FEIS. This subarea traverses Valencia, Socorro, and Sierra Counties.

3.3 WATER MANAGEMENT AND PROJECT FEATURES

The Rio Chama and Rio Grande are extensively managed for flood control and beneficial uses. Irrigation diversions have been in operation in parts of New Mexico since at least the 10th century *anno domini* (AD), well before the arrival of Spanish explorers. From the 1500s to 1800s, Spanish colonization resulted in the increased development of acequias (canals) for irrigation purposes. By the late 1880s, several thousand acres of land in the Middle Rio Grande Basin were under irrigation (Bullard and Wells, 1992). These early developments set the course for water development in the Middle Rio Grande, and established prior and paramount water rights for the Indian Pueblos in the area. The hydrology and major water-management features in the project subareas are reviewed in this subsection.

3.3.1 Physical Features in the Upper Project Subarea (Outlet works of Heron Dam to Angostura Diversion)

San Juan-Chama Project

Congress authorized construction of the SJC Project under Public Law 87-483 on June 13, 1962. SJC Project collection and diversion units are located in the upper reaches of the San Juan River in south-central Colorado and in Willow Creek in north-central New Mexico. All of the San Juan portions of the project are located on the west slope of the Continental Divide and all of the Willow Creek/Rio Chama facilities lie east of the Divide. Collection and diversion facilities are located on tributaries of the San Juan River in Colorado. These facilities consist of three small diversion dams on the Rio Blanco, Little Navajo, and Navajo Rivers. In addition, a conduit system consisting of closed feeder canals, siphons, and three tunnels (Blanco, Little Oso, and Azotea) transport water beneath the Continental Divide to the Willow Creek drainage and into Heron Reservoir. The Heron Dam and Reservoir are the SJC Project features located farthest upstream in the Rio Grande drainage (Reclamation, 1971). Figure 3.3-1 shows where the tunnels enter Willow Creek.

The purpose authorized by Congress for the SJC Project is to furnish water from the Colorado River Basin to the Middle Rio Grande Valley for municipal and industrial supply, irrigation uses in depressed areas of Northern New Mexico, or supplemental irrigation. Table 3.3-1 lists the SJC water contractors. Albuquerque signed a repayment contract for its SJC water in 1963, and amended their contract in 1965. The City took its first delivery of SJC water in 1972 (CH2M Hill, 1995a).

TABLE 3.3-1
SAN JUAN-CHAMA WATER CONTRACTORS

Contractor	Allocation (ac-ft/yr)
City of Albuquerque	48,200
Middle Rio Grande Conservancy District	20,900
Jicarilla Apache Nation	6,500
Santa Fe City and County	5,605
Cochiti Reservoir Recreational Pool	5,000
Pueblo of San Juan	2,000
County of Los Alamos	1,200
Pojoaque Valley Irrigation District	1,030
Española	1,000
Town of Belen	500
Town of Bernalillo	400
Village of Los Lunas	400
Village of Taos	400
Red River	60
Village of Taos Ski Valley	15
Un-contracted	2,990
Total:	96,200

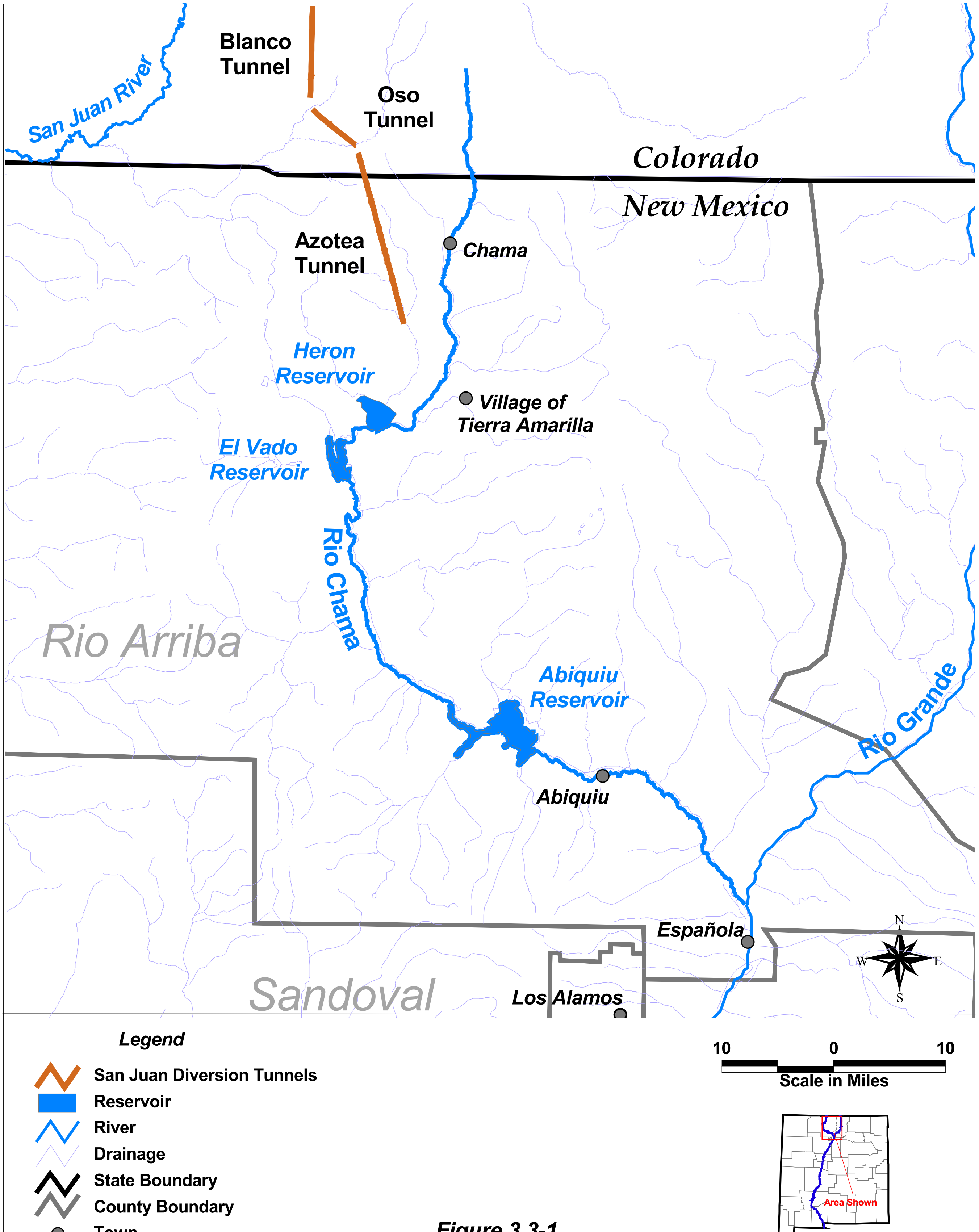

Figure 3.3-1
San Juan Chama Project Tunnels and Associated Reservoirs Located on the Rio Chama (Existing San Juan Project Features)

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Rio Chama Watershed

The Rio Chama originates in extreme southern Colorado and flows 115 miles south and east to its confluence with the Rio Grande. The Rio Chama is the largest tributary to the Rio Grande in New Mexico (Fogg *et al*., 1992). Portions of the Rio Chama drainage are located in Conejos and Archuleta counties, Colorado and Taos and Sandoval counties, New Mexico. Rio Arriba County, New Mexico contains the majority of the Rio Chama drainage. Total river length in New Mexico is approximately 60 miles, with a drainage area of 3,159 mi^2, of which 2,146 mi^2 are above Abiquiu Dam. Principal tributaries above El Vado Dam are Rio Brazos, with a drainage area of 168 mi^2, and Willow Creek, with a drainage area of 193 mi^2. Elevations in the watershed range from about 12,000 feet amsl in the San Juan Mountains to about 5,600 feet amsl at the mouth of the Rio Chama (USACE, 1995).

On November 7, 1988, Congress passed Public Law 100-633 designating the Rio Chama between El Vado and Abiquiu Reservoirs as a national Wild and Scenic River.

The Carson National Forest occupies 856,700 acres of Rio Arriba County, and the Santa Fe National Forest occupies 531,600 acres (USACE, 1995). The Rio Chama enters the designated Wild and Scenic River section at an elevation of about 6,710 feet amsl at El Vado Reservoir. The river drops at an average rate of slightly more than 15 feet per mile throughout the reach.

Heron Dam and Reservoir (Rio Chama)

Heron Dam and Reservoir are located on Willow Creek, a tributary of the Rio Chama, just above the creek's confluence with the Rio Chama. The dam and reservoir provide a regulating and storage capability for San Juan River water diverted through the Continental Divide. The Colorado River Compact allocated New Mexico 11.25 percent and the diversion and reservoirs associated with the San Juan – Chama Project allow New Mexico to exercise part of its allocation. The reservoir has a storage capacity of about 401,000 ac-ft and a surface area of 5,950 acres. The dam is an earthfill structure rising about 269 feet above the streambed with a crest 1,220 feet long. The crest of the dam has an elevation of 7,199 feet amsl. Heron Dam is located 5 miles upstream from El Vado Dam and Reservoir. Heron Reservoir is operated by Reclamation in compliance with applicable federal and state laws, including the San Juan-Chama Project authorization and the Rio Grande and Colorado Compacts. Under these laws, only imported San Juan-Chama Project water may be stored in Heron Reservoir; there are no provisions for storing native Rio Grande water. Native Rio Grande waters cannot be stored in Heron Reservoir and must be by-passed through Heron Reservoir on a regular basis. Heron Reservoir is a cold water reservoir with depths ranging from 30 to more than 100 feet (Reclamation, 1997b). By agreement with Reclamation, the State of New Mexico developed Heron Lake State Park for public recreational use, and is responsible for operation and maintenance of the park.

El Vado Reservoir (Rio Chama)

El Vado Dam, located on the Rio Chama about 160 miles north of Albuquerque, was built by the MRGCD in 1934-1935, was rehabilitated by Reclamation in 1954-1955, and is currently operated by Reclamation pursuant to an agreement with MRGCD. Native waters stored and released from El Vado are subject to restrictions of the Rio Grande Compact. Water imported into the Rio Grande via the SJC Project and stored in El Vado Reservoir is not subject to restrictions under the Rio Grande Compact (USACE, 1995).

El Vado Reservoir has a maximum storage capacity of 209,330 ac-ft. With sediment storage capacity, the volume of available water is approximately 180,000 ac-ft/yr. The top of the active conservation storage is located at elevation 6,902 feet amsl.

Rio Chama from El Vado Dam to Abiquiu Reservoir

On November 7, 1988, Congress passed Public Law (PL) 100-633, designating the Rio Chama between El Vado and Abiquiu Reservoirs as a national Wild and Scenic River. This legislation designated the segment from the El Vado Ranch launch site downstream to the beginning of US Forest Service Road 151 as a wild river. The segment from the beginning of US Forest Service Road 151 downstream to an elevation of 6,343 feet amsl was designated as a scenic river. The two segments combined are approximately 25 miles in length (Fogg *et al*., 1992).

The Rio Chama enters the Wild and Scenic River section at an elevation of about 6,710 feet amsl, and then drops at an average rate of slightly more than 15 feet per mile. Throughout most of the area studied as a result of the Wild and Scenic River designation, the Rio Chama is slightly entrenched, with the ratio of floodplain width to channel width generally less than 2 to 1. Sinuosity is generally less than 1.15 above the Christ-in-the-Desert-Monastery. Below the confluence with the Rio Gallina, the floodplain widens considerably; however, sinuosity is still relatively low (Fogg *et al*., 1992).

Abiquiu Dam and Reservoir (Rio Chama)

Abiquiu Dam and Reservoir are located in Rio Arriba County, New Mexico on the Rio Chama, 32 river miles from its confluence with the Rio Grande, which occurs at RM 245 on the Rio Grande, 1,621 miles above the mouth of the Rio Grande. The total drainage area above Abiquiu Reservoir is 2,146 mi^2. Abiquiu Dam is a rolled-earth structure, 30 feet wide at the top and 2,000 feet wide at the bottom, with a maximum height above streambed of 341 feet (USACE, 1995).

Abiquiu Dam and Reservoir are operated primarily for flood and sediment control, as well as storage of SJC water. Abiquiu is operated by the USACE Albuquerque District under PL 97-140. Maximum pool of the reservoir, at elevation 6,374.7 feet amsl, is 15,536 acres, with an incremental capacity of 342,500 ac-ft and a total capacity of 1,541,024 ac-ft. The SJC water-storage pool has a water surface elevation of 6,220 feet amsl, with a current storage capacity of 189,307 ac-ft. The City and other entities that contract for SJC Project water can store up to 200,000 ac-ft of water in Abiquiu in accordance with a contract between the entities and the USACE.

A maximum flow below Abiquiu Dam of 2,990 cfs was recorded in July 1965, and minimum flows of 0 cfs have been recorded numerous times since Abiquiu began operation in February 1963 (USACE, 1995). Evacuation of SJC water may be required when the snowmelt forecast indicates a need for flood capacity exceeding 302,000 ac-ft.

The snowmelt runoff forecast point for the Rio Chama is the inflow to El Vado Reservoir.

Rio Chama from Abiquiu Dam to Rio Grande Confluence

In the Rio Chama below Abiquiu Dam, summer and fall flows are higher than natural due to increased reservoir releases, including releases of imported SJC water and storage from Abiquiu Reservoir. Release of native water stored in upstream reservoirs is addressed in subsequent sections.

Abiquiu Dam has regulated Rio Chama flows below the dam since 1963. The hypolimnetic release from the dam supports the production of salmonids for several miles downstream. The NMDGF has designated the first 7 miles of the Rio Chama below Abiquiu Dam as special trout water, allowing only two trout per person per day to be harvested.

Rio Chama Acequias

The term “acequia” in New Mexico denotes either the physical features associated with a surface irrigation system (ditch) or the elected board, its members, and the community it supports. Currently it is estimated that there are 800 community acequia associations, mostly in the north central portions of the state (USACE, 1999). Seventeen acequias currently exist on the Rio Chama from Abiquiu to the Rio Grande confluence near Española. The reported rates of diversion for 15 of these acequias are up to 15 cfs (USACE, 1999).

The diversion structure is located on the stream to be diverted and consists of either a diversion dam or heading structure. The distinction between a heading and diversion dam is a heading does not span the entire channel whereas a diversion structure does. These structures have varying construction techniques. Brush, timbers, and boulders comprise the bulk of the less permanent structures. These structures require frequent maintenance and modifications to keep operating after high flows and to enable diversions at low flows. The permanent structures are concrete or gabion dams with integrated sluiceway, control gates and headgates.

Rio Grande from Rio Chama/Rio Grande Confluence to Cochiti Reservoir

The morphologic character of the Rio Grande changes below its confluence with the Rio Chama. The Rio Chama carries a much higher load of sand and fine sediment than does the Rio Grande above the confluence. This factor and the increase in flow combine to make the Rio Grande below the Rio Chama a wider, flatter, and sandier river (Reclamation, 1971).

The reach of the Rio Grande from its confluence with the Rio Chama to Cochiti Reservoir is approximately 15 miles long. The average longitudinal gradient is about 6 feet per mile, and the channel width averages about 300 feet. Predominant bed materials are gravel and sand, and the riverbanks are largely sandy with some gravel. Major tributaries in the reach are the Rio Pojoaque and Santa Cruz Creek, both ephemeral streams (Reclamation, 1971).

The majority of this reach is canyon-bound with the remainder in open floodplain. This reach has a high gradient, with a lower gradient in the open reaches. Gravel, cobbles, and boulders, with little fine material, dominate the substrate. There is low sinuosity and little segmentation with the exception of several concrete instream diversion structures near Velarde.

The USGS Otowi Gage is located below the confluence of the Rio Chama with the Rio Grande at the Otowi Bridge near San Ildefonso, New Mexico. The period of record for this gage is from February 1895 to December 1905 and June 1909 to the present, making it one of the oldest gages in the United States.

Much of the Española Reach was channelized in the 1950s. Below the Rio Chama, the channel's bottom width increases to 70 feet to accommodate a flow design capacity of 7,850 cfs. No riverbank protection was present until the mid-1980s, and the river had shown a tendency to return to its natural braided and meandering state. Levees were built in the 1950s to protect the City of Española from flooding. Past gravel mining activities have adversely impacted the Española Reach. In extracting sand and gravel products, miners have excavated the actual riverbed at various locations. This lowering of the riverbed has overly steepened the river slope and destabilized the channel for a considerable distance upstream. Typically, the river responded by upstream downcutting of the riverbed, causing the banks to become excessively high and steep. Caving and sloughing of unstable banks has caused widening of the river channel and increased braiding (Reclamation, 1971).

This is a cold water reach with low conductivity and turbidity. Some tributary streams that enter this section can introduce high sediment loads during storm events. There are point discharges from wastewater effluent from the communities upstream, but the water quality of the reach is most influenced by non-point sources. There are historical and current sources from mining and heavy metals in the Red River drainage that then enter the Rio Grande.

Cochiti Dam and Reservoir (Rio Grande)

Construction of the Cochiti Dam and Reservoir was authorized by the Flood Control Act of 1960. Cochiti Dam is located on the Middle Rio Grande in Sandoval County in north central New Mexico. It is located just downstream of White Rock Canyon near the confluence of the Santa Fe River and the Cañada de Cochiti. It is upstream of the confluence of the Rio Grande with the Jemez River.

Cochiti Dam is a rolled, earthfill embankment with a crest length of approximately 5 miles and a crest height of 250 feet above the Rio Grande streambed. Reservoir capacity is 596,400 ac-ft but sediment accumulation reduces that capacity. Cochiti Reservoir (lake) has a surface area of 9,365 acres at the top of the flood control pool and extends approximately 20 miles upstream into White Rock Canyon. Cochiti Dam serves as a diversion point for irrigation water for downstream users. Water is released to the Cochiti Eastside Main Canal on the left (east) bank and to the Sili Main Canal on the right (west) bank for irrigation of several thousand acres. Use of the river for irrigation in this area predates the construction of Cochiti Dam by many years.

Cochiti Reservoir is operated for flood control, sediment control, recreation, and the conservation and development of fish and wildlife resources. During normal, non-flood-control operation, irrigation and other requirements are met by regulating outflows to equal inflows to the extent possible (USACE, 1996a).

The USACE operates Cochiti Dam and Lake pursuant to PL 86-645, as follows:

- The outflow of Cochiti Lake during each spring flood and thereafter will be at the maximum non-damaging rate of flow that can be carried at the time in the channel of the Rio Grande through the middle valley; provided, that whenever during the months of July, August, September, and October, there is more than 212,000 ac-ft available within the reservoir for flood regulation and the inflow to the reservoir (exclusive of upstream releases from flood control storage) is less than 1,500 cfs, no water will be withdrawn from storage within the reservoir and the releases from upstream flood control storage will be retained in the reservoir;

- Storage of water in and the release of water from the reservoir will be accomplished for flood and sediment control; provided, that the USACE will endeavor to avoid encroachment on the upper 212,000 ac-ft of capacity in Cochiti Reservoir, and that all reservoirs in the Middle Rio Grande project will be evacuated on or before March 31 of each year; and

- All reservoirs of the Middle Rio Grande project (including Cochiti Reservoir) will be operated at all times in the manner described in conformity with the Rio Grande Compact, and no departure from the operation schedule set forth in the Act will be made except with the advice and consent of the Rio Grande Compact Commission; provided, that whenever the USACE determines that an emergency exists affecting the safety of major structures or endangering life and shall advise the Rio Grande Compact Commission in writing these rules of operation may be suspended during the period of and to the extent required by the emergency.

Rio Grande from Cochiti Dam to Angostura Diversion Dam

For approximately 20 miles, from Cochiti Dam to the Angostura Diversion Dam, the Rio Grande consists of a sand and gravel riverbed and has highly erodible, sandy banks. The past influence of Cochiti Dam on this reach has produced severe erosion problems. Cut-off of its sediment load at the dam has resulted in the degradation and armoring of the riverbed and made the relatively erodible banks increasingly more vulnerable (Reclamation, 1971).

The dam influences peak flows and flow duration. Operating procedures at the dam limit maximum flow releases to 10,000 cfs. The storage and release of floodwaters has diminished the magnitude of peak flows, while increasing the duration of lower flows (Reclamation, 1971).

Throughout the Cochiti Reach, the river channel averages approximately 300 feet wide and the river’s longitudinal slope is approximately 6.7 feet per mile. Prior to channelization in the late 1950s and early 1960s, this section of the river was braided with numerous islands and bars. Early channelization efforts included construction of pilot channels and installation of Kellner jetty jack fields. Built up levees on both sides of the river confine overbank flows. San Felipe Pueblo lies adjacent to the west riverbank and is currently unprotected by levees and, therefore, is a notable exception (Reclamation, 1971).

Tributaries in the Cochiti Reach are ephemeral streams. Galisteo Creek and Tonque Arroyo are the largest. Several lesser arroyos also enter the Rio Grande in the Cochiti Reach. Galisteo Creek is an intermittent source of significant quantities of fine sediment. A USACE retention dam on Galisteo Creek limits discharges to 2,000 cfs (Reclamation, 1971). This reach of the Rio Grande has perennial flow. The hydrograph is modified to reduce the peak in some years with extended release in years of high inflow. Under flood control operations, Cochiti Dam passes flows ranging between about 5,000 cfs and 8,500 cfs, depending upon downstream channel conditions. There is a spring peak that coincides with snowmelt runoff.

This reach has levees on the east side and is incised in the upper sections. The width-to-depth ratio is lower in the incised section than in the downstream section. This is due to sediment capture by Cochiti Dam and lack of upstream sources of sediment. The substrate in the upper section is armored cobble. The arroyos introduce sediment to the lower sections of this reach, and a higher percentage of fine sediments are found on the surface of the armored cobble. This finer sediment moves downstream with higher flows. The streambed gradient is moderate, and is lower than the reach above Cochiti Reservoir.

This reach has low sinuosity, and routine channel maintenance (e.g., bank stabilization) activities are performed. The segmentation in this reach is limited to the Angostura diversion structure on the downstream end and Cochiti Dam on the upstream end.

Angostura Diversion Dam (Rio Grande)

Angostura Diversion Dam is part of the MRG Project irrigation delivery system. The Angostura Dam, located about 5 miles north of the Town of Bernalillo, is a concrete and sheet-piling dam with sand and gravel along the edges with a concrete weir section 4.5 feet high and 800 feet long. Angostura was completed in 1934, and Reclamation rehabilitated this structure in 1958. Diversion capacity is 650 cfs (Reclamation, 1971).

Jemez Dam and Jemez Canyon Reservoir (Rio Grande)

The Jemez River enters the Rio Grande just below the Angostura Diversion Dam. Formerly, this tributary contributed a heavy sediment load to the Rio Grande, but Jemez Dam, completed in 1953, now regulates Jemez River flows for flood control and sediment retention.

3.3.2 Physical Features in the Middle Project Subarea (Angostura Diversion Dam to the Albuquerque SWRP Outfall)

Prior to substantial human alteration, the Rio Grande floodplain was characterized by a braided, slightly sinuous river that broadly meandered laterally within the 1- to 4-mile-wide floodplain. The river was bordered by a continually changing mosaic of cottonwood and willow stands of varying ages, sizes, and configurations, interspersed with more open areas of grass meadows, ponds, small lakes, and marshes.

The Pueblo of Santa Ana initiated a restoration plan in 1996, including non-native plant species removal, revegetation using native species, Kellner jetty jack removal, and monitoring activities. Phase I of this work within the river has recently been completed (USACE, 2002), including channel realignment, bank stabilization, and the construction of a gradient restoration facility, approximately 4 miles upstream of NM Highway 550 bridge.

Tributaries

Major tributaries in the Middle Reach are the Arroyo de las Barrancas, Calabacillas Arroyo, and San Antonio Arroyo. In addition, major stormwater inflows occur from the AMAFCA's NDC discharges into the Rio Grande above the City's northern limits. These discharges are discussed in detail in the section on Floodwater Conveyances.

In the river reach between Angostura Diversion Dam and the return of Rio Grande native flows to the Rio Grande via the SWRP outfall, numerous irrigation return flows enter the Rio Grande. These return flows are generally uncharacterized with respect to flow and water quality. Documentation of flow rates is being undertaken by the MRGCD. Wastewater treatment plant effluents also enter this reach of the Rio Grande, including two at Rio Rancho totaling 1.5 mgd (2.3 cfs) and one at the Town of Bernalillo with a flow of 0.8 mgd (1.2 cfs).

Oxbow

The Oxbow is approximately 48 acres. City Open Space purchased this site in early 2001. The Oxbow receives water from two sources: the San Antonio Arroyo and the Corrales Riverside Drain. The Oxbow is the terminus for both of these water conveyance structures. The Oxbow is an adjacent wetland to the Rio Grande.

The Oxbow can be divided into three parts: upper (north of Berm A), middle (between Berms A and B) and lower (South of Berm B) sections. There are two berms separating the three sections: one berm (Berm A) separates the upper and middle sections and another berm (Berm B) separates the middle section from the lower section. The San Antonio Arroyo and part of the Corrales Riverside Drain empty into the middle section of the Oxbow. There are three culverts, which drain water from the Corrales Riverside Drain into the middle section of the Oxbow.

Southside Water Reclamation Plant

The SWRP is located at RM 178 and discharges approximately 55 to 60 mgd (85 to 92 cfs) of treated municipal wastewater into the Rio Grande at its outfall downstream from the City. The closest gaging station is located approximately 5.4 miles upstream at the Central Avenue Bridge (RM 183.4) in Albuquerque.

Floodwater Conveyances

There are several floodwater-drainage conveyances that direct water from adjacent uplands to the Rio Grande in this reach. These developments are located primarily in the urbanized areas of metropolitan Albuquerque. Principal features of this system are the Albuquerque Diversion Channels. These channels were completed by USACE in 1972 to convey floodwaters originating on or near the steep slopes of the Sandia Mountains east of Albuquerque through the highly developed residential and business districts of the City and to discharge these waters into the Rio Grande. Two large diversions and associated works account for the majority of floodwaters in this system. The NDC passes through an easement along Sandia Pueblo lands. This system is fully described in a biological evaluation report prepared for the City's National Pollutant Discharge Elimination System (NPDES) permit for stormwater discharges to the river (Parsons, 2000). The NDC urban drainage basin contains approximately 92 mi^2. The basin extends from the Sandia Pueblo on the north to Gibson Boulevard on the south, and from I-25 on the west to the Sandia Mountain foothills on the east. This area is largely developed with a mix of residential (41 percent), agricultural or vacant (37 percent), and commercial (15 percent) uses, with scattered industrial use (4 percent). It also includes all drainage from the main campus of the University of New Mexico. Except for approximately 1 mile near its mouth, where it is a wide, unlined area vegetated with a combination of wetland and riparian vegetation, the NDC is concrete lined (Parsons, 2000).

Additional urban drainages are characterized in the stormwater NPDES evaluation report (Parsons, 2000). Descriptions include 11 additional conveyance systems within the City and the surrounding area.

3.3.3 Physical Features in the Lower Project Subarea (Albuquerque SWRP Outfall to Headwaters of Elephant Butte Reservoir)

Rio Grande from SWRP to Isleta Diversion Dam

This reach is perennial, with constant discharge from the SWRP outfall. On the east side of Albuquerque, and mostly south of Central Avenue, the South Diversion Channel (SDC) drains approximately 11 mi^2 of mostly urban area. This basin contains predominantly commercial (30 percent) and residential (41 percent) development. Albuquerque International Airport lies within this drainage basin, as does Kirtland Air Force Base. Discharge from this conveyance enters the Rio Grande south of Albuquerque and downstream from the SWRP via Tijeras Arroyo (Crawford *et al*., 1993; Parsons, 2000). The SDC is largely unlined, with riprap banks, and is a regulated water of the United States.

Isleta Diversion Dam (Rio Grande)

Isleta Diversion Dam (RM 169.3) is a reinforced concrete structure, 5 feet high and 674 feet long with 30 radial gates. Diversion capacity is 1,070 cfs (Reclamation, 1971). The original structure was completed in 1934, and Reclamation rehabilitated the dam in 1955. This dam serves the Belen Division of the MRGCD.

Sevilleta National Wildlife Refuge (Rio Grande)

Resident wildlife at the Sevilleta National Wildlife Refuge (NWR) includes desert bighorn sheep, pronghorn, mule deer, mountain lion, and bear. Bird species include bald eagle, peregrine falcon, northern shoveler, northern pintail, American coot, wood duck, canvasback, redhead, great blue heron, black-crowned night heron, sandhill crane, killdeer, long-billed dowitcher, red-tailed hawk, kestrel, and burrowing owl.

Rio Puerco and Rio Salado (Rio Grande)

The character of the Rio Grande changes significantly below its confluence with the Rio Puerco. The hydrologic regime and the heavy sediment loads periodically contributed by the Rio Puerco and Rio Salado strongly influence the downstream morphology of the Rio Grande. Both of these tributaries are ephemeral, but periodically contribute high sediment-laden flows in summer due to intense thunderstorm activity (Reclamation, 1971).

The Socorro Reach extends approximately 35 miles downstream from the San Acacia Dam. The sandy riverbed slopes approximately 5 feet per mile, and the banks are low and sandy. Mean size of the riverbed sands is about 0.01 inch. This channel is relatively straight, but its width varies from more than 1,000 feet to less than 200 feet (Reclamation, 1971).

San Acacia Diversion Dam (Rio Grande)

The San Acacia Dam serves the Socorro division of the MRGCD and is 7.5 feet high and 700 feet long with 29 radial gates. Construction of this diversion structure was completed in 1934, and Reclamation rehabilitated the dam in 1958. Diversion capacity is 283 cfs (Reclamation, 1971).

Bosque del Apache National Wildlife Refuge (Rio Grande)

The Bosque del Apache NWR encompasses 11 miles of the Rio Grande, and its lands are exclusively dedicated to the conservation and management of resident and migratory wildlife and its associated habitat (Reclamation, 1971).

San Marcial Reach (Rio Grande)

The 5-mile reach between the south boundary of the Bosque del Apache NWR and the Elephant Butte Reservoir reservation boundary is also similar morphologically to the Socorro Reach. In the San Marcial Reach, backwater effects of the reservoir influence sediment transport, particularly when the reservoir pool is very high (Reclamation, 1971).

The riverbed is sand and the banks are low and sandy. The river channel tends to be braided and has alternating wide and narrow widths but as a rule tends to be wide (Crawford *et al*., 1993).

San Marcial Railroad Bridge (Rio Grande)

The San Marcial Railroad Bridge is located upstream of the headwaters of Elephant Butte Reservoir. The railroad bridge limits the hydraulic capacity to 4,200 cfs of the Rio Grande through this reach (Reclamation, 2000a). This limits the discharges at Cochiti Reservoir and the potential for overbank flooding throughout the Middle Project Subarea.

Low-Flow Conveyance Channel (Rio Grande)

The Low-Flow Conveyance Channel (LFCC) parallels the river below San Acacia Diversion Dam. The LFCC is a manmade channel constructed in the 1950s designed to efficiently convey water and sediment to Elephant Butte Reservoir and provide deliveries to the Socorro Valley division of MRGCD and to Bosque Del Apache NWR. Confining flow to a deep, narrow channel was originally planned to minimize seepage and evapotranspiration. Efficient conveyance of sediment in the LFCC was proposed to lessen deposition and aggradation in the floodway (Reclamation, 1971).

During normal operation, up to 2,000 cfs can be diverted into the LFCC at San Acacia Diversion Dam, with excess water released into the floodway below the dam. Operation of the LFCC has been suspended since 1985. Operation of the LFCC previously had a considerable effect on the hydrology of the Rio Grande between the San Acacia Diversion Dam and Elephant Butte Reservoir. Additionally, the LFCC also carries stormwater runoff, irrigation return flow, and ground water seepage (Reclamation, 2000a).

A levee built from the spoil excavated from the LFCC runs along the west side of the river. In the past, extensive jetty jack fields were installed to stabilize the west bank and protect the LFCC. No stabilization work has been undertaken on the sparsely developed east side of the river (Reclamation, 2000a).

Elephant Butte Reservoir Headwaters (Rio Grande)

The headwaters of Elephant Butte Reservoir are located at RM 57 and are the downstream limit of the ROI. Elephant Butte Dam was authorized by Congress in 1905 as a Rio Grande Project storage facility. The dam was completed in 1916, and currently is owned and operated by Reclamation. The structure is a concrete gravity dam 301 feet high and 1,674 feet long, including spillway. The total authorized conservation storage pool is 2,065,010 ac-ft at an elevation of 4,407 feet amsl (Reclamation, 1971).

3.4 POTENTIALLY AFFECTED RESOURCES

Table 3.4-1 summarizes the resource categories that could potentially be affected by the DWP within each subarea. Baseline conditions and potential project environmental effects are described in Sections 3.5 through 3.29 for the 25 resource categories listed in Table 3.4-1. Resource effects are discussed only for subareas in which a potential DWP impact on those resources was identified during the impact analysis. As indicated in the table, several resource categories in the Upper and Lower Project Subareas, for which construction activities, land exchange/purchases, significant change in hydrology, or other operation effects would not occur, are not discussed in detail in the resource-specific sections of this FEIS.

The surface and ground water hydrology of the Rio Grande is very complex. While hydrologic resources are considered within Section 3.16 as a separate resource category, there are relationships between hydrology and other resource categories that were considered during the environmental analysis. Biological resources, riparian vegetation, threatened and endangered species, and wildlife/aquatic life are directly or indirectly dependant upon the river for habitat, food and cover or sustainability. Water quality, human health and safety, and the socioeconomic costs of the water project are connected to the hydrology of the river, and its ability to meet the needs of the human population in the area. Because various Native American entities may have assets associated with the river or concerns about the condition of the river, there is a link between those resource areas and the hydrology analyzed within this document.

TABLE 3.4-1
POTENTIALLY AFFECTED RESOURCE CATEGORIES BY PROJECT SUBAREA

	Project Subarea		
Resource Category	**Upper**	**Middle**	**Lower**
Aesthetics/Visual Resources	X	X	
Air Quality		X	
Aquatic Life	X	X	X
Biodiversity	X	X	X
Cultural Resources		X	
Environmental Justice		X	
Energy		X	
Floodplains	X	X	
Geology		X	
Hazardous Materials		X	
Human Health and Safety		X	
Hydrology (Surface Water and Ground Water)	X	X	X
Indian Trust Assets and other Tribal Resources	X	X	X
Land Use		X	
Noise and Vibration		X	
Recreation	X	X	
Riparian Areas	X	X	X
Socioeconomic Factors		X	
Soils		X	
Threatened and Endangered Species	X	X	X
Traffic and Circulation		X	
Upland Vegetation		X	
Water Quality	X	X	X
Wetlands/Non-Wetland Waters	X	X	X
Wildlife	X	X	X

3.5 AESTHETICS/VISUAL RESOURCES

3.5.1 Introduction

Concerns identified during DWP scoping about project-related effects on aesthetics and visual resources focused on the visibility of new project structural facilities, including pump stations and diversion structures. Visual resources were evaluated for potential effects from construction of new facilities in the Middle Project Subarea, and from the addition of the City's SJC water in the Upper Project Subarea, particularly the Wild and Scenic River portion of the Rio Chama.

The analysis method used to determine any effects on aesthetics/visual resources involved locating proposed structures relative to sensitive viewsheds in the Middle Project Subarea, and estimating any resulting changes in the viewsheds. Potential changes included increased visual contrast, blocking or disruption of existing views, or reduced public opportunities to view scenic resources.

3.5.2 Affected Environment

Aesthetics and visual resources include the presence or absence of man-made features, landforms, water surfaces, and vegetation relative to the surroundings and setting of an area. These features are the primary characteristics of an area or project that determine its visual character and the manner in which people view the setting. Six public-use areas/parks, which constitute sensitive viewsheds, were identified within a 0.25-mile radius of the action-alternative construction zones. The bosque also is considered a sensitive environmental area and viewshed. Existing visual character in the project area consists of three distinctly different settings:

- The first setting encompasses the Wild and Scenic River segment of the Rio Chama. After passing through El Vado Reservoir, the City's SJC water would flow approximately 30.4 miles southeast to Abiquiu Reservoir, through the Rio Chama Canyon Wilderness area. As part of the national Wild and Scenic River system, this area contains specific aspects of concern with respect to visual and aesthetic resources.

- A complex of tall cottonwood trees dominates portions of the riparian corridor (the bosque) defined by the Rio Chama and Rio Grande channels and associated floodplains. These riparian woodlands either create a continuous tree band along the river or are intermixed with openings and small stands of willows, salt cedar, Russian olive or other shrubs and small trees (Crawford *et al*., 1993). Much of the riparian corridor in the metropolitan area (Middle Project Subarea) is used for recreation and as open space.

- The third setting includes the complex of urban, recreational, commercial, open space and light-industrial area that collectively define the developed portion of the City's water service area in the Middle Project Subarea. This setting is characterized by a mixture of many different structural forms, and by views that change from one location to another. All of the attributes of the developed City infrastructure, including existing water conveyances, lie within this setting.

3.5.3 Environmental Consequences

There would be no effects on aesthetics or visual resources in the Upper or Lower Project Subareas under any of the DWP alternatives, as no project facilities would be constructed there. Potential direct, indirect, and cumulative effects on these resources within the Middle Project Subarea are considered below for each of the four alternatives evaluated. Visual and aesthetic resources were inventoried, and any changes from existing conditions due to the project were determined. Neighboring land use is important in the determination of visual and aesthetic resources, particularly from the standpoint of recreational or residential use.

Effects from No Action Alternative

Under the No Action Alternative, DWP facilities would not be constructed, and no effects on aesthetics and visual resources would occur. However, additional ground water wells and new reservoirs would be required if the DWP is not implemented. Such structures are common in all parts of the City. Existing structures within the Middle Project Subarea are infrastructure, commercial, residential, and industrial facilities typical of a large metropolitan area. There are similar facilities and structures at and near the alternative locations today. Construction of additional non-project structures within the urban area would not substantially increase visual clutter noticeable from the existing alternative sites. Non-DWP construction near the alternative sites, and visible from these sites, is likely to continue in the future.

Under the DWP No Action Alternative the current aesthetics and viewsheds would be maintained. Therefore, there would be no direct, indirect, or cumulative effects on the aesthetics or viewsheds within the Middle Project Subarea if the No Action Alternative was implemented.

Effects from Angostura Diversion

Under Angostura Diversion, new construction at the Angostura Diversion Dam would consist of renovation of the existing structure and construction of a new fish screen and fishway system near the existing diversion works. Because the area surrounding the diversion facility and the entrance to the Albuquerque Main Canal has been previously disturbed, modification of the dam would have only short-term construction related effects on the existing viewshed. Once constructed, the fish screen structure would not disrupt existing views from the river and bosque because it would not extend more than a few inches above ground. The pump station would be visible from Highway 313 (at its junction with Tramway and 4th Streets; on the Southern Boundary of the Sandia Pueblo).

The area near the Chappell Drive WTP currently is a gravel quarry, with associated cement plant operations. Therefore, construction of the WTP would not disrupt the present view near or around the current mining operations. The WTP setting may be an aesthetically enhanced improvement as the sand and gravel are mined out, and heavy truck traffic in the area decreases.

Construction of new raw-water transmission and potable water distribution pipelines would generally be confined to existing ROWs through developed areas. Because these lines would be below grade there would be only temporary direct construction related effects on some viewsheds. Implementation of Angostura Diversion would result in temporary direct visual/aesthetic effects on the existing river and bosque setting during construction, and the pump station would incorporate permanent structural additions that would be visible from the bosque and river banks. However, the new structures would not completely block the current views, and environmental commitments (see Section 3.5.4) could mitigate some of the aesthetic/visual effects of the alternative. Angostura Diversion is not considered to have adverse effects on this resource category.

Effects from Paseo del Norte Diversion

Under Paseo del Norte Diversion (the preferred alternative), the new surface-diversion dam proposed for construction near Paseo del Norte would be visible from Paseo del Norte during and after construction. Construction on the east side of the Rio Grande at this location would be within the Rio Grande Valley State Park. Pedestrians, cyclists and equestrians heavily use the trails and footpaths within this area of the bosque.

The new Paseo del Norte diversion dam would be the only new structure under any DWP alternative that would be visually dominant to the average viewer. Because it would be placed in the river (an open area), the new diversion facilities would be clearly visible from the Paseo del Norte and Alameda Bridges, as well as to pedestrians in the bosque between Paseo del Norte and Alameda. The Paseo del Norte Diversion pump station, to be situated on the eastern riverbank near the diversion dam, also may be visible at certain times. Visual effects from construction of the WTP, and pipelines would be the same as described for Angostura Diversion.

Implementation of Paseo del Norte Diversion would result in temporary direct aesthetic/visual effects on the existing river and bosque settings near Paseo del Norte due to construction activities, and the diversion, fishway, and pump station facilities would be permanent structural additions that would be visible from the Paseo del Norte and Alameda Bridges and from the bosque and river banks. However, the new structures would not completely block the current views, and proposed mitigation measures (see Section 3.5.4) mitigate some of the aesthetic/visual effects of the alternative.

Effects from Subsurface Diversion

The Subsurface Diversion Alternative would require construction within the river itself. This activity, and related construction on the east bank would have a temporary, direct visual impact for bosque visitors. This alternative also would require construction of three pump stations in the bosque viewshed near Paseo del Norte. Visual effects from construction of the Chappell Drive WTP and pipelines would be the same as described for Angostura Diversion.

Implementation of Subsurface Diversion would result in temporary direct aesthetic/visual effects on the existing river and bosque settings near Paseo del Norte due to construction activities, and the three pump stations would be permanent structural additions that would be visible to visitors in the bosque and along the river banks. However, the new structures would not completely block the current views, and proposed mitigation measures (see Section 3.5.4) would mitigate some of the aesthetic/visual effects of the alternative.

Summary of Environmental Consequences

DWP action alternatives would result in the construction of permanent new structures in sensitive viewsheds or viewing areas. The Angostura Diversion would place one new pump station near a sensitive viewshed. Paseo del Norte Diversion would place one new pump station near the bosque and new surface diversion facilities in the Rio Grande. The Subsurface Diversion would place three new pump stations in the bosque.

Direct effects on aesthetics and visual resources would result from the placement of structures (*i*.e., new diversion structure, reservoirs, pump stations, and roads) in the Middle Project Subarea. These structures would be permanent, and depending upon an individual's vantage point, would not block or disrupt any existing views. The direct effects of constructing project facilities in the Middle Project Subarea would be mitigated by several environmental design features. Existing views would not be disturbed or changed, especially when considering the present urban landscape. There is no predicted increased visual contrast, blocking, or disruption of views, or reduced public opportunities to view any scenic resources. As a result of this analysis, there are no cumulative effects attributable to this project within this resource area. Table 3.5-1 summarizes the effects on aesthetic and visual resources attributable to the DWP alternatives.

TABLE 3.5-1
SUMMARY OF PROJECT EFFECTS
ON AESTHETIC OR VISUAL RESOURCES

Evaluation Criterion	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Location and size of project facilities that would block most of an existing viewshed	Potential structures, located primarily in urban areas, one pump station; no disruption of existing viewsheds.	An existing diversion dam and new, slightly visible fish screens; no disruption of existing views.	A new low-profile diversion dam, visible from roads and bosque, and one pump station in the bosque.	Three pump stations, visible from within the bosque.

With the implementation of the environmental design features discussed in Section 3.5.4, no substantial temporary, long-term, or cumulative adverse effects on aesthetics or visual resources would be expected from the project. The effects under the action alternatives would be the construction of the facilities required for the project, regardless of action alternative. The No Action Alternative may require additional facilities, visible from various locations within the City. There are no short-term use versus long-term-productivity concerns attributable to any of the alternatives for this resource category, nor are there any known irreversible and irretrievable commitments of aesthetic or visual resources.

3.5.4 Proposed Mitigation Measures

The following proposed mitigation measures would minimize or eliminate potential DWP effects on aesthetics and visual resources from all action alternatives:

- Appropriate landscaping and interposed wall structures, consistent with site maintenance, access, and security, would minimize visual effects and prevent vandalism and graffiti. The City Public Works Department would coordinate the onsite requirements for construction of project facilities with local and adjacent neighborhood associations.

- Appropriate wall structure patterns and colors would be used to minimize visual intrusion. The Public Works Department would coordinate the onsite requirements for construction of project facilities with local and adjacent neighborhood associations.

- Appropriate site access limitations and maintenance activities would be implemented to provide security and prevent vandalism and graffiti and to ensure continued visual minimization.

3.6 AIR QUALITY

3.6.1 Introduction

The primary project-related air-quality issues identified during DWP scoping activities were the following:

- Generation and control of fugitive dust during construction, and

- Generation of objectionable odors during DWP construction or operations.

The only areas in which these effects could occur are the action-alternative construction zones in the Middle Project Subarea. These zones would lie along the Rio Grande corridor within Bernalillo County and near the Towns of Algodones and Bernalillo in Sandoval County.

3.6.2 Air Pollutants and Regulations

Air Pollutants

Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the surface topography, the size of the air basin, and the prevailing meteorological conditions. Air quality is described by the concentrations of various pollutants in the atmosphere, which are generally expressed in units of parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). The significance of a pollutant concentration is determined by comparing it to federal and/or state ambient air quality standards. Ambient air quality standards represent the maximum allowable atmospheric concentrations of various pollutants that may occur and still protect public health and welfare, with a reasonable margin of safety.

The air pollutants of concern considered in this air quality analysis include volatile organic compounds (VOCs), nitrogen oxides (NOx), ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), respirable particulate matter less than 10 micrometers in diameter (PM_{10}), and lead (Pb).

VOCs generally are released from burning of fossil fuels and through the use of such products as solvents, paints, and glues. Motor vehicles and the petroleum industry are significant sources of VOCs. VOCs are precursors to photochemical ozone production.

Nitrogen oxides (NOx) are organic gases that are also released from burning of fossil fuels. Significant sources of NOx include motor vehicles and fuel-burning industrial equipment. Nitrogen dioxide (NO_2) is one of the major NOx gases of concern because it plays a major role in the atmospheric reactions that produce ground-level ozone.

Ozone (O_3) is an odorless, colorless gas that is not usually emitted directly into the air, but at ground level is created by a chemical reaction between NOx and VOCs in the presence of heat and sunlight. Ground-level ozone is the principal component of smog and can act as a lung irritant.

Carbon monoxide (CO) is an odorless, colorless gas released as a byproduct of incomplete combustion of fossil fuels. Motor vehicles and fuel burning industrial equipment are significant sources of CO. CO can affect humans through interfering with the oxygen-carrying capacity of blood, resulting in lack of oxygen to tissues.

Sulfur dioxide (SO_2) is a colorless, nonflammable gas with a pungent odor detectable by the human nose at low concentrations. It belongs to the family of gases called sulfur oxides (SOx) that are released from the combustion of fuel containing sulfur, mostly coal and oil. SO_2 may cause health problems because it is a pulmonary irritant and contributes to respiratory illness, alterations in pulmonary defenses, and aggravation of existing cardiovascular disease.

PM_{10} is a complex mixture of very small solid or liquid particles, composed of chemicals, soot, and dust. Because only small particles can be inhaled into the lungs, PM_{10} is defined as "inhalable particles" that include microscopic, invisible particles that are 10 micrometers (millionths of a meter) or less in diameter. Significant sources of PM_{10} include burning of wood, diesel and other fuels; industrial plants; agriculture (plowing, burning off fields); and unpaved roads. PM_{10} can cause health problems because they are capable of by-passing the body's natural defenses in the nose and throat and entering the lungs. $PM_{2.5}$ is particulate matter with a diameter less than or equal to 2.5 micrometers. Those suspended particles in the atmosphere with aerodynamic diameters larger than 10 micrometers are collectively referred to as total suspended particulates (TSP).

Lead (Pb) in ambient air exists primarily as Pb vapors, very fine Pb particles, and organic halogens such as Pb bromide and Pb chloride. Nearly all of the Pb in the environment is due to human activities; common sources in the atmosphere are gasoline additives, nonferrous smelting plants, and battery and ammunition manufacturing.

Air Quality Regulations

Clean Air Act (CAA) of 1970. Under the authority of this act, the EPA established nationwide ambient air quality standards to protect public health and welfare, with an adequate margin of safety. These federal standards, known as the National Ambient Air Quality Standards (NAAQS), were developed for six "criteria" pollutants: O_3, NO_2, CO, PM_{10}, SO_2, and lead (Pb). Although O_3 is considered a criteria air pollutant and is measurable in the atmosphere, it is not often considered as an air pollutant when calculating emissions. This is because O_3 is typically not emitted directly from most emissions sources, but is formed in the atmosphere from its precursors, NO_X and VOC that are directly emitted from various emission sources. For this reason, NO_X and VOCs are commonly reported in an air emissions inventory instead of O_3.

The NAAQS are defined in terms of concentration (e.g., parts per million [ppm] or micrograms per cubic meter [$\mu g/m^3$]) determined over various periods of time (averaging periods). Short-term standards (one-hour, eight-hour, or 24-hour periods) were established for pollutants with acute health effects and may not be exceeded more than once a year. Long-term standards (annual periods) were established for pollutants with chronic health effects and may never be exceeded. Under the CAA, state and local agencies may establish air quality standards and regulations of their own, provided these are at least as stringent as the federal requirements. In New Mexico, state ambient air quality standards are established by the New Mexico Environmental Improvement Board and the Albuquerque-Bernalillo County Air Quality Control Board (for non-Indian lands within Bernalillo County) (A-BCAQCB).

Clean Air Act Amendments of 1977 (1977 CAAA). The 1977 CAAA established local air quality planning processes and required areas that exceed the NAAQS (nonattainment areas) to develop a plan that demonstrates attainment of the NAAQS. This plan is to be prepared by local agencies and incorporated into the overall State Implementation Plan (SIP) of each state, which is designed to eliminate or reduce the severity and number of NAAQS violations. Areas in nonattainment of a NAAQS are required to show reasonable further progress toward attaining the standard, or sanctions could be imposed in the form of a ban on construction of major new facilities, or withholding federal funding for highways, water treatment facilities, or air quality planning. Progress toward attainment is demonstrated in the SIP by showing a decrease in future emissions.

Clean Air Act Amendments of 1990 (1990 CAAA). The 1990 CAAA established, among other things, new federal nonattainment classifications, new emission control requirements, and new compliance dates for nonattainment areas. The nonattainment classifications are based on a design day value, which is the fourth highest pollutant concentration recorded in the nonattainment area during a 3-year period. The requirements and compliance dates are based on the nonattainment classification. In addition, the 1990 CAAA has required federal actions to determine whether a project would conform to the requirements of the most recent federally-approved SIP. Final guidelines on how to perform the conformity analysis were promulgated by the EPA in 1993. If emissions from a federal action proposed in a nonattainment area exceed the annual thresholds identified in the rule, a conformity determination is required of that action. The thresholds become more restrictive as the severity of the nonattainment status of the region increases. Under the General Conformity Rule of the CAA, Section 176(c), activities shall not: (a) cause or contribute to any new violation, (b) increase the frequency or severity of any existing violation, or (c) delay timely attainment of any standard, interim emission reductions or milestones in conformity with an implementation plan's purpose of eliminating or reducing the severity and number of violations of the NAAQS or achieving attainment of NAAQS.

In 1997, EPA promulgated two new standards: a new 8-hour O_3 standard (which could eventually replace the existing 1-hour O_3 standard) and a new standard for $PM_{2.5}$, which are fine particulates (with diameters less than 2.5 micrometers) that have not been previously regulated. In addition, EPA revised the existing PM_{10} standard. The two new standards were scheduled for implementation over a period of several years, as monitoring data became available to determine the attainment status of areas in the U.S. However, EPA was challenged in court on these new and revised standards. The D.C. Circuit Court of Appeals remanded the new 8-hour O_3 standard back to EPA for further consideration. The Court also stated that the new $PM_{2.5}$ standard was allowed to remain in place - but affected parties can apply to have this standard vacated under certain conditions - and that the revised PM_{10} standard was vacated and replaced by the pre-existing PM_{10} standard. The matter was then appealed to the U.S. Supreme Court which upheld the 8-hour O_3 standard and instructed the EPA to develop a reasonable interpretation of the nonattainment implementation provisions. The Supreme Court also validated the EPA's standard setting authority and procedures. In March 2002, the remaining challenges to the $PM_{2.5}$ standard were rejected. EPA is seeking promulgation of the new ozone and $PM_{2.5}$ standards by December 2004.

The EPA established both primary and secondary NAAQS under the provisions of the CAAA. Primary standards define levels of air quality necessary to protect public health with an adequate margin of safety. Secondary standards define levels of air quality necessary to protect public welfare (i.e., soils, vegetation, and wildlife) from any known or anticipated adverse effects from a criteria air pollutant. The CAAA also set emission limits for certain air pollutants for new or modified major sources based on best demonstrated technologies, and established health-based national emissions standards for hazardous air pollutants.

The CAAA does not make the NAAQS directly enforceable, but requires each state to promulgate a state implementation plan (SIP) that provides for implementation, maintenance, and enforcement of the NAAQS in each air quality control region (AQCR) in the state. The CAAA also allows states to adopt air quality standards that are more stringent than the federal standards. The ambient air quality standards for New Mexico (except Bernalillo County and Indian Lands) are contained in the New Mexico Administrative Code Title 20, Environmental Protection, Chapter 2, Air Quality Statewide, Part 3, Ambient Air Quality Standards. Table 3.6-1 contains the national and New Mexico ambient air quality standards. Additionally, the Albuquerque-Benalillo County Air Quality Control Board has adopted by reference standards and air quality goals that are applicable within Bernalillo County, but not on Indian lands. Some of the goals are more stringent than the state and federal standards; however, the A/BCAQB air quality goals are not enforceable (New Mexico 2000c). Table 3.6.2 lists the A/BCAQB goals.

TABLE 3.6-1
NATIONAL AND NEW MEXICO AMBIENT AIR QUALITY STANDARDS

Criteria Pollutant	Averaging Time	Primary NAAQS[a,b,c]	Secondary NAAQS[a,b,d]	New Mexico Standards[a,b,e]
Carbon Monoxide	8-hour	9 ppm (10,000 μg/m3)	9 ppm (10,000 μg/m3)	8.7 ppm
	1-hour	35 ppm (40,000 μg/m3)	35 ppm (40,000 μg/m3)	13.1 ppm
Lead	Quarterly	1.5 μg/m3	1.5 μg/m3	-
Nitrogen Oxides (measured as NO_2)	Annual	0.053 ppm	0.053 ppm	0.05 ppm
	24-hour	(100 μg/m3)	(100 μg/m3)	0.10 ppm
Ozone[f]	1-hour	0.12 ppm (235 μg/m3)	0.12 ppm (235 μg/m3)	-
	8-hour	0.08 ppm (157 μg/m3)	0.08 ppm (157 μg/m3)	-
Particulate Matter (measured as PM_{10})	Annual	50 μg/m3	50 μg/m3	-
	24-hour	150 μg/m3	150 μg/m3-	-
Particulate Matter (measured as $PM_{2.5}$)[f]	Annual	15 μg/m3	15 μg/m3	-
	24-hour	65 μg/m3	65 μg/m3	-
Sulfur Oxides (measured as SO_2)	Annual	0.03 ppm (80 μg/m3)	No standard	0.02 ppm
	24-hour	0.14 ppm (365 μg/m3)	No standard	0.10 ppm
	3-hour	No standard	0.50 ppm (1,300 μg/m3)	-
Hydrogen Sulfide	1 hr	-	-	0.01 ppm
Total Reduced Sulfur	½ hour	-	-	0.003 ppm
	1 hour	-	-	
TSP	24 hour	-	-	150 μg/m3
	7 day	-	-	110 μg/m3
	30 day	-	-	90 μg/m3
	Annual	-	-	60 μg/m3

[a] National and state standards, other than those based on an annual or quarterly arithmetic mean, are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is less than or equal to one.

[b] The NAAQS and New Mexico standards are based on standard temperature and pressure of 25 degrees Celsius and 760 millimeters of mercury.

[c] National Primary Standards: The levels of air quality necessary to protect the public health with an adequate margin of safety. Each state must attain the primary standards no later than three years after the state implementation plan is approved by the EPA.

[d] National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after the state implementation plan is approved by the EPA.

[e] New Mexico 2002a.

f The ozone 8-hour standard and $PM_{2.5}$ standards are included for information only. A 1999 federal court ruling blocked implementation of these standards, which the EPA proposed in 1997. In March 2002 the D.C. Circuit Court rejected the remaining challenges to the 1997 $PM_{2.5}$ standard. EPA is seeking promulgation of the new ozone and $PM_{2.5}$ standards by December 2004.

μg/m3 = micrograms per cubic meter, "-" = no existing standard.

TABLE 3.6-2
AMBIENT AIR QUALITY GOALS

Pollutant	Averaging Time	Maximum Concentration
Carbon Monoxide	1-hour	13.0 ppm
	8-hour	-
Nitrogen Dioxide	24-hour average	0.062 ppm
	Annual average	0.053 ppm
TSP	24-hour average	150 µg/m3
	7- day average	-
	30-day average	-
	Annual average	60 µg/m3
Ozone (O_3)	1-hour average	0.120 µg/m3
Particulate Matter (measured as PM_{10})	24-hour average	150 ppm
	Annual average	-
Lead	Quarterly	1.5 µg/m3
Sulfur Dioxide	24-hour average	0.10 ppm
	Annual average	0.004 ppm
Hydrogen Sulfide	1-hour average[a]	0.003 ppm
Total Reduced Sulfur	½-hour average	0.003 ppm

Source: New Mexico 2002c.

Federal actions must comply with the EPA Final General Conformity Rule published in 40 CFR 93, subpart B (for federal agencies) and 40 CFR 51, subpart W (for state requirements). The Final Conformity Rule, which took effect on January 31, 1994, requires all federal agencies to ensure that proposed agency activities conform with an approved or promulgated SIP or federal implementation plan (FIP). Conformity means compliance with a SIP or FIP for the purpose of attaining or maintaining the NAAQS. Specifically, this means ensuring the federal activity does not: 1) cause a new violation of the NAAQS; 2) contribute to an increase in the frequency or severity of violations of existing NAAQS; 3) delay the timely attainment of any NAAQS; or 4) delay interim or other milestones contained in the SIP for achieving attainment.

The Final General Conformity Rule only applies to federal actions in designated nonattainment or maintenance areas, and the rule requires that total direct and indirect emissions of subject criteria pollutants, including ozone precursors, be considered in determining conformity. The rule does not apply to actions that are not considered regionally significant and where the total direct and indirect emissions of nonattainment criteria pollutants do not equal or exceed *de minimis* threshold levels for criteria pollutants established in 40 CFR 93.153(b). The State of New Mexico *de minimis* threshold levels are the same as the federal standards (New Mexico, 200b). A federal action would be considered regionally significant when the total emissions from the proposed action equal or exceed 10 percent of the nonattainment or maintenance area's emissions inventory for any criteria air pollutant. If a federal action meets *de minimis* requirements and is *not* considered a regionally significant action, then it does not have to go through a full conformity determination. Ongoing activities currently being conducted are exempt from the rule so long as there is no increase in emissions equal to or greater than above the *de minimis* levels as the result of the federal action. Table 3.6-3 lists the *de minimis* levels for nonattainment areas.

TABLE 3.6-3
DE MINIMIS THRESHOLDS IN NONATTAINMENT AREAS

Criterria Pollutant	Degree of Nonattainment	De Minimis Level (tpy)
Ozone (VOC and NO_x)	Serious	50
	Severe	25
	Extreme	10
	Other ozone nonattainment areas outside ozone transport region	100
	Marginal or moderate nonattainment within ozone transport region	50 (VOC) 100 (NO_x)
Carbon Monoxide (CO)	All	100
Particulate Matter (PM_{10})	Moderate	100
	Serious	70
Sulfur Dioxide (SO_2)	All	100
Lead (Pb)	All	25

Sources: 40 CFR 93 1999, New Mexico, 2002b.
tpy tons per year.

3.6.3 Regional Air Quality

The EPA classifies the air quality within an air quality control region (AQCR) according to whether or not the concentration of criteria air pollutants in the atmosphere exceeds primary or secondary NAAQS. All areas within each AQCR are assigned a designation of either attainment or nonattainment for each criteria air pollutant. An attainment designation indicates that the air quality within specific areas of an AQCR is either “unclassified” or that the air quality is as good as or better than NAAQS for individual criteria air pollutants. Unclassified indicates that the air quality within an area cannot be classified and is therefore treated as attainment. Nonattainment indicates that concentration of an individual criteria air pollutant at a specific location exceeds primary or secondary NAAQS.

The Albuquerque-Mid Rio Grande Intrastate AQCR 152 (revised on December 27, 2002) includes the Albuquerque area, Bernalillo County, those portions of Sandoval County that are east of the Continental Divide, and portions of Valencia County. Table 3.6-4 lists the air quality status for the counties in the AQCR.

TABLE 3.6-4
AIR QUALITY STATUS FOR COUNTIES IN AIR QUALITY CONTROL REGION 152

CO	NO_2	SO_x	PM_{10}	Ozone
Albuquerque area and Bernalillo County -- designated attainment; All other counties—unclassifiable/attainment	All counties—cannot be classified or better than national standards	All counties—better than national standards	All counties—unclassifiable/ attainment	All counties—unclassifiable/ attainment

Sources: 40 CFR 81.332.

In addition to the federal standards, airborne particulate matter in the City and Bernalillo County area is regulated under Albuquerque-Bernalillo County Air Quality Control Board regulations for Airborne Particulate Matter, Title 20, Chapter 11, Part 20 of the New Mexico Administrative Code (20 NMAC 11.20). Local permitting and regulatory enforcement by the City's Department of Environmental Health for sources within Bernalillo County are based on these regulations. New Mexico also has a regulation for Smoke and Visible Emissions (20 NMAC 2.61.110) for sources outside Bernalillo County, which limits open-air emissions of 30-percent opacity or greater from mobile equipment to 10 seconds duration or less at elevations below 8,000 feet asml. Diesel powered highway and non-highway motor vehicles in Bernalillo County that may claim an exemption from certain visible emission limits for a period of ten minutes if the excessive visible air contaminant emissions are a direct result of cold engine start-up and provided the motor vehicle is in a stationary position (20 NMAC 20.11.103.12D).

If a complaint is filed with the Albuquerque-Bernalillo County by someone observing a motor vehicle emitting visible air contaminant emissions in excess of that allowed by the regulations, a signed written complaint will authorize the Department to request the owner to have the vehicle tested. If the vehicle fails the opacity test or does not present the motor vehicle for testing, the Department may take enforcement action against the owner.

3.6.4 Affected Environment

An air emissions inventory is an estimate of total mass emissions of pollutants generated from a source or sources over a period of time, typically a year. Accurate air emissions inventories are needed for estimating the relationship between emission sources and air quality. The quantities of air pollutants are generally measured in pounds (lbs) per hour or tons per year (tpy). All emission sources may be categorized as either mobile or stationary emission sources. Stationary emission sources may include boilers, generators, fueling operations, industrial processes, and burning activities, among others. Mobile emission sources include activities such as on and off highway vehicle operations, waste disposal and recycling, and miscellaneous sources.

The evaluation area for this resource category is located in Bernalillo County, which is within Albuquerque-Mid Rio Grande Intrastate AQCR 152. Table 3.6-5 lists the 1999 air emissions for Bernalillo County. Although portions of two other counties (Sandoval and Valencia) are within AQCR 152, only the emissions data for Bernalillo County are listed in the table. The activities associated with the alternatives would be localized in the area near the river within Albuquerque, and emissions from the activities would not be likely to affect the portions of Sandoval and Valencia Counties within AQCR 152.

TABLE 3.6-5
BASELINE AIR EMISSIONS FOR BERNALILLO COUNTY

County	CO (tpy)	VOC (tpy)	NO_x (tpy)	SO_x (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
CY99 Totals:	180,226	28,150	28,969	4,626	58,675	11,729

Note: VOC is not a criteria air pollutant. However, VOC is reported because, as an ozone precursor, it is a controlled pollutant.

tpy tons per year.
Source: AIRData 2002.

As shown in Table 3.6-4, EPA has designated the air quality within all of Bernalillo County as better than NAAQS for SO_2 and NO_2 (i.e., an attainment area), and unclassifiable attainment for CO and O_3. However, portions of Albuquerque have been designated as not meeting primary standards for TSP. The remainder of Bernalillo County is designated as better than NAAQS for TSP and unclassifiable attainment for PM_{10}.

3.6.5 Environmental Consequences

The two issues raised during DWP scoping concerned the potential for dust or other emissions from project construction or operations that would cause air quality conditions to degrade substantially, and the potential for objectionable odors from project construction or operation. As discussed in Section 3.6.3 and Table 3.6-4, EPA has designated the air quality within all of Bernalillo County as better than NAAQS for SO_2 and NO_2, (*i.e.,* an attainment area), and unclassifiable/attainment or attainment for CO, O_3, and PM_{10}. Unclassified indicates that the air quality within an area cannot be classified and is therefore treated as attainment.

Impacts to air quality in attainment areas would be considered significant if pollutant emissions associated with the implementation of the federal action caused or contributed to a violation of any national, state, or local ambient air quality standard, exposed sensitive receptors to substantially increased pollutant concentrations, represented an increase of ten percent or more in affected AQCR's emissions inventory, or exceeded any significance criteria established by the New Mexico SIP.

With respect to the General Conformity Rule, impacts to air quality would be considered significant if emissions increased a nonattainment or maintenance area's emissions inventory by ten percent or more for individual nonattainment pollutants; or exceeded *de minimis* threshold levels established in 40 CFR 93.153(b) for individual nonattainment pollutants. Since the air quality within the ROI for the project area is considered an attainment area, the proposed alternatives would be exempt from further conformity requirements specified by the EPA Final General Conformity Rule, and a conformity determination would not be required.

Impacts to air quality would be considered significant if federal actions resulted in annual emissions of a pollutant greater than 250 tons per year [definition of a "major stationary source" in an attainment area as defined in 40 CFR 52.21(b)(1)], or exceeded any significance criteria established by the New Mexico SIP.

Under the No Action Alternative, new water transmission lines and new ground water wells would be installed to meet the demand for potable water. The emissions generating activities for constructing ground water wells would be minimal as compared to other ground disturbing activities associated with constructing new water transmission lines. It is assumed that emissions generated from constructing the water transmission lines would be similar to constructing the pipeline for the Chappell WTP. Fugitive dust from ground disturbing activities and combustive emissions from equipment operation would be generated as a result of the activities.

Fugitive dust would be generated from activities associated with soil disturbance and from equipment and vehicular traffic moving over the disturbed site. These emissions would be greatest during the initial site preparation activities and would vary from day to day depending on the construction phase, level of activity, and prevailing weather conditions.

The quantity of uncontrolled fugitive dust emissions from a construction site is proportional to the area of land being worked and the level of construction activity. The EPA has estimated that uncontrolled fugitive dust emissions from ground disturbing activities would be emitted at a rate of 80 lbs of TSP per acre per day of disturbance (EPA, 1995). In an EPA study of air sampling data at a distance of 50 meters downwind from construction activities, PM10 emissions from various open dust sources were determined based on the ratio of PM10 to TSP sampling data. The average PM10 to TSP ratios for top soil removal, aggregate hauling, and cut and fill operations is reported as 0.27, 0.23, and 0.22, respectively (EPA, 1988). Using 0.24 as the average ratio for purposes of analysis, the emission factor for PM10 dust emissions becomes 19.2 lbs per acre per day of disturbance.

The EPA also assumes that 230 working days are available per year for construction (accounting for weekends, weather, and holidays), and that only half of these working days would result in uncontrolled fugitive dust emissions at the emitted rate described above (EPA, 1995). The emissions presented in Table 3.6-6 include the estimated annual PM_{10} and $PM_{2.5}$ emissions associated with the project activities. These emissions would produce slightly elevated short-term PM_{10} and $PM_{2.5}$ ambient air concentrations.

Specific information describing the types of construction equipment required for a specific task, the hours the equipment is operated, and the operating conditions vary widely from project to project. Emissions were calculated using established cost estimating methodologies for construction and experience with similar types of construction projects (Means, 2000). Combustive emissions from construction equipment exhausts were estimated by using EPA approved emissions factors for heavy-duty diesel-powered construction equipment (EPA, 1985). The emissions data presented in Table 3.6-6 include the baseline emissions data for Bernalillo County and the No Action Alternative, and compares the alternative with the baseline condition. The table presents the estimated annual emissions from construction equipment exhaust and ground disturbing activities associated with the alternative.

TABLE 3.6-6
ESTIMATED ANNUAL EMISSIONS FOR NO ACTION ALTERNATIVE

Criteria Air Pollutant	CO (tpy)	VOC (tpy)	NOx (tpy)	SOx (tpy)	PM10 (tpy)	$PM_{2.5}$ (tpy)
CY99 Totals[a] Bernalillo County	180,226	28,150	28,969	4,626	58,675	11,729
Annual Emissions[b] from Alternative	8.95	3.40	29.80	3.21	94.01	18.8
Annual Emissions from Alternative as Percent of CY99 for the County	0.005%	0.012%	0.100%	0.069%	0.160%	0.160%

a AIRData 2002.
b Estimated annual emissions from No Action Alternative activities.
tpy tons per year.
Note: VOC is not a criteria air pollutant. However, VOC is reported because, as an ozone precursor, it is a controlled pollutant. Lead (Pb) is not calculated for mobile sources. Fuels used by these sources contain no lead; therefore, there are no emissions factors associated with mobile sources.

Review of the data in Table 3.6-6 indicates that the greatest increase in emissions from the No Action Alternative activities would be PM_{10} (91.01 tons), which equates to 0.16 percent of the PM_{10} emissions within the Bernalillo County area. The effects would be temporary, fall off rapidly with distance from the proposed construction site, and would not result in any long-term impacts.

The No Action Alternative activities would be exempt from the Final General Conformity Rule so long as there is no increase in emissions equal to or greater than the *de minimis* levels as the result of the federal action. Emissions from the No Action Alternative activities would not increase emissions above *de minimis* levels. Therefore, the alternative would be exempt from further conformity requirements specified by the EPA Final General Conformity Rule and a conformity determination would not be required.

Additionally, since this alternative would not include operational activities of the Chappell Drive WTP, there would be no air quality effects relating to odor.

Under the Angostura Diversion Alternative, activities associated with construction of the Chappell Drive WTP are also included. Emissions generated as a result of the actions described in Section 2.5.7 and 2.5.8 would include fugitive dust from ground disturbing activities and combustive emissions from equipment operation.

Fugitive dust would be generated from activities associated with soil disturbance and from equipment and vehicular traffic moving over the disturbed site. These emissions would be greatest during the initial site preparation activities and would vary from day to day depending on the construction phase, level of activity, and prevailing weather conditions.

Assuming the same methodology as that described for the No Action Alternative, emissions were calculated for this alternative. The emissions presented in Table 3.6-7 include the estimated annual emissions from equipment exhaust associated with the proposed activities. Table 3.6-7 lists the annual emissions and the annual percent of change when compared to the baseline for the proposed alternative.

TABLE 3.6-7
ESTIMATED ANNUAL EMISSIONS FOR ANGOSTURA DIVERSION ALTERNATIVE

Criteria Air Pollutant	CO (tpy)	VOC (tpy)	NOx (tpy)	SOx (tpy)	PM10 (tpy)	$PM_{2.5}$ (tpy)
CY99 Totals[a] Bernalillo County	180,226	28,150	28,969	4,626	58,675	11,729
Annual Emissions[b] from Alternative	46.45	10.01	102.62	11.01	213.09	42.62
Annual Emissions from Alternative as Percent of CY99 Emissions for the county	0.026%	0.036%	0.354%	0.238%	0.363%	0.363%

a AIRData 2002.
b Estimated annual emissions from Angostura Diversion Alternative and Chappell Drive WTP activities.
tpy tons per year.
Note: VOC is not a criteria air pollutant. However, VOC is reported because, as an ozone precursor, it is a controlled pollutant. Lead (Pb) is not calculated for mobile sources. Fuels used by these sources contain no lead; therefore, there are no emissions factors associated with mobile sources.

The emissions would produce slightly elevated air pollutant concentrations. Review of the data in Table 3.6-7 indicates that the greatest volume of emissions would be NO_X (102.62 tons) and PM_{10} (213.09 tons), which equates to 0.354 percent and 0.363 percent, respectively, of the PM_{10} emissions within the Bernalillo County area. However, the effects would be temporary, fall off rapidly with distance from the proposed construction sites, and would not result in any long-term impacts.

The Angostura Diversion Alternative activities would be exempt from the Final General Conformity Rule so long as there is no increase in emissions equal to or greater than the *de minimis* levels as the result of the federal action. Emissions from the alternative activities would not increase emissions above *de minimis* levels. Therefore, the alternative would be exempt from further conformity requirements specified by the EPA Final General Conformity Rule and a conformity determination would not be required. Any work or facility on Sandia Pueblo land would be subject to Clean Air Act requirements and federal regulations.

Additionally, this alternative would include operational activities associated with treating water at the Chappell Drive WTP. Based on the conceptual design parameters for odor control discussed in Section 2.5.7, it is estimated that there would be no adverse impacts associated with treating the water entering the proposed WTP.

Under Paseo del Norte Diversion alternative, activities associated with construction of the Chappell Drive WTP are also included. Emissions generated as a result of the actions described in Section 2.5.2, 2.5.7, and 2.5.8 would include fugitive dust from ground disturbing activities and combustive emissions from equipment operation.

The methodologies used to calculate emissions for the No Action and Angostura Diversion Alternatives were used to estimate the emissions for the Paseo del Norte Diversion Alternative. As with the Angostura Diversion Alternative, the activities associated with construction of the Chappell Drive WTP are also included with this alternative. Table 3.6-8 lists the annual emissions for the alternative and compares them to the emissions for the Bernalillo County area.

TABLE 3.6-8
ESTIMATED ANNUAL EMISSIONS FOR PASEO DEL NORTE DIVERSION ALTERNATIVE

Criteria Air Pollutant	CO (tpy)	VOC (tpy)	NOx (tpy)	SOx (tpy)	PM10 (tpy)	$PM_{2.5}$ (tpy)
CY99 Totals[a] Bernalillo County	180,226	28,150	28,969	4,626	58,675	11,729
Annual Emissions[b] from Alternative	30.48	6.74	62.48	6.70	204.89	40.98
Annual Emissions from Alternative as Percent of CY99 Emissions for the county	0.017%	0.024%	0.216%	0.145%	0.349%	0.349%

a AIRData 2002.
b Estimated annual emissions from Paseo del Norte Diversion Alternative and Chappell Drive WTP activities.
tpy tons per year.
Note: VOC is not a criteria air pollutant. However, VOC is reported because, as an ozone precursor, it is a controlled pollutant. Lead (Pb) is not calculated for mobile sources. Fuels used by these sources contain no lead; therefore, there are no emissions factors associated with mobile sources.

The emissions would produce slightly elevated air pollutant concentrations. Review of the data in Table 3.6-8 indicates that the greatest volume of emissions would be PM_{10} (204.89 tons) and $N0_X$ (62.48 tons), which equates to 0.349 percent and 0.216 percent, respectively, of the PM_{10} and NO_X emissions within the Bernalillo County area. However, the effects would be temporary, fall off rapidly with distance from the proposed construction sites, and would not result in any long-term impacts.

Similar to the other alternatives, the Paseo del Norte Diversion Alternative activities would be exempt from the Final General Conformity Rule and a conformity determination would not be required.

Additionally, this alternative would include operational activities associated with treating water at the Chappell Drive WTP. Based on the conceptual design parameters for odor control discussed in Section 2.5.7, it is estimated that there would be no adverse impacts associated with treating the water entering the proposed WTP.

Under the Subsurface Diversion alternative, activities associated with construction of the Chappell Drive WTP are also included. Emissions generated as a result of the actions described in Section 2.5.3, 2.5.7, and 2.5.8 would include fugitive dust from ground disturbing activities and combustive emissions from equipment operation.

The methodologies used to calculate emissions for the other alternatives were used to estimate the emissions for the Subsurface Diversion Alternative. Similarly, the activities associated with construction of the Chappell Drive WTP are also included with this alternative. Table 3.6-9 lists the annual emissions for the alternative and compares them to the emissions for the Bernalillo County area.

TABLE 3.6-9
ESTIMATED ANNUAL EMISSIONS FOR SUBSURFACE DIVERSION ALTERNATIVE

Criteria Air Pollutant	CO (tpy)	VOC (tpy)	NOx (tpy)	SOx (tpy)	PM10 (tpy)	$PM_{2.5}$ (tpy)
CY99 Totals[a] Bernalillo County	180,226	28,150	28,969	4,626	58,675	11,729
Annual Emissions[b] from Alternative	12.32	2.37	25.48	2.74	231.56	46.31
Annual Emissions from Alternative as Percent of CY99 Emissions for the county	0.007%	0.008%	0.088%	0.059%	0.395%	0.395%

a AIRData 2002.
b Estimated annual emissions from Subsurface Diversion Alternative Chappell Drive WTP activities.
tpy tons per year.
Note: VOC is not a criteria air pollutant. However, VOC is reported because, as an ozone precursor, it is a controlled pollutant. Lead (Pb) is not calculated for mobile sources. Fuels used by these sources contain no lead; therefore, there are no emissions factors associated with mobile sources.

The emissions would produce slightly elevated air pollutant concentrations. Review of the data in Table 3.6-9 indicates that the greatest volume of emissions would be PM_{10} (231.56 tons) and $PM_{2.5}$ (46.31 tons), which equates to 0.395 percent, respectively, of the PM_{10} and $PM_{2.5}$ emissions within the Bernalillo County area. However, the effects would be temporary, fall off rapidly with distance from the proposed construction sites, and would not result in any long-term impacts.

Similar to the other alternatives, the Subsurface Diversion Alternative activities would be exempt from the Final General Conformity Rule and a conformity determination would not be required.

Additionally, this alternative would include operational activities associated with treating water at the Chappell Drive WTP. Based on the conceptual design parameters for odor control discussed in Section 2.5.7, it is estimated that there would be no adverse impacts associated with treating the water entering the proposed WTP.

3.6.6 Summary of Environmental Consequences

There would be no direct emissions of regulated pollutants attributable to operations of the proposed diversion, pumping, and WTP facilities. No objectionable odors or emissions would be generated during construction or operation of the WTP. Operation of the DWP under action alternatives would not affect air quality. Table 3.6-10 summarizes DWP effects on air quality in the Middle Project Subarea for the four alternatives. Dust and vehicle emissions within the Middle Project Subarea during construction are temporary, and would not accumulate or result in violations of State or federal air quality regulations. In addition there would not be any long-term increase in local traffic attributable to the action alternatives. Construction contractors' equipment would be required to meet opacity and other equipment-emission regulations.

Construction of the water pipelines also would not adversely affect air quality because their linear nature would prevent the possible accumulation of dust and/or vehicular emissions in any one area. Air emissions from WTP plant operations will be treated to meet all applicable air quality standards before being discharged to the atmosphere, and therefore will not contribute to degradation of air quality in the AQCR. Based on the lack of any continuous and substantive emissions or accumulation of particulate matter, from DWP construction or operation, there would be no adverse cumulative effects on air quality in the Middle Project Subarea under any of the DWP alternatives.

There are no adverse effects from construction and operation of any action alternative that cannot be avoided, or considerably lessened by appropriate construction BMPs, as required by City permits and other regulations (see Section 3.6.4). The same techniques would apply to any construction that may occur related to the No Action Alternative. Short-term versus long-term productivity would not be a concern with either the proposed action alternatives or the No Action Alternative. There are no known irreversible or irretrievable commitments of resources associated with air quality.

In summary, the construction emissions fall below the 10 percent level that would be considered regionally significant by the EPA if the region were nonattainment for any of the criteria pollutants as stated in 40 CFR 51, Subpart W, Section 852. However, the area is in attainment. Therefore, the air emissions from each of the action alternative construction activities would not be considered significant.

3.6.7 Proposed Mitigation Measures

Environmental air-quality regulations minimize the level of blown dust or vehicle emissions by specifying control practices to be implemented by the construction contractor. Requirements stipulated in the *Development Process Manual* (City, 1997) for construction activities mandate that the types of construction activities to be associated with implementation of the DWP must include implementation of the specific air-quality protection measures. Compliance with these measures would be required to obtain City construction permits, and implementation of these BMPs would ensure that substantial adverse effects on air quality would not result from construction or operation of the project. These proposed mitigation measures include the following:

- Limit the amount of trench that would be open at any time.

TABLE 3.6-10
SUMMARY OF PROJECT EFFECTS ON AIR QUALITY

Evaluation Criteria	No Action	Angostura Diversion	New Surface Diversion	Subsurface Diversion
Emissions from construction equipment causing violations of standards	Some non-DWP related construction of pump houses, wells and other facilities may be required; no violations likely	With mitigation, no air emissions would exceed standards	With mitigation, no air emissions would exceed standards	With mitigation, no air emissions would exceed standards
Emissions that result in non-attainment of NAAQS	Some non-DWP related construction of pump houses, wells and other facilities may be required; no violations likely	With proposed mitigation measures and construction management practices, no non-attainment violations	With proposed mitigation measures and construction management practices, no non-attainment violations	With proposed mitigation measures and construction management practices, no non-attainment violations
Generation of dust or other emissions that degrade air quality	Some non-DWP related construction of pump houses, wells and other facilities may be required; no violations likely	Dust likely in unpaved areas during construction; amount depends upon climate and moisture conditions; minimized by construction techniques	Dust likely in unpaved areas during construction; amount depends upon climate and moisture conditions; minimized by construction techniques	Dust likely in unpaved areas during construction; amount depends upon climate and moisture conditions; minimized by construction techniques
Emission of objectionable odors	Some non-DWP related construction of pump houses, wells and other facilities may be required; no violations likely	Off gas from the water treatment plant operations would be filtered, and would not pose an odor nuisance	Off gas from the water treatment plant operations would be filtered, and would not pose an odor nuisance	Off gas from the water treatment plant operations would be filtered, and would not pose an odor nuisance

- Each construction contractor would be responsible for assuring that construction equipment (especially diesel equipment) meets City opacity standards for operating emissions.

- The EPA estimates that the effects of fugitive dust from construction activities would be reduced significantly with an effective watering program. This will be implemented pursuant to City dust control ordnances.

- Conform to the BMPs to minimize particulate and dust emissions from construction work sites that are specified in the City excavation, grading, and surface disturbance permits that would be obtained for this project.

- Each construction contractor would acquire excavation, grading, and surface disturbance permits that specify BMPs to minimize particulate and dust emissions from construction work sites.

- Each construction contractor would adhere to any other requirements placed on the activity, and be subject to inspection by the City to enforce the requirements of the permits and the requirements of 20 NMAC 11.20 (New Mexico, 1997).

3.7 AQUATIC LIFE

3.7.1 Introduction

Concerns identified during scoping focused on the potential effects of reservoir fluctuations on recreational fishery species. Surface water velocity and depth changes in portions of the Rio Chama and Rio Grande were also noted. The project-related aquatic life issues identified during scoping activities are listed in Appendices B through D and documented in a USFWS letter dated August 18, 1998 (Appendix N).

Aquatic-life resources are those organisms associated with the riverine and lacustrine systems in the Rio Grande, the Rio Chama, and the associated reservoirs. These resources occur in all three project subareas. Fisheries are discussed in particular for locales where this resource was noted as a concern during scoping events.

The methods of analysis used to evaluate DWP effects on aquatic life were to determine areas that would be affected by proposed in-river construction, and to estimate the hydraulic effects (flow and water-level changes) in reservoir and riverine systems attributable to the project operations (see Hydrology Resource Section 3.16). The amount of aquatic habitat altered, if any, was then evaluated for potential effects on aquatic life, as indicated by reservoir drawdowns, and effects on channel morphology within the river.

3.7.2 Affected Environment

Two aquatic habitat types that could be affected by the DWP were identified: reservoir habitat and riverine habitat. All reservoirs involved in DWP operation lie within the Upper Project Subarea. The riverine habitat extends through all project subareas. These potentially affected habitats within the project subareas are described below.

Reservoir Fisheries

El Vado Reservoir on the Rio Chama is stocked with kokanee salmon and rainbow trout. This fishery does not thrive due to the close presence of Heron Dam, which releases through the bottom strata of the water column, keeping productivity low.

Game fish in Abiquiu Reservoir (Rio Chama) are managed by NMDGF for a put-grow-and-take, two-story cold and warmwater fishery (USACE, 1995). Abiquiu Reservoir supports a warm- to coolwater fishery consisting of percids and centrarchids such as walleye (*Stizostedion vitreum*) and smallmouth bass (*Micropterus dolomieui*), and a coldwater sport fishery consisting of salmonids such as rainbow trout

(*Oncorhynchus mykiss*). Self-sustaining populations of walleye and smallmouth bass exist in the reservoir (USFWS, 1996). Rainbow trout are stocked into the reservoir by NMDGF.

Cochiti Reservoir, on the Rio Grande, does not have a thriving fishery. This is due to a lack of littoral habitat and low water-retention times. Largemouth bass, crappie, walleye, and catfish are the primary species comprising the fishery.

Riverine Fisheries

Rio Chama

On the Rio Chama, there is not a fishery between the outlet works of Heron Dam and the headwaters of El Vado Reservoir due to low productivity from the upstream influence of Heron Reservoir, and it is not managed as a recreational fishery as defined by the NMDGF.

The first few miles below El Vado Dam are recognized as providing some of the best brown and rainbow trout fishing in New Mexico. This section holds the record for brown trout in the state, and produces several trophy-sized fish each season. Damage to habitat from winter streamflow fluctuations has been reduced since 1983, and an improvement in the fishery has been observed. However, highly turbid conditions result from reservoir releases and sediment input from side drainages during storm events. Sediment yields from the side drainages may be the most significant limiting factor on fishing opportunities (Fogg *et al*., 1992).

Based on catch counts, the best fishing opportunities appear to occur in the first 5 to 10 miles below El Vado Dam. River access below El Vado Ranch is limited to a few four-wheel drive roads and trails. Road access to the river will be further restricted in the future, and eventually may be eliminated. Fishing access by boat may be a viable alternative to hiking in from the nearest trailhead (Fogg *et al*., 1992).

A coldwater game fishery is supported within the designated Wild and Scenic River segment of the Rio Chama. Species of interest include brown trout, rainbow trout, and kokanee salmon in the upper 15 miles of this segment, and channel catfish throughout the entire designated segment. Fourteen native and non-native fish species have been documented in the Rio Chama downstream from El Vado. Longnose dace and white sucker are the most numerous, while fathead minnow, black crappie, green sunfish, river carpsucker, and kokanee salmon are uncommon. Other species include Rio Grande chub, flathead chub, Rio Grande sucker, and common carp (Fogg *et al*., 1992).

Native fishes found in the Rio Chama below the dam are Rio Grande chub (*Gila pandora*), Rio Grande sucker (*Catostomus plebeius*), flathead chub (*Platygobio gracilis*), longnose dace (*Rhinichthys cataractae*), river carpsucker (*Carpiodes carpio*), and fathead minnow (*Pimephales promelas*). Introduced fish species that occur in the Rio Chama are rainbow trout (*Oncorhynchus mykiss*), white sucker (*Catostomus commersoni*), common carp (*Cyprinus carpio*), and green sunfish (*Lepomis cyanellus*).

Catchable-size rainbow trout are stocked by NMDGF immediately below El Vado Dam. Most of these stocked fish remain within 4 miles of the stocking location and provide good angling within that range. Rainbow trout are spring spawners and are not likely to reproduce naturally in the area below El Vado Dam due to high spring runoff flows. The NMDGF has requested that streamflow in the Rio Chama downstream from El Vado Dam be managed to protect and maintain the naturally reproducing brown trout fishery. Brown trout are seldom caught or electrofished farther than 15 miles downstream. This may result from a deterioration of water quality below El Vado Dam (Fogg *et al*., 1992).

In the Rio Chama, a minimum flow of 150 cfs is required to support brown trout during the winter period (Fogg *et al*., 1992). To support other fish species, Turner *et al*. (1977) suggest a minimum flow of 50 cfs should be provided for rainbow trout and white sucker, and 200 cfs for channel catfish and carp. Therefore, a minimum of 50 cfs may support two fish species; 150 cfs would support three species; and 200 cfs would support five species of fish. In addition, a minimum flow of at least 40 cfs is critical for maintaining habitat for benthic macroinvertebrates, a major food source. Species that occupy the Rio Chama are indicative of relatively clear, cool, fast-flowing water (Platania, 1991). They include brown trout, rainbow trout, flathead chub and longnose dace. Between the Abiquiu Reservoir outlet and the Rio Chama/Rio Grande confluence more species occur, including river carpsucker, black bullhead, channel catfish, green sunfish, and largemouth bass, which are typically found in warmer, slower-moving water.

Rio Grande

The reach between the Rio Chama confluence and the headwaters of Cochiti Reservoir is primarily on Pueblo lands and is not actively managed as a recreational fishery. Table 3.7-1 lists the status of native fishes in the Middle Rio Grande. Twelve of the twenty-four native fish species are no longer found in the Middle Rio Grande. The RGSM is listed as endangered and is discussed in Section 3.24. Fish species in the Rio Grande reach below Cochiti Dam are principally coolwater minnows and suckers; several species of piscivirous nonnative gamefish are present. Changes in habitat that occurred after completion of the dam, in addition to altering the thermal regime of the river, allowed these species to become principal members of the fish community (USFWS, 1999a). The fish community in this reach is almost exclusively nonnative fish dominated by white suckers, and bass and perch escapement from Cochiti Reservoir. The Cochiti tail-water is a rainbow trout fishery maintained by stocking catchable-size fish.

The Rio Grande, from Albuquerque to Elephant Butte Reservoir, does not contain a recreational fishery, and is not managed as such by the NMDGF. However, the irrigation drains and canals near Albuquerque are stocked in the winter months with rainbow trout for a put-and-take fishery.

In the Lower Project Subarea, the Elephant Butte Reservoir delta region provides a habitat type unique within this reach, and is a transition zone from lotic (flowing) to lentic (standing) aquatic habitats. Aquatic conditions in the delta region associated with the headwaters of Elephant Butte Reservoir represent relatively extreme habitat conditions for native warmwater fish associated with the Middle Rio Grande. Fish communities in the delta were sampled in 1997 and 1998 during a period of high reservoir levels (Broderick, 2000). The fish community in the delta consisted of five

TABLE 3.7-1
CURRENT STATUS OF NATIVE FISHES IN THE MIDDLE RIO GRANDE

Species	Status
Shovelnose sturgeon (*Scaphirhynchus platorynchus*)	Extirpated
Longnose gar (*Lepisosteus osseus*)	Extirpated
American eel (*Anguilla rostratra*)	Extirpated
Roundnose minnow (*Dionda episcopa*)	Extirpated
Speckled chub (*Machrhybopsis aestivalis*)	Extirpated
Rio Grande shiner (*Noropis jemexanus*)	Extirpated
Blue sucker (*Cycleptus elongatus*)	Extirpated
Gray redhorse (*Moxostoma congestum*)	Extirpated
Blue catfish (*Ictalurus furcatus*)	Extirpated
Freshwater drum (*Aplodinotus grunniens*)	Extirpated
Phantom shiner (*Notropis orca*)	Extirpated, Extinct
Rio Grande bluntnose shiner (*Notropis simus*)	Extirpated, Extinct
Gizzard shad (*Dorosoma cepedianum*)	Present
Red shiner (*Cyprinella lutrensis*)	Present
Rio Grande chub (*Gila pandora*)	Present
Rio Grande silvery minnow (*Hybognathus amarus*)	Present, Endangered
Fathead minnow (*Pimephales promelas*)	Present
Flathead chub (*Platygobio gracilis*)	Present
Longnose dace (*Rhinichthys cataractae*)	Present
Rio Grande sucker (*Catostomus plebius*)	Present
River carpsucker (*Carpoides carpio*)	Present
Smallmouth buffalo (*Ictiobus bubalus*)	Present
Flathead catfish (*Pylodictis olivaris*)	Present
Bluegill (*Lepomis macrochirus*)	Present

Source: Sublette *et al*. (1990).

native species dominated by red shiner, gizzard shad, and smallmouth buffalo, and three nonnative species dominated by common carp.

3.7.3 Environmental Consequences

The following evaluation criteria are considered in evaluating potential aquatic-life effects:

- A large-scale reservoir drawdown that leads to fish kills on the Rio Chama or Rio Grande,
- Lowered water tables that could result in reduced recreational fishery quality, and
- Habitat alterations caused by changes in flow velocity and/or depth of the river.

Effects from No Action Alternative

The river and operations would not affect aquatic habitats or organisms outside the bounds of normal seasonal and river operational fluctuations. However, continued pumping from the ground water aquifer at a rate that exceeds recharge rates would contribute to continuing declines in ground water levels, which could affect 373 acres of riparian vegetation in the Middle Project Subarea and could modify streamside habitats, and therefore could indirectly affect aquatic life. Riparian vegetation is considered in Section 3.21.

For the No Action Alternative, the City would compensate for its ground water pumping effects using its various water sources. As compared to the action alternatives, the effects of pumping under the No Action Alternative would cause a difference in flow in the Lower Project Subarea. The change in flows predicted at the I-25 Bridge under No Action would range from +10 cfs in 2006 to -22 cfs in 2040. These small changes in available water below the SWRP may temporarily affect specific areas of the river and subsequently individuals of a given species. Long-term or permanent effects on aquatic life are not anticipated.

Effects from Angostura Diversion

Addition of the City's SJC water into the riverine system in the upper reach of the Upper Project Subarea would have a beneficial effect on the fisheries and other aquatic organisms in the area between Heron Dam outlet and the Angostura Diversion facility. This conclusion was reached based on the presence of the SJC water in the Rio Chama and the Rio Grande that adds consistency to the flows (hydrograph) in those reaches of the rivers and, to some extent, City SJC flows would be managed in cooperation with Reclamation and BLM to support Rio Chama recreational fisheries.

It was determined during the hydrologic analysis (Hydrology Section 3.16) that the additional City SJC water in the river would result in an increase in stage of less than one tenth of a foot increase at the Chamita gage and up to two tenths of a foot increase at the Otowi gage. San Felipe gage would see an increase of less than one tenth of a foot. There would be no effect in river stage in the Lower Project Subarea (see Hydrology Resource Section 3.16). This is the same for all three action alternatives.

Reservoir operations would not be expected to change with implementation of the proposed action (CH2M Hill, 2003). The City will continue to take full delivery of its SJC water from Heron Reservoir. Winter fisheries releases are maintainable under the project action alternatives either with or without waivers and regardless of initial storage conditions in El Vado and Abiquiu Reservoirs. Regarding reservoir levels, model simulations while not definitive of all operational scenarios suggest no major changes in historic maximum and minimum storage volumes and elevations of SJC reservoirs

(CH2M Hill, 2003). The City would release its SJC water from Abiquiu Reservoir on a near constant basis, which would increase the amount of water in the river from Abiquiu Dam to the point of diversion. Releases would be coordinated with the OSE in accordance with the approved diversion permit.

Winter fisheries releases would be maintainable under this action. The ability to maintain winter fisheries releases in the Rio Chama below El Vado and Abiquiu is based on the maintenance of a specified minimum flow of 185 cfs during winter months, except during low-flow and drought years, when 100 cfs has been the specified minimum flow, as measured at El Vado. Minimum fishery releases at Abiquiu were set at 70 cfs. Implementation of Angostura Diversion would not markedly change historic maximum and minimum storage volumes and elevations of SJC reservoirs (CH2M Hill, 2003).

Operation of the project under Angostura Diversion would not result in drying of river segments in the Middle Project Subarea. It could affect aquatic life along the 33-mile reach from the proposed Angostura diversion to the SWRP outfall (Middle Project Subarea) because of a net depletion of native Rio Grande water. The hydrologic effects of these depletions and the subsequent effects on the endangered Rio Grande silvery minnow (RGSM) are discussed in detail in Section 3.24. Effects on other aquatic organisms in this reach would be similar.

Review of historical discharge measurements made in the river in the vicinity of the Albuquerque gage at Central Avenue suggests that the reduction in flows of up to 65 cfs during severe low flow (170 cfs at Albuquerque gage) (see operational scenario in Hydrology Section 3.16) would have the following effects:

- A 0.1- to 0.2-feet-per-second (ft/sec) reduction in flow velocity, within a typical range of 1.0 to 1.4 ft/sec;
- A 20- to 30-foot reduction in river channel width, within a typical range of 70 to 130 feet, respectively; and
- A change in water depth below the diversion point ranging from ± 0.1 foot during a mean low monthly flow to 0.3 foot in the narrowest part of the channel during a severe low flow (assuming a constant net diversion of 65 cfs of native Rio Grande water) (CH2M Hill, 2003).

It should be noted that the changes to river velocity depth and widths caused by the No Action Alternative are similar to those listed above.

Potential changes in velocity, river channel width, and water depth are associated with severe drought conditions and would occur only when flows in the range of 170 cfs total river flow were occurring. Additionally, these changes would be temporary and would be eliminated when flows were again elevated as a result of seasonal precipitation and runoff patterns. Therefore, these changes in velocity, river channel width, and water depth are not properly characterized as losses, rather they are temporal effects. Hence, aquatic resources would not be lost but rather redistributed based on availability of habitat. Even if individuals were harmed in the process, there is no evidence to support these losses having permanent resource level effects. Aquatic organisms have the capability to, and normally do, seek optimum habitat conditions. It can be assumed that aquatic organisms will attempt to maintain themselves in suitable habitats, and will move when additional habitat is available (Sublette, *et al*., 1990; Hoagstrum and Brooks, 1999; and Rieman and McIntyre, 1993).

When aquatic habitat is changed or altered in a natural flow condition, this is not referred to as a loss of habitat. The condition is temporary, and would be expected to change with a different flow condition. The aquatic habitat, in this situation, is not lost but altered, and aquatic species would move to seek a suitable habitat. The losses, in this case, refer to temporary modifications of available habitat that would become available with a different flow condition, thus mimicking natural conditions.

The project effects from operation of Angostura Diversion would not affect the fishery in the depletion reach. This temporary condition during severe low flow could reduce available habitat by up to 43%, however velocities or changes in water depth would not be as restrictive. In the Middle Project Subarea, there is no recreational fishery. However, project operations would be managed for the RGSM, and these management efforts would be supportive of other native warmwater fishes in this reach in that river flows would be managed to maintain flows throughout this reach.

The existing Angostura Diversion Dam is a barrier to upstream movement of aquatic life in the Rio Grande. Angostura Diversion Alternative would include construction of a new 50-foot-wide, 1,500-foot-long rock-lined fishway on the western side of the dam. This proposed fishway would be designed to enhance aquatic habitat by providing a safe route around the existing diversion dam. The modified diversion would be equipped with a V-shaped, 250-foot-long fish screen in the existing concrete-lined channel immediately below the diversion dam. This facility would include a 36-inch fish by-pass or return pipe for routing screened fish back to the Rio Grande. Both the by-pass and fishway would constitute aquatic-habitat enhancements of an existing structure.

Direct in-river construction effects would be temporary and localized. Approximately 0.5 acres of aquatic habitat would be temporarily lost during construction at the ends of the fishway and near the existing dam. A channel would be maintained during in-river construction activities to allow fish and other aquatic life passage. Any stranded fish would be salvaged and moved below the construction area. Indirect operational effects on aquatic life would be minimal, based on the minor changes in aquatic habitat as indicated by slight changes in depth, velocity, and stream width.

The cumulative effects on aquatic resources in the Middle Project Subarea also would be minimal, as the percentage of total flows to be diverted by the project is small. There would be a minor positive effect on aquatic resources in the Upper Project Subarea from release of the City's SJC water into the river channels.

There would be no anticipated changes in hydraulic conditions, water quality, or aquatic habitat in the Lower Project Subarea as a result of implementation of Angostura Diversion. The depletion effect would be eliminated at the SWRP outfall, where the native Rio Grande water would be returned to the channel as described in the Hydrology Section 3.16. These additional flows that would be present in the Rio Chama and the Rio Grande in the Upper Project Subarea would be considered positive.

Because changes in flows would be minimal, as described above, and because the effects of changes in flows and habitat availability would be temporary and limited to certain subreaches of the river, there would be no direct, indirect, or cumulative effects to fisheries and other aquatic life within the reservoirs attributable to reservoir operations in the Upper Project Subarea. Detailed analysis of project effects on reservoir and Rio Chama hydrology is provided in Appendix L. Past, connected, and cumulative actions within the Rio Grande, including dam construction, modified flows and sediment regimes, changes in water quality, and the introduction of non-native species, have modified and negatively affected the aquatic habitat of the Rio Grande. Changes in traditional water-management operations conducted by federal agencies are planned for the future, as are system-maintenance activities. In addition, several entities are constructing and planning river and riparian restoration projects, which would be beneficial to the aquatic resources within the project area. The cumulative effects of the proposed action on the RGSM are considered in detail in Section 3.24. Effects on aquatic species other than the RGSM would be related to changes in the hydrographs of the Rio Grande and the Rio Chama, and to related changes in velocity, depth, and stream width. As described above, these changes would be minimal. The detailed analysis of effects on the RGSM is sufficiently conservative with respect to drying effect and discontinuous flows to afford protection to other species.

There would be no adverse effects from DWP Angostura Diversion on aquatic life that could not be avoided or lessened through planned mitigation (see Section 3.7.4). Short-term losses of in-river habitats may occur during construction, temporarily affecting aquatic habitat. Steps taken to mitigate effects in these areas would prevent any long-term productivity losses. In conclusion, aquatic life would be temporarily impacted by the DWP. Addition of the City's SJC water to the Rio Chama and portions of the Rio Grande and the proposed mitigation measures discussed below would more than compensate for these effects. As defined and discussed above, effects on aquatic species would be minimal. Environmental enhancements that increase habitat diversity, stabilize flows and promote river reconnectivity would likely be beneficial for many aquatic species.

Effects from Paseo del Norte Diversion

Construction and operation of the new surface diversion dam north of Paseo del Norte, as proposed under DWP Paseo del Norte Diversion Alternative, would have the same effects on fisheries, reservoir levels, aquatic life and related hydrology in the Upper Project Subarea as discussed above for Angostura Diversion. Effects in the Lower Project Subarea also would be the same as those discussed for Angostura Diversion. Aquatic-life effects in the Middle Project Subarea under Paseo del Norte Diversion are described below. There would be 0.2 acres of aquatic habitat lost to dam construction. About 1.8 acres would be temporarily lost due to construction of the dam, access roads, backfill areas, etc. during in-river construction.

The City would begin to curtail diversion of its SJC water from the Rio Grande when the native flows above the diversion point reached 260 cfs or less. As the flows continue to decline, the City would reduce diversions until the river reaches 130 cfs of native water at the diversion point and 130 cfs of flow downstream in the river channel. At that point, the City would suspend surface water diversions until flows recover, and temporarily would rely solely on ground water for drinking water.

The alternative calls for construction of a 50-foot-wide, low-gradient, V-shaped fishway to provide a route for aquatic species movement around the dam while the adjustable-height crest gates are raised. The crest gates would likely be raised from 2-3 feet above river bottom for a large portion of each year. The gates would probably only lay flat (about 0.5 feet above river bottom) for a 30-45 day period when flows were greater than 3,000 cfs. The fishway would operate at a flow velocity of approximately 2 ft/sec and an average flow rate of 50 cfs. The surface water intake would be constructed along the east side of the sluice channel. As described in Section 2, fish screen panels would be located across the entrance of each of the 10 intake compartments to prevent entrainment of aquatic species. The fish screens would be designed for a maximum approach velocity of 0.2 ft/sec at the peak diversion rate of 142 cfs, to avoid pinning any species against the screens (CH2M Hill, 2001a, c).

Direct in-river construction effects would be temporary and localized. A channel would be maintained during in river construction to allow fish passage, and any stranded fish would be salvaged and moved below the construction area. Indirect effects on aquatic life would be minimal, based on the small changes in aquatic habitat as indicated by changes in depth, velocity, and stream width (see discussion for Angostura Diversion, above). During low flow, water depth could be reduced by up to 0.3 foot in the narrowest section of the river under a constant net diversion of 65 cfs of native Rio Grande water (CH2M Hill, 2003).

Flow depletions under Paseo del Norte Diversion would affect about 15 miles in the Middle Project Subarea, from the new diversion point near Paseo del Norte to the SWRP outfall. The nature and magnitude of these effects on aquatic life, as represented by the RGSM, are evaluated in Section 3.24 (Threatened and Endangered Species). River depletions during DWP operations under Paseo del Norte Diversion would not contribute to flow intermittency.

There would be no anticipated changes in measurable flow, water quality (see Section 3.27), or habitat in the Lower Project Subarea due to implementation of Paseo del Norte Diversion. The depletion effect would be eliminated by the return of native Rio Grande water at the SWRP outfall (at the lower end of the Middle Project Subarea).

Cumulative effects on aquatic life from implementation of Paseo del Norte Diversion would include minimal habitat losses where new in-stream facilities are constructed. Use of the fishway by aquatic species is an area of uncertainty. There would be opportunities to include design parameters in the fishway to accommodate species other than the RGSM. Additionally, monitoring of the use of the fishway would be included as a mitigation measure. Any effects of the dam as a barrier would be offset by the proposed mitigation measures discussed below. In conclusion, aquatic life would be slightly impacted. Addition of the City's SJC water to the Rio Chama and portions of the Rio Grande and the mitigation, discussed in Section 3.7.4, would more than compensate for these effects.

Effects from Subsurface Diversion

Construction of a Subsurface Diversion at Paseo del Norte would have similar effects on fisheries, reservoir levels, aquatic life and hydrology in the Upper Project Subarea as discussed for Angostura Diversion. Effects on aquatic life in the Middle and Lower Projects Subareas are anticipated to be the same under Subsurface Diversion as described for Angostura Diversion, and the length of Rio Grande in which net flows would be depleted (15 miles) would be as described for Paseo del Norte Diversion.

The City would begin to curtail diversion of its SJC water from the Rio Grande when the native flows above the diversion point reached 260 cfs or less. As the flows continue to decline, the City would reduce diversions until the river reaches 130 cfs of native water at the diversion point and 130 cfs of flow downstream in the river channel. At that point, the City would suspend surface water diversions until flows recover, and temporarily would rely solely on ground water for drinking water.

Subsurface Diversion would involve in-river construction, and affecting about 100 acres of the riverbed, would be conducted during an approximate 9 to 12 month period over two winter seasons (Schertler, 2001). Three subsurface collector systems would be installed in the riverbed on the east side of the river near Paseo del Norte. The nature and magnitude of these effects on aquatic life, as represented by the RGSM, are evaluated in Section 3.24 (Threatened and Endangered Species). However, implementation of this alternative would lower the water table beneath approximately 552 acres of riparian areas near the collectors by as much as 3 feet (see Section 3.21 for riparian vegetation). This change could affect riverbank habitat, and could therefore indirectly affect aquatic life that uses overbank areas.

Cumulative effects on aquatic life from implementation of Subsurface Diversion would include minimal habitat losses where new, subgrade in-stream facilities are constructed. These effects would be offset by the mitigation discussed in Section 3.7.4. In conclusion, aquatic life would be temporarily impacted at a minimal level. Addition of the City's SJC water to the Rio Chama and portions of the Rio Grande, and implementation of the mitigation discussed below, would compensate for these effects.

Summary of Environmental Consequences

DWP action alternatives would result in the construction of permanent structures in and near the Rio Grande. Direct and indirect effects on aquatic life from construction would be minimal and temporary under all action alternatives, particularly with the implementation of the mitigation measures and environmental enhancements noted in Section 3.7.4.

Temporary loss of aquatic habitat due to construction would affect 1.8 acres of aquatic habitat for the Paseo del Norte diversion dam. A total of 0.2 acres of aquatic habitat would be permanently lost due to the presence of the bladder dam at Paseo del Norte.

All action alternatives would result in diversion of the same amounts of water and the same changes in Rio Chama and Rio Grande flows. Reservoir operations would not change as a result of project implementation. Direct effects from operation of all action alternatives would include minor increases in river flows in the Upper Project Subarea. Flow depletion in the Middle Project Subarea would be the same for all action alternatives, though the lengths of the depletion zones would vary from 15 miles for Paseo del Norte Diversion and Subsurface Division to 33 miles for Angostura Diversion. Analysis of these effects on aquatic organisms and their habitats, as represented by the RGSM, is provided in Section 3.24. River cross-section analyses presented in that section indicate no loss of river connectivity and no contribution to river intermittency, because of the DWP. Based on the lack of change in river connectivity, the lack of a contribution to river intermittency, and the temporal nature of the changes predicted, effects of these depletions would be minor. The No Action Alternative, as compared to the action alternatives, would have operational effects in the Lower Project Subarea from +10 cfs in 2006 to -22 cfs in 2040 (see Hydrology Section 3.16).

Operational effects of all action alternatives would be minimal based on incorporation of the proposed mitigation measures noted below. No substantial temporary or long-term adverse effects on aquatic life would result. Historically, mainstem dams, diversion dams without fishways or fishscreens, with associated water depletions, and the introductions of non-native species have been thought to alter the Rio Grande native fish fauna. Effects have included barriers to migration, reduction of preferred habitats, and increased predation and competition. Future, or planned projects, would not substantially lessen or mitigate for past impacts such as the presence of the MRG Project diversion dams. However, contributions to the stability of the riverine ecosystem would be considered beneficial.

The in-river construction effects, related to the DWP, are temporary, and a channel would be maintained for fish passage. Stranded fish would be recovered. Within the Upper Project Subarea, no changes to upstream reservoirs are expected, and fisheries flows would be maintained (see Section 3.16). The fishway and fish screen outfall at Angostura would replace approximately 1.8 acres of riparian soil with rock/cobble/sand, or a concrete bottom from construction at those facilities. The fishway component would include additional aquatic habitat. The Paseo del Norte Diversion dam replaces about 0.2 acres of riverine bottom with concrete apron structure for the diversion dam. The fishway at Paseo del Norte Alternative would have a similar effect as at Angostura. Regarding the Subsurface Alternative, no permanent disruption of the river bottom is likely.

The length of depletion of approximately 15 miles for Paseo del Norte Diversion, was analyzed for potential effects to the RGSM in Section 3.24. There would be no loss of river connectivity or loss of RGSM habitat attributable to the DWP as indicated by this analysis. There may be some loss of reproductive propagules of fish within the fish screens of Angostura Diversion and Paseo del Norte Diversion. From a cumulative effects standpoint, the amounts of propagules are not expected to be a substantial effect to the fish within the river. The consideration of "take" regarding the RGSM is detailed in Section 3.24. Future cumulative effects to aquatic life would not be more severe or sustained within the Upper and Lower Project Subareas than those already attributable to past actions because aquatic habitats are not modified. The analysis of habitat and river conditions within the Middle Project Subarea, or depletion zone, indicates no adverse physical effects to the habitat of the RGSM, or a loss of river connectivity under the operating criteria defined for the project. When extrapolated to other aquatic species, there are no cumulative effects of the DWP to aquatic life. Effects associated with the changes in water velocity, depth, river width and river connectivity would not result in permanent changes to aquatic habitat or aquatic species. Long-term or permanent effects associated with loss of individuals of a species with respect to that population remain an uncertainty but would be expected to be minimal.

As a result of Section 7 consultations with the USFWS, the curtailment flows described in the FEIS have been increased by 60 cfs. The proposed curtailment strategy is an enhancement as more water is in the river than with No Action during the driest months of the year (reference Figures 3.16-7 through 3.16-9). The minimum flow to date over the last ten years at the Albuquerque gage was 106 cfs on October 21, 2002. To allow for seepage losses from the preferred alternative at Paseo del Norte, the amount of flow by-passed due to curtailment was increased to 130 cfs. This 60 cfs increase in the curtailment rate also applies to the other action alternatives of the FEIS. The curtailment flow, where the City would have the diversion shut down completely, is a result of the consultation with the USFWS revised to a total river flow of 560 cfs from the previous 500 cfs at Angostura above the diversion, and at 260 cfs from the previous 200 cfs total river flow for the other two diversion alternatives.

The Hydrologic Engineering Center - River Analysis System (HEC-RAS) models completed for the RGSM illustrate the amounts and types of habitats available for the RGSM under a variety of flow conditions. The RGSM, a native cyprinid, and a "sensitive" species, would have available habitat under most average flow conditions in the river. Cumulative effects associated with changes in water velocity, depth, river width and river connectivity attributable to the project, and compared to water changes associated with No Action, would not result in permanent changes to aquatic habitat, as reflected by the needs of a sensitive native fish. Habitat requirements for the RGSM serve as a benchmark to reasonably determine effects of the proposed project on other aquatic species, much as risk assessment is applied to the weakest or most vulnerable species within a community or ecosystem.

There are no short-term use versus long-term productivity concerns attributable to any of the action alternatives for aquatic life, nor are there any known irreversible and irretrievable commitments of resources with respect to aquatic life. DWP effects on aquatic life are summarized in Table 3.7-2.

3.7.4 Proposed Mitigation Measures

Proposed mitigation measures to enhance RGSM habitat would also create habitat for other aquatic life native to the Rio Grande in the Middle Project Subarea. Design features of the habitat enhancements would be tailored to benefit the RGSM in particular. The following project design features would minimize or eliminate potential project effects on aquatic resources:

- Fishway: The proposed fishway for Angostura Diversion and Paseo del Norte Diversion would be designed to enhance aquatic habitat by providing a route around the existing Angostura and new surface dam at Paseo del Norte (see Figures 2.5-1 and 2.5-3).

- Fish screens: Angostura Diversion also would be equipped with a V-shaped, 250-foot long fish screen in the existing concrete-lined channel immediately below the diversion dam (see Figure 2.5-1). The sluice channel for Paseo del Norte Diversion would be equipped with fish screens as well (see Figure 2.5-3).

TABLE 3.7-2
SUMMARY OF PROJECT EFFECTS ON AQUATIC LIFE

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Reservoir level changes that lead to fish kills	None	No substantive change between historic maximum and minimum reservoir levels as a result of project operations. Increase flow-through volume in reservoirs of Upper Project Subarea	No substantive change between historic maximum and minimum reservoir levels as a result of project operations. Increase flow-through volume in reservoirs of Upper Project Subarea	No substantive change between historic maximum and minimum reservoir levels as a result of project operations. Increase flow-through volume in reservoirs of Upper Project Subarea
Lowered water tables that reduce fishery quality	Potential indirect effect due to ground water pumping of approximately 373 acres of riparian vegetation in Middle Project Area by lowered water table, which could modify streamside habitats	Increased flows from the City's SJC water would support current water table in Upper Project Subarea; no effect on water table in Middle or Lower Project Subareas	Increased flows from the City's SJC water would support current water table in Upper Project Subarea; no effect on water table in Middle or Lower Project Subareas	Increased flows from the City's SJC water would support current water table in Upper Project Subarea; approximately 552 acres of riparian vegetation in Middle Project Area would be affected by lowered water table, which could modify streamside habitats
Habitat Modification	None	No permanent substantive changes in flow velocity or river width or depth in any project subarea. 0.5 acres of aquatic habitat temporarily lost during in-river construction near the existing dam and ends of fishway to connect to the river. 1.5 acres of aquatic habitat temporarily lost by in-river construction for the potable water transmission line	No permanent substantive changes in flow velocity or river width or depth in any project subarea. 0.2 acres of aquatic habitat lost to dam construction. 1.8 acres temporarily lost due to construction of dam, access roads, backfill areas during in-river construction. 1.5 acres of aquatic habitat temporarily lost by in-river construction for the potable water transmission line crossing.	No permanent substantive changes in flow velocity or river width or depth in any project subarea. 1.5 acres of aquatic habitat temporarily lost by in-river construction for the potable water transmission line crossing. 100 acres temporarily lost due to construction of subsurface collectors, access roads, backfill areas, etc. during in-river construction

- Operational criteria: Water diversions would be curtailed, as defined by the Operation Criteria defined in Section 2, a flow of 180 cfs below Angostura and 130 cfs below the new surface dam at Paseo del Norte.

- During installation of the Subsurface Diversion, the City would require the construction contractor to use appropriate BMPs to minimize and contain the discharge of suspended sediments into the Rio Grande.

- During construction in the river, any fish stranded by construction of the facility would be salvaged and relocated to a different portion of the river. By agreement, USFWS staff would be available to relocate fish if they inadvertently become separated from the main river channel by construction activities.

- During installation of the Subsurface Diversion facility, the City would require the construction contractor to maintain an open channel (velocity less than 3 ft/sec) in the Rio Grande for fish passage around the construction site at all times.

3.8 BIODIVERSITY

3.8.1 Introduction

Consideration of biodiversity is a requirement of the Council on Environmental Quality (CEQ, 1993) and was not identified as a concern during scoping. Biological diversity, or biodiversity, refers to the variety and abundance of species, their genetic composition, and their communities (Wilson, 1988). The current worldwide rate of species extinction is increasing (Wilson, 1985). Physical alteration of ecosystems, as a result of resource development and changing land use, is the primary cause of biodiversity loss (CEQ, 1993). When natural areas are converted to industrial, residential, agricultural, transportation, or other uses, ecosystems are disrupted and biodiversity is diminished. Managing for biodiversity includes taking steps to prevent risks to natural habitats and biological processes.

Two methods of analysis were used to determine biodiversity effects.

- Within the Middle Project Subarea, the project’s proposed new structures were mapped. They were then evaluated, using both field investigations and a literature review, to determine if a structure would affect biodiversity as reflected by a loss of habitats or the destruction of wetlands.

- Throughout the study area, effects to biodiversity as a result of modification of the river channel were evaluated based on changes in water flow rates, operational changes, and accompanying changes in hydrology and river hydraulics.

3.8.2 Affected Environment

Special interest plant and animal groups can be described as any specific ecosystems, communities, or species that are particularly jeopardized within the geographic region in question (CEQ, 1993). No special interest plant and animal groups have been identified along the Rio Chama or its reservoirs and the Rio Grande upstream of the proposed diversion structures.

As discussed in Sections 3.21 (Riparian Areas), 3.24 (Threatened and Endangered Species), 3.26 (Upland Vegetation), and 3.29 (Wildlife), most native plant and wildlife species continue to be widespread throughout the Middle Rio Grande region. Plant species that are threatened by development primarily are associated with areas of limited extent, such as wetlands and riparian corridors, including bosque areas. Most wildlife species of concern are associated with these habitat types.

A Bosque Ecosystem Monitoring Program (BEMP) site is located in the area between Alameda Boulevard and Paseo del Norte on the east side of the river. This BEMP site is one of seven that has been monitored by the University of New Mexico and has been used for environmental studies by Bosque School since 1996. It features one of the few remaining stands of large Rio Grande cottonwoods with a dense understory of New Mexico olives (Crawford, 2001).

A part of the Upper Project Subarea, the Rio Chama between El Vado and Abiquiu, has been designated a Wild and Scenic River. Therefore, this area is considered a unique natural resource under Section 1508.27(b)(3) of the CEQ (1978) guidelines for implementing NEPA.

3.8.3 Environmental Consequences

The following evaluation criteria are considered in evaluating potential biodiversity effects:

- Loss of special interest plants, animal groups, or wetlands due to construction or operation.
- Effects of alternatives on "landscape" diversity.
- Long-term stream flow depletion effects on biodiversity.

Effects from No Action Alternative

Under the No Action Alternative, DWP diversions would not occur. Continued operation of the City's wells and decline of the ground water aquifer would have no direct or indirect effects on biodiversity in the project area.

Effects of All Action Alternatives

No effects to biodiversity in any subarea are anticipated from any of the three action alternatives. This determination was based on the extent of the action alternatives, its limited effect on aquatic and terrestrial ecosystems (discussed in other resource areas throughout Section 3), and the mitigation measures incorporated into all of the action alternatives to preserve existing ecosystem elements, including plantings of native vegetation and stocking of native fish species.

The BEMP site between Alameda Boulevard and Paseo del Norte would be avoided during construction of either Paseo del Norte Diversion or Subsurface Diversion. Therefore, there would be no effects to biodiversity within this area from the implementation of these alternatives.

Additional flows of the City's SJC water would occur within the section of the Rio Chama that has been designated a Wild and Scenic River. However, the addition of water to this area would not harm the natural condition of the channel or its associated biological resources. Therefore, there would be no effects to biodiversity.

There are no known special-interest plant communities in areas where construction would occur. There are no known special-interest wildlife species within the area that would be affected by the project. Therefore, the action alternatives would not disrupt any special-interest plant communities or special-interest wildlife species.

There would not be any permanent loss of wetlands or a substantial, permanent loss of wildlife or fisheries habitat. Construction would be scheduled during low-flow and dormant conditions. This would help protect nesting migratory birds and other breeding animals in the project area from construction effects. The proposed new low-head adjustable height dam will not fragment habitat since the fishway, the sluiceway, and the time when the dam is not raised will be effective mechanisms for fish passage.

Summary of Environmental Consequences

The cumulative effects from development throughout the region include the current threat to the RGSM. Past construction and operation of water facilities within the ROI have likely contributed to some loss of biodiversity within the ROI. Historically, main stem dams, diversion dams and modification of the floodplain have impacted biological resources in the project subareas.

An analysis of the DWP effects upon the present biodiversity indicated no loss of jurisdictional wetlands, or impacts upon special interest plants or animals from the DWP alternatives. Consideration of threatened and endangered species is presented in Section 3.24. The analysis of riparian vegetation is considered in Section 3.21. Future or planned projects are primarily river restoration, operations or maintenance projects, and may have some effects upon available water supply or habitats. Due to the absence of any special interest plants or animals that are not avoided by placement of alternatives, or a permanent loss of wetlands or other habitats, there is no additive cumulative effect from the DWP alternatives to existing biodiversity.

In addition, as discussed in Section 3.24, none of the alternatives would increase or decrease the threat to the RGSM. There would not be any adverse effects to biodiversity from any of the alternatives that could not be avoided or mitigated.

3.8.4 Proposed Mitigation Measures

Proposed mitigation measures will include design elements that will reduce effects on construction locations and other actions to replace or replicate ecosystem elements. Mitigation elements of the proposed action, including fishways, planting of native vegetation and stocking of native fish, are discussed in Appendix O. Other elements include annual monitoring of the fishway.

3.9 CULTURAL RESOURCES

3.9.1 Introduction

The cultural resource issues identified during DWP scoping activities were primarily related to concerns about direct or construction effects on cultural resources, especially if those effects would degrade or destroy the resource. Cultural resources typically are defined as cultural structures, artifacts, sites, or places that were made or used by humans and that are at least 50 years old or, if less than 50 years old, are of unique character and importance.

Traditional Cultural Properties (TCPs) are cultural resources of importance to various members of the community. Substantial scoping and community involvement opportunities have been completed by the City for purposes of identifying and evaluating TCPs (Appendices B, C, D, F, G and Section 4). The Sandia Pueblo identified the river as a TCP and had concerns about traditional use of the river. Additionally, the Santa Ana, San Felipe, and Isleta Pueblos are located along the river.

Under the requirements of the National Historic Preservation Act of 1966 (as amended), federal agencies must take into consideration the effects of their actions on significant cultural resources. The implementing regulations for the National Historical Preservation Act (NHPA) (36 CFR Part 800) call for identifying cultural resources that will be impacted by a project, evaluating the significance of those resources, determining the effect of the project on significant cultural resources, and mitigating any adverse effects of the project on those resources, all in consultation with the State Historic Preservation Officer (SHPO). Criteria are defined in the eligibility requirements for listing cultural sites and districts on the National Register of Historic Places (NRHP). Methods of analysis included searching the state archaeological site files (the Archaeological Records Management System) and historical archives for known archaeological and historic sites in the DWP construction areas and water transmission line corridors in the Middle Project Subarea. Pedestrian surveys were conducted of portions of the construction zones that were not previously fully developed. The significance of cultural resources identified within these zones was evaluated in consultation with the New Mexico SHPO. Details of literature-review and field-inventory methods are described in the DWP cultural resources inventory report (Ecosystem Management, Inc. [EMI], 2002). Concurrence by the New Mexico State Historical Preservation Officer for No Adverse Effect for the Paseo del Norte Diversion Alternative and the Subsurface Diversion Alternative was given on July 26, 2002 (Appendix G).

3.9.2 Affected Environment

The Region of Influence (ROI) contains cultural remains that reflect a rich and varied prehistory and history. Previous archaeological evidence indicates that from 9500 BC through the A.D. 500s, the area was used by early hunters and gatherers for food procurement and seasonal campsites; and from the A.D. 600s through 1500s, ancestral Puebloan farmers built settlements. Historic European migrants also left archaeological remains across the landscape, including some of the earliest Hispanic settlements from the 1600s to 1800s, and more recent Euroamerican resources from the 1880s through 1940s. Remains include ancestral Puebloan occupations that range from simple artifact scatters to large, complex Pueblos with associated kivas. Hispanic and Euroamerican resources include a mix of artifact scatters, dwellings, irrigation features, and churches.

Much of the evaluation area has been disturbed by modern construction, flooding, erosion, and water management practices. The Middle Project Subarea was the focus of the cultural resources evaluation because this is the subarea in which project related ground disturbing activities that could impact cultural remains would take place. While it is possible that unidentified subsurface cultural deposits may be present in DWP construction zones, the degree of previous development/disturbance and/or the riverside context in most of the proposed construction areas reduces the likelihood of encountering significant subsurface remains during construction.

Along the Rio Grande and in the City, present day Pueblos and historic resources are relatively well documented. There are nine Pueblos present within the project subareas, as shown on Figure 3.9-1.

Other historic communities and architecture that could potentially be affected by the DWP are confined to the City of Albuquerque. Within the City limits, the proposed water lines would be constructed in the communities of North Albuquerque, Mid-Heights, Near-Heights, North Valley, and the West Side. In the North Valley, distribution water lines would be laid through one of the City's oldest Spanish settlements, the village of Los Candelarias. On the northeast side of the City, the routes extend first through areas annexed to the City after 1940, and then through Mid-Heights neighborhoods and into the Near-Heights, which were annexed by the City between 1920 and 1939. The Los Candelarias neighborhood has the potential for encountering subsurface cultural resources, particularly during construction. Monitoring during construction will be required in particularly sensitive areas, and contractors and personnel would need to be made aware of this increased likelihood of discovery while working in this area. Some pre-1952 adobe and masonry structures located very near the transmission lines may be vulnerable to damage from vibration. Vulnerable structures will be monitored during construction.

The Middle Rio Grande Project irrigation system also is considered an important historic feature because it is "associated with events that have made a significant contribution to the broad patterns of our history" and it has "made a measurable impact on local life" (SWCA, Inc., 1997). Although most of the original irrigation system features have been upgraded, removed, or destroyed during reconstruction and paving of the flood-control and irrigation system, the system as a whole retains its historic importance. The Middle Rio Grande Project irrigation system has been recommended for listing in the NRHP based on criterion A the "broad patterns of history" criterion (Ackerly, *et al*., 1997). A site records search of the Archaeological Records Management Section (ARMS) of the Museum of New Mexico resulted in finding 124 archaeological sites that had been previously registered within 1 kilometer (km) (0.8 mile) radius of the project area.

During the course of the Class III survey, six sites, twelve currently used historic bridges, nine currently used historic irrigation features, and a currently used diversion dam were visited. The survey resulted in finding one new prehistoric and two new historic sites shown in Table 3.9-1 and 17 isolated occurrences. Three previously recorded sites were also revisited. These six sites are within the proposed project limits and area of potential effect depending upon the selected alternative. Analysis of the cultural resources recorded during the DWP survey indicated that two of the sites are eligible for nomination to the NRHP or the State Registry of Cultural Properties, a lithic scatter and an abandoned segment of historic acequia (EMI, 2002a). Three other sites (LA 112421, 112423, and 114200) are part of the Middle Rio Grande Project irrigation system recommended eligible under criterion A as noted above.

3.9.3 Environmental Consequences

The following evaluation criteria are considered in evaluating the potential effects on cultural resources:

TABLE 3.9-1
SITES DOCUMENTED DURING PEDESTRIAN SURVEY OF PROJECT AREA

ID No. [a/]	Type	Description
LA 112421	Current Irrigation Ditch	Segment of the Atrisco Feeder
LA 112423	Current Irrigation Ditch	Segment of the Albuquerque Main Canal
LA 114200	Current Irrigation Ditch	Segment of the Albuquerque Main Canal
LA 132366	Lithic scatter	Lithic artifact and debitage site of unknown aboriginal affiliation
LA 132367	Irrigation ditch	Abandoned historic ditch segment
LA 132368	Irrigation ditch	Abandoned segment of the historic Griegos Lateral of the Albuquerque central irrigation system

[a/] ID No.= identification number; LA = ARMS Laboratory of Anthropology site number.

- A prehistoric or historic cultural resource (including the Middle Rio Grande Project irrigation system) would be adversely affected if a potentially eligible site or human remains were disturbed or destroyed without completion of an approved data recovery program or without concluding the process outlined in the Native American Graves Protection and Repatriation Act when Native American remains are discovered, if applicable.

- MRGCD and Reclamation records on the existing NRHP-eligible MRG Project irrigation system were compared to DWP development plans to determine the specific effects of the project on the irrigation system.

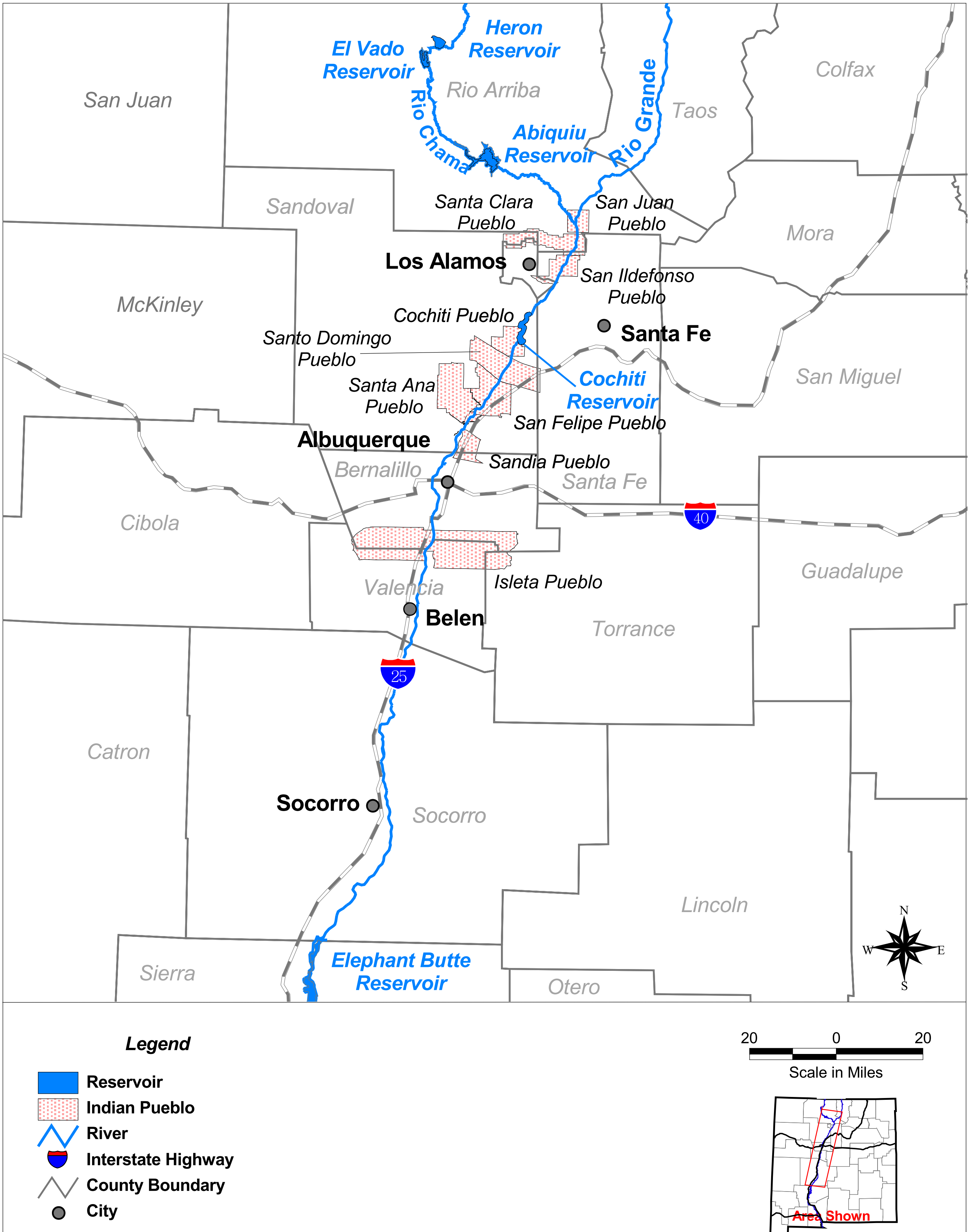

Figure 3.9-1
Locations of Pueblos in the Project Area

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Effects from No Action Alternative

Under the No Action Alternative, there would be no project-related construction, and therefore no cultural resources would be directly or indirectly affected by construction. The active segments of the NRHP-eligible MRG Project irrigation system would remain in use, with MGRCD responsible for their maintenance and upkeep. Because additional ground water wells would be required to meet future potable water demand, it is possible that cultural resources could be affected by construction of such wells and their ancillary access roads and distribution pipelines. Because the locations of future wells and pipelines are unknown, potential effects on cultural remains cannot be determined. Pedestrian survey of specific impact zones and subsequent resource analysis would be required if the No Action Alternative is implemented. If subsidence related to ground water pumping were a substantial effect, it would likely harm historic structures or other cultural resources by damaging foundations or other aspects of those resources.

Effects from Action Alternatives

None of the DWP action alternatives would directly affect any of the previously recorded non-irrigation-related sites. The west side transmission line would be re-routed to avoid LA 132366, an artifact scatter. The only historic districts that would be affected by the DWP would be the Los Candelarias neighborhood in the North Valley and the Monte Vista/College View neighborhood, through which the east and west side transmission lines would pass. Because this line would be constructed within existing road/utility rights-of-way (ROWs), no adverse long-term effects on structures in the districts are anticipated. However, pipeline construction activities under all three action alternatives could affect portions of historic irrigation canals (i.e., acequias). Project effects on these acequia sites would be temporary. Subsurface resources that are not visible from the present-day ground surface also could be encountered during DWP construction.

Approximately 12 percent of the total project impact area under the action alternatives would involve previously undeveloped areas, most of which would occur along the raw-water conveyance route from the Rio Grande to the Chappell Drive WTP. Less than 1 percent of the total areas of the respective historic acequias that would be intersected by the proposed water pipelines would be affected by the project. Where a proposed raw-water conveyance route crosses a component of the MRG project irrigation system, its characteristics were recorded according to guidelines issued by the SHPO (1999). The following components of the NRHP-eligible MRG project irrigation system would be crossed by proposed water pipelines: Alameda Interior Drain, Alameda Lateral, Albuquerque Main Canal, Albuquerque Riverside Drain, Barelas Irrigation Feature, Barr Main Canal, Chamisal Irrigation Feature, Chamisal Lateral, and San Jose Interior Drain. There would be no adverse effects to these facilities. These acequias would be restored to their current conditions when any disturbances occur during construction of the raw-water conveyance routes.

Under Paseo del Norte Diversion (the preferred alternative) and the Subsurface Diversion, there would be no adverse effects on cultural resources, provided the acequias are restored to their current condition after water-line construction has been completed.

Under the Angostura Diversion, the Angostura Diversion dam would be modified. Bridges and irrigation features along the Atrisco Feeder would be impacted if it is chosen for the conveyance of raw water to the WTP. If the Albuquerque Main Canal is chosen as the conveyance route, there would be no impacts to this canal or to the Atrisco Feeder. Three active acequias sites (LA 112412, LA 112423, and LA 114200) and one inactive acequia site (LA 132367) along the route are considered eligible for listing on the NRHP and/or the State Register of Cultural Properties. Project effects on these acequia sites would be temporary if they are restored to their present operating condition after water line construction has been completed. The Albuquerque Riverside Drain, sometimes referred to as the Atrisco Feeder, would be the preferred method for transportation of the raw water from the Angostura Diversion Dam. It is likely the Atrisco Feeder would require enlargement to assure a safe capacity of 450 to 500 cfs required to allow 142 cfs for the DWP and the original capacity of 270 to 300 cfs capacity for irrigation purposes (CH2M Hill, 2003). To enlarge the capacity of the feeder, there would be the need to remove some vegetation and other obstructions from side slopes of the channel, removal of about 1 foot of accumulated sediment, and a widening of about 8 feet in most reaches. The access road on one side would require some reconstruction. Improvements would be needed for at least six bridge crossings, one wasteway to the river, at the Corrales siphon south of Bernalillo, and at the undercrossing of the NM-44 Bridge at Bernalillo. Finally, there are a number of ‘drainage inlet pipes’ that would require replacement. The adverse effects of the Angostura Diversion would consist of dam modifications, channel widening, bridge removal, or removal of other irrigation features. The adverse effects could be mitigated by additional documentation. Any adverse effects to the river as a TCP would need to be mitigated through ongoing communications with Sandia Pueblo.

There would be no direct effects on known cultural resources along the proposed east-trunk water-distribution routes. The proposed west-trunk water-distribution routes would potentially affect newly recorded sites LA 132366 and LA 132368 (Table 3.9-2). LA 132366 is a prehistoric artifact scatter that is in good condition and is considered eligible for listing on the NRHP under criterion D, information potential. The site is on private land on the West Mesa. The proposed water distribution route would be realigned to avoid the site completely.

LA 132368 is an abandoned irrigation feature (flume) along the Alameda Drain. The irrigation feature is an abandoned segment of the Griegos Lateral that is part of the Middle Rio Grande Project irrigation facilities. Most of the abandoned lateral has been altered by residential development, and the remaining portion of the flume at the Alameda Ditch has been partially destroyed and is in poor condition. This site is not considered eligible for NRHP listing. Therefore, construction of the proposed water-distribution line through this area would not have an adverse effect on any known significant cultural resources (EMI, 2002).

Summary of Environmental Consequences

With the No Action Alternative, there is the potential of ground subsidence associated with continued ground water pumping. This event could lead to effects upon historic structures or other cultural resources. Effects could consist of structural damage, failure, or loss of artifacts or recoverable data.

TABLE 3.9-2
SUMMARY OF PROJECT EFFECTS ON CULTURAL RESOURCES

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
NRHP-eligible or –listed resources to be damaged or destroyed	Subsidence could affect historic structures if unabated	Temporary construction effects on less than 1% of historic acequias Adverse effects to the Angostura Diversion Dam and the Atrisco Feeder	Temporary construction effects on less than 1% of historic acequias	Temporary construction effects on less than 1% of historic acequias
Traditional Cultural Properties	At Isleta Pueblo Rio Grande flow changes could potentially affect traditional cultural use of the river	At San Felipe, Santa Ana, Sandia, and Isleta, Rio Grande flow changes could potentially affect traditional cultural use of the river by Pueblos	No effect	No effect
Known burial sites or human remains to be disturbed	None	None; if human remains are encountered during construction, NAGPRA compliance or New Mexico State Burial Law compliance would be enforced	None; if human remains are encountered during construction, NAGPRA or New Mexico State Burial Law compliance would be enforced	None; if human remains are encountered during construction, NAGPRA or New Mexico State Burial Law compliance would be enforced

The Angostura Diversion Alternative would have adverse effects on the Angostura Diversion Dam and the Atrisco Feeder. Some rework and stabilization of the Atrisco Feeder would be required to change the capacity for water delivery. These adverse effects could be mitigated through additional documentation. Sandia Pueblo has expressed concern about effects on traditional cultural use of the river under this alternative.

No known sites of interred human remains would be affected by the project. Project effects would be limited to temporary ground disturbances during construction in three types of locations: 1) along existing ditch channels; 2) in the ROWs of arterials that separate one neighborhood from another; and 3) within individual neighborhoods. The proposed water lines would also have minor effects on the known historical (acequia) sites. For those MRG project and other historic acequias that are considered eligible for NRHP listing, the proposed water lines would disturb very short segments of the overall irrigation systems (EMI, 2002). The effects would be temporary during construction, and the ditch systems would be restored to their pre-project conditions following completion of construction. Care would be taken during construction to avoid impacts on historic buildings during construction of water transmission lines through neighborhoods, and impacts on recorded sites and irrigation features would be temporary. Most of the excavation along existing ROWs would be limited to the roadbeds, and would not affect structures, gutters, curbs, or sidewalks.

From August 20th to 22nd, and November 20th to 21st 2003, a Class III cultural resources survey of approximately 99 acres was completed to analyze additional potable water line alternatives. The line alternatives are described in Section 2.5.8. The vast majority of the project areas was heavily disturbed by previous construction activities, utilities, and urban development. During the course of the Class II survey, no cultural resource sites were encountered. Two isolated occurrences were identified and recorded (EMI, 2004).

3.9.4 Proposed Mitigation Measures

The following measures would minimize or eliminate potential project effects to the known or undiscovered cultural resources described in the previous section:

- Any portions of the Middle Rio Grande Project irrigation system that would be affected by construction would be carefully documented prior to construction and restored to their pre-construction condition following construction.

- A cultural resources discovery plan was prepared as part of the cultural resources inventory report (EMI, 2002). The plan has been approved by Reclamation and will be submitted to the SHPO for their approval prior to the beginning of construction. The plan outlines procedures for protecting newly discovered cultural resources, evaluating their importance, and avoiding or mitigating the project's adverse effects. The plan also details procedures for complying with the NAGPRA or New Mexico state burial laws, in the event human remains are discovered. The plan includes the following provisions:

  - A pre-construction meeting;

  - The availability of archaeological assistance during construction; and

  - Evaluation of discoveries for NRHP eligibility.

- Before ground disturbing construction work takes place, a meeting would be conducted to inform construction crews of the potential for disturbing subsurface cultural resources, and of the required discovery-plan procedures should a site or human remains be encountered.

- Precautions would be taken to ensure qualified archaeological assistance would be immediately available in case of a discovery. The discovery plan approved by Reclamation and SHPO outlines these precautions in detail (EMI, 2002). Work would cease if cultural resources are unearthed during construction activities. The archaeologist would either be present during construction, or available to respond to a telephone call from the site to evaluate the unearthed materials and to ensure that any uncovered cultural resources are appropriately recorded or avoided, in accordance with the discovery plan.

- Any cultural resources encountered during construction would be documented and evaluated as to their NRHP eligibility. Reclamation would consult with the SHPO regarding the eligibility of these sites. LA 132366 would be avoided by realigning the project, or a data-recovery plan approved by Reclamation and the SHPO would be implemented to mitigate adverse effects.

- Construction of the DWP would not begin until consultation with the SHPO is completed.

- Water transmission lines would be located to minimize impacts on historic structures. Care would be taken during construction to minimize impacts on vulnerable structures.

- The City would submit a final DWP design report showing all pipeline alignments to Reclamation. Reclamation would consult with the SHPO to ensure compliance with NHPA on any additions or changes to the pipeline alignments, including required monitoring of sensitive areas including historic structures.

- Consultation would occur with the Pueblos as necessary.

Implementing these measures would avoid or reduce construction effects. No long-term DWP operational effects on cultural resources that would require mitigation measures are anticipated.

3.10 ENERGY

3.10.1 Introduction

The primary energy issues identified during the DWP scoping process were whether or not implementation of the proposed action would 1) require additions to the power infrastructure in the area, or 2) affect the availability of electrical power in the area.

The method of analysis used to determine any effects on the local energy supply or power utility consisted of estimating, from engineering details and specifications, the total number of kilowatt hours (kWH) of energy that would be required annually to operate each of the action alternatives and to implement mitigation, and estimating the potential for increased energy consumption/costs associated with the No Action Alternative.

3.10.2 Affected Environment

The utility infrastructure within Bernalillo County and the City is well established. Additional power service for electricity and natural gas would be required for new facilities constructed as part of the DWP. Public Service Company of New Mexico (PNM) is the utility company that would be responsible for supplying electrical and natural gas service to project facilities. Currently, PNM does not anticipate any need for additional substations as a result of this project (Bagher, 2001). Some of PNM's electrical power is produced from coal-fired plants.

Electrical powerlines and substations are currently located in reasonable proximity to all proposed permanent facilities (e.g., diversion structures, pump stations, and the WTP) under the DWP action alternatives, most of which would be located near existing utility corridors. Temporary electrical power lines may be required during construction phases. Natural gas mains also are present in the utility corridors.

3.10.3 Environmental Consequences

The following evaluation criteria are considered in evaluating the potential effects on energy:

- DWP would increase demand in excess of utility capacity.
- DWP would require substantial additions to power infrastructure in the project area.
- DWP would substantially affect the availability of electrical power in the project area.

It was assumed that the electrical, gasoline, and diesel fuel requirements related to construction activities would not pose excessive demand on the existing power/fuel supplies. Therefore, only energy effects from facility operations are evaluated.

Effects from No Action Alternative

If the No Action Alternative is implemented, there would be no DWP-related effects on the existing utility infrastructure or energy supply. However, possible construction of new ground water wells would result in the need for electrical power to operate pumps. In 2000, the City's ground water well fields consume approximately 116 million kWH per year. If the DWP is not constructed, it has been estimated that up to 130 ground water wells would be required to meet potable water demand in the Albuquerque service area. The operation of the 130 pumping wells would require approximately 167 million kWH in 2060. Approximately 40 of the 130 wells would be new wells. PNM has sufficient capacity to supply this projected demand within its current power grid (Bagher, 2001).

Effects from Angostura Diversion

Based on design estimates, it is anticipated that operation of the new surface diversion at the Angostura Dam and the associated booster pumping station to be located near the NDC under Angostura Diversion would require 14 million kWH per year (CH2M Hill, 2000c); operation of the Chappell Drive WTP would require an additional 56 kWH per year. A "standby" generator is required for Angostura Diversion at the pump station located near the NDC channel. The generator would insure water delivery would continue in the event of a power outage. The City would operate the pump station and WTP in accordance with detailed O&M manuals. The City would also require 60 million kWH in 2060 for continued ground water pumping. The projected total electrical power demand of 129 million kWH per year for Angostura Diversion is within PNM's supply capability. The use of commercially available electricity represents a direct effect on energy supply. However, because implementation of Angostura Diversion would not require expansion of the existing power infrastructure or affect the availability of electrical power to other users in the City, there would be no adverse direct or cumulative adverse effects on energy resources from this alternative.

Natural gas would be used to heat permanent building structures proposed for the Angostura Diversion. The quantity of gas required to heat these buildings was considered to be negligible, and would not pose an undue demand on PNM's gas-distribution infrastructure or supplies. Therefore, consumption of natural gas for heating purposes under this alternative would not have an adverse direct or cumulative effect on local natural gas resources. However, any consumption of a fossil fuel (e.g., natural gas or the coal used by PNM to generate electricity) represents an irretrievable and irreversible commitment of those non-renewable resources (see Section 3.32).

Effects from Paseo del Norte Diversion

Based on operating design estimates, it is anticipated that operation of the new surface diversion at Paseo del Norte and the associated pumping station under the Paseo del Norte Diversion would require 13 million kWH per year (CH2M Hill, 2000c), which is 1 million kWH per year less than Angostura Diversion. The power requirement for operation of the Chappell Drive WTP would be the same as Angostura Diversion, 56 million kWH per year. The City would operate the pump station and WTP in accordance with detailed O&M manuals. The City would also require 60 million kWH in 2060 for continued ground water pumping. The projected total electrical power demand of 128 million kWH per year for Paseo del Norte Diversion is within PNM's supply capability. Although the use of commercially available electricity represents a direct effect on energy supply, implementation of Paseo del Norte Diversion would not require expansion of the existing power infrastructure or affect the availability of electrical power to other users in the City. Therefore, there would be no adverse direct or cumulative adverse effects on energy resources from this alternative.

Natural gas would be used to heat permanent structures proposed under the Paseo del Norte Diversion. The quantity of gas required to heat these buildings was considered to be negligible, and would not pose an undue demand on PNM's gas-distribution infrastructure or supplies. Therefore, consumption of natural gas for heating purposes under this alternative would not have an adverse direct or cumulative effect on local natural gas resources. However, any consumption of a fossil fuel (e.g., natural gas or the coal used by PNM to generate electricity) represents an irretrievable and irreversible commitment of these non-renewable resources (see Section 3.32).

Effects from Subsurface Diversion

Based on design estimates, it is anticipated that operation of the new subsurface diversion at Paseo del Norte and the three associated pumping stations under the Subsurface Diversion would have an energy requirement of 13 million kWH per year.

The power requirement for operation of the Chappell Drive WTP would be 56 million kWH per year, the same as projected for Angostura Diversion and Paseo del Norte Diversion. The City would also require 60 million kWH in 2060 for continued ground water pumping. The projected total electrical power demand of 128.5 million kWH per year for Subsurface Diversion is within PNM's supply capability. Although the use of commercially available electricity represents a direct effect on energy supply, implementation of Subsurface Diversion would not require expansion of the existing power infrastructure or affect the availability of electrical power to other users in the City. Therefore, there would be no adverse direct or cumulative adverse effects on energy resources from this alternative.

Natural gas would be used to heat permanent building structures proposed for the Subsurface Diversion. The quantity of gas required to heat these buildings was considered to be negligible, and would not pose an undue demand on PNM's gas-distribution infrastructure or supplies. Therefore, consumption of natural gas for heating purposes under this alternative would not have an adverse direct or cumulative effect on local natural gas resources. However, any consumption of a fossil fuel (e.g., natural gas or the coal used by PNM to generate electricity) represents an irretrievable and irreversible commitment of those non-renewable resources (see Section 3.32).

Summary of Environmental Consequences

The No Action Alternative would require additional wells and would require 167 million kWH of energy in 2060 to meet the increasing water demand. Angostura Diversion would require 129 million kWH of energy in 2060 to annually operate the pump stations, WTP, and for continued ground water pumping. The Paseo del Norte Diversion would require 128 million kWH in 2060, and for continued ground water pumping and the Subsurface Diversion would require 128.5 million kWH of energy to annually operate related pump stations and the Chappell Drive WTP, and for continued ground water pumping (CH2M Hill, 2000c). Direct effects would include increased demand. Existing power infrastructure and supply would not be stressed beyond the present capability to provide needed electrical service to the DWP. Sources of power and adequate supply would likely be available to meet future needs of this and other planned projects. Therefore, no cumulative effects to energy are predicted. Table 3.10-1 summarizes the environmental consequences of the DWP alternatives on energy resources. However, any power that is generated from combustion of fossil fuels would represent an irreversible and irretrievable commitment of those non-renewable resources.

Energy use within the Albuquerque area has increased as the City has grown. In terms of cumulative effects, past and present needs of the City have been adequately met by the existing utilities. For the reasonable foreseeable future, based upon the project requirements, the DWP would not create an excessive demand on the existing energy supply or a requirement for additional power infrastructure. There may be some offsetting gains in energy as the DWP reduces the need to pump ground water from City wells. There are no known adverse effects on energy resources that can not be avoided by effective operation of project facilities. Except as noted below, neither short-term uses of the resources nor long-term productivity of other resources would be affected.

TABLE 3.10-1
SUMMARY OF PROJECT EFFECTS ON ENERGY RESOURCES

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Energy requirement for diversion-system operations (kWH/year)	Not Applicable	13,500,000	12,500,000	13,000,000
Energy requirement for pumping and treatment plant operations (kWH/year)	Not Applicable	55,500,000	55,500,000	55,500,000
Energy requirement from wells (kWH/year)	182,000,000	60,000,000	60,000,000	60,000,000
Total energy requirement of alternatives (kWH/year)	182,000,000	129,000,000	128,000,000	128,500,000
Additions to power infrastructure or changes in power availability	None	None	None	None

3.10.4 Proposed Mitigation Measures

To ensure efficient energy use, the City would require:

- WTP and pumping stations would be operated in accordance with the standards of O&M manuals that would be completed during and after design and construction of these facilities.
- Structures that will house workers on a routine basis (e.g., the WTP) would be designed to meet all building codes and insulation requirements for energy efficiency.
- Compliance with these design and operational measures would be required to obtain City construction permits. Building heating, ventilation, and air conditioning systems would be appropriately sized and maintained to minimize energy consumption.

3.11 ENVIRONMENTAL JUSTICE

3.11.1 Introduction

During the DWP scoping process, no environmental justice concerns were raised. Executive Order 12898 regarding “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” provides as of February 11, 1994, that each federal agency make achieving environmental justice part of their mission by identifying and addressing disproportionate high and adverse human health effects of its programs, policies or activities on minority or low-income populations. The order applies to all federal actions that require NEPA documentation, and has three general objectives: 1) focus the attention of federal agencies on the human health and general environmental conditions in minority and low-income communities with the goal of achieving environmental justice; 2) foster nondiscrimination in federal programs that could substantially affect human health or the environment; and 3) give minority and low-income communities greater opportunities for public participation on matters relating to human health and safety.

The method of analysis used to determine any effects of the DWP alternatives on low-income and minority populations consisted of mapping populations within the Middle Project Area, and calculating the per-capita income of the populations near the construction zones for each action alternative. Once this was completed, project construction sites and water transmission corridors and project operation impacts were compared to percent-minority/low-income populations by census tract in Bernalillo County. Construction and river depletion effects were considered for San Felipe, Santa Ana, and Sandia Pueblos.

There are, in general, five guiding principles when determining any environmental justice issues. These include 1) identify minority and low-income populations in the area affected by the project. The South Valley was one potential location for placing the water treatment plant and was evaluated with others, but was found unacceptable for several reasons. The South Valley is a diverse area, and contains many ethnic and various populations of high, middle and low incomes. 2) Consider relevant public health data and industry data regarding multiple and cumulative exposure of minority and low-income populations to human health or environmental hazards. Exposures to hazards from this project are low to all populations within Albuquerque. 3) Recognize interrelated cultural, social, occupational, historical, or economic factors that could amplify environmental effects of the project. This was done during the development of the City water strategy, and completing a list of sites at various locations throughout Albuquerque. 4) Develop effective public participation strategies that overcome linguistic, cultural, institutional, geographic, and other barriers. The City held a series of public meetings to present and refine the location for the WTP. These meetings were in addition to the NEPA scoping meetings. Residents consistently attended, expressed reservations, and helped direct the location of the WTP portion of the project away from the South Valley, which resulted in the City selecting the Chappell Drive WTP site.. 5) Assure meaningful community representation in the process. This was accomplished through the NEPA scoping meetings and the early site location meetings.

3.11.2 Affected Environment

The project area is composed of a mixture of income levels and land uses, none of which are considered to be predominantly minority or low-income populations (Bureau of Business and Economic Research [BBER], 1998). Existing land use along the DWP pipeline corridor alignments, at proposed pump stations, storage and distribution tanks, WTP, and the subsurface water-diversion facility locations are predominantly commercial, light industrial, mixed residential, and open space. Field investigations of the areas to be affected by DWP construction activities under the action alternatives did not reveal or suggest the presence of community characteristics that would be considered to represent disproportionately minority or low-income neighborhoods.

Figure 3.11-1 shows the results of mapping percent-minority populations by City census tract (BBER, 1998) relative to the proposed DWP construction areas. Bernalillo is one of 33 counties in New Mexico and is one of three counties in the Albuquerque Metropolitan Statistical Area (MSA). Its total population in 2000 was 556,678 (Census, 2000). The City of Albuquerque itself lies entirely within Bernalillo County. In 1999, Bernalillo County had a per-capita income of $27,287, which was substantially higher than the statewide average of $21,836 (BBER, 2001). During the 1990s, county per-capita income grew at a rate of 4.8 percent per year. The estimated median family income for the entire Albuquerque MSA in 2001 is $49,000 (U.S. Department of Housing and Urban Development, 2001). Annual average employment in Bernalillo County in 2000 was 307,709 individuals, and the unemployment rate averaged 3.2 percent (New Mexico Department of Labor, 2001). Employment by sector was greatest for services, government, and wholesale/retail trade, with approximately one-third of all employed individuals working in a service-related position in 2000.

3.11.3 Environmental Consequences

For the purposes of this evaluation, environmental justice effects would occur if there would be disproportionate adverse effects on minority or low-income neighborhoods by project implementation. With the Angostura Diversion, the canal work for delivery of raw water and the pump station on Sandia Pueblo land would require construction efforts on Pueblo lands. There are possibilities of flow depletions in the Rio Grande on San Felipe, Santa Ana, and Sandia Pueblos. Because all of the proposed raw-water diversion facilities or pump stations under any of the three action alternatives would be located along the Rio Grande and in the bosque of the Middle Project Area (i.e., outside of developed neighborhoods), there would be environmental justice issues related to the siting, construction, or operation of these DWP features. There would not be any effects in the Upper and Lower Project Subareas. However, the raw-water conveyance and potable water transmission lines and associated storage reservoirs would lie within developed parts of the City, and the Chappell Drive WTP would be located in an industrial area.

Effects from No Action Alternative

No environmental justice effects would be expected under the No Action Alternative for the DWP because there would be no project-related construction activities that could unfairly affect minority or low-income neighborhoods. Although construction of new ground water wells, pump houses, and water transmission lines might be required to meet potable water demands, it is anticipated that hydrogeologic conditions and distribution requirements rather than socioeconomic characteristics would be the primary factors governing selection of sites for new wells. New water transmission lines from any new wells likely would be constructed within existing road or utility-corridor ROWs to minimize disturbance of commercial and residential structures. There would be no disproportionate displacement, relocation, economic, or any other effect on minority or low-income populations of the community. Therefore, no adverse environmental justice effects are anticipated under the No Action Alternative.

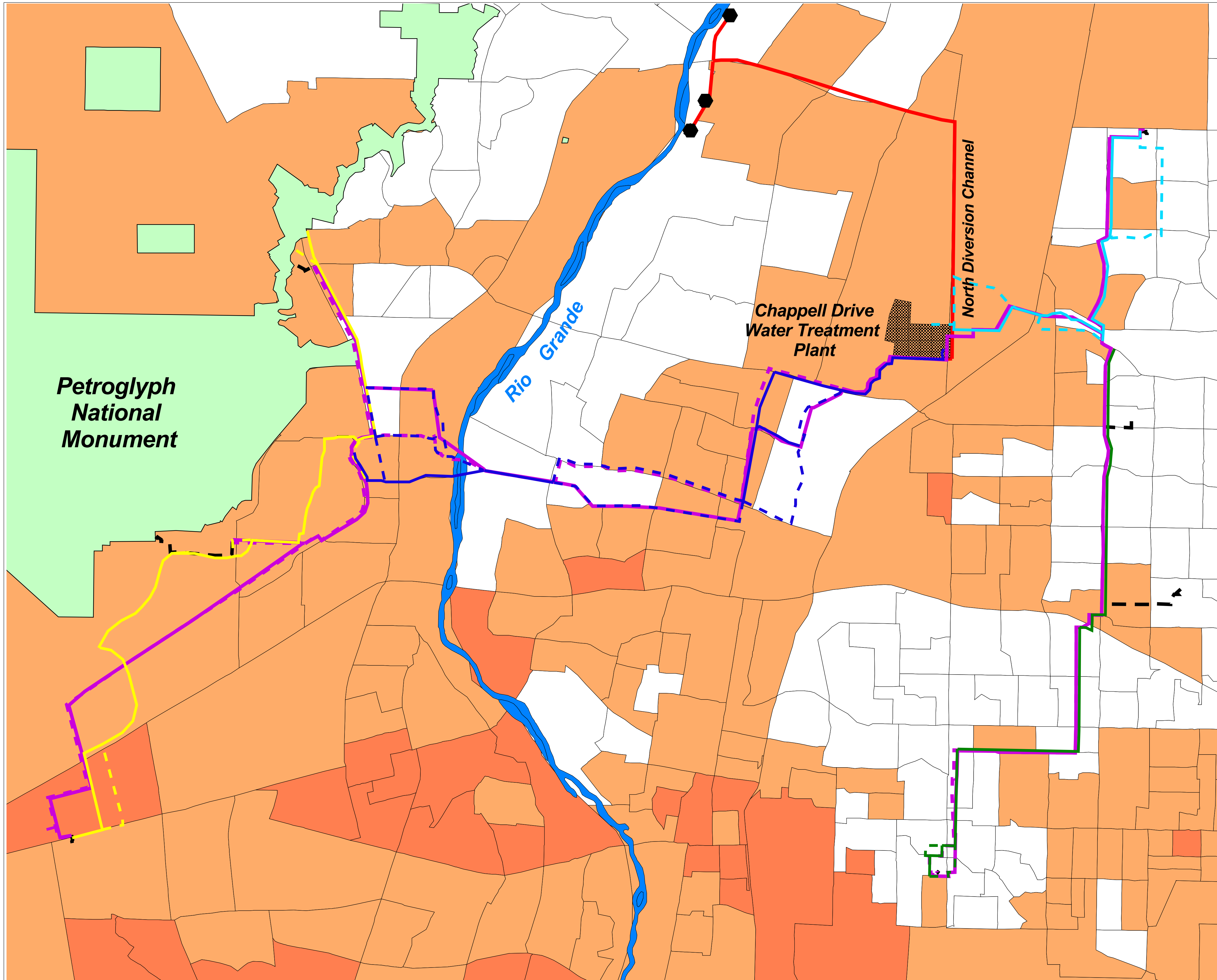
Effects from Angostura Diversion

Minority or low-income neighborhoods would not be disproportionately affected by implementation of Angostura Diversion. Figure 3.11-1 shows the percent-minority population by census tract in relation to the proposed water pipeline corridors, and the WTP. As indicated on the figure, the proposed pipeline alignments would cross a wide spectrum of community neighborhood types. The narrow, linear characteristics of pipeline routes would ensure that there would be no disproportionate concentration of facilities in neighborhoods or community sections that would be considered low-income or predominantly minority occupied. The water distribution lines would be located in neighborhoods that are considered middle income or in areas that are primarily devoted to business and light industrial activities. Project construction effects would be anticipated to last no more than 2 days in any particular location along the alignment route (see Section 3.18). This disruption would be considered to be a temporary nuisance.

Angostura Diversion water-distribution lines would be constructed in both Sandoval and Bernalillo Counties. Pipeline routing was determined by the location and engineering hydraulics of moving water between the existing storage, water source, and distribution facilities. Proposed construction would affect 338 acres of land in Sandoval County and 127 acres in Bernalillo County, for a total disturbance area of 465 acres. Census tracts in these two counties where proposed construction would take place currently have 17,710 residents, 14,095 (80 percent) of who are White, and 3,615 (20 percent) of who are non-White (BBER, 1998). The current average per-capita income for census tracts crossed by pipelines or with other Angostura Diversion disturbances is $10,953 (BBER, 1998). The proposed Chappell WTP would require disturbance of 161 acres. Approximately 18 percent of census tracts in the vicinity of this facility have non-White populations, and the per-capita income is $10,406 (BBER, 1998).

The access to the Angostura Diversion would be on the Santa Ana Pueblo. Angostura Diversion conveyance canals and drains are located on the Santa Ana and Sandia Pueblo. While these canals and drains are currently in use, and there is an access agreement with MRGCD, it may be necessary to upgrade these facilities. In that event, it would be necessary to increase the ROW by approximately 8 feet of width along 14.5 miles (approximately 14 acres) for construction purposes. An appropriate agreement between the City and the affected Pueblos would need to be completed. Additionally, Angostura Diversion requires a pump station site of approximately 1.5 acres to be located on Sandia Pueblo property near the North Diversion Channel. This would also require an appropriate agreement between the City and Sandia Pueblo.

There would be no adverse effects concerning environmental justice under Angostura Diversion because existing neighborhoods would be equally affected by the short-term construction activity attributable to the project, and all resultant water services would be provided equitably. None of the project construction or operational characteristics would require the displacement or relocation of minority or low-income population members.



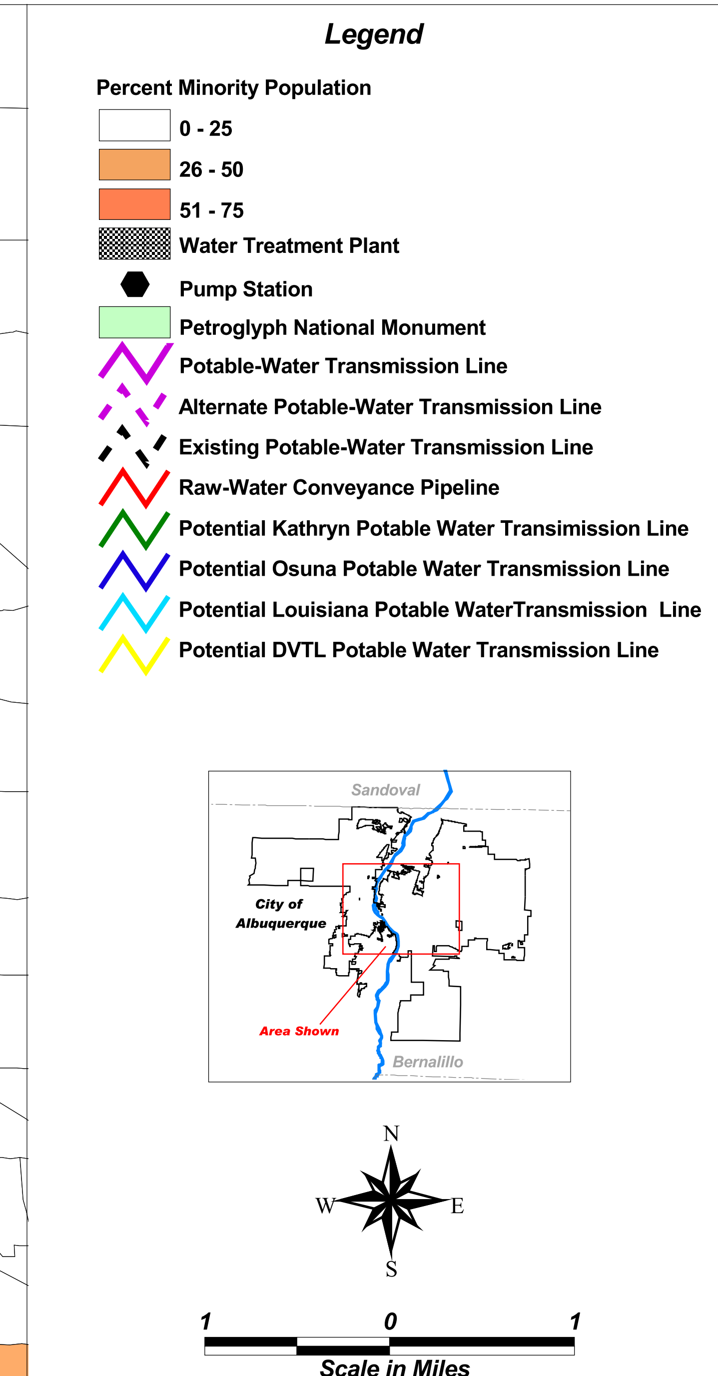


Figure 3.11-1
Percent Minority Population by Census Tract in City of Albuquerque

Source: 1995 Tiger Data - U.S. Census Bureau

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This alternative, if implemented, would affect three Pueblos. There is by implication, involvement of minority communities as their lands are crossed. These are not new conveyance facilities, and the effect would consist of renovation of the conveyance facilities. The movement of water has historically occurred within the canals, and continuing this use would not present any additional hazards or exposures of contamination to the Pueblos or any other minority community. It may, in fact, improve the delivery capability of the conveyance facilities for the current users. In terms of water quality, availability and other aspects of the potable water, there is no disproportionate aspect of the water project.

DWP water provided to all users is from the same pipe and of the same quality. Water management in times of shortages will affect all customers in the same fashion, given existing infrastructure restrictions. Current plan is for water to benefit all municipal and industrial customers of the City.

Effects from Paseo del Norte Diversion and Subsurface Diversion Alternatives

The proposed Paseo del Norte Diversion and Subsurface Diversion pipeline routes and storage reservoirs, as well as the Chappell Drive WTP, would be located entirely within Bernalillo County, and alignments and construction impacts for these two action alternatives would be identical. Based on census data for the tracts through which the pipelines would be constructed, there are 14,213 total residents, 11,045 (78 percent) of who are White, and 3,168 (22 percent) of who are non-White residents. The per-capita income in the affected tracts is $12,204 (BBER, 1998). The location and impact area of the WTP would be the same as described for Angostura Diversion.

There would be no adverse direct or cumulative effects concerning environmental justice under the Angostura Diversion or Paseo del Norte Diversion Alternatives because existing neighborhoods would be equally affected by the short-term construction activity attributable to the project, and all resultant water services would be provided equitably. None of the project construction or operational characteristics would require the displacement or relocation of minority or low-income population members.

Summary of Environmental Consequences

Potential environmental justice effects were determined by comparing non-White populations and income levels for affected areas with county-wide conditions. This comparison shows that areas affected by construction of the action alternatives have a lower-than-average non-White population than does either Sandoval or Bernalillo County, and the per-capita income in project-affected census tracts is about the same as the average county-wide income levels. On this basis, it was concluded that a disproportionate effect on minority or low income populations would not occur if DWP Angostura Diversion, Paseo del Norte Diversion or Subsurface Diversion, or No Action, is implemented.

There would be no effects concerning environmental justice because existing neighborhoods would be equally affected by the short-term project construction activities, and the same water service would be provided to all neighborhoods. There are no adverse effects that could be entirely avoided by selection of WTP location and transmission corridors different than those proposed under the action alternatives. There are no irreversible and irretrievable commitments of resources attributable to environmental justice. Table 3.11-1 summarizes the DWP effects on minority and low-income populations in the Middle Project Subarea.

TABLE 3.11-1
SUMMARY OF PROJECT EFFECTS ON
MINORITY AND LOW INCOME POPULATIONS

Evaluation Criterion	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Minority or low income neighborhoods disproportionately affected by project implementation	None	Construction and flow depletion in the Sandia, San Felipe, and Santa Ana Pueblo areas.	None	None

3.11.4 Proposed Mitigation Measures

Because there would be no anticipated disproportionate adverse effects on human health or the environmental conditions of minority or low-income groups attributable to the DWP, no environmental commitments or mitigation measures were identified or required to address project-related environmental justice concerns.

3.12 FLOODPLAINS

3.12.1 Introduction

During the DWP scoping process no floodplain concerns were identified related to potential project effects. Executive Order 11988 requires federal agencies to “take action . . . to restore and preserve the natural and beneficial values served by floodplains.”

Floodplains are regulated by the Federal Emergency Management Agency (FEMA) through the National Flood Insurance Program. The placement of a facility within a 100-year floodplain requires FEMA approval for two aspects. First, the facility must be designed so that its base is at least 1 foot higher than the water surface elevation for the 100-year flood. Second, an analysis must be performed to determine the effects of the new facility on water surface elevations associated with the 100-year flood. The FEMA certification process for facilities that would change flood surface elevations involves physical map revisions, with FEMA’s decision documented in a conditional letter of map revision. The City will also comply with Bernalillo County Code, Chapter 38 – Flooding and City of Albuquerque Development Process Manual, Chapter 22 – Drainage, Flood Control, and Erosion Control.

In the Upper Project Subarea, floodplain effects were evaluated using the rating curve for the staff gage below Abiquiu Reservoir and the Otowi staff gage. Based on the rating curves, the potential water surface elevation changes that would be anticipated with the addition of the City's SJC water were estimated.

Within the Middle Project Subarea, floodplain effects were determined by calculating the area within the Rio Grande floodplain that would be required for placement of facilities. For the Paseo del Norte Diversion, the USACE HEC-RAS model was used to simulate flood elevations for the 100-year flood before and after the proposed action (CH2M Hill, 2001a). (A 100-year flood has a 1 percent chance of occurring in any year. It is a measure of flood probability, not frequency.) Modeling was not conducted for facilities associated with the Angostura Diversion or for the Subsurface Diversion.

No new facilities would be constructed and flows for the action alternatives would not change in the Lower Project Subarea. The action alternatives return native flows at the SWRP neither increasing or decreasing flows nor river stages in the Lower Project Subareas.

3.12.2 Affected Environment

FEMA maps showing the inundation area that would occur with a 100-year flood are available for Bernalillo County (FEMA, 1996). These maps, which are quite large, ranging in scale from 1:6,000 in urban areas to 1:24,000 in rural settings, are included here by reference. They can be obtained from the FEMA Flood Map Store on the Internet at:

http://web1.msc.fema.gov/webapp/commerce/command/ExecMacro/MSC/macros/welcome.d2w/report.

Within all project subareas, all alternatives would result in minimal changes in stage (see Hydrology Resource Section 3.16). Within the Middle Project Subarea, where project facilities would be constructed within the Rio Grande floodplain, the maps show that the 100-year flood would be contained within the river's east and west levees.

3.12.3 Environmental Consequences

The following conditions would be considered environmental changes substantial enough to lead to effects on floodplains:

- Acres of 100-year floodplain lost or with degraded capacity.
- Increase in surface water elevation of the floodplain.
- Area within the floodplain requiring placement of fill.

Effects from No Action Alternative

The No Action Alternative would not require new construction or operation activities within either the Rio Chama or Rio Grande floodplains. Therefore, there would be no effect to the floodplains as a result of this alternative.

Effects from Angostura Diversion

The Rio Chama would experience flows between Heron Reservoir and Abiquiu Reservoir that are similar to historical flow patterns. Floodplains in this area would not be affected.

The addition of approximately 65 cfs to the river from Abiquiu Reservoir to the diversion point would increase the river stage near Chamita by about an inch during low flow conditions. An even smaller effect to the river stage would occur with higher flows. Therefore, the floodplain in this stretch would experience no substantive effects from the Angostura Diversion.

Facilities within the 100-year Rio Grande floodplain would consist of a fishway, fish screen and fish by-pass. Collectively, project facilities in this area would occupy 1.8 acres within the 100-year floodplain of the Rio Grande.

Modeling was not performed on pre- and post-project conditions at Angostura to determine the effects of these facilities on the water surface elevation of the 100-year flood. However, Angostura Diversion should not involve facilities within the floodplain that would cause the surface elevation of the 100-year flood to increase. The 100-year flood would continue to be contained within the river's east and west levees.

During construction, areas within the floodplain would be occupied by features such as soil stockpiles. These stockpiles would be created by relocating soils within the floodplain rather than importing new materials. Locally, there could be minor increases in floodplain capacity in areas of soils excavation and minor decreases in capacity in stockpile areas. However, the effects on the overall floodplain capacity would be negligible. These short-term effects would end with construction completion.

Effects from Paseo del Norte Diversion

Effects to floodplains associated with the Rio Chama would be identical to those described for the Angostura Diversion. No effects would occur upstream from Abiquiu Reservoir, and there would be no substantive effects between Abiquiu Reservoir and the diversion.

Facilities within the 100-year Rio Grande floodplain near Paseo del Norte Bridge would include a new diversion dam and a pump station. Together, these facilities would occupy about 6.6 acres within the 100-year floodplain of the Rio Grande.

Modeling (based on the USACE HEC-RAS model) was performed on pre-and post-project conditions to determine the effects of Paseo del Norte Diversion facilities on the water surface elevation of the 100-year flood. The model considered the effects from all 6.6 acres of the 100-year floodplain that would be required for location and operations of structural features. The HEC simulation showed that the largest change in water levels during a 100-year flood would occur just upstream from the new diversion and pump station. At this site, the flood surface elevation would increase by approximately 3.5 inches. Under post-project conditions, the east levee would have a freeboard of about 5.5 inches during a 100-year flood, and the west levee would have about 10.5 inches of freeboard (CH2M Hill, 2001a). During construction, short-term effects from such actions as stockpiling of soils would be similar to those described for the Angostura Diversion. These effects would end with construction completion.

Effects from Subsurface Diversion

Subsurface Diversion effects to floodplains associated with the Rio Chama would be identical to those described for the Angostura Diversion. No effects would occur upstream from Abiquiu Reservoir, and there would be no substantive effects between Abiquiu Reservoir and the diversion.

Facilities within the 100-year Rio Grande floodplain near the Paseo del Norte Bridge would include subsurface horizontal collectors and three pump stations. Together, these facilities would occupy about 10.6 acres within the 100-year floodplain of the Rio Grande.

Modeling was not performed to determine the effects of Subsurface Diversion facilities on the water surface elevation of the 100-year flood. However, modeling at this same site was conducted for the Paseo del Norte Diversion, which would disturb more area than the Subsurface Diversion. Based on these results, it is expected that the Subsurface Diversion would increase the surface elevation of the 100-year flood by slightly less than 3.5 inches, and that the freeboards would be about 5.5 inches for the east levee and about 10.5 inches for the west levee. Short-term construction-related effects would be similar to those described for the Angostura Diversion.

Summary of Environmental Consequences

The anticipated effects of the proposed project alternatives are summarized in Table 3.12-1. Direct physical effects to the floodplain from any of the action alternatives would include construction and fill within the 100-year floodplain at the diversion structure location. Because the construction would conform to permit guidelines and would not affect the flood-carrying capacity of the Rio Grande, it would not cause indirect effects. The proposed action does not affect the surface elevations associated with the 100-year floodplain.

Cumulatively, numerous structures have previously been placed in the Rio Grande's historical 100-year floodplain. In the vicinity of the proposed project features, some of these include bridges, existing diversion structures, the east and west levees, and buildings outside of the levees. Together, these structures have decreased the river's flood-carrying capacity and created the types of conditions that led to establishment of the National Flood Insurance Program. With the implementation of that program, floodplain development is regulated to protect floodplain functions. Therefore, the proposed action, in conjunction with existing structures and foreseeable future actions, should not have additional adverse effects on floodplains in the project area.

There are no known adverse effects that cannot be avoided within the county guidelines to construct within a 100-year floodplain.

TABLE 3.12-1
SUMMARY OF PROJECT EFFECTS TO FLOODPLAINS

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Increase in the water surface elevation of the 100-year flood between Abiquiu Reservoir and the diversion point (inches)	0	Less than 1	Less than 1	Less than 1
Area within the 100-year floodplain occupied by permanent structures (acres)	0	3.6	6.8	9.3
Increase in the Rio Grande water surface elevation of the 100-year flood at the location experiencing the largest change in water levels (inches)	0	0	3.5	Less than 3.5

Short-term use versus long-term productivity considerations are not a concern. In both the short and long term, the flood-carrying capacity of the Rio Grande would not be affected by the action alternatives.

Because the flood-carrying capacity would not be affected, there would not be any irreversible or irretrievable commitment of floodplain resources. In addition, project features in the floodplain could be removed in the future, which would restore the floodplain to its pre-project condition.

3.12.4 Proposed Mitigation Measures

There are no specific mitigation measures required for this resource area. The local FEMA administrator was contacted and deferred to the USACE and their HEC-RAS model of the Albuquerque reach – which CH2M Hill used to estimate changes in flood elevations and levee freeboard. After a final design and better topography information is available, FEMA will be contacted again to permit a review of actual facilities. Other than compliance with EO 11998 and the National Flood Insurance Program, as indicated earlier within the resource area discussion, there are no additional requirements. Construction will require some temporary modifications of levees that could include access road construction or improvement and the placement of pipelines within or through levees. Construction may require the removal or modification of Kelner jetty jacks. Both would require coordination with USACE and/or Reclamation. Disturbed areas or facilities would be restored to pre-construction conditions, or as directed by the USACE or Reclamation.

3.13 GEOLOGY

3.13.1 Introduction

During the DWP scoping process, the only geologic concerns identified related to potential project effects on mining operations. Hydrogeologic effects of the proposed DWP alternatives are evaluated in Section 3.16.

The method of analysis used to determine any potential effects on geologic resources was to identify any known geologic or paleontological resources relative to construction zones in the Middle Project Subarea. Any locations where shallow ground water, land subsidence, or slope stability could affect (or be affected by) project construction also were noted. This determination was made by appropriate literature review.

3.13.2 Affected Environment

Sedimentary rocks in the project area range in age from Pennsylvanian through Pleiocene. Igneous rocks of the area can be segregated into the Precambrian intrusive in the San Pedro Mountains and Tertiary and Quaternary extrusives of the southern San Juan Mountains and northern Jemez Mountains. About one-third of the total Rio Chama watershed is considered erosion resistant, but the remainder has a moderate to high erosion rate. Steep tributary slopes, intense thunderstorm activity, and the soft materials traversed by the river have resulted in deep, steep-sided arroyos and canyons that carry coarse as well as fine material to the Rio Chama (USACE, 1995).

The major landforms of the Middle Rio Grande Valley are the result of the area's dominant geologic feature, the deep, sediment-filled Rio Grande Rift. The rift continues to be geologically active, with a considerable number of localized earthquakes. This reach of the Rio Grande is bounded on the east and west by raised landforms and mountains. The valley has a deep trough filled with sand, clay, silt, gravel, and cobble deposits, which are referred to collectively as the Santa Fe Group (Kelley, 1977). The processes that have lead to the formation of gravel and sand include downcutting, backfilling, and stabilization cycles. Typically, the sediments are deposited on the valley floor by fluvial processes. There are blocks of uplifts on both sides of and parallel to the valley. These escarpments are the product of movement along the major fault zones (Kelley, 1977).

The Albuquerque Basin, which is part of the Middle Rio Grande Valley, is about 100 miles long (north-south) and 25-40 miles wide (east-west). Figure 3.13-1 shows the surficial geology of the project area within the Albuquerque Basin south of the Angostura Diversion Dam. Basin fill consists of up to 12,000 feet of sandstone, mudstone, and gravel of the Santa Fe Group, overlain by Quarternary unconsolidated alluvium. The City currently relies on deep wells in the Santa Fe Group aquifer system for the majority of its potable water supply (see Section 3.16). All diversion structures and pump stations proposed under DWP Angostura Diversion, Paseo del Norte Diversion and Subsurface Diversion would be located along the river corridor in this alluvium (Kelley, 1977). Santa Fe Group deposits are exposed in bands on either side of the Rio Grande (Figure 3.13-1). DWP transmission pipelines, storage facilities, and the WTP would be constructed in uplands on the Santa Rosa-Chinle, Santa Fe formations, and gravel pediments. Quarry operations are common in the sand and gravel deposits and pediments throughout the Albuquerque Basin. One such operation is present on the proposed site of the Chappell Drive WTP.

3.13.3 Environmental Consequences

The following criteria are considered in evaluating the potential effects on geologic resources:

- Elimination or curtailment of unique mining operations resulting in shortages of the geologic product being mined.
- Subsidence sufficient to create construction and safety hazards, or to reduce the water-storage capacity of the geologic strata.

Effects from No Action Alternative

Because this alternative would require the continued and expanded reliance on deep ground water to meet current and future water demands, the potential for land subsidence due to aquifer drawdown would likely increase in some areas. Land subsidence would be expected to occur with ground water level drawdowns of 250 feet or more (CH2M Hill, 2003). Based on modeling of the effects of ground water pumping through the year 2060, drawdowns of this magnitude are expected to occur in much of the northeastern part of Albuquerque. This effect of expanded ground water pumping under the No Action Alternative would create construction and safety hazards in subsidence zones. Therefore, the No Action Alternative would have direct and cumulative effects on geologic stability of formations overlying unconsolidated Santa Fe Group sediments in the producing aquifer. Subsidence costs are based on costs associated with structural damage and ensuing lawsuits in a manner to those experienced in Houston and Las Vegas. It was assumed that subsidence will occur in an area that is approximately 5 percent of the total area that the model calculates to have subsidence potential.

Based on the OSE guidelines a total drawdown of 250 feet is prohibited in the declared CMA through 2040. The OSE model predicts that no cell in the Critical Management Area (CMA) will reach 250 feet of drawdown from pre-development in either the No Action of DWP alternatives. In addition the OSE guidelines prescribe a limit of 2.75 feet per year in cells outside of the CMA from 2000 through 2040.

Effects from Action Alternatives

Under the three action alternatives, no geologic or known paleontological resources would be affected by construction of the diversion facilities, pump stations, water transmission lines, or storage reservoirs. Because aquifer drawdown effects would be significantly reduced with the implementation of the DWP, hazards associated with land subsidence and geologic instability also should be reduced. This would be an indirect beneficial effect of the action alternatives.

Approximately 110 acres of an existing gravel quarry would be required to build the WTP on Chappell Drive. Current mining operations in this area include pit recovery, crushing, sizing, and stockpiling of gravel. The gravel deposits targeted by this mining operation are not unique, and are abundant throughout gravel-pediment and alluvial deposits that are found throughout the Middle Rio Grande Valley. Relocation of the active gravel mine may result in the development of new mining operations. Gravel

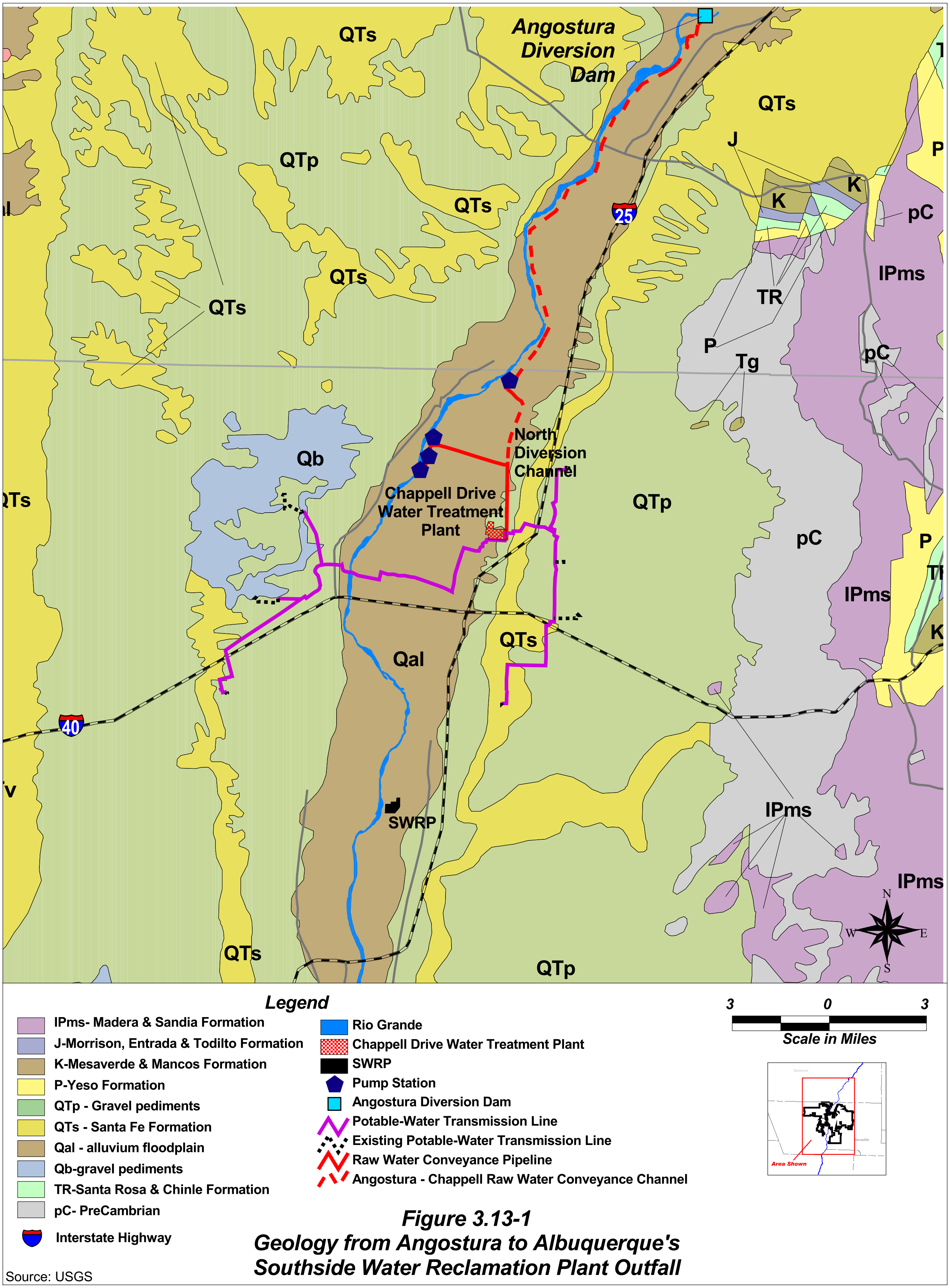

Figure 3.13-1
Geology from Angostura to Albuquerque's Southside Water Reclamation Plant Outfall

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deposits remaining *in situ* at the WTP site would be unrecoverable in the future if any of the three action alternatives is implemented. Loss of gravel production from this site would not significantly affect gravel production in the Middle Rio Grande valley.

The diversion facilities proposed under Angostura Diversion, Paseo del Norte Diversion and Subsurface Diversion would require construction of project components within and near the Rio Grande channel. Proven in-river engineering techniques would be employed to address issues related to construction on unstable, saturated deposits (see Section 3.13.4). No structural facilities proposed under the DWP would be located on slopes greater than 30 percent.

Compared to the No Action Alternative, implementation of action alternatives would have a potential indirect beneficial effect on possible future land subsidence related to aquifer drawdown, and would have direct and cumulative effects on local gravel mining operations. However, shutdown of gravel mining at the WTP site would not substantially affect the supply of gravel for commercial extraction and use in the project area. The DWP would not affect any known paleontological resources.

Summary of Environmental Consequences

Past projects concerning water resources of the Rio Grande have not had any severe or sustained effects upon geologic resources excluding the changing natural geo-morphology of the river. Planned future projects would not be expected to affect geologic resources as they are generally of an operational or maintenance activity. No cumulative effects to geologic resources are expected. There would be no direct, indirect or cumulative negative effects on geological or paleontological resources within the project area as a result of the DWP. No paleontological resources are known to exist in any of the proposed construction zones. Implementation of the DWP would reduce water withdrawals from the aquifer, allow stabilizing recharge, and thereby reduce the risk of subsidence, resulting in positive effects. Conversely, the No Action Alternative would require increased pumping, and could increase the risk of subsidence due to aquifer drawdown.

Cessation of the gravel-mining operation at the Chappell Drive WTP would not adversely impact the overall supply of gravel within the project area. There would be no adverse project effects that could not be avoided or mitigated. Short-term uses versus long-term productivity is not an issue for geologic resources, because gravel supplies are abundant throughout the Middle Rio Grande Valley. The remaining gravel deposits at the site of the WTP may be irretrievable if the plant is constructed, but this condition would not be considered irreversible. Table 3.13-1 summarizes DWP effects on geologic resources by alternative.

3.13.4 Proposed Mitigation Measures

Proven engineering practices would be applied during in-stream construction of diversion facilities and ancillary structures to overcome concerns about building on unstable, saturated materials within the river channel. No other proposed mitigation measures specific to this resource area were identified or deemed necessary.

TABLE 3.13-1
SUMMARY OF PROJECT EFFECTS ON GEOLOGIC RESOURCES

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Loss of unique mineral-recovery operations	None	None	None	None
Project structural facilities located in areas of shallow ground water constraints, or severe (greater than 30 degrees) slopes	None	None	None	None
Contribution to land subsidence	Subsidence risk could increase as a result of increased pumping to meet City requirements	Subsidence risk should decrease as a result of lower ground water pumping	Subsidence risk should decrease as a result of lower ground water pumping	Subsidence risk should decrease as a result of lower ground water pumping

3.14 HAZARDOUS MATERIALS

3.14.1 Introduction

The primary hazardous materials environmental issues identified during DWP scoping activities related to whether or not implementation of the DWP would create hazards to public safety or the environment due to the use, transport, and disposal of hazardous materials; or through accidents, emissions or waste storage near sensitive receptors; or construction and operation of a facility near a previously contaminated area.

The method of analysis used to determine project effects on hazardous materials started with site screening during the alternatives-evaluation phase. Known contaminated sites were mapped within a 0.5-mile corridor along the water-conveyance routes, and the transmission corridors for all the action alternatives. The Middle Project Subarea, where diversion facilities and conveyance/transmission lines would be located, was the only subarea evaluated.

3.14.2 Affected Environment

During the alternatives-evaluation phase of the DWP (see Section 2) the primary focus was to select potential facility locations that were not near known contaminated sites. The locations of many of the contaminated sites in the project area, particularly those with the potential to affect ground water resources, are identified in *Water Resources Strategy Implementation Facility Alternatives – Draft Component Siting Evaluations for Environmental Criteria* (Parsons, 1999). The former Los Angeles landfill site, which is undergoing remediation for soil and ground water contamination, is located east of the NDC and south of Alameda Boulevard (City of Albuquerque, 1992). There are landfill monitoring guidelines (City of Albuquerque, 2001) for any construction within 1,000 feet of a known landfill. Trenching during construction activities associated with development also has the potential to expose hazardous materials.

As shown on Figure 3.14-1, the proposed Angostura Diversion raw-water conveyance pipeline route parallels the east side of the NDC in this area. However, the ground water gradient from the landfill site is away from the NDC and the proposed conveyance pipeline. Another ground water remediation site, Sparton Technologies, is located west of the Rio Grande and the Paseo del Norte Diversion and Subsurface Diversion facilities near Paseo del Norte, outside the 0.25-mile radius evaluated as a potential hazard zone. The raw-water conveyance canals proposed under the Angostura Diversion are open and pass through agricultural lands. Several active fuel underground storage tanks (USTs) and leaking UST (LUST) sites are located along the proposed water-distribution pipeline routes. Those USTs and LUSTs located within 0.25 mile of the proposed water lines are shown on Figure 3.14-2. Several former small, illegal dumpsites within the river corridor have been cleaned up. There is no other evidence of incompatible present or historic land use at any of the action-alternative diversion-facility sites, and there are no hazardous-waste generating or storage sites associated with the proposed DWP diversion facilities or their conveyance routes to the WTP.

3.14.3 Environmental Consequences

The following criteria are considered in evaluating the potential effects for hazardous materials:

- Construction and/or operation of the project would create a hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials.

- Construction and/or operation of the project would create a hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment.

- Construction and/or operation of the project would emit hazardous materials or handle hazardous or acutely hazardous materials, substances, or waste near sensitive receptor exposure points, including residences, existing or proposed schools, and hospitals.

- Project facilities would be located on or adjacent to a substantially contaminated area, and as a result, would create a hazard to the public or the environment.

Effects from No Action Alternative

Because the locations of future ground water wells and associated water pipelines are not currently known, impacts of such construction on existing hazardous waste release, generating, or storage sites cannot be determined. BMPs would be used during construction of wells and ancillary facilities to control the potential for releases of fuels or other toxic or hazardous substances. No hazardous substances would be used during operation of ground water pumping wells. Continued drawdown of the aquifer would potentially induce changes in hydraulic gradients that may influence the fate and transport of existing ground water contaminant plumes, such as the one emanating from the former Los Angeles landfill site.

Effects from Action Alternatives

There are no known hazardous-waste generating, storage, or cleanup sites that would be disturbed by DWP construction activities, either for diversion facilities or the water transmission corridors. The possibility of hazards generated during the transportation, use, or disposal of hazardous materials on a routine basis during project construction or operations would be low, as any regulated substances would be properly containerized during transport and storage. While accident prevention cannot be assured, City and contractor personnel are trained in the management of and response to accidents involving routinely handled materials.

The WTP would not require the storage or use of chlorine gas or other highly volatile or toxic materials. WTP process wastes (e.g., sediments and sludges removed during treatment) would be transported under U.S. Department of Transportation regulations to an approved offsite landfill for disposal. The WTP would be located in an industrial area, and therefore no sensitive receptor exposure points (e.g., schools or hospitals) would be located nearby.

The pipelines associated with all action alternatives conveying the raw water to the WTP would be within the 1,000-foot range of the Los Angeles landfill.

Summary of Environmental Consequences

No direct or indirect adverse environmental effects related to hazardous or toxic materials would be attributable to implementation of the DWP. Past and future projects related to water resources within the ROI would have used and would be expected to use hazardous materials. There is no indication, or known plan, that additional waste sites or other unrecognized hazards would be required for future projects, or for the DWP. There are therefore, no expected cumulative effects related to hazardous materials. Implementing the design features and BMPs outlined in Section 3.13.4 would result in no temporary, long-term, or cumulative adverse effects from hazardous materials under the DWP action alternatives. Under the No Action Alternative, facilities and transmission pipelines would not be constructed, so there would be no expected effects from hazardous and toxic materials. Table 3.14-1 summarizes the DWP-related environmental effects from hazardous materials. A new diversion dam would add minimal additional risk above what already occurs to boating in the Rio Grande.

Figure 3.14-1
Location of Former Los Angeles Landfill

Source: Bernalillo County

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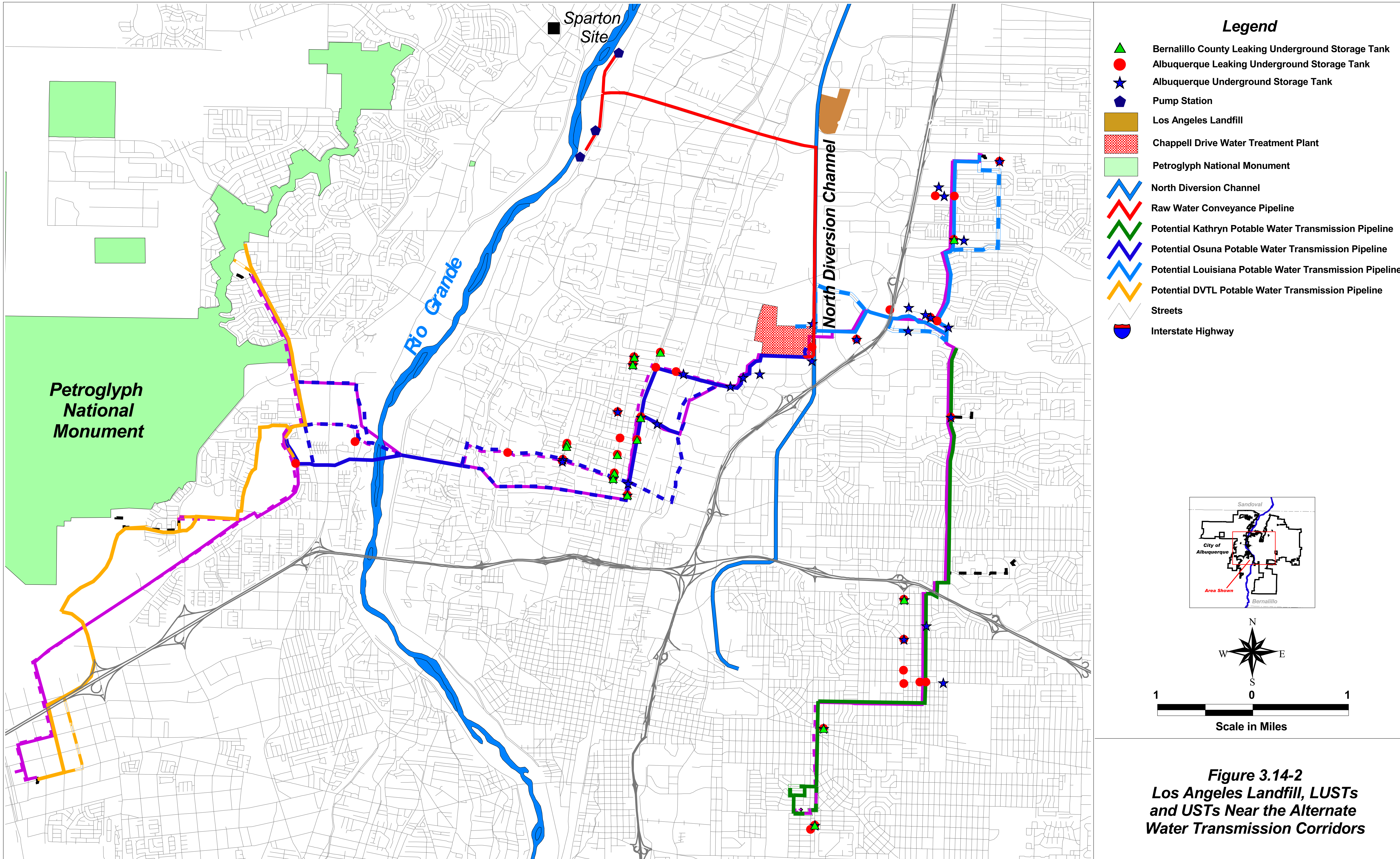

Figure 3.14-2
Los Angeles Landfill, LUSTs and USTs Near the Alternate Water Transmission Corridors

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TABLE 3.14-1
SUMMARY OF HAZARDOUS MATERIALS PROJECT EFFECTS

Evaluation Criterion	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Number of known hazardous waste sites disturbed by project construction or operation	None	None	None	None
Risk of hazardous materials exposure from routine transport and project operations	None	Low	Low	Low

3.14.4 Proposed Mitigation Measures

The City would require the following project design features and regulatory compliance/BMPs for construction projects and operation of the WTP and pumping stations, and any associated structures. These features, when implemented, would minimize or eliminate potential adverse hazardous-materials effects from the project:

- Construction of any DWP facility within 100 feet of a known hazardous waste site, UST, or LUST would be coordinated with the owners of the site or tank to minimize risk of worker or public exposure to hazardous substances.
- The WTP and pumping stations would be operated in accordance with the standards of O&M manuals that would be developed for each individual facility. These manuals would include health and safety plans and emergency-response procedures.
- Transportation of regulated materials would be in accordance with all applicable U.S. Department of Transportation and State of New Mexico regulations.
- Storage of regulated substances would be in accordance with applicable state regulations and municipal ordinances.
- The City would comply with City of Albuquerque Landfill Monitoring Interim Guidelines.

3.15 HUMAN HEALTH AND SAFETY

3.15.1 Introduction

The primary health and safety issues identified during DWP scoping activities were as follows:

- Concerns about the potential health risks associated with accidentally cross-connecting the raw-water conveyance and potable water distribution lines.

- Concerns about the use of chemicals at the WTP.
- Concerns that the project would expose water users to unsafe or unsuitable drinking water.

The risks to the public from physical, chemical, biological and radiological hazards were assessed through conducting a baseline analysis of raw-water quality and by determining factors associated with operating a modern WTP (CH2M Hill, 2000d, 2001a, and 2001c).

3.15.2 Affected Environment

The Middle Project Subarea was the only area evaluated for health and safety concerns, because this is the subarea in which all project construction and operation of facilities would occur. The City's water service area also lies within the Middle Project Subarea (Figure 1.2-1). The public would be the recipient of properly treated potable water for a variety of uses upon delivery of water from the WTP. Both commercial entities and private citizens would have access to this water. There would be no known hazardous, odor, or taste conditions that would be associated with the ultimate delivery of the City's treated SJC water to consumers. The raw, untreated river water will be conveyed from the DWP diversion facilities to the WTP in a conveyance system that is fully isolated from the potable water distribution system which would transmit treated water from the WTP to users in the service area. The current water-distribution system of pipelines and other water-conveyance facilities uses color coding to distinguish potable from non-potable water distribution lines. There would be no opportunity for inadvertent use of water that has not been treated to drinking water standards at the WTP. All water transmitted from the WTP to users would be potable.

Numerous chemicals commonly are used in the treatment of drinking water. Such chemicals would be stored and used at the Chappell Drive WTP under the DWP action alternatives. Table 3.15-1 lists the chemicals that would be stored and used at the proposed WTP (CH2M Hill, 2000d).

The diversion-structure and pump-station construction zones lie within the bosque areas of the Albuquerque reach of the Rio Grande, which are heavily used for public recreation. Any construction zones would need to be secured from public access to control hazards from construction activities. Land uses in the areas surrounding the WTP are commercial and light industrial. Two schools are located within 0.5 mile of the WTP site, including a private school to the west, and a public school southeast of the plant.

The pipeline transmission corridors for delivery of the treated, potable water are located within existing street ROWs through residential and commercial areas.

TABLE 3.15-1
PROCESS CHEMICALS STORED AND USED AT THE WATER TREATMENT PLANT

Chemical	Application
Ferric chloride (40 percent solution)	Used as a coagulant
Sulfuric acid (98 percent solution)	Used to lower the pH of the water to achieve enhanced coagulation for organics removal
Hydrated lime	Mixed with water to form a high-pH slurry used to increase the pH of and stabilize the treated water
Hydrofluosilicic acid (30 percent solution)	Used to add fluoride to the water
Sodium hypochlorite (15 percent solution)	Disinfectant to kill water-borne pathogens
Non-ionic and anionic polymers	Used for coagulation and filter ripening
Hydrogen peroxide (50 percent solution)	Used to enhance oxidation of compounds that affect taste and odor

Source: CH2M Hill (2000d).

3.15.3 Environmental Consequences

The public health and safety effect analysis considered the potential increased risk to the public from physical and chemical hazards associated with the proposed project. For each identified hazard, proximity of the hazard to the public, magnitude of risk, and the composition of the group or community exposed to the potential hazard were considered. The following criteria are considered in evaluating the potential effects on human health and safety:

- Cross-contamination of potable and non-potable water distribution lines such that people were directly exposed to non-potable water.
- Potential exposure to the public of regulated chemicals.
- Exposure of the public to construction hazards, such as open excavations, or the operation of heavy equipment.

Effects from No Action Alternative

Under the No Action Alternative, there would be no diversion of raw water from the Rio Grande, and no treatment of river water for distribution as potable water to the City's water users. Therefore, there would be no public health or safety risks associated with construction of the DWP, inadvertent distribution of untreated river water to users, or storage or use of chemicals at a new WTP. However, because additional ground water wells would be required to meet future demand for potable water if the DWP is not constructed, there would be potential construction hazards related to well and pipeline construction. Current Albuquerque water wells are located throughout the service area, and the locations of future wells would be based on need, property access logistics, and hydrogeological considerations. Routine construction safety practices would prevent exposure of the public to undue physical hazards during well and water line construction.

Ground water currently extracted as drinking water by the City meets applicable drinking-water standards, and therefore is treated only with chlorine prior to its distribution as potable water. With continued aquifer depletion, ground water quality may deteriorate. Also, water currently extracted from some of the City's wells may not meet federal arsenic standards. If treatment of ground water is required to meet drinking-water standards in the future, a WTP would have to be designed, and process chemicals would have to be stored and used.

Effects from Action Alternatives

Because all three action alternatives would involve the construction of new raw-water diversion facilities and pump stations in the bosque along the Rio Grande, construction of new raw-water conveyance corridors from the diversion facilities to the proposed Chappell Drive WTP, treatment of raw water at the WTP, and construction of new distribution pipelines for delivery of the treated water to users, public health and safety concerns essentially would be the same under all DWP alternatives. There would be no potential for inadvertent cross-connection of raw and potable water pipelines during project construction, and therefore there would be no risk of delivery of untreated water to the public. Raw river water will be treated to meet all applicable drinking-water standards before it is distributed as potable water to the City's water service area. There would not be a risk to public health from exposure to the chemicals listed in Table 3.15-1 during their transport to, storage at, or use during operation of the WTP. Construction sites in the bosque and along ROWs in the City limits would be restricted using appropriate signage and fencing to control public access. Therefore, there would be no extraordinary risk to public safety from physical construction hazards.

Summary of Environmental Consequences

No federal or state primary or secondary drinking water quality standards would be exceeded under any of the DWP alternatives or the No Action Alternative. Previous water resource projects and facilities within the ROI have not been shown to have a severe or sustained impact to human health and safety. Foreseeable future projects, if they require construction, could pose some physical or chemical hazard to the public. There would be no temporary, long-term, or cumulative adverse effects on human health and safety from construction or operation of any of the alternatives. The delivery of treated, safe drinking water from a reliable source is considered a beneficial aspect of the project. Chlorine gas would not be used at the facility, and none of the process chemicals proposed for use would pose a public health risk (Table 3.15-1). Table 3.15-2 summarizes the project effects on human health and safety for each alternative.

TABLE 3.15-2
SUMMARY OF PROJECT EFFECTS ON HUMAN HEALTH AND SAFETY

	Alternative			
Evaluation Criteria	**No Action**	**Angostura Diversion**	**Paseo del Norte Diversion**	**Subsurface Diversion**
Number of untreated/potable water line cross-connections likely to be implemented during construction activities	None	None	None	None
Primary and secondary drinking water quality parameters that would be exceeded in treated water	None	None	None	None
Uncontrollable public safety hazards during project construction	None	None	None	None

3.15.4 Proposed Mitigation Measures

The City would require the following project-design features and construction BMPs during DWP implementation and operation. Compliance with these measures would be required to obtain City construction permits. These features, when implemented, would minimize or eliminate potential adverse effects on human health and safety:

- The construction contractor would be required to comply with the City cross-connection ordinance and standards.
- The construction contractor would be required to secure all construction zones to control public access and ensure safety. BMPs and compliance with applicable federal, state, and local construction-site safety regulations and ordinances, as specified in the City construction permits, also would be required.
- The WTP would be operated in accordance with the standards of O&M manuals to be developed during design and construction.

3.16 HYDROLOGY (SURFACE AND GROUND WATER)

3.16.1 Introduction

The primary issues related to hydrology that were identified during scoping were concerns regarding reservoir levels (particularly Heron) and changes in river flows (hydrology) in the Rio Chama and Rio Grande. Project related water rights issues identified during scoping activities are listed in Appendices B through D. Specific issues included the DWP effect on private ground water wells.

This analysis estimated the hydrologic effects of the DWP action alternatives and the No Action Alternative on waterways and drinking-water aquifers in the study area. The analysis includes streamflow conditions, reservoir and river-control operations, and ground water levels (water tables) in the Middle Rio Grande and the Rio Chama. Water rights were assessed by determining whether or not the alternatives would reduce the volume of surface water available to other water rights.

The surface water hydrology analysis was summarized from a report entitled *Hydrologic Effects of the Proposed City of Albuquerque Drinking Water Project on the Rio Grande and Rio Chama Systems* (CH2M Hill, 2003). For details, please refer to this report, which is included as Appendix L. The report:

- Summarizes historic Rio Grande streamflow conditions, the importation of SJC Project water, and the City's rights to and use of water in the Middle Rio Grande Basin.
- Documents annual and monthly flows of the river between Otowi and San Marcial and estimates the contribution of imported SJC water to native Rio Grande flows during the historic period of operation of the SJC Project (1971 - 1998).
- Defines the No Action Alternative as a basis for determining the hydrologic effects caused by the action alternatives on flows in the Rio Grande between Abiquiu and Elephant Butte Reservoirs.
- Develops a preferred scenario for typical operation of the DWP. This includes release and diversion of the City's SJC and Rio Grande water beginning in the first full year of project operation, assumed to be 2006.
- Defines a hydrologic baseline using adjustments to the 1971-through-1998 streamflow record. These include the historical effects of City well pumping and wastewater returns on river flows, and the use of SJC water by others. This analysis is based on the AWRMS River Model, which consists of a coupled series of streamflow spreadsheets and a ground water model of the Albuquerque Basin, referred to as the OSE interim model (Barroll, 1999).
- Compares the effects on Rio Grande flows caused by the No Action Alternative and the action alternatives in dry and normal (near average) years, and under a simulated 3-year drought, using the AWRMS River Model.
- Addresses the effects of the alternatives on flows between the proposed diversion points and the wastewater return outfall below Rio Bravo Bridge in south Albuquerque.
- Estimates the potential effects of DWP diversions on depths and velocities of the Rio Grande in the Albuquerque reach, and on shallow ground water levels in the adjacent bosque.
- Estimates the potential effects on the sedimentation regime of the Rio Grande in the Albuquerque Reach.

- Uses the Riverware© model of the Rio Chama system formulated by the multi-agency Upper Rio Grande Water Operations Model group (URGWOM, 2000) to examine the effects of the alternatives on characteristics such as reservoir levels, rafting water releases, and fisheries releases. The modeling focuses on the effects that DWP releases of the City's SJC water would have on flows and uses of the Rio Chama and Rio Grande above Cochiti Reservoir.

- Estimates the effects of action and No Action Alternatives on aquifer-wide and near-river ground water levels.

- Uses transmission losses that are consistent with the methods that are utilized by the Bureau of Reclamation for conveyance of San Juan Chama water from El Vado to the proposed new diversion dam.

- Completed simulations for specific years of project operation over dry, average, and maximum flow years. Extended drought conditions over a three year period are described. As a result of the operational criteria, when native flows are less than the curtailment rate diversions will cease and the City will increase pumping of ground water.

The sources of information for ground water were obtained from the following:

- *Simulation of Ground Water Flow in the Albuquerque Basin, Central New Mexico, 1991-1994, with Projections to 2020* (USGS, 1995) explains the three-dimensional, finite-difference, ground water-flow model developed by Kernodle, McAda, and Thorn of USGS.

- The RG-960 et al application to the OSE, prepared for the City by CH2M Hill (2001e), provides the basis for seeking approval to increase ground water pumping from 132,000 ac-ft/yr to 155,000 ac-ft/yr. This request included a ground water analysis using the OSE interim ground water model, a version of the USGS (1995) model.

- The hydrology report (CH2M Hill, 2003) provides general ground water information specific to the No Action and DWP action alternatives.

3.16.2 Affected Environment

Water resources management in the Rio Grande Basin is a complex undertaking that involves hydrological, legal, socioeconomic, and environmental concerns. River management and the operation of existing facilities must consider many laws and regulations, including an international treaty with Mexico, several interstate compacts, multiple federal statutes, laws from New Mexico, Colorado, and Texas, and contracts between the U.S. government and local water users. Water resources management also must consider the concerns of multiple public, private and quasi-public water users. Cooperation and coordination among stakeholders is increasingly important to meet the focus of federal agencies on the integration of water resource management and environmental conservation.

Current Surface Water Conditions

Figure 3.16-1 illustrates annual mean flows in the Rio Grande at the Otowi gage from 1900 through 1998. The Otowi gage is the measuring point to determine New Mexico's obligation to Texas under the Rio Grande compact. In accordance with the Colorado, Upper Colorado River, and Rio Grande compacts, the inflows from the San Juan-Chama project are specifically excluded from native flows at the Otowi gage and are accounted for separately. The Otowi gage has one of the longest periods of record on the Rio Grande. As shown on the figure, average annual flows in the Rio Grande at this site range from about 500 cfs in dry years to more than 2,500 cfs in wet years. Typically, average annual flows are about 1,500 cfs.

The average annual flow in the Rio Chama below Abiquiu Dam was 546 cfs for water years 1971 through 1997. These flows range from 213 cfs to 872 cfs.

The Otowi gage is located just downstream from the confluence of the Rio Grande and the Rio Chama. This location makes this gage useful for determining the effects of SJC Project releases, which began in 1971, on Rio Grande flows. From 1971 through 1998, SJC water increased flows at the Otowi gage by an average of 73 cfs, or about 5 percent of native flow.

Downstream from the Otowi gage, the Rio Grande has been modified into a highly regulated and confined river system. Figure 3.16-2 is a schematic of major facilities on the Rio Grande from Cochiti Reservoir to the San Acacia gage, which is some 50 miles upstream from Elephant Butte Reservoir. Within this 116-mile stretch, there are four irrigation diversion points: Cochiti, Angostura, Isleta, and San Acacia. These structures divert water from the river to the MRGCD system of canals and laterals for irrigation of 50,000 to 64,000 acres of cropland, including up to 8,300 acres of Pueblo cropland. Riverside drains and wasteways collect surface water and shallow ground water, and convey it back to the river at numerous locations. The Six Middle Rio Grande Pueblos are entitled to irrigate, at a minimum 8,847 acres of prior and paramount land and 12,600 acres of newly-reclaimed lands. Accounting procedures for this irrigation were established by the Six Middle Rio Grande Pueblos in collaboration with the Bureaus of Reclamation and Indian Affairs.

The City of Albuquerque extends approximately from RM 193 to RM 176. The Angostura Diversion would be located approximately at RM 209.7, while the intake structures for DWP Paseo del Norte Diversion and Subsurface Diversion would be located approximately at RM 192.

Figure 3.16-3 illustrates annual flows in the Rio Grande from 1971 through 1998 at the Albuquerque gage at RM 183.4. The Albuquerque gage is between the DWP diversion point locations and the location where water would be returned to the Rio Grande at the SWRP outfall. Therefore, it is a useful location for evaluating the effects of the DWP on the hydrology of the Rio Grande.

From 1971 through 1998, flows at the Albuquerque gage averaged 1,410 cfs and ranged from about 500 cfs in dry years, to more than 2,500 cfs on an annual basis in wet

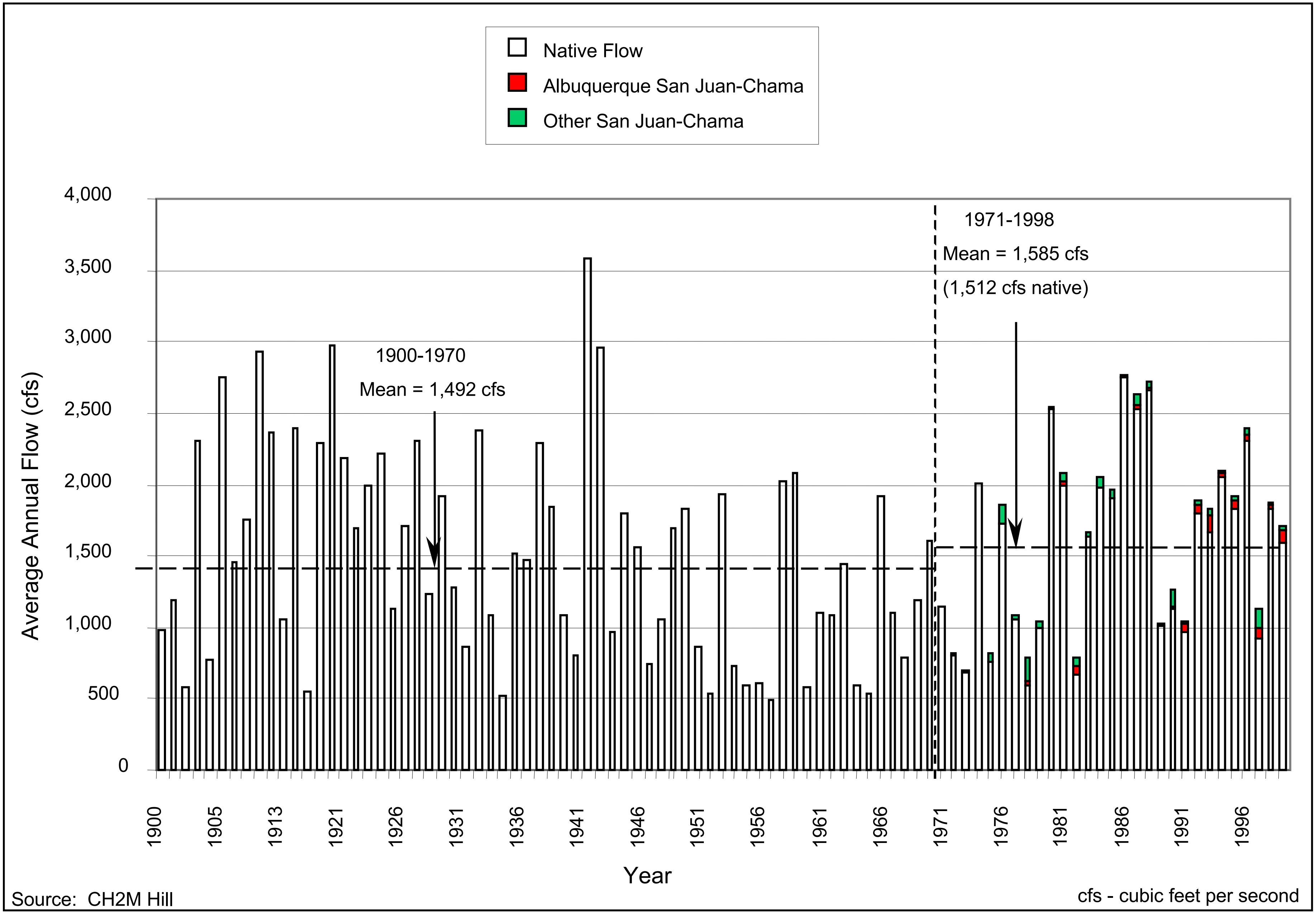

Figure 3.16-1
Annual Flows in the Rio Grande at the Otowi Gage, 1900 through 1998

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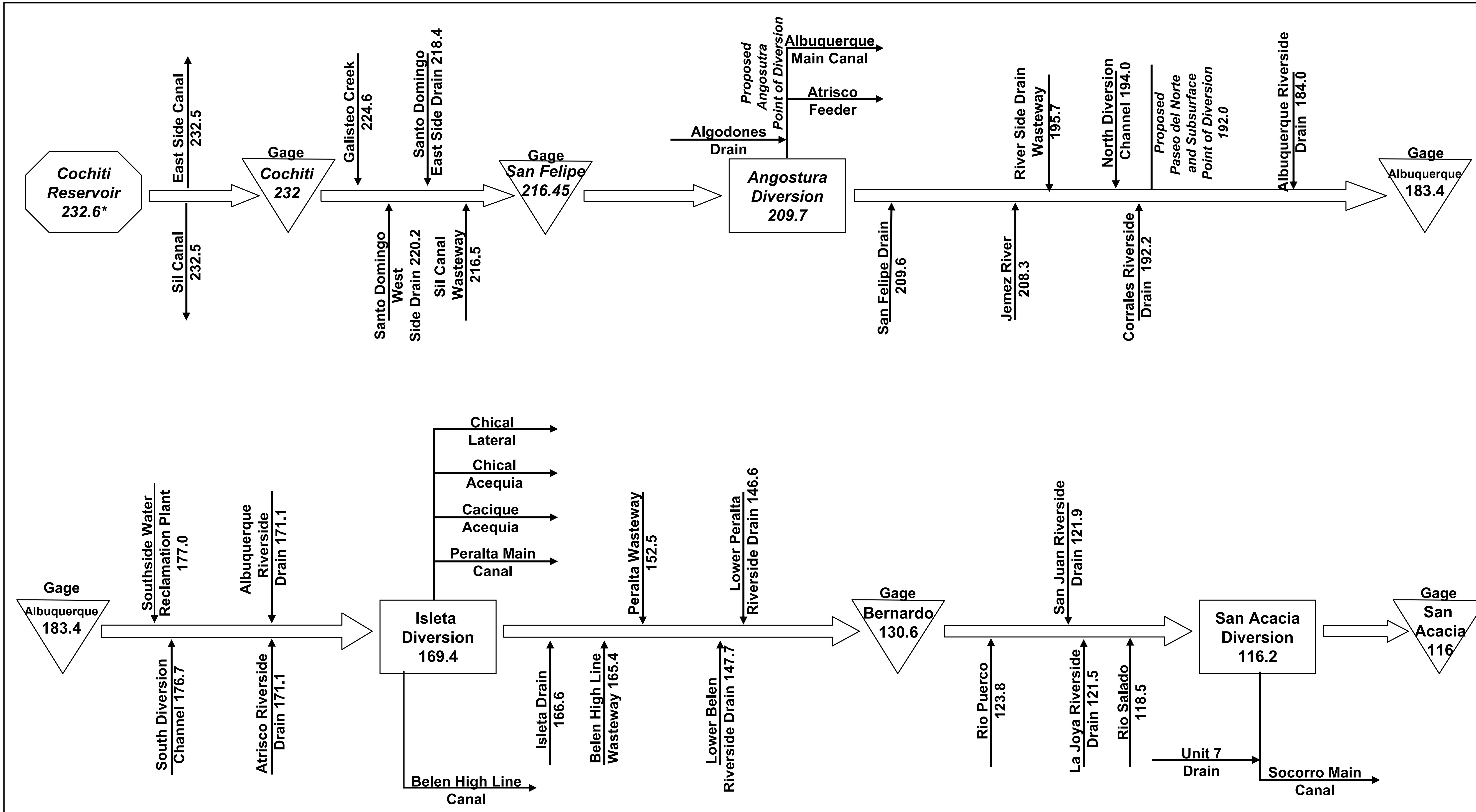

* Numbers represent river miles measured upstream from Caballo Dam
** Arrows show direction of water flow

Figure 3.16-2
Schematic of Existing and Proposed Major Facilities on the Rio Grande from Cochiti Reservoir to San Acacia Gage

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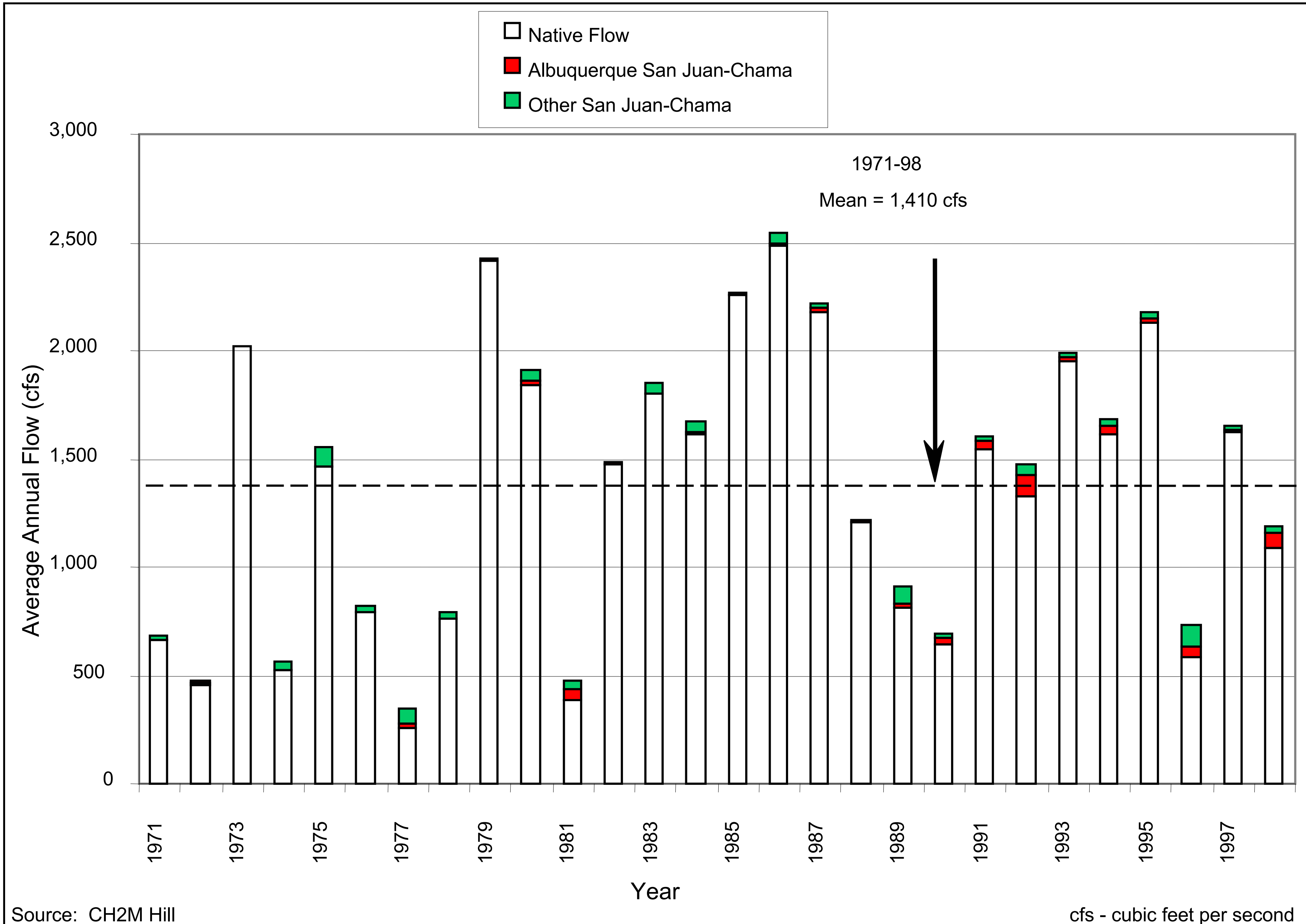

Figure 3.16-3
Annual Flows in the Rio Grande at the Albuquerque Gage, 1971 through 1998

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years. Approximately 18 cfs of this flow on average (and about 32 cfs in the July through October period) has been City SJC water, much of which has been used by the MRGCD for irrigation. On a daily basis, the City wastewater treatment plant receives and treats approximately 55 to 60 mgd of wastewater and discharges the effluent to the Rio Grande.

Average flow and dry-year flow on a monthly basis at the Albuquerque gage are shown on Figure 3.16-4. The year 1977 is the representative dry-year. Abiquiu and Cochiti Reservoirs, which provide flood protection from the drainages upstream from the City, have attenuated the historical flows at this location. As shown in the figure, mean monthly flows are characterized by low baseline conditions of about 500 to 1,000 cfs from August through February. Sporadically, flows increase briefly during this period in response to storms. Flows increase in association with spring runoff from March through June and typically peak above 3,000 cfs in early May. The dry-year flow was derived from the 1972 hydrograph at the Albuquerque gage. This shows that the mean gaged flow for this year was about 550 cfs as compared to a 1,410-cfs average-year mean flow.

Existing Ground Water Conditions

The approximate level of pumping in the Albuquerque Basin, as documented in the OSE ground water model (Barroll, 1999), is 156,800 ac-ft/yr. The aquifers of the Middle Rio Grande region have a limited hydrologic connection to the river. In the Albuquerque area, water table elevations have declined due to pumping and are presently below the elevation of the stream. The result of this limited hydrologic connection is that pumping takes water from storage in the aquifer faster than it is removed from the river. Thus, there are declines in water table elevations. This local disconnection results in additional delay in the time for pumping effects to be felt by the river, as the distance between the pumping locations and the connected reaches of the stream are increased. While local disconnection is an additional factor affecting the timing of pumping impacts on a stream, the characterization of aquifers in the Middle Rio Grande region as stream-connected remains functionally correct (USACE and New Mexico Interstate Stream Commission [ISC], 2000).

Because aquifers in the Middle Rio Grande region are stream-connected, the pumping of ground water affects the water supply available to the region (USACE and ISC, 2000). Figure 3.16-5 identifies the locations of the Albuquerque Basin and the Rio Grande Rift. Figure 3.16-6 indicates current drawdown levels within the Albuquerque area. As can be seen, current ground water drawdown level as a result of City and other pumping generally ranges from 40 to 180 feet in the critical management area (CMA) boundary (NMOSE, 2000).

Existing Hydrologic Effects of the City of Albuquerque's Water Supply System

Water supply sources potentially available to the City include the following. All of the year 2000 values are based on information from CH2M Hill (2003):

- Ground water from the Albuquerque Basin aquifer. The City has a master well permit that allows pumping of up to 132,000 ac-ft/yr (average pumping rate of about 182 cfs) of ground water as long as the effects of that pumping on flow of the

Rio Grande are compensated. In 2000, approximately 114,500 ac-ft of water (average of about 158 cfs) was obtained from this source.

- Surface water from the SJC Project. The City has a contract for 48,200 ac-ft/yr delivered from Heron Reservoir. Because of conveyance losses, about 47,000 ac-ft annually (average of 65 cfs) would be available for use by the City. The City's SJC water is leased, traded, or stored, and is not currently used by the City for municipal and industrial purposes nor to offset river losses to aquifer recharge.

- City SJC water, up to 170,900 ac-ft may be stored in Abiquiu Reservoir.

- Vested and acquired native surface water rights in the Middle Rio Grande Basin totaling about 23,350 ac-ft/yr (average of about 32 cfs). These rights were obtained over the years for consumptive use by the City.

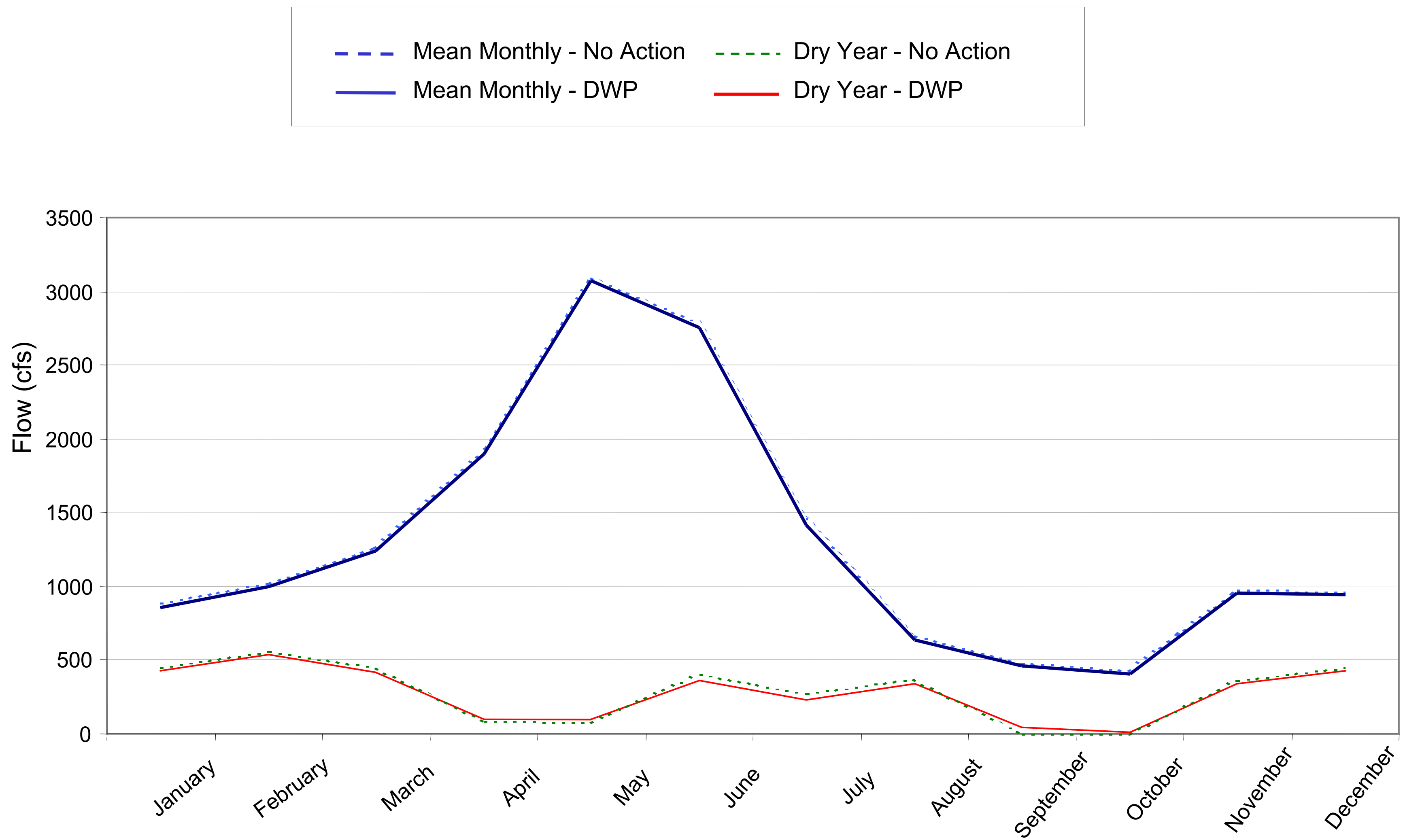
- Treated effluent from the SWRP. The City receives return-flow credit for this discharge into the Rio Grande. In the year 2000, this amounted to about 58,000 ac-ft (about 80 cfs). This volume changes as the volume of water used for municipal purposes changes.

The Rio Grande and the basin aquifer have a limited hydrologic connection. As a result, pumping of the aquifer lowers the water table, which causes river depletions, which periodically infiltrate (or recharge) the aquifer at a rate slower than the pumping rate, which results in a net decline of the ground water table.

In 1956, the State Engineer recognized that pumping the aquifer affects the quantity of water in the stream. Therefore, the City was required to compensate for these impacts. Based on 2000 data, the OSE calculated that Albuquerque's pumping of 114,000 ac-ft of ground water reduced flows in the river by 71,700 ac-ft. Albuquerque replaced these flows in the Rio Grande by discharging about 58,000 ac-ft of treated effluent from the SWRP, and by not using 13,500 ac-ft of its Middle Rio Grande Basin surface water rights (CH2M Hill, 2003). Thus, surface flows have been kept whole or surplused because actual river losses to the aquifer are less than the calculated net effect (Barroll, 1999).

Technical studies conducted in the 1950s and 1960s by the USGS suggested the City's pumping would begin having a negative net effect on Rio Grande flows in the late 1980s. However, these studies also suggested that river and mountain-front recharge and the large size of the Albuquerque Basin aquifer provided the City with a virtually limitless supply of ground water (Bjorklund and Maxwell, 1961).

Hydrogeologic studies and modeling investigations were performed in the 1990s (New Mexico Bureau of Mines and Mineral Resources, 1992; USGS, 1993 and 1995), which suggested that ground water was less abundant than previously thought. These studies found that the size of the highly productive aquifer was smaller than estimated in earlier studies, and that declines in water-table levels already were occurring. These reports predicted that if ground water pumping remained at existing levels, drawdowns would exceed 250 feet in the northeast area of Albuquerque by the middle of the 21st century. This would be beyond the allowable level of drawdowns specified by the OSE



Source: CH2M Hill

Figure 3.16-4
Average and Dry Year Monthly Flows in the Rio Grande at the Albuquerque Gage with and without the Proposed Action

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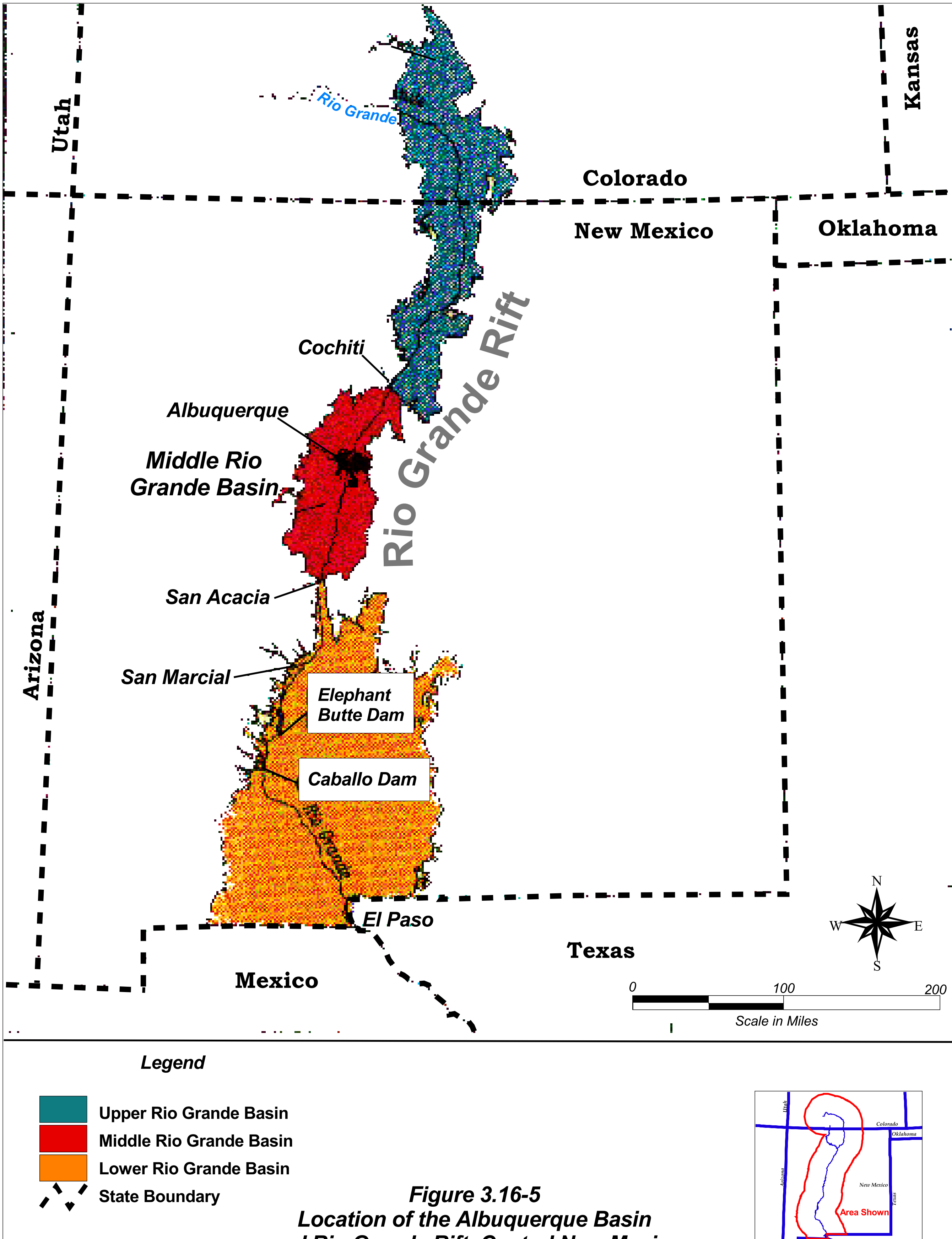

Figure 3.16-5
Location of the Albuquerque Basin and Rio Grande Rift, Central New Mexico (modified from Thorn et al.,1993)

Source: USGS, 1995

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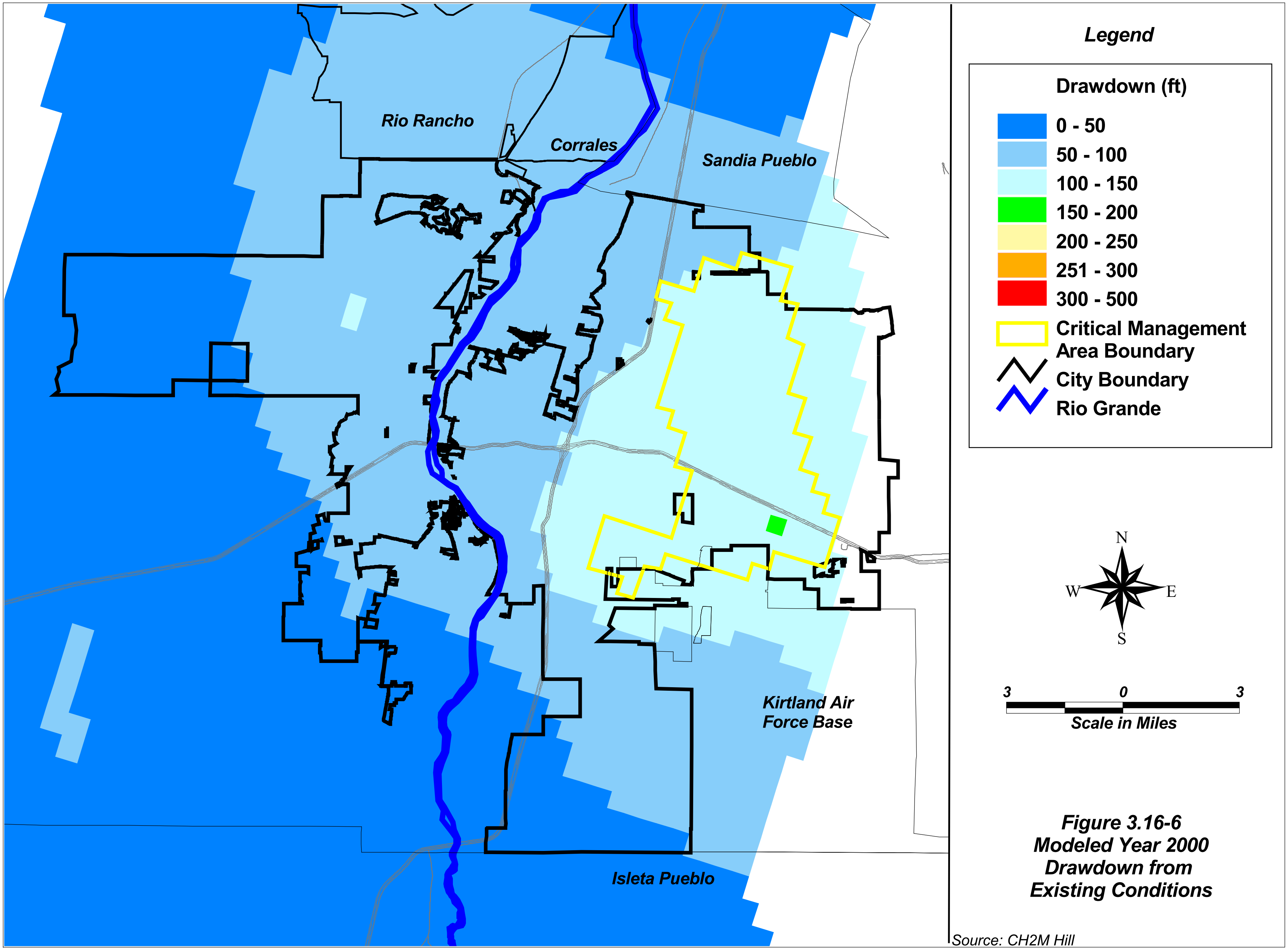

Figure 3.16-6 Modeled Year 2000 Drawdown from Existing Conditions

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administrative guidelines (2000) and could cause extensive property damage due to subsidence. It is estimated that potential subsidence costs could be $166 million for the No Action Alternative and $26 million for all three action alternatives (CH2M Hill, 2002a). These effects would be accelerated if pumping was increased to meet the demands of the City's growing population. Continued investigations using the OSE interim model (Barroll, 1999) further suggested that the effects on Rio Grande flows caused by pumping were less than first calculated by the OSE.

Reclamation and the USACE are major entities responsible for management of water in the Rio Chama and the Rio Grande. Other organizations with a major role in the management of water in the Rio Chama and the Rio Grande include the New Mexico OSE and ISC, as well as many water-right holders and contractors of SJC project water. The latter group includes the City and MRGCD.

Other water users that influence project operations in the Rio Chama and Rio Grande water systems include the six Southern Indian Pueblos of the Middle Rio Grande, and Rio Chama acequia diverters below Abiquiu Reservoir. Storage and release of Rio Grande water for the Pueblos of Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia and Isleta are not subject to terms of the Rio Grande Compact. Accounting for their use is based on established procedures of Reclamation and the Bureau of Indian Affairs.

Water rights of the diverters below Abiquiu Reservoir are protected by the requirements that no storage can take place at El Vado Reservoir that would deprive Rio Chama diverters of their water rights. Thus, all of the natural flow of the Rio Chama is passed through El Vado Reservoir when flows fall below 100 cfs as measured downstream from Abiquiu Reservoir (Fogg *et al*., 1992).

Surface Water and Ground Water Hydrology Analysis Methods

A variety of techniques were used to evaluate effects of the DWP alternatives on various components of the surface water and ground water systems. Brief summaries of the analysis methods are provided below. Complete information on analysis methods can be obtained from the source documents referenced for each technique.

Methods Used to Analyze Effects within the Upper Project Subarea

The Rio Chama would convey the City's SJC water from Heron Reservoir to the Rio Grande. The Rio Chama is a tributary that joins the Middle Rio Grande in the northwest portion of the basin just upstream from the Otowi gage.

A simplified version of the Riverware© model was used to evaluate and compare the effects of the DWP alternatives and the No Action Alternative on the hydrology of the Rio Chama system. The simplified model, called the DWP model, was based on a computer code developed by the multi-agency URGWOM Team (2000). The results are presented in *Modeling the Hydrologic Effects of the AWRMS Drinking Water Project on the Upper Rio Grande – Draft Report, August 2001* (CH2M Hill and Wave Engineering, Inc., 2001).

The DWP model focused on evaluating effects on flows in the Rio Chama in normal, dry, and extended drought years. These included the capability to maintain historical acequia diversions of native flow; and summertime recreational rafting releases, and winter fishery releases using primarily City SJC water. The effects on storage volumes and water levels in El Vado, Abiquiu, and Cochiti Reservoirs also were examined relative to historical conditions (although that analysis is not considered definitive owing to the limited number of simulated years).

DWP model simulations were based on a typical pattern of delivery of City SJC water from Heron Reservoir and a scenario of a constant release from the City-owned storage pool at Abiquiu Reservoir. This would result in a constant flow of about 66 cfs at the Otowi Gage.

The DWP model simulations under both the No Action and DWP alternatives assumed a full consumptive use of individual allocations for other contracted SJC users. These included, but were not limited to, the MRGCD, City of Santa Fe, and Indian Pueblos.

All DWP model runs were made assuming that SJC deliveries from Heron Reservoir were made either within a particular calendar year (without waivers) or under a scenario that included waivers from Reclamation. The with-waivers condition would allow a delay of releases through April of the following calendar year. Waivers have been widely used in past years. Waivers are the process by which Reclamation, at the request of the contractors, with the consent of the Rio Grande Compact Engineer Advisors, allows for SJC contractors to delay delivery of all or a portion of their annual allotment beyond December 31st until the following April 30th. The waiver process, in effect, allows for additional flexibility in managing the SJC resource in any given year.

For the DWP model, assumptions included the initial conditions of reservoir storage by SJC contractor, and the use or absence of waivers. Table 3.16-3 summarizes the model conditions regarding initial reservoir storage conditions. The consideration of waivers in the model is provided in the environmental consequences section.

When short time periods (less than several years) are modeled, the initial storage assumed for each reservoir can greatly affect modeling results. For example, if the initial year follows an assumed low-runoff year that left little water in storage, releases from reservoirs may be severely restricted and shortages could occur. Conversely, starting the model after an assumed high-runoff year that left ample water in storage may not indicate the need to restrict releases, even if the modeled year is relatively dry.

- As shown in tables within Appendix L, two initial storage assumptions, designated high and low, were used in the DWP model to bracket the start-of-year conditions. The high-storage assumption shows the operation when previous conditions were wet and the storage of the system at the start of the model run is at high levels. The low-storage assumption shows the operation when the model run is started after a dry period and there is little storage in the system.

- Comparisons were made between simulated conditions with action and No Action Alternatives based on the 1971 through 1998 hydrologic record. The years 1977 and 1988 were chosen as representative of low-flow and normal years, respectively. As was the case for the evaluation of flows in the Middle Rio Grande, a 3-year drought was simulated by running 1972 back-to-back three times. Curtailed SJC deliveries to the DWP occurred during both the 1977 and 3-year drought modeling scenarios.

For each of the examined scenarios, the starting reservoir level at Abiquiu Reservoir was 50,000 ac-ft for the low condition and 170,900 ac-ft for the high condition. At El Vado Reservoir, starting levels were assumed to be 80,000 ac-ft for the low condition and 160,000 ac-ft for the high condition.

Results of the DWP model runs for the Rio Chama system were used to compare:

- The ability to maintain rafting releases in the Rio Chama below El Vado Reservoir in coordination with Reclamation. Such releases were based on maintaining a flow of 600 cfs during weekdays and 1,000 cfs during weekends, beginning in mid-July and continuing through August.

- The ability to maintain winter fisheries releases in the Rio Chama below El Vado Reservoir and Abiquiu Reservoir.

- At El Vado Reservoir, releases were based on maintaining a flow of at least 185 cfs in winter months during normal years. In low-flow and drought years, the target flow was 100 cfs, based on the specified minimum in the drought year of 2000 - 2001.

- Minimum fishery releases below Abiquiu Reservoir were set at 70 cfs for both normal and low-flow years. These included maximum and minimum volumes and elevations for the action and No Action conditions relative to each other and in comparison to conditions experienced during the historical (1971 through 1998) period.

Results of the SJC-water-release modeling analysis for rafting and fishery releases and for storage effects at Abiquiu Reservoir considering the three action alternatives and the No Action Alternative are summarized in the Environmental Consequences section.

Methods Used to Analyze Effects in the Middle Project Subarea

As described in Section 2, the City would use its SJC surface water in conjunction with its ground water resources to meet water demands. During the early years of the DWP (2006-2027), potable SJC water would be recharged into the aquifer using City wells designed for ASR during the winter, when user demands are low.

The three action alternatives for diversion, conveyance, and treatment of the City's SJC water would meet the following criteria:

- The system would reliably deliver an average of 94,000 ac-ft/yr, or 130 cfs, of water from the river to the City. This includes 47,000 ac-ft/yr of City SJC water and 47,000 ac-ft/yr of borrowed native water. The SJC water would be fully consumptively used and the 47,000 ac-ft/yr of native Rio Grande flows would be returned to the river at the SWRP outfall below Rio Bravo Bridge.

- The pump stations would have an initial capacity of 92 mgd (142 cfs). All other diversion and conveyance facilities would be sized for a peak hydraulic capacity of 120 mgd (186 cfs). This would provide flexibility in operation and the ability to respond to unusual, short-term demands. Several decades hence, if water becomes available and demand warrants, the system could provide for continuous operation at 120 mgd. It was assumed that the diversion and conveyance facilities, and the treatment facilities at Chappell Drive, would be operated at no more than 92 mgd for the first several decades of the project.

As described by CH2M Hill (2003), the criteria above were used to model the No Action Alternative and the three action alternatives to determine their effects on flows in the Rio Grande at five sites:

- San Felipe gage;

- Albuquerque gage;

- Isleta Dam site;

- San Acacia gage; and

- San Marcial gage.

The Isleta site is in effect, an “artificial gage” whose record is based on development of a record with additions and subtractions made for SJC releases, DWP diversions, river effects due to City ground water pumping, wastewater returns, and assumptions for MRG Project drain return flows.

The analysis was performed using the AWRMS River Model, which consists of a coupled series of streamflow spreadsheets and a ground water model of the Albuquerque Basin, called the OSE interim model. The computer code for the OSE interim model is the USGS’s MODFLOW (McDonald and Harbaugh, 1988).

The period from 1971 through 1998 was selected as the hydraulic baseline for evaluating the effects of the alternatives on river flows. This period was selected because it:

- Represents the period of imported SJC water in the river with Heron Reservoir in operation.

- Includes the period of upstream regulation by Abiquiu and Cochiti Reservoirs and engineered channel improvements for flood control and low-flow conveyance.

- Represents the most recent period for which good correlative data on ground water pumping, wastewater return flows, MRGCD diversion data, and other hydrologic information are available.

The 1971-98 record lacks a multi-year drought similar to that which occurred from 1953-57, as documented at the Otowi gage (see Figure 3.16-1). Therefore, the hydrologic analysis inserted a multi-year drought into the 1971 through 1998 hydrologic record to simulate such conditions and demonstrate the effects that the alternatives would have on river flows during an extended period of low flows. Running the dry year of 1972 back-to-back three times created a 3-year drought period. This drought period was inserted more than 15 years into the modeled period (i.e., 2024-2026) so that it would not be affected by any initial modeling assumptions.

The projected flows for 2006 through 2060 were created using the 1971 through 1998 historical flow record. The modeling approach varied demand and water availability through an evaluation period that begins with the year 2006 demand and 1971 river hydrology, through the year 2023 demand using 1988 hydrology. Then the drought year of 1972 was repeated for 2024 through 2026 with the remaining hydrological years of 1992 through 1998 projected with demands through 2033. The second cycle is similar with demand at 2034 using the hydrology of 1971, ending with 2060 demands using 1998 hydrology.

- For all of the alternatives, the 1971 through 1998 gaged stream flow data were adjusted by removing the average monthly historical City SJC water from the record.

- For all of the alternatives, the projected future effects (2006 through 2060) of ground water pumpage and SWRP return flows on river flows were added to the adjusted historical data.

- For the action alternatives, the proposed release and diversion amounts for the alternative were added. In a normal year, this would involve the constant release of about 66 cfs from the City SJC pool in Abiquiu Reservoir (reduced to about 65 cfs at Albuquerque after conveyance losses); and a constant diversion of about 130 cfs, half of which is returned at the SWRP.

The No Action Alternative includes SJC water in the system for the Non-potable Surface Water project (about 3,000 ac-ft/yr) and for outstanding leases for about up to a maximum of 2,600 ac-ft/yr.

The analysis of all of the alternatives assumed that the City's conservation plan would be fully implemented as scheduled. This would include a 40 percent reduction in per capita demand by 2015, resulting in an average annual per capita use of 150 gallons per day (gpcd). Beyond 2015, the 150 gpcd rate was applied to projected future population growth rates of 1.1 to 1.7 percent.

Results of the AWRMS River Model runs for the Rio Grande were used to determine:

- Changes in seasonal flow at the Albuquerque gage.

- Changes in wetted channel characteristics.
- Flow below the wastewater treatment plant with and without the project.

Methods Used to Analyze Effects on Groundwater

Key assumptions that were used in the model included:

Baseline schedule involving a uniform distribution of the pumping in City wells normalized on the well capacity with a maximum overall pumping rate of 167,000 ac-ft/yr under the No Action Alternative by 2060.

Model runs were made under the City's adopted scenario of "continued growth trends with conservation," which includes future growth rates of between 1.1 and 1.7 percent and a substantial reduction in per capita water demands from 250 to 150 gpcd by 2015. Results were evaluated in terms of the OSE-prescribed "net-effect" on the river and in terms of new administrative criteria for drawdowns listed in the *Middle Rio Grande Administrative Area Guidelines for Review of Water Right Applications* published by the OSE in September 2000 (OSE, 2000).

Regarding hydrologic effects, the model runs evaluated the "net effect" on the Rio Grande, which includes pumping-induced seepage losses from the river to the aquifer minus wastewater return flows. A negative "net effect" means that an offset is needed, either by using the City's vested and acquired "native" water rights (about 24,020 as of (2002) ac-ft/yr) or a portion of the City's SJC allotment of 48,200 ac-ft/yr.

Based on results of the OSE interim model and assumptions stated, the hydrology report in Appendix L identified the change in volume of ground water volume pumped annually and cumulatively.

Methods Used to Analyze Effects on Ground Water Levels at the Subsurface Diversion

The subsurface infiltration gallery in Subsurface Diversion could affect the nearby ground water system. This alternative would include more than a mile of slotted pipe or well screens (horizontal collectors) arrayed in three 11-armed collectors. Each arm would extend 400 to 500 feet from a central hub. The collectors would be buried approximately 15 feet beneath the river bed upstream and downstream from the Paseo del Norte Bridge.

CH2M Hill (2003) used the Microfem© model to model drawdowns that would be expected in the vicinity of the infiltration gallery. The baseline information for the Rio Grande riverfront that was used as model inputs was collected by the USGS and the City. Details of the analysis method are provided in Appendix L.

3.16.3 Environmental Consequences

Effects from No Action Alternative

The No Action Alternative would continue and increase the reliance on ground water pumping into the foreseeable future. Such pumping would increase the river effects of quantities of river water seeping into the Albuquerque Basin aquifer and increase ground water returns to the river via the SWRP.

Figures 3.16-7 through 3.16-9 gives snapshots in time showing the predicted Net Annual Gain/Loss in flow upstream of the Bernalillo County line continuing downstream from the SWRP and I-25 Bridge for both action and No Action Alternatives. The figures show the net effect of the No Action Alternative on the Rio Grande for selected years from 2006 to 2060.

Depletion effects occur through the Albuquerque reach of the river as shown in Table 3.16-1. This depletion, as a result of continued pumping, ranges from 54 to 84 cfs from 2006 to 2060 at the Albuquerque gage. This is a 5.9 percent average annual reduction for the 2006 to 2060 period at the Albuquerque gage.

Figure 3.16-10 and 3.16-11 show the drawdown in the Albuquerque Basin under the No Action Alternative, Pre-Development to 2040 and 2060 indicating that with continued pumping, ground water levels would continue to decline to 250 in 2040 and up to 300 feet in 2060 in the northeast or the critical management area (CMA) boundary (NMOSE, 2000).

TABLE 3.16-1
COMPARISON OF EFFECTS OF DWP AND NO ACTION ALTERNATIVES RIO GRANDE FLOWS IN THE ALBUQUERQUE REACH, 2006-2060

Location								
Year	Bernalillo County Line		Central		Rio Bravo		I-25 Bridge (Isleta)	
	No Action	DWP	No Action	DWP	No Action	DWP	No Action	DWP
	Incremental Differences in Flow in cfs							
2006	4	98	-47	-68	-71	-88	-18	-32
2012	3	63	-56	-77	-81	-93	-25	-29
2020	4	69	-61	-94	-88	-106	-24	-26
2030	4	69	-68	-99	-98	-114	-25	-24
2040	4	59	-78	-89	-112	-108	-27	-6
2050	4	69	-85	-109	-122	-128	-32	-17
2060	13	69	-90	-119	-133	-141	-33	-17

The Middle Rio Grande Administrative Area (MRGAA) Guidelines require that the City well pumpage cannot cause the CMA to exceed a total drawdown of 250 feet as measured from pre-development condition to the year 2040. Currently, the drawdown in the CMA on the east side of the City is less than 250 feet. The MRGAA Guidelines also require that the rates of decline cannot exceed 2.75 feet per year for areas not in the CMA (RG 960) (CH2M Hill, 2001e).

Effects from Action Alternatives

Despite differences in the locations of their diversion points, or in their type of water collection structure, the three action alternatives would have similar effects on the hydrology of the Middle Rio Grande. The operation criteria of these alternatives also are similar, regardless of their point or method of diversion. Therefore, most of the effects of these three alternatives are discussed together.

The greatest difference among the three action alternatives is the length of river that would experience depletions in native river flow. Angostura Diversion, with a diversion at Angostura, would reduce flows in about 32 miles of the river. Paseo del Norte Diversion and Subsurface Diversion, which would divert water near the Paseo del Norte Bridge, would reduce native flows in approximately 15 miles of Rio Grande river channel.

Between Abiquiu Dam and proposed diversion locations, the action alternatives would result in an additional flow in the Rio Grande of approximately 42,200 ac-ft/yr (60 cfs), compared to the No Action Alternative. Ground water pumping effects to the river would be reduced and return flows from the SWRP and use of the City's native Rio Grande water rights would ensure that there are minimal hydrologic effects below the SWRP.

Rio Grande flows resulting from the operation of Angostura Diversion would be as follows and are graphically represented in Figure 3.16-12.

In a normal year, action Angostura Diversion would be capable of diverting 94,000 ac-ft/yr (or 130 cfs on a continuous basis) from the river. Under this hydrologic condition, 47,000 ac-ft/yr (65 cfs) would be returned to the river at the SWRP just downstream from the Rio Bravo Bridge. This level of diversion would occur only when the total flow at the diversion point exceeded 560 cfs, including the City's 65 cfs of SJC water, 65 cfs of native water, and 250 cfs of MRGCD irrigation water being diverted. This would assure a native by-pass flow of at least 180 cfs.

- When river flow at the diversion point is between 560 cfs and 495 cfs (with 250 cfs still going to MRGCD), the City would continue to release and divert its full 65 cfs of City SJC water. It would curtail diversion of native Rio Grande flows so that at least 180 cfs of the by-pass flow remained in the channel immediately downstream from the diversion point.

- When river flow at the diversion point reaches 430 cfs, the City would stop releasing the City's SJC water from Abiquiu Reservoir, and would shut down the diversion system and water treatment plant, and the entire City water demand would be met by ground water from City wells.

Rio Grande flows resulting from the operation of the Paseo del Norte Diversion and Subsurface Diversion (diversion near Paseo del Norte) would be as follows and as graphically represented in Figure 3.16-13.

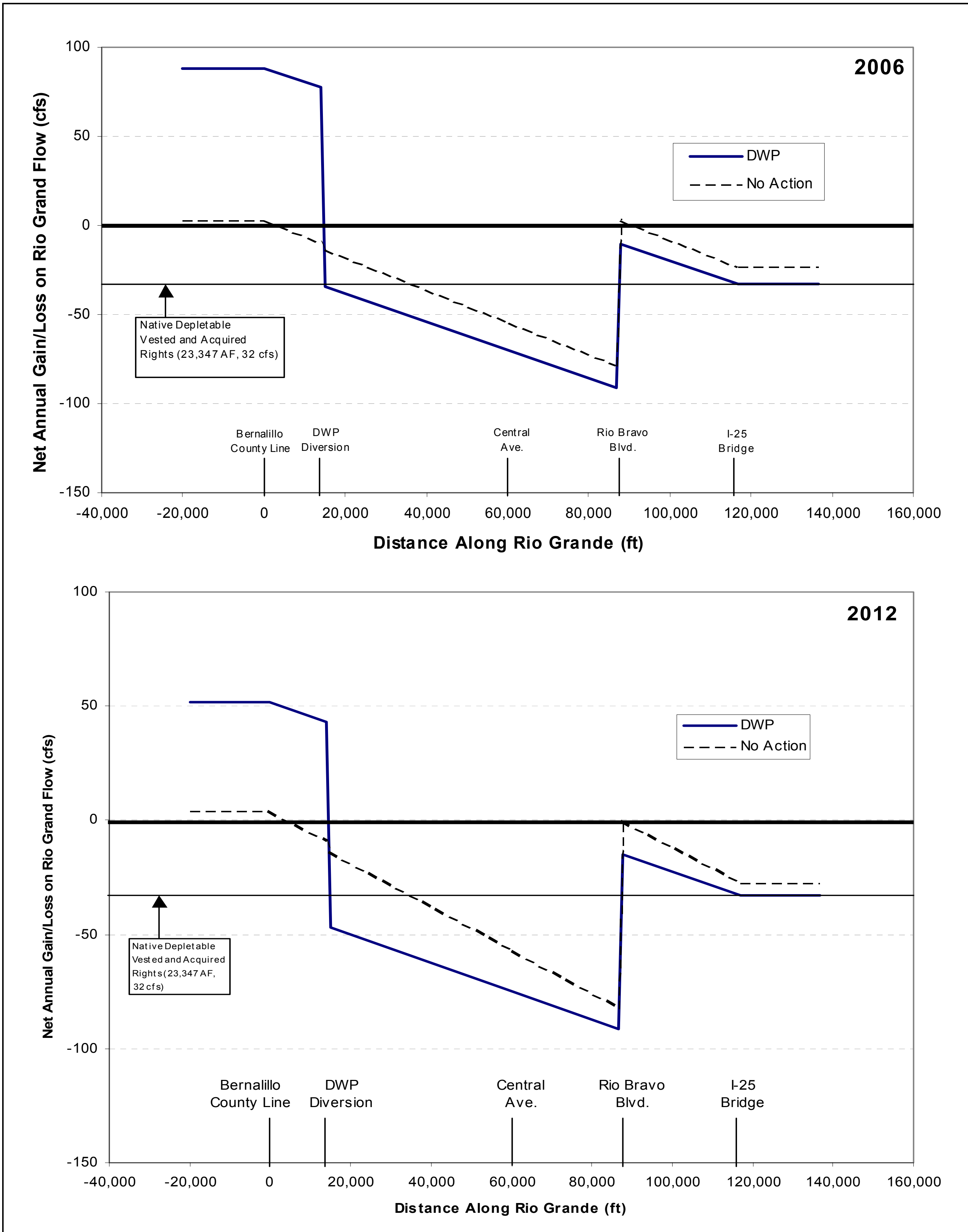

Figure 3.16-7
Comparison of Simulated DWP and No Action Effects on Rio Grande Flows, 2006 and 2012

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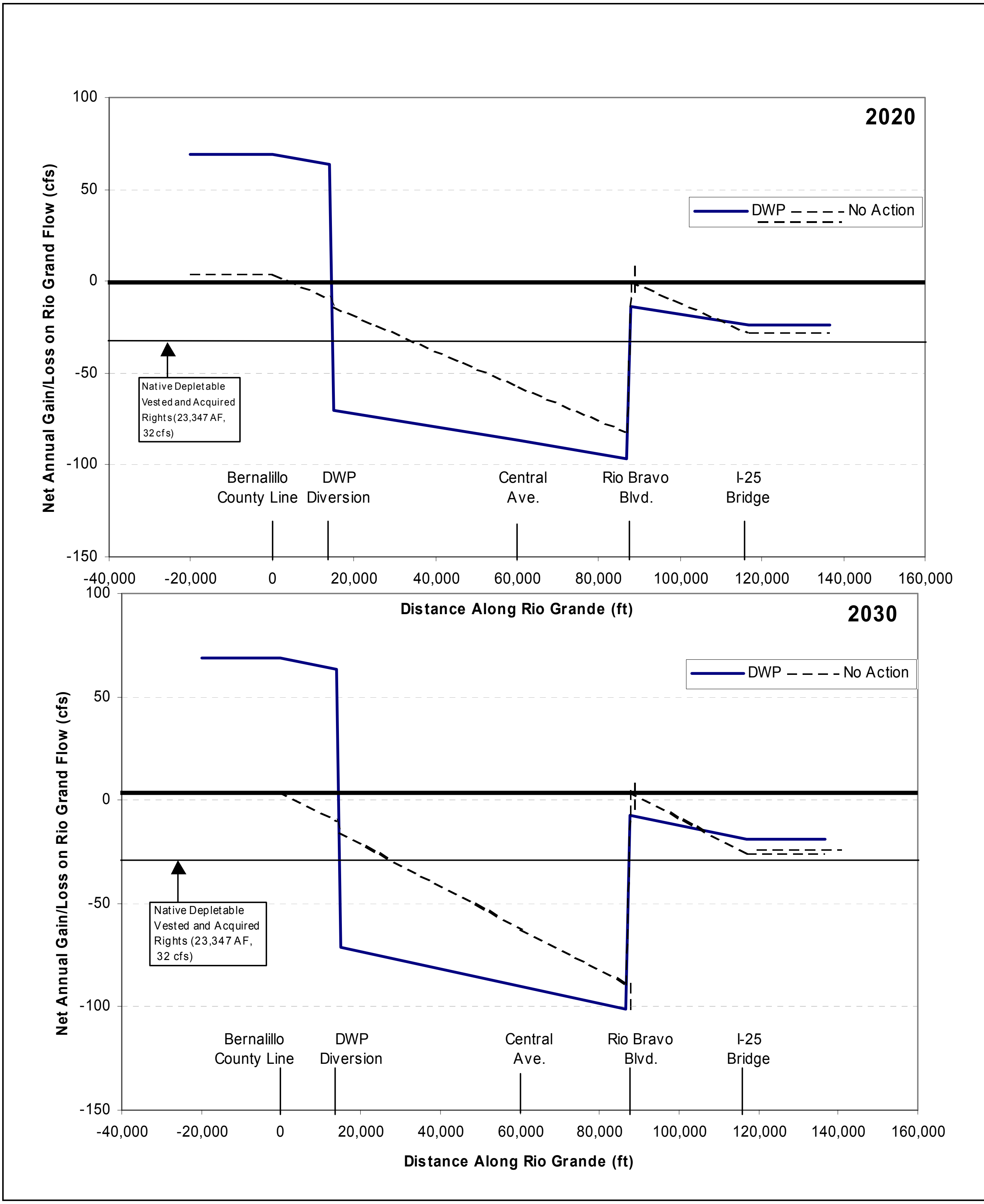

Figure 3.16-8
Comparison of Simulated DWP and No Action Effects on Rio Grande Flows, 2020 and 2030

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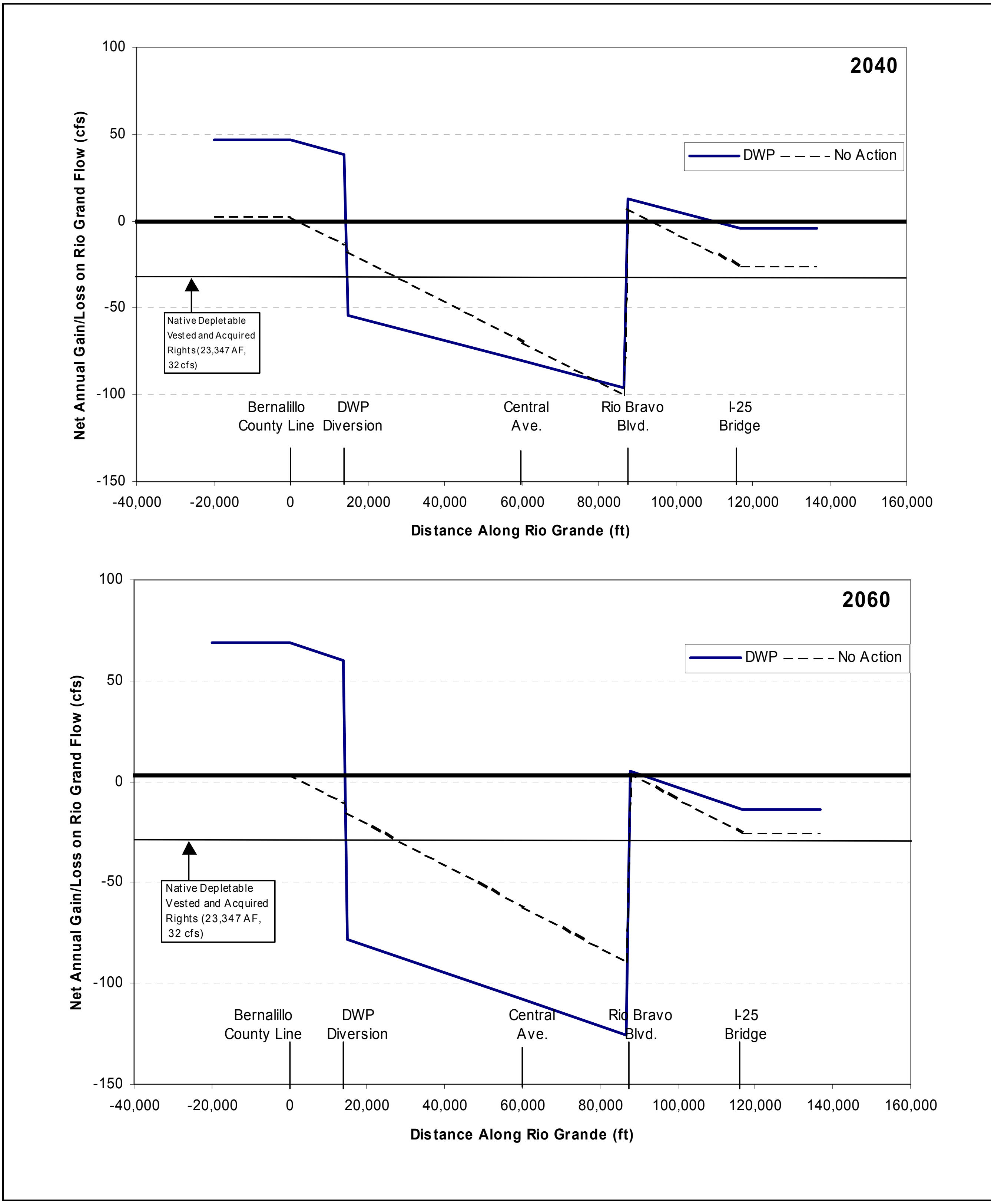

Figure 3.16-9
Comparison of Simulated DWP and No Action Effects on Rio Grande Flows, 2040 and 2060

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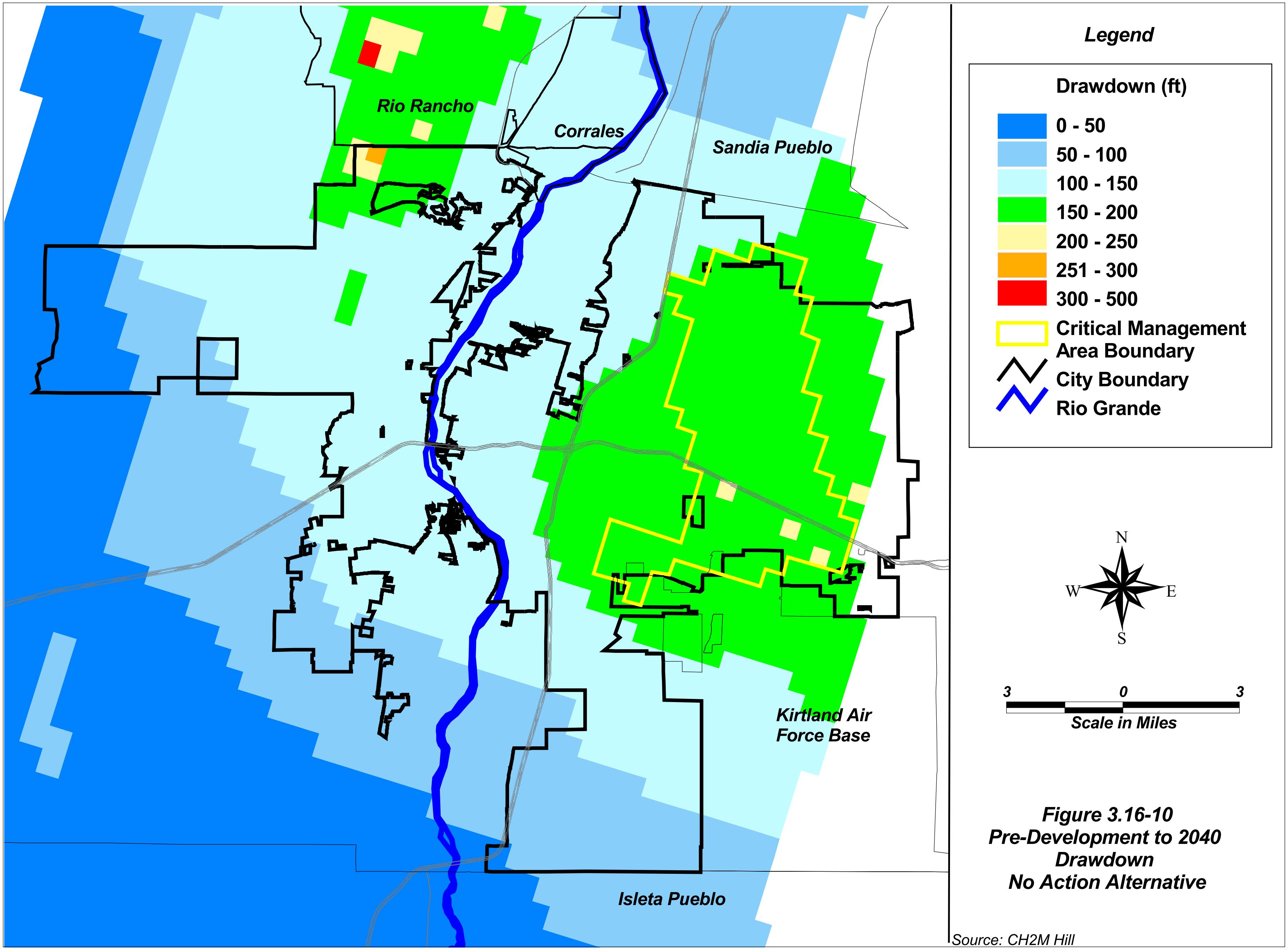

Figure 3.16-10
Pre-Development to 2040 Drawdown
No Action Alternative

Source: CH2M Hill

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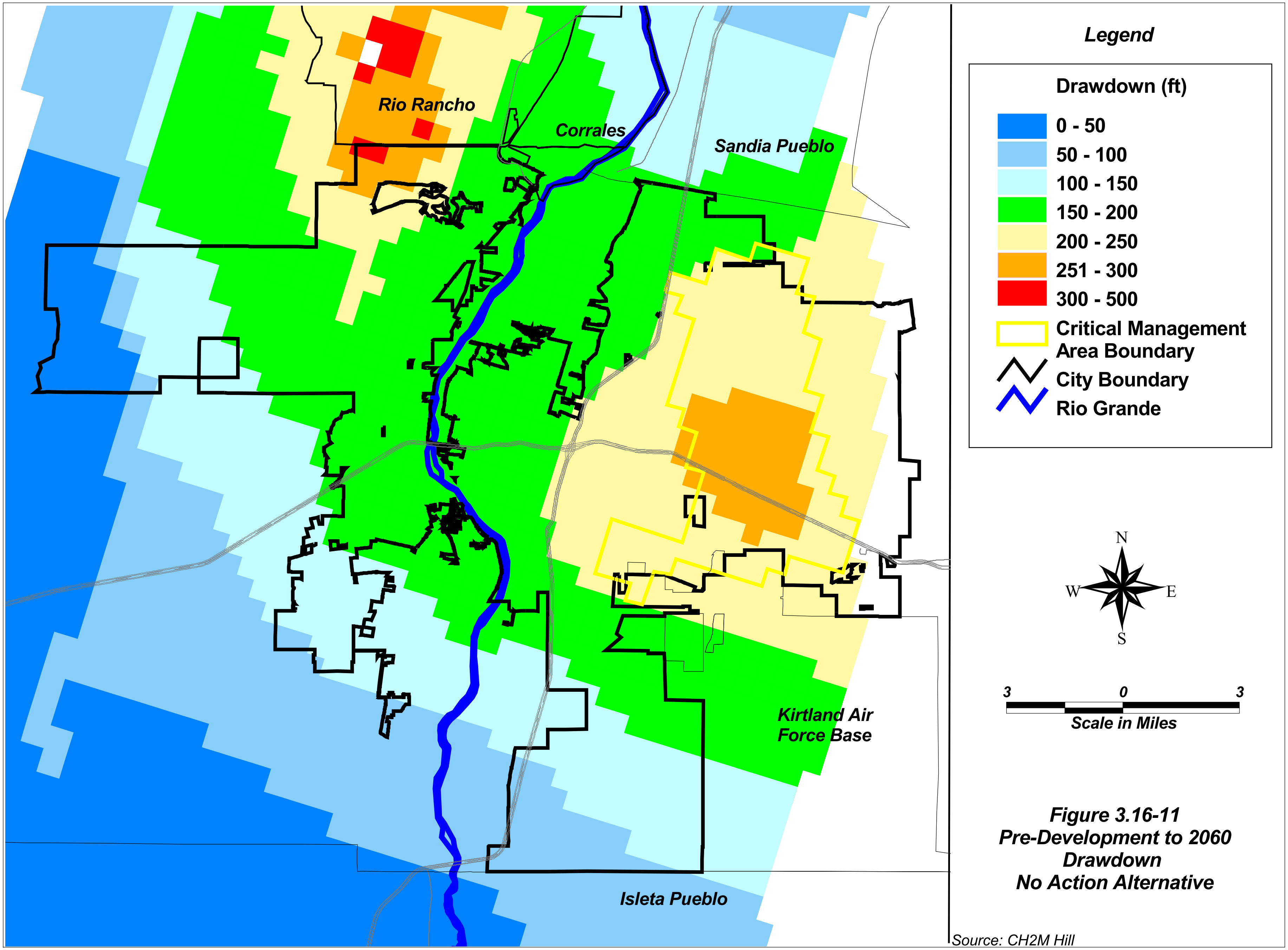

Figure 3.16-11
Pre-Development to 2060 Drawdown
No Action Alternative

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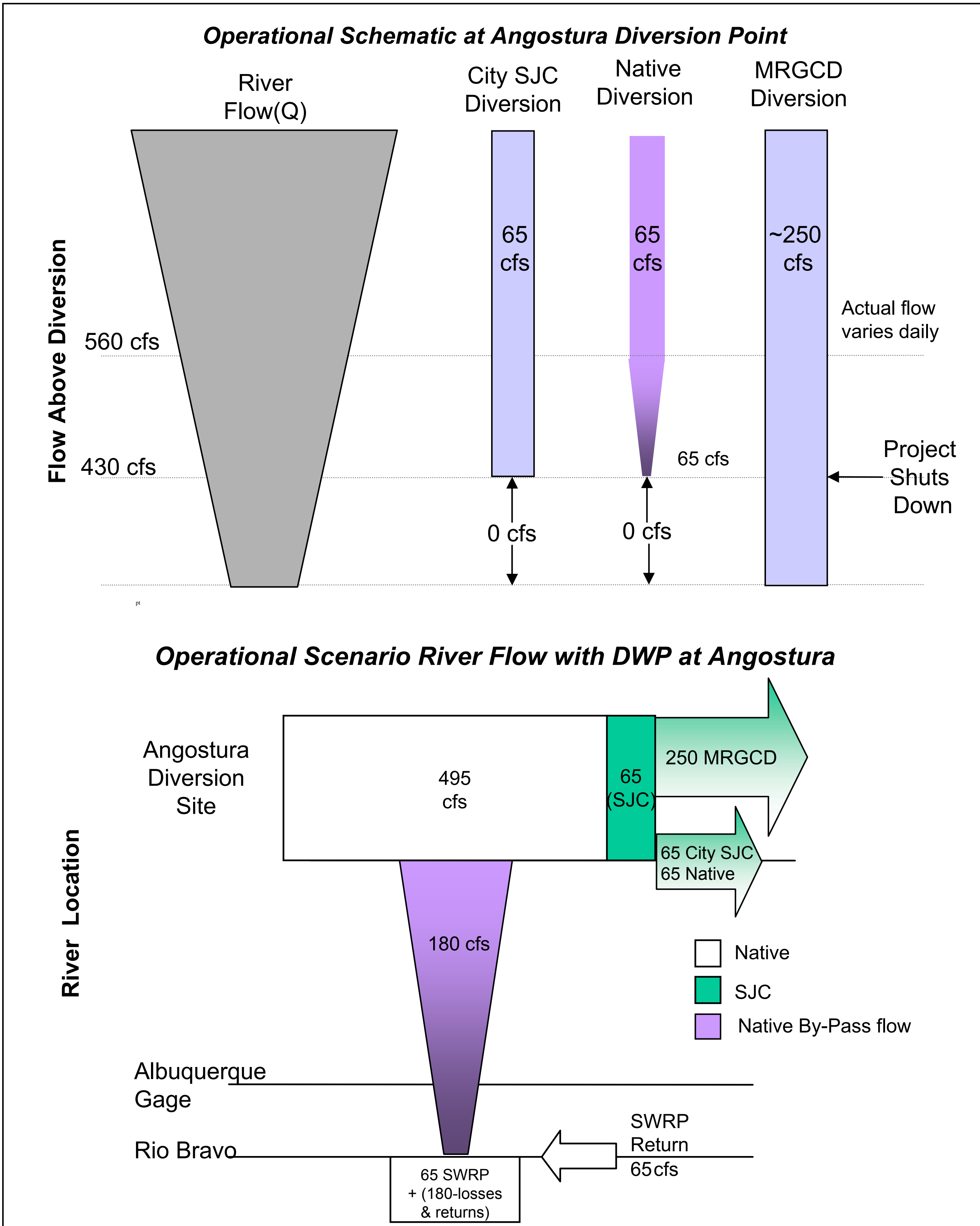

Figure 3.16-12
Summary of Release/Diversion Scenario for Angostura Diversion and Relation to River Flows Assuming Diversion at Angostura Diversion Dam

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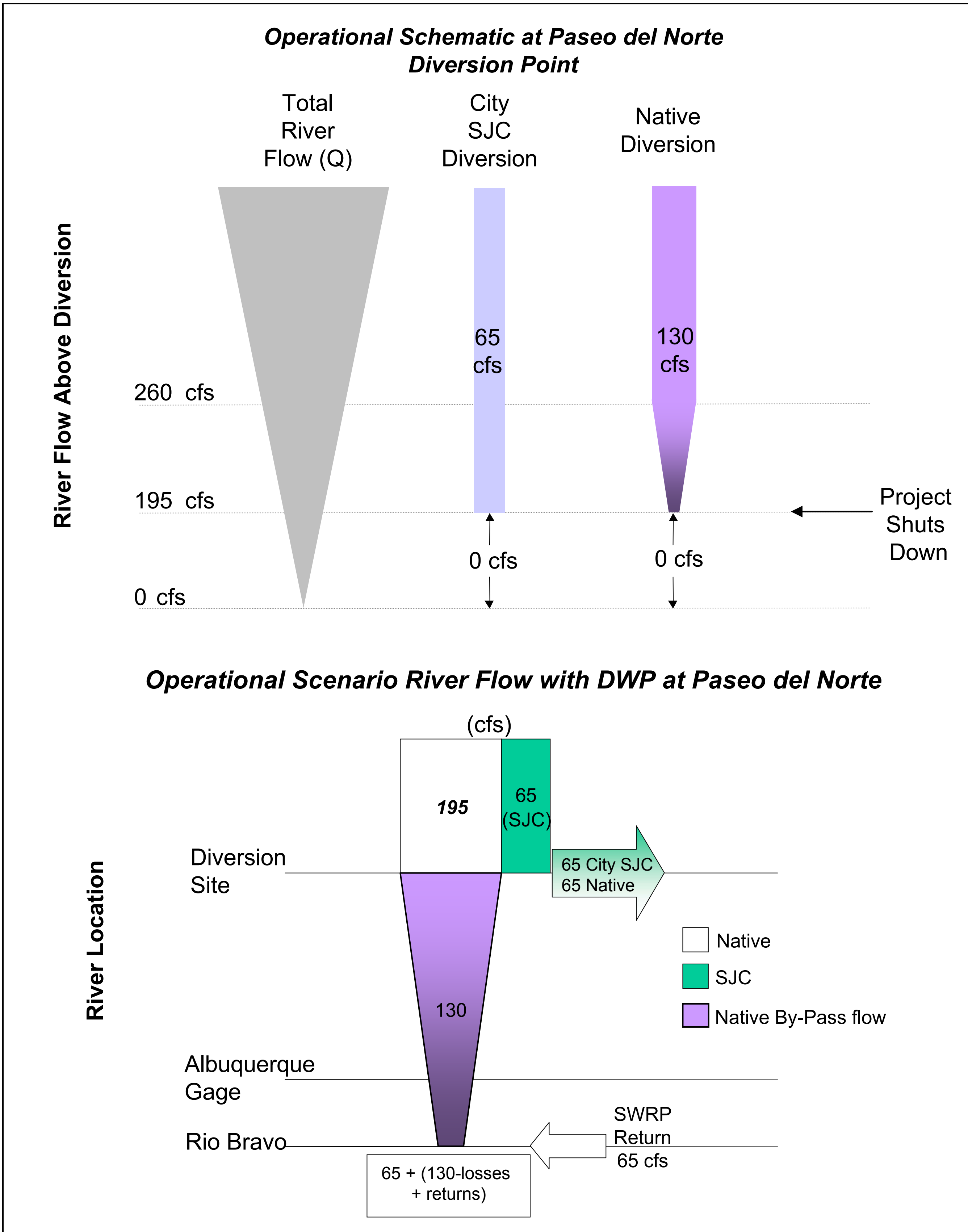

Figure 3.16-13
Summary of Release/Diversion Scenario for Paseo del Norte and Subsurface Diversions and Relation to River Flows Assuming Diversion at Albuquerque Near Paseo del Norte

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In a normal year, Paseo del Norte Diversion and Subsurface Diversion would be capable of diverting 94,000 ac-ft/yr (or 130 cfs on a continuous basis) from the river. Under these conditions, 47,000 ac-ft/yr (65 cfs) of native water would be returned to the river at the SWRP just downstream from the Rio Bravo Bridge. This level of diversion would occur only when the total flow at the diversion point exceeded 260 cfs, including the City's 65 cfs of the City's SJC water and a native flow of at least 195 cfs.

- When river flows at the diversion point are between 260 cfs and 195 cfs, the City would continue to divert its full 65 cfs of the City's SJC water. It would curtail its diversion of native Rio Grande flows so that at least 130 cfs of by-pass flow remained in the channel immediately downstream from the diversion point.

- When river flows at the diversion point reach 195 cfs, the City would stop releasing the City's SJC water from Abiquiu Reservoir, and would shut down the diversion system and water treatment plant. The remaining flow of the Rio Grande would be passed unimpeded, and the entire City water demand would be met by ground water from City wells.

Direct effects on hydrology from any of the action alternatives would include a near constant increase of about 60-70 cfs, consisting of the City's SJC water, between Abiquiu Reservoir and the diversion point at any time the diversion system was operating. At the diversion point under normal flow conditions, 65 cfs of the City's SJC water, plus 65 cfs of native Rio Grande flow would be removed from the river. Relative to the historic mean flow of 1,410 cfs at Albuquerque, there would be a depletion of 70 cfs to 108 cfs. This depletion represents a 7.4 percent average annual reduction in the mean annual flow for a the 2006 to 2060 period at the Albuquerque gage. The No Action Alternative would cause a depletion for the 2006 to 2060 period of about 5.9 percent of the historic mean flow.

Figure 3.16-14 provides a comparison of the effects of the Paseo del Norte Diversion and Subsurface Diversion and No Action Alternatives on flows of the Rio Grande in the Middle Project Subarea. The simulated reach extends from a few miles upstream of the Bernalillo County line (near the confluence of the river with the AMAFCA North Diversion Channel to just above the Isleta Diversion Dam [CH2M Hill, 2003]).

Simulated average flow conditions in the year 2030 are shown in which the project diversion of 130 cfs (65 cfs of native water and 65 cfs of SJC water) would occur at the diversion points of Paseo del Norte Diversion and Subsurface Diversion north of Paseo del Norte Bridge, and with the depletion restored by the return flow at the SWRP near Rio Bravo. The depletion caused by the No Action Alternative is quite similar, with a somewhat lower flow resulting at the SWRP (CH2M Hill, 2003).

Also shown are river flows in 2040, a severe dry year for runoff in the Rio Grande. Unlike the previous figure for 2030, this figure shows depletion from a 'zero baseline' in order to better show the differences of effects due to Paseo del Norte Diversion and Subsurface Diversion versus the No Action Alternative, and to depict the depletions that would occur during a month of curtailment in diversion under Paseo del Norte Diversion or Subsurface Diversion. As was the case for the 2030 conditions, the average depletions in flows are similar across the Middle Project Subarea for both No Action and action alternatives. Again, the No Action Alternative results in a lower flow (about 20 cfs lower) in the river below the SWRP.

There is also an improvement (more than 50 cfs) in flows during a curtailment month under Paseo del Norte Diversion and Subsurface Diversion (CH2M Hill, 2003).

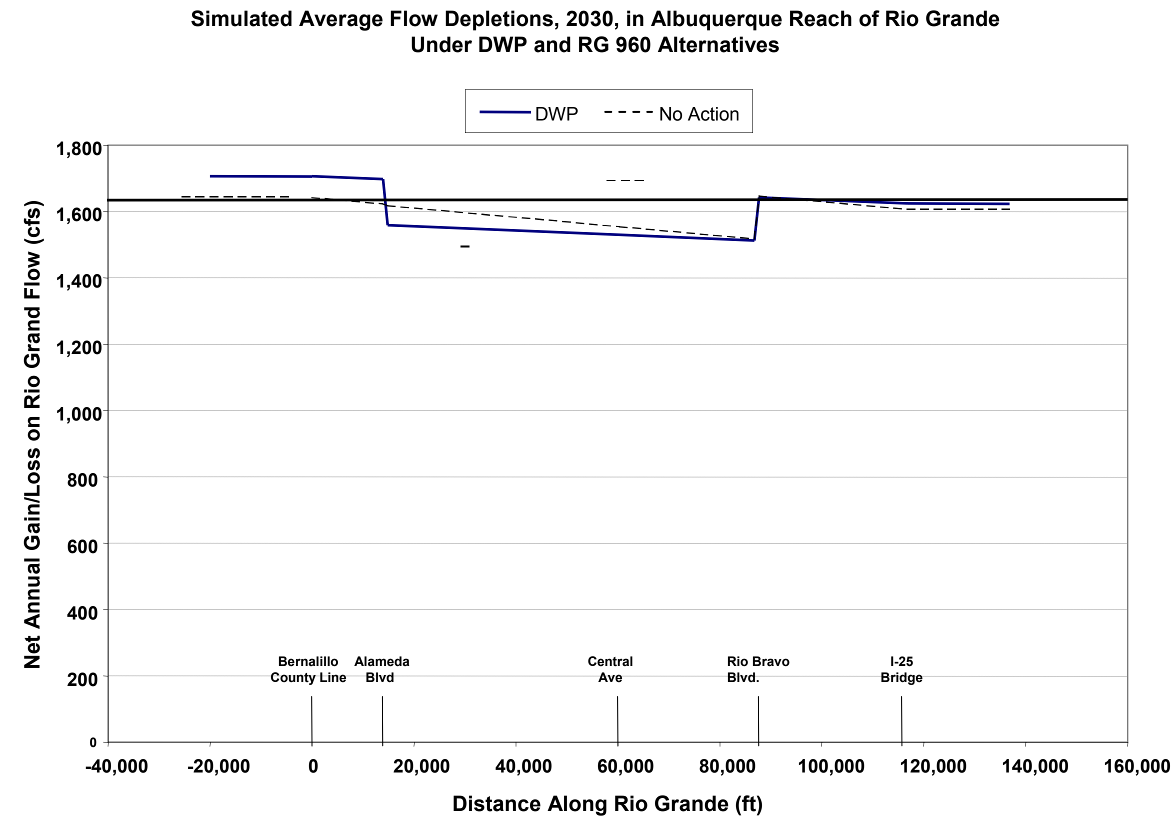
There is also an important difference between the action and No Action Alternatives with respect to potential depletion of the Rio Grande at the Albuquerque gage. Based on model simulations, with the DWP there is a reduction in the number of simulated months of no flow at the Albuquerque gage from 16 to 4 months over the 2006-60 period. Effects of the action alternatives on annual quantities in the Rio Grande just downstream from the SWRP outfall are shown in Figure 3.16-15.

Relative to the DWP, the No Action Alternative would cause additional drawdown in the shallow ground water table beneath the bosque areas of the Albuquerque reach of the river. Just how much is unclear, because of the large cell size used in the OSE ground water model. The OSE model suggests that up to about 580 additional acres could experience up to 3 feet of water level declines as compared to the DWP alternative.

Pumping of ground water would be substantially reduced to approximately 73,000 ac-ft/yr with implementation of the DWP by the year 2060. The spikes in pumping shown in Figure 3.16-15 would occur when combined flows in the Rio Grande of native water and the City's SJC water dropped below the operational criteria and project diversions were curtailed. Private water wells cannot be adversely impacted in order to receive an Office of State Engineer permit for diversion. The cumulative total pumping through 2060 for the No Action Alternative is 2.3 million ac-ft. Ground water resources of the basin will be protected, and slightly improved, over time, with the project. The established water rights of others can not be impaired under state law. The City must prove this in order to acquire a diversion permit. There is some impact to the shallow water within the bosque associated with the implementation of the Subsurface Alternative (Section 3.16, Figures 3.16-20 and 3.16-21); however, there are no shallow residential wells in the bosque. The effects to vegetation, and the appropriate mitigation measures to the vegetation are considered in Section 3.21 (Riparian Areas).

When comparing Figure 3.16-6, 2000 Drawdown in Albuquerque Basin Aquifer, Pre-Development to Figure 3.16-16 Pre-Development to 2040 Drawdown – DWP drawdown contours remain relatively the same. This implies that additional drawdowns would be negligible until the year 2040 with the DWP. Areas potentially experiencing subsidence by 2060 were also identified.

Figure 3.16-17 indicates the potential ground water drawdown within the Albuquerque Basin at the year 2060 with the DWP alternative. The ground water levels are less affected with the project in place than under the No Action Alternative comparing Figure 3.16-11 to 3.16-17.



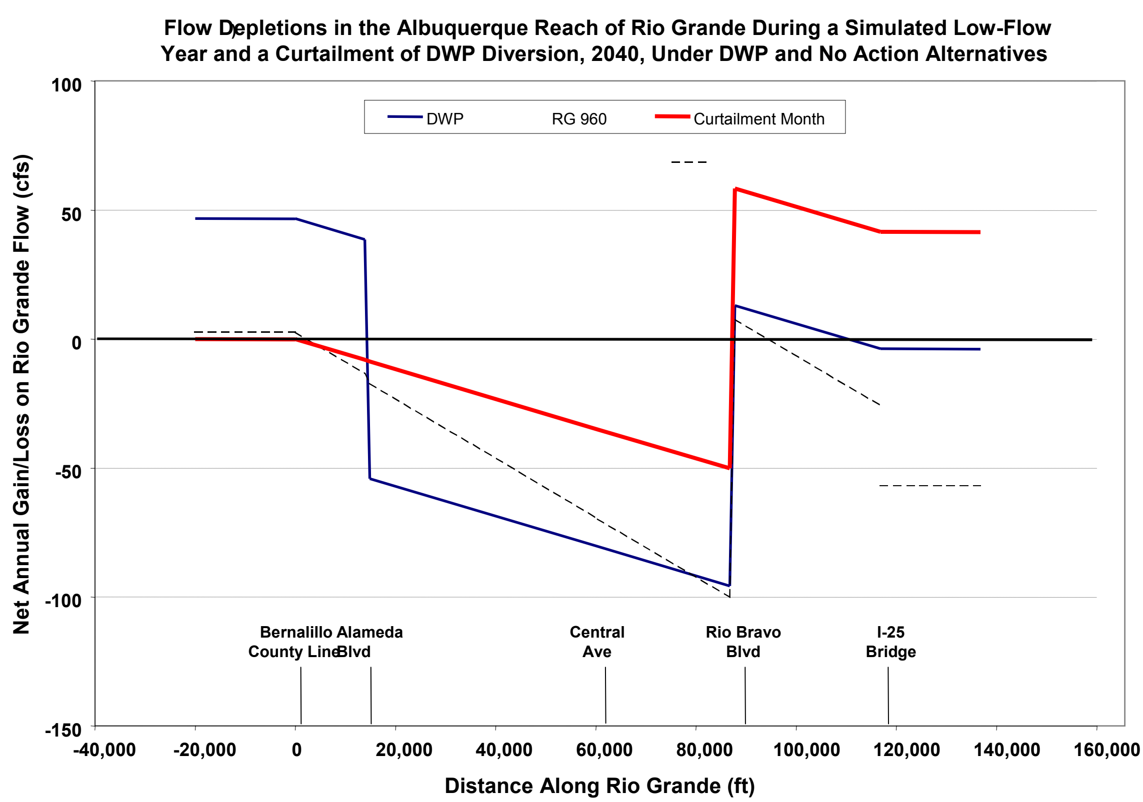


Figure 3.16-14
Comparison of Effects of the No Action and Paseo del Norte and Subsurface Diversions on the Rio Grande in the Middle Project Subarea

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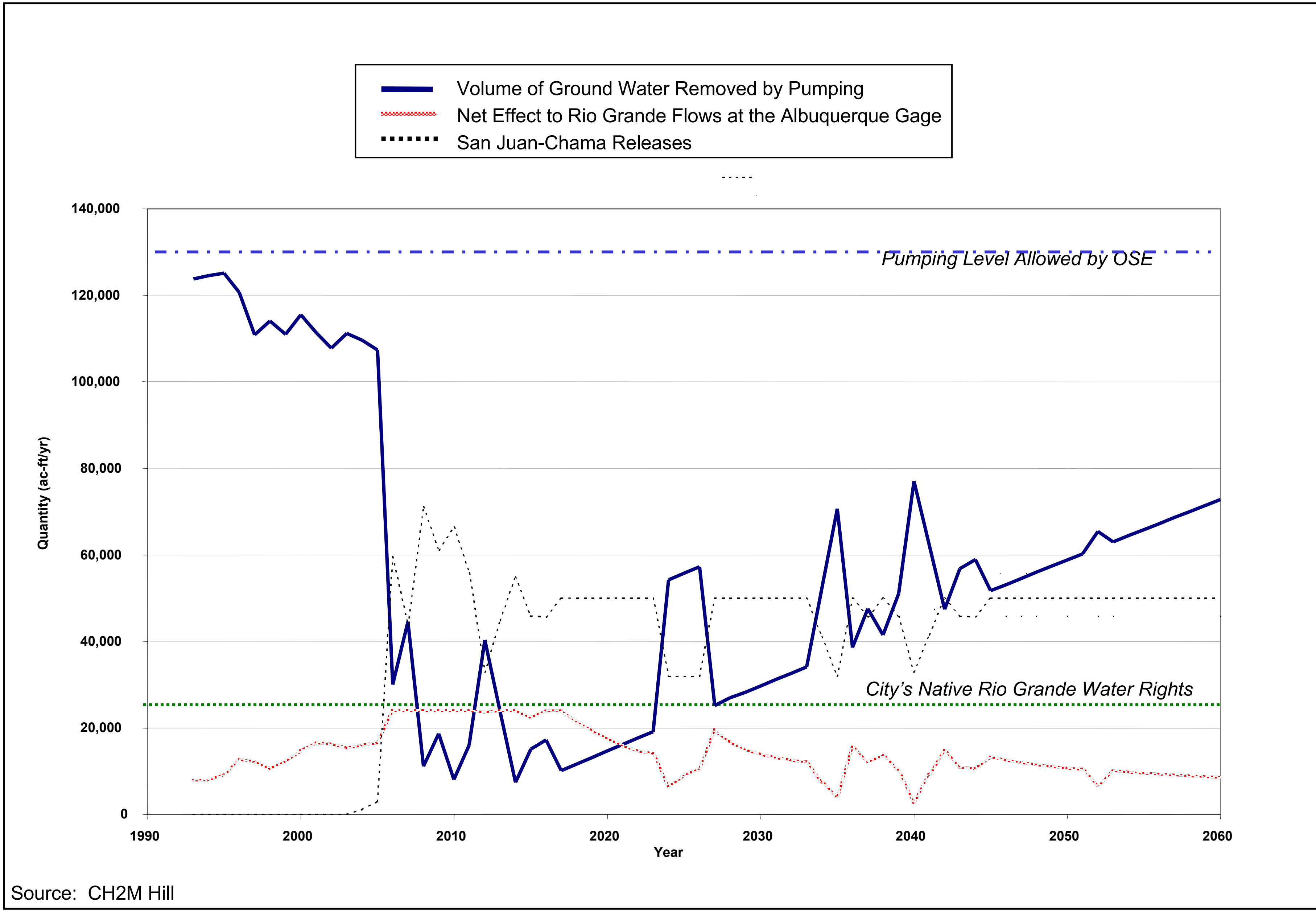

Figure 3.16-15
Predicted Effect of the Action Alternatives on the Rio Grande Downstream from the SWRP

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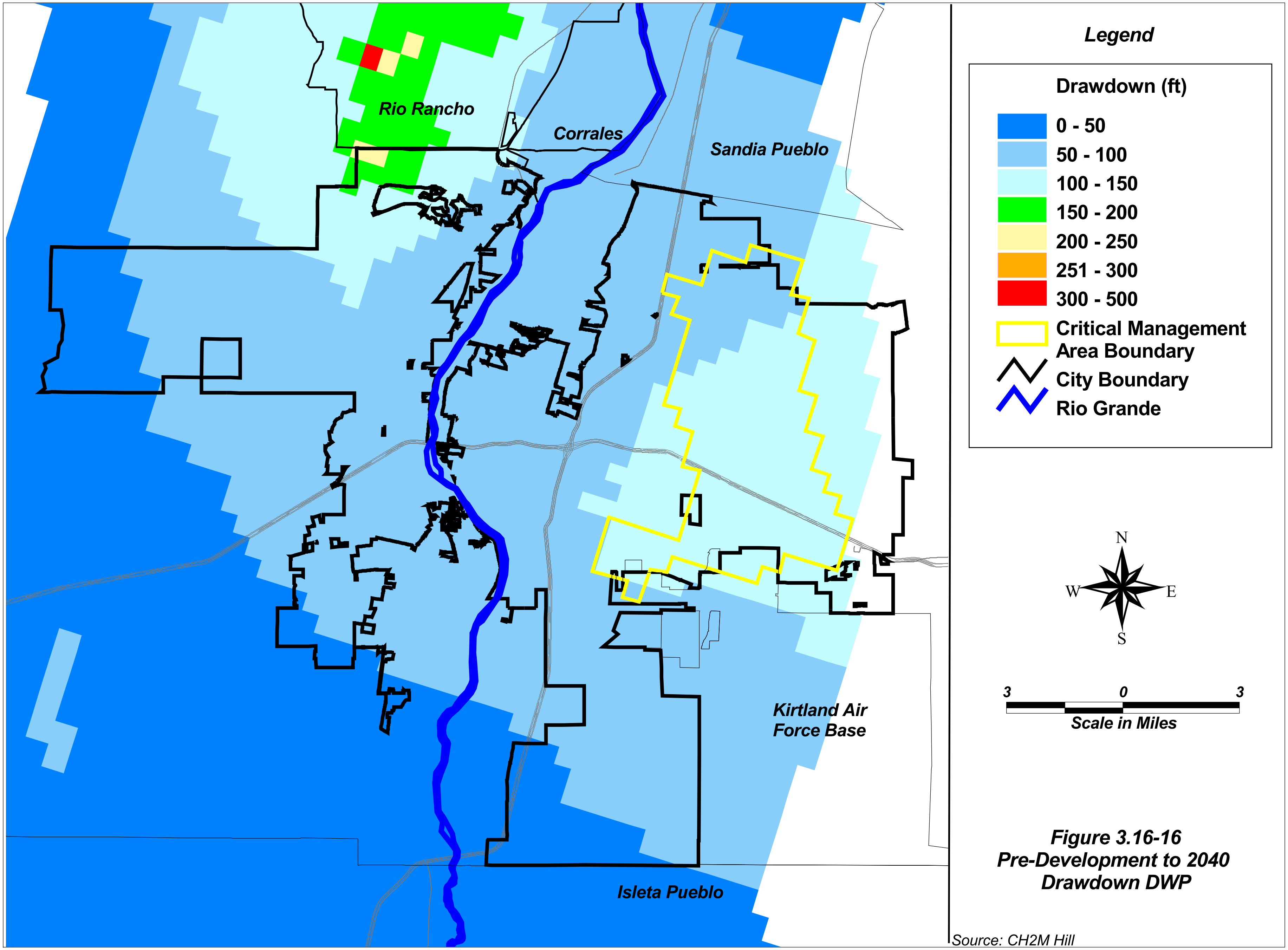

Figure 3.16-16
Pre-Development to 2040
Drawdown DWP

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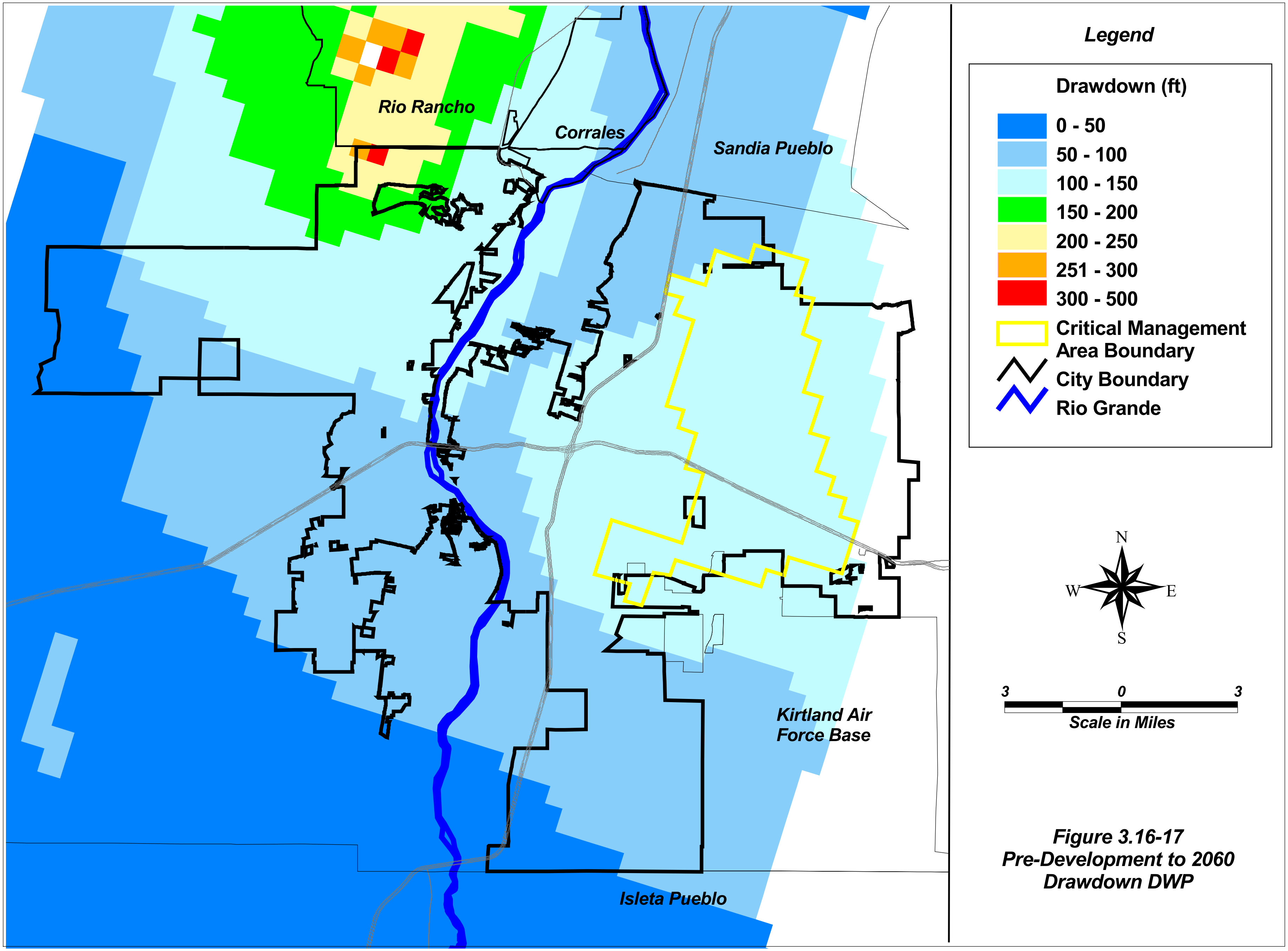

Figure 3.16-17
Pre-Development to 2060
Drawdown DWP

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Figure 3.16-18 illustrates monthly flows in the Rio Grande at the Albuquerque gage for the action alternatives and the No Action Alternative, based on hydrologic projections for the years 2006 through 2060.

As shown in the figure, the patterns of flow would be virtually identical. On the average over the 54-year period, the action alternatives would produce a flow in the Rio Grande at the Albuquerque gage that was 1.5 percent lower than would occur with the No Action Alternative. Generally, this would represent a flow that was 20 to 30 cfs lower than that occurring under the No Action Alternative. Figure 3.16-19 shows how the proposed aquifer recharge program will be operated. The WTP will operate at an essentially constant rate of 84 mgd or 130 cfs. Peak summer demands are considerably higher than the WTP capacity and would be met with City ground water well pumpage. During low demand periods, typically October through March, the WTP would be producing sufficient water to allow the ground water wells to be turned off. During this period, recharge to the aquifer would be affected by treated water being injected into the City ground water aquifer. The water available for recharge would be highest (to 15,000 ac-ft/yr) during early project years (2006-2010), and gradually decline to zero in later years due to increased demand because of increased population.

CH2M Hill (2003) conducted a study to estimate effects of the DWP on wetted channel characteristics (hydraulic geometry) of the Albuquerque reach. Consistent with the flow data presented in Figures 3.16-4 and 3.16-18, they found that in the long term, the action alternatives and the No Action Alternative would result in few differences in the river's hydraulic geometry. The study evaluated the historical hydraulic geometry from the period 1971 through 1998 to the hydraulic geometry that would occur in the future, both with and without implementation of the DWP. The intent was to provide a basis for assessing effects on the Rio Grande silvery minnow and vegetation in the riparian corridor. This analysis considered:

- Wide and narrow sections of the river;
- Three sets of conditions, including mean annual flow, mean monthly low flow, and severe monthly low flow; and
- Locations above the diversion point, where the Rio Grande would be conveying an additional 65 cfs (on average, counting curtailment periods) of the City's SJC water, and below the diversion point, where native flows in the Rio Grande would be reduced under either the action or No Action Alternatives.

Details of the analysis process and the results are provided in Appendix L. The analysis found that maximum changes in water depths in the Albuquerque reach caused by the proposed action would be quite minor, varying from the historical conditions by no more than 0.1 feet even during a mean low monthly flow condition. During a severe low flow (170 cfs at the Albuquerque gage), water levels could be reduced by up to 0.3 feet in the narrowest sections of the river under a constant diversion of 130 cfs. In wider parts of the river, there would be no difference in water level depths under such severe low flow conditions. No Action effects on hydraulic geometry would be quite similar to those of the action alternatives.

Effects within the Upper Project Subarea

As described in Section 3.16.2, operations of the Upper Project Subarea were modeled to determine, with either the action alternatives or the No Action Alternative:

- If winter fisheries releases in the Rio Chama below El Vado Reservoir and Abiquiu Reservoir could be maintained; and
- What the effects would be on surface water elevation in reservoir levels, including the historical, minimum, average, and maximum reservoir storage and pool elevations. This analysis was not definitive because limitations in the Rio Chama Riverware® model did not allow for full simulation of the 2006-60. Rather, only a few selected years could be modeled.

Model runs were made assuming that the City's SJC water deliveries from Heron Reservoir were made within a particular calendar year (without waivers) or under a scenario that included waivers from the Bureau of Reclamation. The with-waivers condition would allow a delay of releases through April of the following calendar year.

As stated previously, the model runs included the capability to maintain historic acequia diversion of native flow, summertime recreational rafting releases, and winter fishery releases using primarily City SJC water. The effects on storage volumes and water levels in El Vado, Abiquiu, and Cochiti Reservoirs were also examined relative to No Action. Storage and water level in Heron would not be affected by the DWP since the City would continue to take full delivery of its SJC water.

With Waivers

Winter Fisheries Releases - Table 3.16-2 shows that minimum releases below both El Vado and Abiquiu could be maintained for every scenario, although the minimum flow below El Vado would change based on the available water supply. For example, the normal year minimum flow was 185 cfs, but the minimum flow was assumed to be 100 cfs in dry years, such as 1977 and the simulated 3-year drought period. This condition was based on the minimum flow of 100 cfs that was maintained below El Vado in 2001.

Rafting Releases - Also from Table 3.16-2 it can be seen that rafting releases could be maintained for every scenario except for the No Action Alternative during the dry year (1977) and the simulated 3-year drought period. During low-water years, rafting releases could not always be maintained with the No Action Alternative. (The City may not participate in future rafting-release operations unless compensation can be obtained for increased evaporation losses caused by surplus water delivery to Abiquiu during hot summer periods).

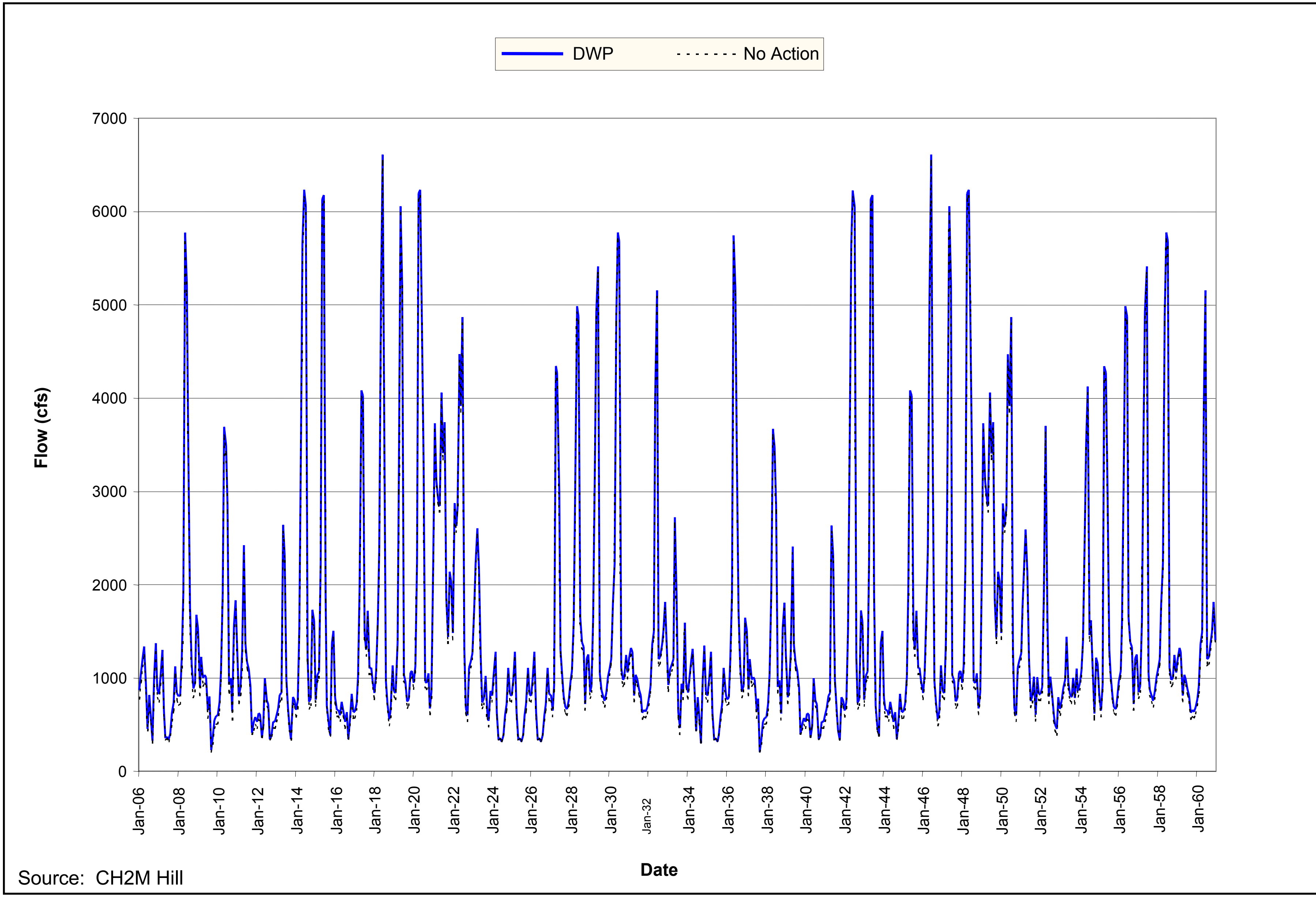

Figure 3.16-18
Hydrograph of Predicted Project Effects at the Albuquerque Gage, 2006 through 2060

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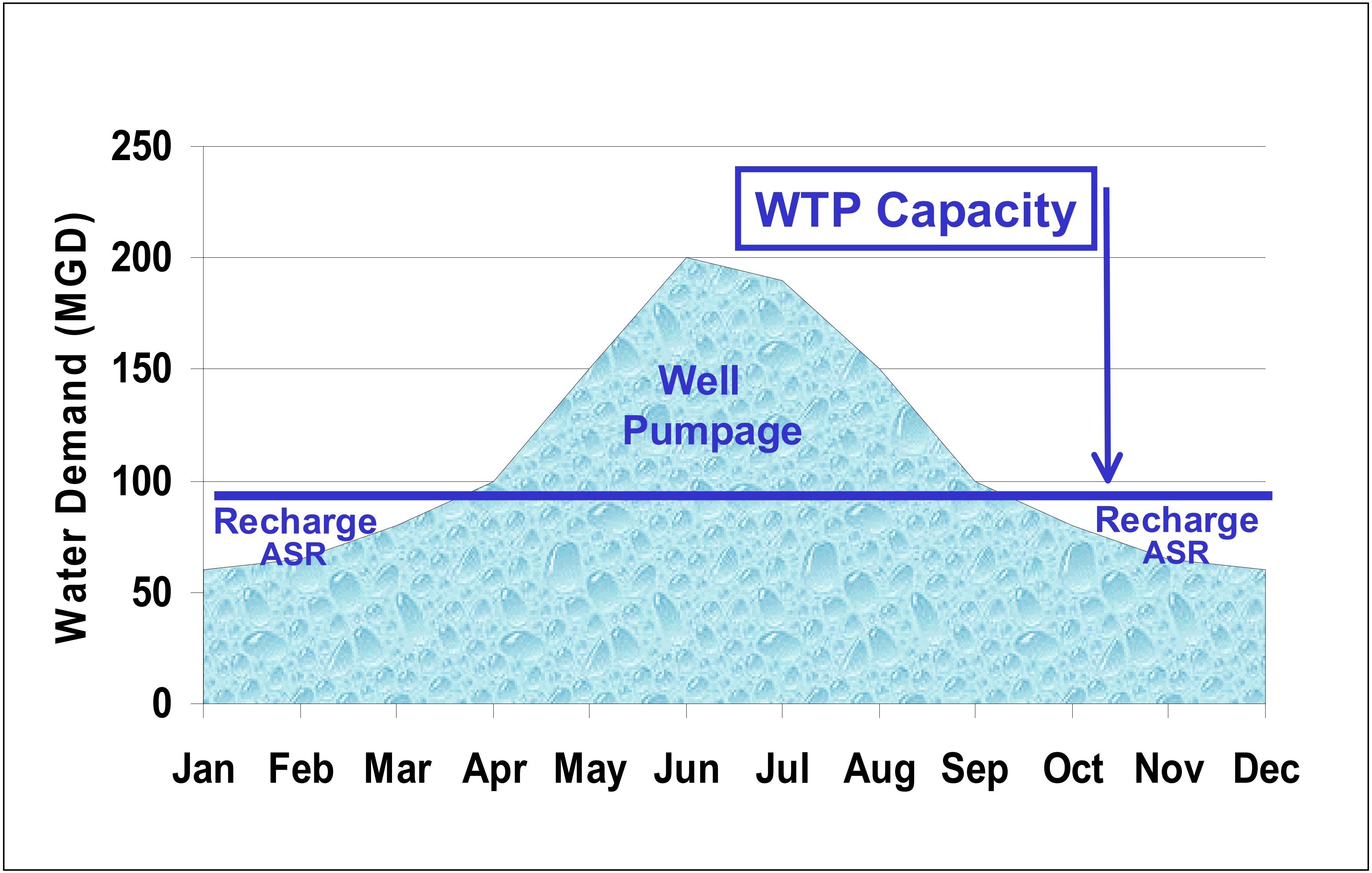

Figure 3.16-19
Summary of Release/Diversion Scenario for DWP and Relation to River Flows Assuming Diversion at Albuquerque

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**TABLE 3.16-2
RAFTING WEEKENDS AND MINIMUM FISH RELEASES
WITH WAIVERS (CFS)**

Conditions	Max Rafting Weekends	Modeled Rafting Weekends	El Vado Min. Fish Release	Modeled El Vado Min. Fish Release	Abiquiu Min. Fish Release	Modeled Abiquiu Min. Fish Release
Dry Year (1977) No Action High Initial Conditions	7	7	100	100	70	70
Dry Year (1977) DWP High Initial Conditions	7	7	100	100	70	70
Dry Year (1977) No Action Low Initial Conditions	7	6	100	100	70	70
Dry Year (1977) DWP Low Initial Conditions	7	7	100	100	70	70
Normal Year (1988) No Action High Initial Conditions	7	7	185	185	70	70
Normal Year (1988) DWP High Initial Conditions	7	7	185	185	70	70
Normal Year (1988) No Action Low Initial Conditions	7	7	185	185	70	70
Normal Year (1988) DWP Low Initial Conditions	7	7	185	185	70	70
3-Year Drought No Action High Initial Conditions	21	17	100	100	70	70
3-Year Drought DWP High Initial Conditions	21	21	100	100	70	70
3-Year Drought No Action Low Initial Conditions	21	16	100	100	70	70
3-Year Drought DWP Low Initial Conditions	21	21	100	100	70	70

Comparison to Historical Abiquiu Reservoir Levels- Table 3.16-3 shows the comparison of the model results to the historical record for Abiquiu Reservoir. The results showed that the maximum storage in Abiquiu Reservoir for each scenario was always less than the historical maximum storage in Abiquiu Reservoir. The minimum storage for Abiquiu reservoir fell below the historical minimum storage for both the dry year and drought low initial storage DWP scenarios.

Without Waivers

Winter Fisheries Releases - As shown in Table 3.16-4, the minimum fisheries releases below Abiquiu Reservoir could be maintained for every scenario.

TABLE 3.16-3
COMPARISON OF ABIQUIU STORAGE WITH HISTORICAL RECORDS (WITH WAIVERS)

Condition	Initial Storage (ac-ft)	Minimum Storage (ac-ft)	Maximum Storage (ac-ft)	Average Storage (ac-ft)
Historical (1977-2000 records)	---	16,530	402,260	154,226
Dry Year (1977) No Action High Initial Conditions	170,000	132,910	175,536	158,180
Dry Year (1977) DWP High Initial Conditions	170,000	109,388	170,091	141,915
Dry Year (1977) No Action Low Initial Conditions	50,000	27,918	61,840	45,973
Dry Year (1977) DWP Low Initial Conditions	50,000	9,628	52,149	30,660
Normal Year (1988) No Action High Initial Conditions	170,000	163,590	182,217	175,570
Normal Year (1988) DWP High Initial Conditions	170,000	137,542	174,257	153,689
Normal Year (1988) No Action Low Initial Conditions	50,000	49,937	69,020	60,483
Normal Year (1988) DWP Low Initial Conditions	50,000	32,166	61,487	46,029
3-Year Drought No Action High Initial Conditions	170,000	130,725	173,204	155,701
3-Year Drought DWP High Initial Conditions	170,000	117,822	178,681	153,325
3-Year Drought No Action Low Initial Conditions	50,000	33,729	59,332	49,324
3-Year Drought DWP Low Initial Conditions	50,000	12,761	71,572	44,359

**TABLE 3.16-4
RAFTING WEEKENDS AND MINIMUM FISH RELEASES (CFS)
WITHOUT WAIVERS**

Condition	Max Rafting Weekends	Modeled Rafting Weekends	El Vado Min. Fish Release	Modeled El Vado Min. Fish Release	Abiquiu Min. Fish Release	Modeled Abiquiu Min. Fish Release
Dry Year (1977) No Action – High Initial Conditions	7	7	100	100	70	70
Dry Year (1977) DWP – High Initial Conditions	7	7	100	100	70	70
Dry Year (1977) No Action – Low Initial Conditions	7	5	100	100	70	70
Dry Year (1977) DWP – Low Initial Conditions	7	7	100	100	70	70
Normal Year (1988) No Action – High Initial Conditions	7	7	185	185	70	70
Normal Year (1988) DWP – High Initial Conditions	7	7	185	185	70	70
Normal Year (1988) No Action – Low Initial Conditions	7	7	185	185	70	70
Normal Year (1988) DWP – Low Initial Conditions	7	7	185	185	70	70
3-Year Drought No Action – High Initial Conditions	21	17	100	100	70	70
3-Year Drought DWP – High Initial Conditions	21	21	100	100	70	70
3-Year Drought No Action – Low Initial Conditions	21	13	100	100	70	70
3-Year Drought DWP – Low Initial Conditions	21	21	100	100	70	70

Rafting Releases - Table 3.16-4 also shows that rafting releases could be maintained for every scenario except for the No Action Alternative during the dry year (1977) and the simulated drought period. During low-water years, rafting releases could not be maintained on several weekends with the No Action Alternative because of a lack of water in Heron Reservoir.

Comparison to Historical Abiquiu Reservoir Levels - Table 3.16-5 compares model results to the historical record. As shown in the table, the maximum storage in Abiquiu Reservoir for each scenario was always less than the historical maximum storage in Abiquiu. The minimum storage for Abiquiu Reservoir also fell substantially below the historical minimum storage for both the dry year and drought low initial storage DWP scenarios.

Table 3.16-2 shows that with waivers and regardless of the initial storage conditions, high, normal, or low, that the maximum number of rafting weekends could still be maintained with the DWP. It also shows that fishery flows could be maintained.

Table 3.16-3 shows the results of action and No Action Alternatives on storage under a with-waivers assumption, therefore extending SJC water movement out of Heron until April of the following year. For varying initial storage conditions, the model shows the minimum, maximum and average end of year storages that could be achieved with the DWP for a dry year, normal year, and a 3-year drought.

Table 3.16-4 shows that without waivers and regardless of the initial storage conditions, high, normal, or low, that the maximum amount of rafting weekends could still be maintained with the DWP for all scenarios except for the 3-year drought under high and low initial storage conditions. It also shows that fishing flows could be maintained.

Table 3.16-5 shows a simulated condition wherein waivers were not allowed by Reclamation, therefore the SJC water movement out of Heron was completed by the end of the year. For varying initial storage conditions, the model shows the minimum, maximum and average end of year storages that could be achieved with the DWP for a dry year, normal year, and a 3-year drought.

TABLE 3.16-5
ABIQUIU STORAGE COMPARISON WITHOUT WAIVERS

Condition	Initial Storage (ac-ft)	Minimum Storage (ac-ft)	Maximum Storage (ac-ft)	Average Storage (ac-ft)
Historical (1977-2000 records)	---	16,530	402,260	154,226
Dry Year (1977) No Action – High Initial Conditions	170,000	138,687	175,536	159,999
Dry Year (1977) DWP – High Initial Conditions	170,000	131,043	170,268	151,764
Dry Year (1977) No Action – Low Initial Conditions	50,000	27,918	61,840	45,045
Dry Year (1977) DWP – Low Initial Conditions	50,000	9,628	65,923	37,750
Normal Year (1988) No Action – High Initial Conditions	170,000	163,590	182,217	175,612
Normal Year (1988) DWP – High Initial Conditions	170,000	137,542	178,821	161,867
Normal Year (1988) No Action – Low Initial Conditions	50,000	49,937	69,020	60,114
Normal Year (1988) DWP – Low Initial Conditions	50,000	32,166	63,912	51,898
3-Year Drought No Action – High Initial Conditions	170,000	129,685	173,204	156,684
3-Year Drought DWP – High Initial Conditions	170,000	132,481	179,416	163,659
3-Year Drought No Action – Low Initial Conditions	50,000	30,788	60,317	49,215
3-Year Drought DWP – Low Initial Conditions	50,000	19,608	89,897	53,094

Effects of the Subsurface Diversion

The method used to evaluate the effects of the Subsurface Diversion on ground water is described in Section 3.16.2 and Appendix L. The results indicated that maximum drawdowns from existing ground water depths in the bosque area from the operation of the subsurface collectors would be 3 to 3.5 feet. This includes drawdown effects caused by the subsurface diversion for the nearby subsurface diversion for the Non-potable Water Reclamation Project (Parsons, 2000). Each of the three 11-armed collector systems would cause similar localized drawdowns. Figure 3.16-20 shows where the shallow ground water table level has been lowered by 3 feet as a result of ground water pumping for one set of horizontal collectors. By spacing the three systems properly, it appears that mutual interference (and increased drawdowns) can be avoided. The effects of the projected 1- to 3.5-foot drawdowns to riparian vegetation are discussed in Section 3.21 and are shown in Figure 3.16-21.

Environmental Consequences Summary

Upper Project Subarea

- Winter Fishing Flows – Minimum releases below both El Vado and Abiquiu Reservoirs would be maintained for every scenario with and without the action alternatives (Table 3.16-2).

- Change in River Stage below Chamita Gage – The addition of 66 cfs of City SJC water would increase the river stage no more than one tenth of a foot.

Middle Project Subarea

Streamflow differences are clearly indicated in the CH2M Hill Hydrology report and in many places in the FEIS. The amounts of City SJC water in the system, while more than under No Action or under historic conditions, are so little changed as to make estimation of water surface elevations, widths, velocities, etc. virtually meaningless. All of the above will be in the range of those typically experienced in the Rio Grande system. The same can be said for reservoirs. And because the URGWOM/Riverware® model has severe limitations in running more than a few years of record (as well as other limitations related to routing of more than one-day's duration), it is not practical to provide reservoir hydrographs representative of the entire simulated period of 2006-60. Normal year, dry year, and extended drought (3-year) periods were simulated as a reasonable compromise to evaluate hydrologic effects likely to be seen over the 2006-60 period.

No Action Alternative

The No Action Alternative would continue to increase the reliance on ground water pumping and there is an assumption that the City's SJC would not be available except for small quantities for the Non-potable Surface Water Reclamation Project, and for relatively minor lease agreements through 2011.

- Basin Aquifer Pumping – The City would continue to compensate for ground water pumping by using existing native surface water rights. The OSE pumping limit of 132,000 ac-ft/year would not be exceeded until the year 2030. Ground water levels would continue to decline from 100 to 250 feet and would reach to 250 to 300 feet within the northeast CMA boundary by 2060.

- Ground Water – Between 2006 and 2060 pumping would steadily increase at a rate of 10,000 to 15,000 ac-ft per decade to meet the water needs of a growing population. Total ground water removed from aquifer storage (i.e., non-renewable water) is estimated to be about 2.0 million acre-feet over the 2006 to 2060 period (CH2M Hill, 2003). RG960 is expected to be exceeded by 2030.

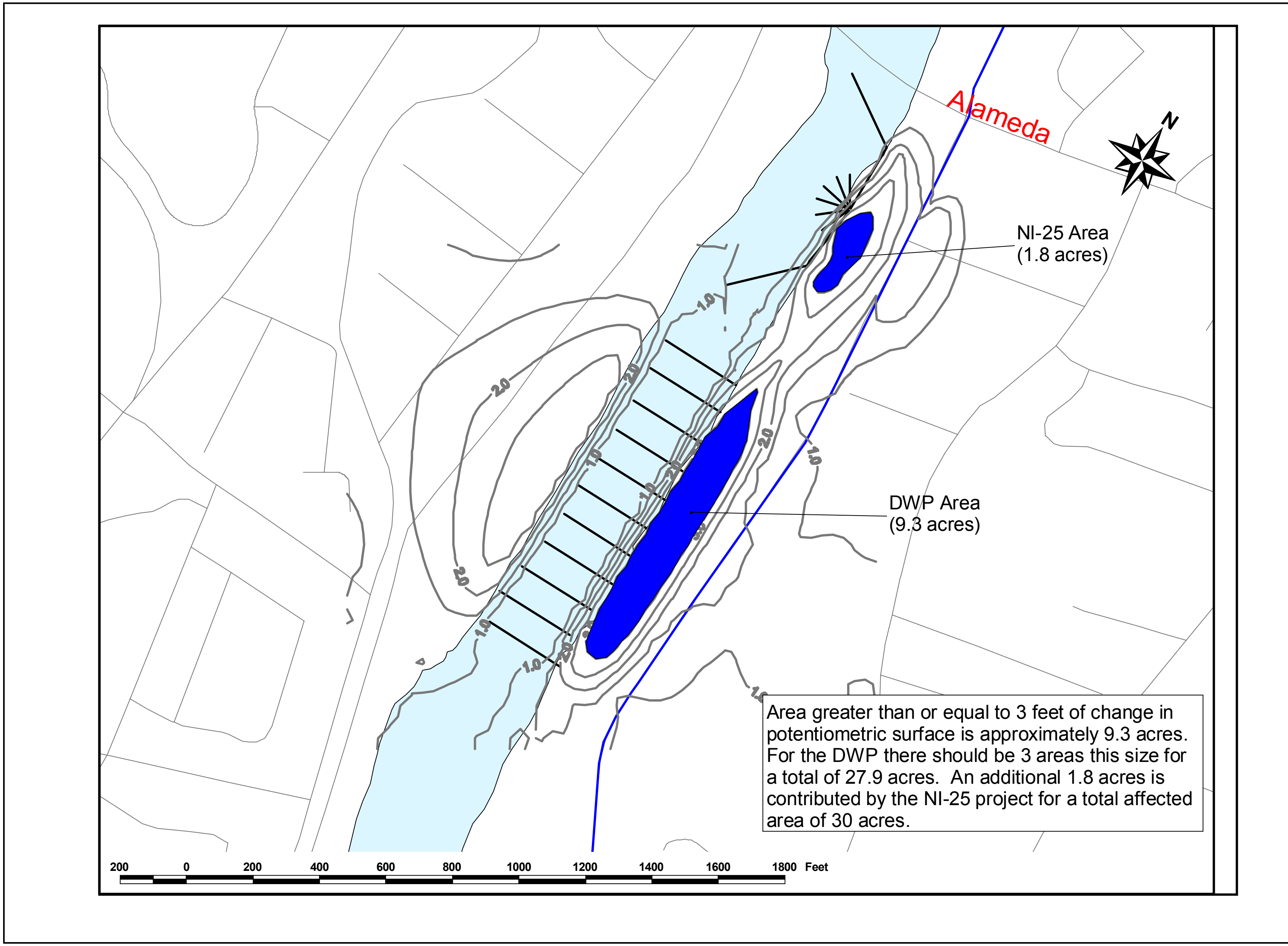

Figure 3.16-20
Area where the Shallow Ground Water Table Level Would be Lowered by 3 Feet as a Result of Ground Water Pumping for One Set of Horizontal Collectors and the North I-25 Surface Water Reclamation Project

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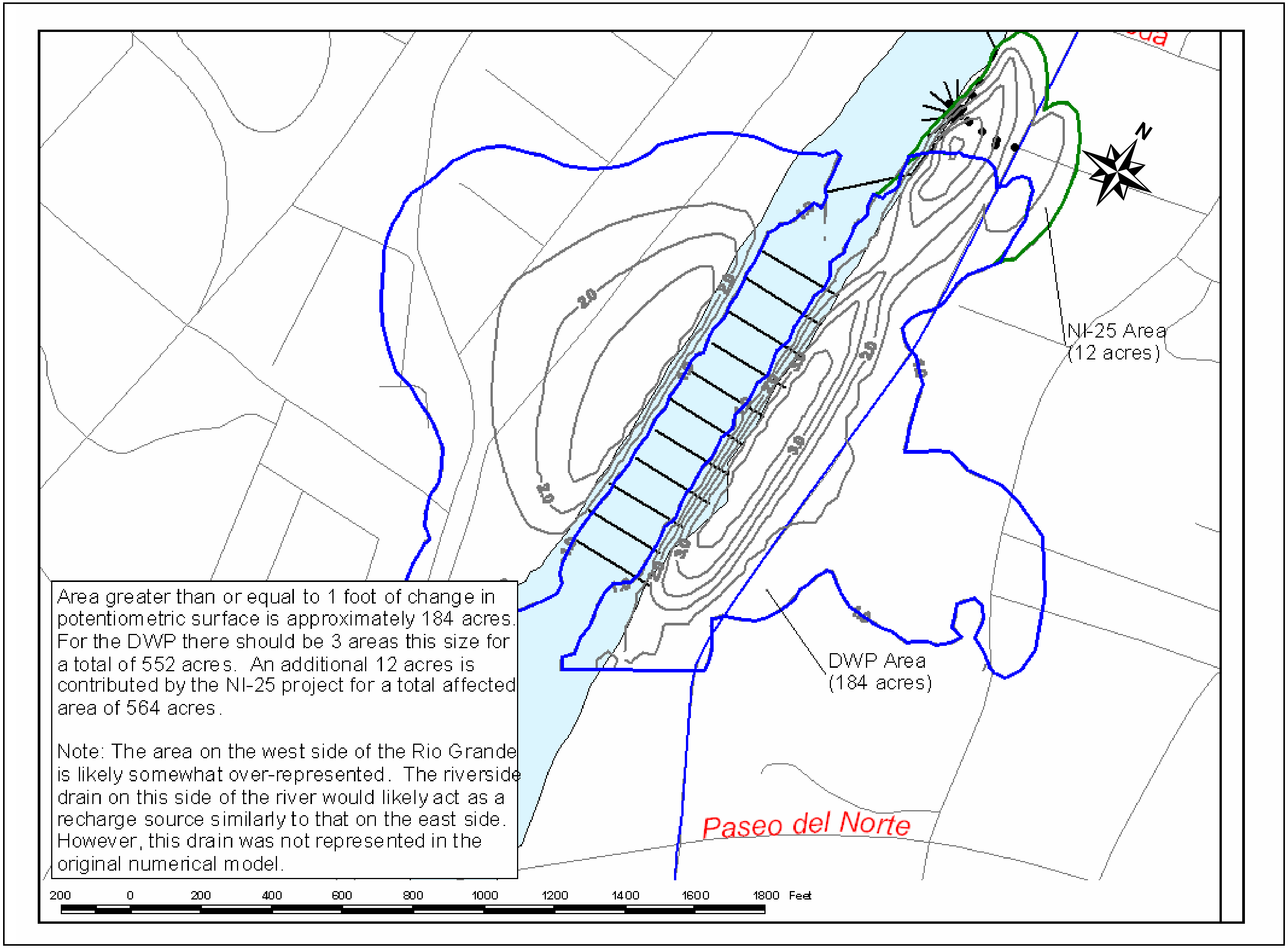

Figure 3.16-21
Area where the Shallow Ground Water Table Level Would be Lowered by 1 Foot as a Result of Ground Water Pumping for One Set of Horizontal Collectors and the North I-25 Surface Water Reclamation Project

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- River Seepage – Depletions of flows in the Rio Grande in excess of return flows from the SWRP would increase over time as aquifer drawdowns cause increased river seepage. The deficiency would increase from about 12,000 ac-ft/yr in 2006 to more than 22,000 ac-ft/yr in 2060.

- Native Flows – Average flows in the Rio Grande would slowly decrease over time due to the increased river seepage as a result of ground water pumping. Also, a depleted reach of the river would occur across the Albuquerque metropolitan area.

- Sediment Regime – The existing sediment regime would not be modified.

Angostura Diversion

- Basin Aquifer Pumping – The need for ground water pumping would be substantially reduced and ground water levels are less affected with the project in place, therefore avoiding exceedance of the MRGAA.

- Ground Water – As a result of implementation of the project, the aquifer ground water levels would decline at a much slower rate per decade and the City would be able to continue utilizing its native water rights for river depletions due to ground water pumping through the year 2060. Total ground water pumping is estimated to be 2.3 million acre-feet over the 2006 to 2060 period; the aquifer would be restored between 2006 and 2030.

- River Seepage – A reduction in river seepage will occur due to a decrease in ground water pumping.

- Flows in the MRG Project canal/drain system below Angostura would increase from an approximate range of 250 cfs to 500 cfs during the irrigation season to a range of 380 cfs to 630 cfs. With the proposed improvements to the canal system there should be no potential flood impact from the DWP.

- Native Flows –Similar to No Action but somewhat longer at 32 miles, a depleted reach will be generated below the diversion point by this project. However, the river will be surcharged with approximately 65 cfs of added City SJC water from Abiquiu Reservoir to the diversion point compared to the No Action Alternative. The hydrologic analysis indicates that the flow patterns would be virtually identical to and that flows would be a few percent lower than No Action flows at the Albuquerque gage.

- Sediment Regime – The sediment regime will essentially remain the same. However, the City will work with MRGCD to operate the diversion dam in a manner to minimize sediment problems in the irrigation system.

Paseo del Norte Diversion and Subsurface Diversion – Diversion near Paseo Del Norte Bridge

- Basin Aquifer Pumping – The need for ground water pumping would be substantially reduced and ground water levels are less affected with the project in place therefore, avoiding exceedance of the MRGAA.

- Ground Water – As a result of implementation of the project, the aquifer ground water levels would decline at a much slower rate per decade and the City would be able to continue utilizing its native water rights for river depletions due to ground water pumping until the year 2040. Total ground water pumping is estimated to be 2.3 million acre-feet over the 2006 to 2060 period. The aquifer would be restored between 2006 and 2030.

- River Seepage – Relative to No Action, there will be a reduction in seepage due to lower rates of ground water pumping.

- Native flows – A 15 mile depleted reach will be generated below the diversion point by this project. However, the river will be surcharged by approximately 65 cfs of City SJC water from Abiquiu Reservoir to the diversion point compared to the No Action Alternative. The hydrologic analysis indicates that the flow patterns would be virtually identical to and that flows would be minimally lower than No Action flows at the Albuquerque gage.

- Shallow Ground Water – For Subsurface Diversion, it was estimated that maximum drawdowns in the Bosque would not exceed 3 to 3.5 feet.

- Sediment Regime – The sediment regime will essentially remain the same. However, the City will work with MRGCD to operate the diversion dam in a manner to minimize sediment problems in the irrigation system.

Lower Project Subarea

- No Action Alternative – For the No Action Alternative the City would compensate for its ground water pumping effects using its varying water sources. There is also estimated to be a reduction in flow below the SWRP of 23 cfs to 32 cfs.

- All three action alternatives – There is estimated to be a reduction in flow of 4 cfs to 33 cfs.

A summary of hydrology effects is shown in Table 3.16-6.

3.16.4 Proposed Mitigation Measures

The proposed project would be operated in accordance with applicable state and federal statutes, regulations and permits. Operational management such as reduced diversions at low flows is discussed in Section 3.16.3.

TABLE 3.16-6
SUMMARY OF HYDROLOGY EFFECTS

Evaluation Criterion	Alternative			
	No Action	**Angostura Diversion**	**Paseo del Norte Diversion**	**Subsurface Diversion**
Maximum drawdown from pre-development conditions within the critical management area boundary in the year 2060 (feet below surface)	200-260	100-130	100-130	100-130
Total ground water pumping (million ac-ft) removed from aquifer storage	7.1	2.3	2.3	2.3
Total length of river channel likely to experience average annual water flow increase of 65 cfs (miles) relative to the No Action Alternative	0	171.3	189	189
Total length of river channel where flows would be depleted by project operations (miles)	15	32.7	15	15
Total annual reduction in water from City's SWRP discharged to Rio Grande (ac-ft/yr.)	0	0	0	0
Length of river in which future operational reservoir releases would exceed the capacity of the active channel or cause river bank erosion (miles)	0	0	0	0
Average annual reduction in mean annual flow for a typical year midway through the project in the Rio Grande at the Albuquerque gage (percent)	5.9	7.4	7.4	7.4
Average annual reduction in flow in the Rio Grande in an average water year between the SWRP outfall and Isleta Diversion Dam (percent)	0	0	0	0
Reduction in flow in the Rio Grande downstream of the SWRP outfall during low flow periods as a result of diverting surface water (percent)	0	0	0	0
Simulated zero flows (modeled over 2006 at the ABQ gage)	23	16	16	16
Number of modeled years without waivers in which winter minimum fisheries releases could be met (maximum = 54)	54	54	54	54
Number of modeled years without waivers in which rafting releases could be met (maximum = 54)	48	54	54	54
Maximum reduction in shallow water table elevation in the vicinity of the Paseo del Norte Bridge (feet)	1 to 3	0	0	3 to 3.5

The City would create, maintain, and update an accounting system that would document the proposed project's effects on the flow regime of the Rio Grande. The accounting system would identify the location(s) and quantity(ies) of water depletion from the river, the amount returned to the river, and the amount of water that would be consumed through beneficial use.

- When river flows above the diversion point are less than 260 cfs (for the preferred alternative), the City will adjust operations of the surface diversion dam and begin curtailing diversion amounts to minimize depletion effects downstream. The City has the option to shut down the plant earlier When flows just above the diversion point fall below 260 cfs, at the surface diversion dam, the City will begin curtailing the quantity of the native (non-San Juan-Chama) water diverted by reducing the diversion amount by 1 cfs for each 1 cfs reduction of native flow, but will continue to release and divert the full 65 cfs of its San Juan-Chama water. When native flow reaches 130 cfs just above the diversion, all raw water diversions and San Juan-Chama water releases will be suspended (100 percent curtailment), the adjustable height dam will be completely lowered (about 0.5 ft above the river bottom). During periods of curtailment, the City will offset decreases in the amount of raw water diverted by increasing the amount of ground water pumped for potable use. During periods of complete shut down of river diversions, the City's water service area will be supplied entirely from ground water wells and the City's San Juan-Chama water will be stored in Abiquiu for later release as part of the groundwater storage and recovery program. The operation and discharge from the Southside Water Reclamation Plant will not change as a result of the Drinking Water Project. Currently about 60,000 ac-ft/yr is discharged as treated effluent to the river below Rio Bravo Bridge. Based on population trends and current estimates of 46 percent of the water being used consumptively, return flow to the river is projected to increase to nearly 76,000 ac-ft/yr by 2040 and 92,000 ac-ft/yr by 2060 (reductions due to non-potable projects).

- During installation of the diversion facility, the City would require the construction contractor to use appropriate BMPs to minimize and contain the discharge of suspended sediments into the Rio Grande.

- The City will conduct environmental enhancements with a coordinated sediment management element. Sediment management would include elements of concern with respect to flood control and compact delivery requirements. The City will seek to coordinate and facilitate appropriate sediment management actions with respect to Jemez Reservoir, Cochiti Reservoir, Galisteo Reservoir, irrigation diversion dams, and AMAFCA facilities.

- If existing river gages are incapable of measuring the flows, the City would install appropriate stream gaging. The City would also install meters in the pump station at the diversion structure to measure the amount of water diverted on a constant basis. The City will be installing new gages at Alameda. The proposed diversion would be metered and a gage installed at Paseo del Norte and I-25 below the SWRP discharge. Flow data will be available to the public on a real time basis via USGS or the City.

- The City will participate in an interagency group that includes Reclamation, the USFWS, Office of the State Engineer (OSE), the New Mexico Department of

Game and Fish, and the Interstate Stream Commission to monitor and manage the effectiveness of both current and long-term environmental enhancement measures described above. This group will identify and recommend to the City and the USFWS necessary management changes to address environmental issues that are uncertain or unforeseen as a result of operating the DWP.

- The City will create, maintain, and update an accounting system that will identify the location(s) and quantities of water released from upstream reservoirs, diverted from the river, and the amount returned to the river. The City will also provide annual reports to the State Engineer with copies to the USFWS showing the timing of releases of San Juan-Chama water and diversion and return flow amounts. If curtailment of diversion of San Juan-Chama water were necessary during any year due to stream flow conditions, this will also be reported.

- When flows are low due to drought, the City may, in coordination with the USFWS, decide to shut the diversion off during the entire summer to avoid impacts to the environment. The City will coordinate with the Service beginning April 15 of each year to determine when the diversion facility will curtail or cease operations.

- The City will meet with the USFWS to discuss their Annual Operation Plan for the DWP by May 15 of each year.

- The City will provide the USFWS with an annual report on water accounting for the previous year by February 15 of each year. The City's accounting system will identify the locations and quantities of San Juan-Chama water released an diverted from the river, the amount returned to the river, and the amount of water that will be consumed through beneficial use.

- The City will notify the USFWS in writing regarding any changes in operations related to curtailment of increases of diversions.

- The City will install meters in the pump station at the diversion structure to continuously measure the amount of water diverted. Gauging information related to the City's DWP will be made available to the USFWS on a real-time basis.

- When developing release schedules for San Juan-Chama water, the City will work with Reclamation, the USFWS, OSE, the New Mexico Department of Game and Fish, and the Interstate Stream Commission so that release can benefit stream fisheries above the diversion. However, the City's releases must be consistent with state and federal laws, and must be approved by OSE. The City's San Juan-Chama water will be released from storage in upstream reservoirs in accordance with the conditions set forth in the approved OSE permit. The application for diversion of the City's San Juan-Chama water for this project was submitted to the OSE in May 2001. Upon approval, the City will provide a copy of the permit to the USFWS. The final release schedule will be determined by the City under the conditions of the permit.

- The City has a revised water conservation goal of a 40 percent reduction in demand compared to the baseline established in 1995. The timeframe for the implementation of the new goal will be ten years starting in 2005 and ending in 2014. This goal supplements the original 30 percent reduction goal that is projected to be achieved in 2005.

- The City has developed a drought management strategy for a drought reserve for the City water supply.

3.17 INDIAN TRUST ASSETS AND OTHER TRIBAL RESOURCES

3.17.1 Introduction

This section addresses the responsibilities of Reclamation to 1) recognize and fulfill its legal obligation to identify, protect, and conserve the trust resources of federally recognized Indian tribes and tribal members (use of "Tribes" include Pueblo Indians); and 2) to consult with Tribes on a inter-government basis whenever plans or actions that affect tribal trust resources, trust assets, or tribal health and safety are proposed. Indian Trust Assets (ITAs) or resources are defined as legal interests in assets held in trust by the U.S. government for Indian tribes or individual tribal members. Examples of ITAs are lands, minerals, water rights, other natural resources, money, or claims. An ITA cannot be sold, leased, or otherwise alienated without the approval of the federal government. For any proposed federal action, Reclamation, in cooperation with any Tribe affected by a project, would inventory and evaluate any assets held in trust. Reclamation has determined that ITAs could include Indian water rights and any trust land and natural resources. The Six Middle Rio Grande Pueblos are entitled to irrigate, at a minimum, 8,847 acres of prior and paramount land and 12,600 acres of newly-reclaimed lands.

As part of the coordination activities for the City's proposed DWP, Reclamation issued letters of invitation for government-to-government coordination/consultation to 27 federally recognized Pueblos and Tribes (see Appendix F). Consultation with these entities and the Bureau of Indian Affairs was requested to identify Indian trust resources that could be affected by the DWP. Meetings have been held with several Tribes, and some written correspondence identifying Tribal concerns has been received (Appendix F). The Six Middle Rio Grande Basin Pueblo Water Right Coalition, the Pueblo of Sandia, the Pueblo of Isleta, the Pueblo of Taos, the Pueblo of Ysleta Del Sur, and the Pueblos of Cochiti have expressed interest or concern with potential effects of the DWP, and comments were made on the DEIS by the Pueblos of Sandia, Isleta, and Santa Ana (Appendix M). The Hopi and Mescalero Apache reviewed the DEIS and had no specific comments.

Although no potentially affected ITAs have been formally identified by Tribes, Reclamation has determined that ITAs could include Indian water rights and any trust land and natural resources. Several Tribes have expressed concern for tribal resources which may not be defined as ITAs. Since there could be effects to non-ITA tribal resources, this FEIS addresses those issues as well as potential effect to ITAs. Pueblo water rights are a creation of federal law and are senior in priority to other water rights.

3.17.2 Affected Environment

About 74 miles of the Rio Grande within the ROI passes through a total of nine federally recognized Pueblos located below Abiquiu Reservoir (Figure 3.9-1): the Pueblos of San Juan, Santa Clara, San Ildefonso, Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta. This reach of the river spans portions of the Upper and Lower Project Subareas, and all of the Middle Project Subarea. The longest river reach through any one Pueblo is 18 miles, across the Cochiti Pueblo; the shortest reach is about 4 miles, through the Santo Domingo Pueblo. The two Pueblos located nearest the proposed water-diversion facilities in the Middle Project Subarea are Sandia Pueblo to the north and Isleta Pueblo to the south. Angostura Diversion alternative would use the Atrisco Feeder to convey river water to the WTP, and would traverse portions of the San Felipe, Santa Ana, and Sandia Pueblos. Angostura Diversion for the City's DWP would affect the reach of the Rio Grande which flows through these three Pueblos. The Pueblos use the river for traditional and cultural purposes. The Pueblos have also implemented habitat restoration projects along the river and are committed to protecting the river and riparian ecosystem. Additionally, if the Angostura Diversion is implemented, a pump station would be constructed on Sandia Pueblo land near the AMAFCA NDC outfall to the Rio Grande under Angostura Diversion.

Sandia Pueblo occupies about 23,000 acres north of the City. The Rio Grande flows through the Pueblo for about 9 miles, starting near Bernalillo and ending near Albuquerque. The southern Pueblo boundary is about 3 miles north of the proposed Paseo del Norte Diversion and Subsurface Diversion facility sites near Paseo del Norte. The Pueblo maintains the Sandia Lakes Recreational Area, which includes trails and other recreational facilities associated with the Rio Grande bosque (riparian corridor).

Isleta Pueblo occupies about 211,000 acres south of the City. It is the closest Pueblo south of the proposed diversion facilities. The Rio Grande enters the Pueblo near the I-25 Bridge, and flows through the Pueblo for about 10 miles. The distance from the SWRP to the Isleta Pueblo is about 3 miles.

Several Tribes have consulted and coordinated with Reclamation regarding potential effects of the City's DWP. Copies of all correspondence with Tribes is provided in Appendix F and Appendix M. Tribal concerns include the following:

- Effects on domestic and municipal water supplies.
- Effects on exercise of reserved water rights.
- Impairment of water quality or quantity.
- Effects of City effluent on water supplies.
- Effects of reduced water quantity or quality on traditional and cultural practices.
- Effects of reduced water quantity or quality on the environment, including habitat improvements, bosque health, and endangered species.

- Direct effects of construction on Pueblo land.
- Effects on Cochiti Reservoir storage.

3.17.3 Environmental Consequences

The following criteria area considered in evaluating the potential effects on ITAs and other Tribal resources:

- Adverse effects on ITAs, tribal health and safety, or cultural resources, or other Tribal resources resulting from construction or operation of the DWP.
- Water quality and quantity in the Rio Grande.
- Water quality and quantity in the Santa Fe Group aquifer.
- Construction on Native American lands.

Project-related effects on cultural resources are evaluated in Section 3.9.

Effects from No Action Alternative

The No Action Alternative would not directly affect any identified Indian trust resources or ITAs or other Tribal resources. Under No Action, continued ground water pumping to meet all City demands would continue to deplete the aquifer. This could indirectly reduce the quality and/or quantity of ground water available to Tribes pumping from the aquifer. Because of increased river losses to the aquifer over time as ground water pumping continues, the No Action Alternative would also result in reduced river flows and below Albuquerque of 23 cfs to 32 cfs. These relatively small flow reductions could potentially diminish the character of the river but not be expected to cause substantial changes in its quality or quantity.

Effects from Angostura Diversion

Water volume and quality in the Rio Grande were identified as Tribal resource categories that could be affected by the DWP. The project would increase river flows by approximately 65 cfs relative to the No Action Alternative through the Pueblos of Santo Domingo, Cochiti, San Juan, Santa Clara, and San Ildefonso. In general the quality of the City's SJC water is good, based on total dissolved solids (see Section 3.27), and release of the City's SJC water would have no effect on water quality in the river upstream from the proposed Angostura Dam diversion point.

The additional City SJC water in the river would result in an increase in stage of less than one tenth of a foot increase at the Chamita gage and up to two tenths of a foot increase at the Otowi gage. San Felipe gage would see an increase of less than one tenth of a foot.

The reach of the river through the parts of the San Felipe, Santa Ana, and Sandia Pueblos downstream from the Angostura Diversion Dam would be affected by a net reduction in flow of up to 65 cfs of native river water relative to the No Action Alternative; native water would be returned to the river at the SWRP (south of Sandia Pueblo and north of Isleta Pueblo). In the Rio Grande at Central, the depletion relative to the No Action Alternatives is estimated to range from 10 to 28 cfs over the life of the project. The length of this depletion from the Angostura Dam to the SWRP outfall is approximately 33 miles. In the Middle Project Subarea in low flow conditions, the stage decrease would be no more than three tenths of a foot. Downstream from the SWRP outfall, it is estimated that river flows would decrease through 2020 (by 4 to 10 cfs) and increase after that through the life of the project. Increased flows would range from 6 cfs in 2030 to 18 cfs in 2060.

This DWP alternative calls for use of the existing Main Canal and riverside drain for conveyance of diverted raw water to the WTP. These MRG Project conveyance structures, which currently are used to convey diverted irrigation water, cross Santa Ana, San Felipe, and Sandia Pueblo lands. Repairs or modifications of these existing structures would be necessary to improve conveyance efficiency under Angostura Diversion. Construction effects along the Atrisco Feeder/Albuquerque Drain are both temporary and permanent-temporary, because the surface area would be restored to pre-existing or better condition from enlarging/improving the capacity of the conveyance features, and permanent due to the enlargement of the ROW and pump station. The Atrisco Feeder would require enlargement to assure a safe capacity of 450 to 500 cfs required to allow 142 cfs for the AWRMS-DWP and the original 270 to 300 cfs capacity for irrigation purposes (and reserve adequate capacity for flood-related flows).

Consequently, to enlarge the hydraulic capacity of the Atrisco Feeder, vegetation and obstructions need to be removed from side slopes of the canal, removal of about 1 foot of accumulated sediment on the bottom and a widening of about 8 feet in most reaches. Total earthwork over the 14.5 mile length of the channel would be on the order of 0.3 million cubic yards. The access road on at least one side would require reconstruction. In addition, improvements will be needed for at least six existing bridge crossings, one agriculture return flow to the river, at the Corrales siphon south of Bernalillo, and at undercrossing of the NM-44 Bridge at Bernalillo. Finally, there are a number of ‘drainage inlet pipes’ that empty into the Atrisco Feeder (approximately 10) that would require replacement during channel excavation (CH2M Hill, 2001c). Land resources affected due to construction on certain areas of the Pueblo are noted. Construction effects along the Atrisco Feeder/Albuquerque Drain are both temporary and the surface area would be restored to pre-existing or better condition from enlarging/improving the capacity of the conveyance feature and permanent due to the enlargement of the ROW and the pump station.

Angostura Diversion also would require construction of a pump station at the terminus of the canal and drain, near the southern boundary of Sandia Pueblo, near the AMAFCA NDC outfall to the Rio Grande. Any work or facility on Sandia Pueblo land would be subject to Clean Air Act requirements and federal regulations. Construction of a new pump station would require the use of approximately 5 acres of Pueblo land, which currently is used as undeveloped pasture. From the pump station, untreated river water would be conveyed along the AMAFCA NDC to the WTP at Chappell Drive via a proposed subgrade pipeline up to 72 inches in diameter. In the Middle Project Subarea, Sandia Pueblo has expressed concerns about the physical effects of installing water-diversion and conveyance facilities on its land and the exact position of the Pueblo towards the City use of land to install DWP facilities would need to be determined and coordinated with the BIA.

Effects from Paseo del Norte Diversion and Subsurface Diversion

The construction and operation of the Paseo del Norte Diversion and Subsurface Diversion facilities to be located near Paseo del Norte would not adversely affect ITA resources. Construction areas for the diversion dam and subsurface collectors at Paseo del Norte would not be on tribal or Pueblo lands, nor would the proposed conveyance route from those alternatives to the Chappell Drive WTP cross any Tribal or Pueblo lands.

In-stream flows from Abiquiu Reservoir to Paseo del Norte would increase by a net amount of 65 cfs relative to the No Action Alternative. The timing of the City's SJC water releases would be as described for the Angostura Diversion. No adverse water-quality effects are anticipated as a result of this increased flow. River flow depletions between the Paseo del Norte diversions and the SWRP outfall would not affect downstream Pueblos. Downstream of the SWRP river flows are expected to decrease from 2006-2020 and increase from 2030-2060. These flow changes through Isleta Pueblo (from –10 cfs to +22 cfs) would not be expected to cause any adverse effects.

Summary of Environmental Consequences

Between Abiquiu Reservoir and any of the proposed DWP diversion locations at either Angostura or Paseo del Norte, future in-river flows through the Pueblos of Santo Domingo, Cochiti, San Juan, Santa Clara, San Ildefonso, and San Felipe would be increased relative to the No Action Alternative by approximately 65 cfs of the City's SJC water that would be delivered to the City. Flows through the Pueblos of Sandia and Santa Ana would also be increased by approximately 65 cfs relative to the No Action Alternative if a Paseo del Norte diversion location is selected. This increase would not be expected to adversely affect water supply (which would increase), water quality (no pollutants would be introduced), or the stability or maintenance of riparian ecosystems along the riverbanks of Sandia Pueblo. Depletions of in-stream flows would affect the portions of the Santa Ana, San Felipe, and Sandia Pueblos below the point of diversion only under the Angostura Diversion. However, the water volumes and the resulting hydrologic changes of both increased flows upstream and decrease flows downstream from the diversion facilities would be difficult to differentiate from background variations under existing conditions. All action alternatives would result in minor flow changes through the Pueblo of Isleta.

Conveyance of water diverted at the Angostura Diversion through existing MRG Project irrigation canals would require modification of the canal segments of those conveyances that cross Sandia, Santa Ana, and San Felipe lands. Construction of a new pump station near the mouth of the NDC would require 5 acres of Sandia Pueblo land. The DWP would not be expected to affect Pueblo domestic and municipal water supplies. There would be no anticipated adverse effects on Indian Trust resources, assets, or tribal health and safety from the No Action Alternative or from construction or operation of DWP alternatives Paseo del Norte Diversion and Subsurface Diversion. The Angostura Diversion would require modification of the existing MRG Project canal across Pueblo lands and construction of a new pump station on 5 acres of Sandia Pueblo land. Table 3.17-1 summarizes anticipated project effects on ITAs and other Tribal resources by alternative. The hydrologic analysis is presented in Section 3.16. The Critical Management Area does not include the Sandia Pueblo. Pueblo water rights are a creation of federal law and are senior in priority compared to other water rights.

TABLE 3.17-1
SUMMARY OF PROJECT EFFECTS ON INDIAN TRUST ASSETS AND OTHER TRIBAL RESOURCES

Evaluation Criterion	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Number and location of affected Indian Trust Assets and other Tribal resources	Possible indirect effect to ground water supply	Construction effects of modification of canal and construction of pump station. Flow depletion through Pueblo of Santa Ana, Pueblo of Sandia, and a portion of the Pueblo of San Felipe.	Small flow decreases and increases through Pueblo of Isleta	Small flow decreases and increases through Pueblo of Isleta

3.17.4 Proposed Mitigation Measures

No environmental design features or mitigation measures have been identified or proposed for the DWP to address ITA or Indian resource concerns because the DWP will not adversely impact ITAs. With the preferred alternative, there are no adverse impacts to ITAs. The effects assessment identified no substantial or major effects on Indian lands in the project area. Coordination would continue between Reclamation, the BIA and all Pueblos involved to minimize any effects to land or water resources.

3.18 LAND USE

3.18.1 Introduction

Land-use concerns identified during project scoping activities were related to the possibility that completion of the DWP would require conversion of private lands to the public domain.

The method of analysis for the land-use evaluation consisted of mapping each diversion alternative, conveyance routes, and transmission corridors in the Middle Project Subarea. Current land-use designations (e.g., residential, commercial, open space, Pueblo lands, roadways and utility corridors, and agricultural lands) near and along these locations were then identified using geographic information system (GIS) techniques, and ground-truthing site visits were conducted to verify geographic information. Designated prime or unique farmlands, as defined by the U.S. Department of Agriculture (USDA, 1992), also were considered. Areas affected by any possible required changes in land use or zoning due to construction or operation of the DWP were identified.

3.18.2 Affected Environment

Land use was evaluated for the Middle Project Subarea, where construction activities for a raw-water diversion facility, WTP, and water-conveyance routes are proposed. Land uses and ownership in the vicinity of the proposed action alternatives are varied. Designated land uses in the project areas include residential, commercial, industrial, water management (i.e., drainages and flood control), rangeland/agriculture, Pueblo, and recreation/open space. Figure 3.18-1 shows land-use types in relation to the proposed water transmission corridors.

Prime farmland is defined as land being suitable for the production of any food, feed, fiber, forage, and oilseed crops, and is designated by soil type (USDA, 1992). No designated prime or unique farmlands were identified within the project area.

3.18.3 Environmental Consequences

The following criteria were considered in evaluating the potential effects of the DWP on land use:

- A change in land ownership from private to public, or destruction of prime or unique farmlands.

Project effects on land use are discussed by each alternative in the following subsections.

Effects from No Action Alternative

Long-term requirements for installation of new ground water wells and related water transmission lines potentially could affect private lands, though such projects would not be expected to significantly affect land uses or zoning patterns.

Effects from Angostura Diversion

Under the Angostura Diversion, the existing Angostura diversion facility and 14.5 miles of the Albuquerque Main Canal and the Atrisco Main feeder/drain would be modified. The existing facility is located in the Rio Grande channel and is operated by MRGCD. The current surrounding land uses are primarily semi-rural residential, Pueblo lands, and rangeland, with some irrigated and formerly irrigated farmlands. A pump station would be constructed on Sandia Pueblo land near the mouth of the AMAFCA's NDC. Land uses surrounding the proposed pump-station location include semi-rural residential on Sandia Pueblo lands and water management (e.g., flood control and irrigation) and municipal services (i.e., wastewater treatment) in floodplain and riverine areas. No designated prime or unique farmlands would be affected by any of the components of Angostura Diversion.

The Angostura Diversion raw-water conveyance corridor to the new WTP would cross residential, commercial/industrial, City open space/recreational, agricultural (including currently and formerly irrigated lands and rangeland), Rio Grande bosque/riverine areas, and Pueblo lands. Under Angostura Diversion, up to five residential areas would be

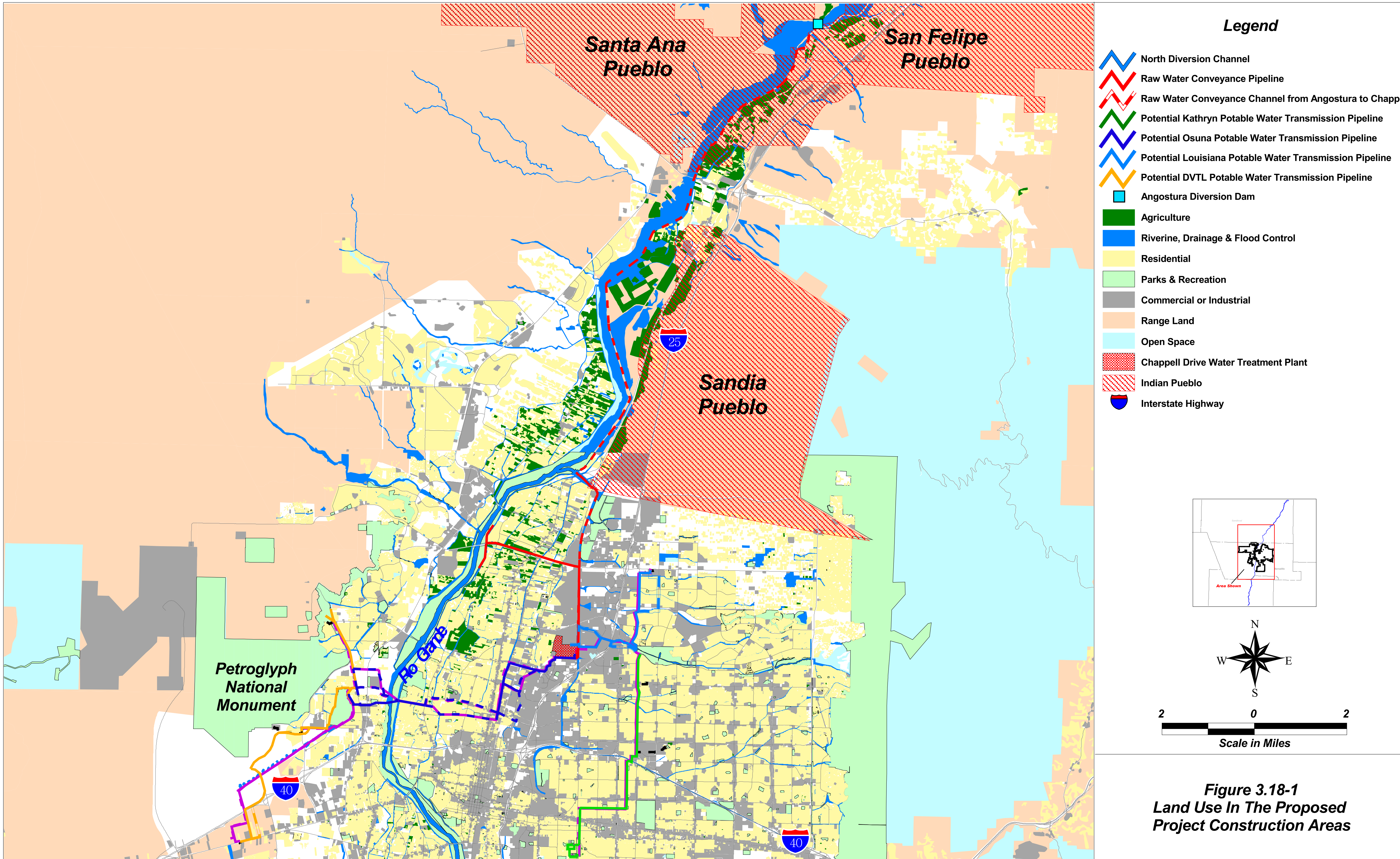

Figure 3.18-1
Land Use In The Proposed Project Construction Areas

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affected by construction between the Angostura Diversion site and the AMAFCA NDC. These residential properties are inter-mixed with agriculture, rangeland, bosque, and Pueblo Lands areas.

The Bernalillo Wastewater Treatment Facility outfall is located near the proposed conveyance route, but would not be affected by project activities. Nor would the City's open space areas be disturbed by construction or operation of DWP Angostura Diversion, as construction would take place in existing MRG Project ROWs.

The fishway on the west side of the river and the raw-water conveyance corridors would affect San Felipe Pueblo lands near the Angostura Diversion site. The conveyance corridors also would cross Santa Ana and Sandia Pueblo lands, and access and use permission (e.g., through lease and/or easement agreements) would be required from Sandia Pueblo to allow construction of a new pump station on approximately 5 acres of Pueblo land in the vicinity of the NDC.

Approximately 14.5 miles of the existing water-conveyance system (i.e., the Albuquerque Main Canal and the Atrisco Main feeder/drain) would be temporarily disturbed during construction to upgrade these open, unlined and cement-lined conveyance channels to prevent flooding of adjoining properties. Construction would require both temporary construction easements and permanent use and access easements through Pueblo lands. Trenching to install approximately 5 miles of 72-inch underground water pipeline along the NDC from the new pump station to the Chappell WTP site also would be required. Construction of potable water distribution pipelines would take place within existing utility corridors and road ROWs (see Figure 3.18-1), and effects in these areas would be temporary. Construction of pipelines within road ROWs would require trenching to allow for the underground installation of water pipelines; all disturbed roadways would be restored to their pre-construction condition. Bore-and-jack methods would be used to install pipelines beneath major road intersections (e.g., of four-lane roads) and railroad crossings to minimize disruptions in traffic flow.

Approximately 110 acres of land was purchased by the City for construction of the WTP at the Chappell Drive site (CH2M Hill, 2001c). This land was acquired from a privately owned and operated commercial sand-and-gravel mining operation in December 2001. Acquisition of the WTP site by the City would be the only change in land ownership attributable to the DWP. Land uses adjacent to the WTP site are commercial/industrial and high-density residential (apartment complex). There are no known changes to zoning anticipated.

Effects from Paseo del Norte Diversion

The proposed surface diversion under Paseo del Norte Diversion would be constructed on 4.5 acres of City open space land near Paseo del Norte. Approximately 1.23 linear miles of open-space recreational trails along the Albuquerque Reach of the Rio Grande would be temporarily affected during construction of the new diversion dam, a fishway, and a pumping station in the vicinity of the Paseo del Norte river crossing. The Corrales Levee Rehabilitation Project, which is a ground water fed, micro-irrigation bosque/native restoration project on the west bank of the Rio Grande, is located on City open space lands approximately 300 to 500 feet south of the proposed diversion dam (Linderoth, 2000). This project, which is jointly operated by USACE and the Natural Resource Conservation Service Plant Materials Center, would not be affected by construction or operation of the proposed surface water diversion dam and pumping station.

Two semi-rural residential subdivisions located in the vicinity of the proposed Paseo del Norte Diversion surface diversion site near Paseo del Norte could be indirectly affected by noise and dust during construction of the new diversion dam and ancillary facilities. These subdivisions are Los Ranchos de Albuquerque Village on the east side of the Rio Grande, and Whispering Pine Estates on the west side of the river. Both of these semi-rural residential areas are zoned to allow the keeping of horses and other farm animals. Construction effects would be temporary. No commercial/industrial properties, Pueblo lands, or designated prime or unique farmlands would be affected by the proposed action at this location.

The construction site and effects on property-ownership and land use conditions for the WTP are identical for all three action alternatives. Under the Paseo del Norte Diversion, raw water would be conveyed from the diversion point at Paseo del Norte to the WTP at Chappell Drive via existing canals and new pipelines to be constructed within existing utility corridors and road ROWs. Upgrading of existing conveyance structures, and construction of new pipelines for both raw-water conveyance to the WTP, and potable water distribution from the WTP to the service area, would result in temporary construction impacts along these routes, as described for the Angostura Diversion. The routes of the potable water distribution pipelines for this alternative are shown on Figure 3.18-1. Land uses in the area affected by this alternative are primarily residential, with some commercial/industrial usage.

Effects from Subsurface Diversion

Construction of diversion and pump-station facilities under the Subsurface Diversion (subsurface diversion near Paseo del Norte) could affect as much as 552 acres of bosque, river channel, and City open space, due to the nature of the subsurface collector design and construction logistics. The northern set of subsurface collector arms would extend nearly to the location of the Corrales Levee Rehabilitation Project, which is located in the bosque on the west side of the river channel, just north of the Paseo del Norte crossing. Because this rehabilitation project relies on ground water it potentially could be affected by subsurface diversion of water from the bed of the river under Subsurface Diversion (Linderoth, 2000).

The primary residential areas in the vicinity of Subsurface Diversion are the semi-rural subdivisions of Los Ranchos de Albuquerque Village on the east side of the Rio Grande and Bernalillo County including Whispering Pine Estates and Cerca del Rio on the west side of the river. The raw-water conveyance and potable water distribution lines, as well as the Chappell Drive WTP site (Figure 3.18-1), would be the same under this alternative as described for Paseo del Norte Diversion. Therefore, impacts would be as described in Section 3.18.3.3. No Pueblo or commercial land-use areas or designated prime or unique farmland (USDA, 1992) would be affected by this alternative.

Summary of Environmental Consequences

None of the DWP action alternatives, nor the No Action Alternative, would require a change in existing land uses or zoning for project construction or operations. No effects would occur to designated prime or unique farmland or agricultural production as defined by USDA (1992).

The 110-acre parcel of commercial/industrial land required for construction of the WTP has been purchased from its former private owners to the City. The land-use classification and zoning of this site would remain the same. Under Angostura Diversion, temporary construction and permanent access easements would be required for the canal improvements. Construction of a pump-station on 5 acres of Sandia Pueblo land near the NDC would also require negotiation of a lease agreement between the City and the Pueblo of Sandia with BIA involvement. Based on this evaluation, no long-term adverse effects on land use would be attributable to construction or operation of the DWP. Past water resource activities and facilities have changed or altered land use patterns, specifically the agricultural use of water, and dams for flood control. While the DWP does require some land for its facilities, this amount would not contribute to modifying land use patterns within the ROI. Table 3.18-1 summarizes the anticipated DWP effects on land use by alternative.

TABLE 3.18-1
SUMMARY OF PROJECT EFFECTS ON LAND USE

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Area changed from private to City ownership (acres)	None	~110 for Chappell Drive WTP	~110 for Chappell Drive WTP	~110 for Chappell Drive WTP
Areas that would require a change in land use designation/zoning (acres)	None	Lease of ~5 acres of Sandia Pueblo lands for pump station	None	None
Designated prime or unique farmland to be withdrawn (acres)	None	None	None	None

3.18.4 Proposed Mitigation Measures

Construction of portions of all DWP action alternatives would temporarily disturb residential, commercial, open space, and other land uses. Permanent loss of current land uses would be associated only with those specific locations where new features of the three action alternatives (i.e., diversion facilities, pump stations, and the WTP) would be constructed outside of existing utility corridors and ROWs. City permit requirements for all construction phases would limit the amount of surface disturbance and would require implementation of BMPs for dust and traffic control and compliance with noise ordinances. Other mitigation measures, discussed in detail in Appendix O, also would be incorporated into the project construction and operating activities to prevent conflicts with existing land uses.

- The contractor would adhere to project work-hour restrictions (work allowed only between 7 a.m. and 10 p.m.) within 500 feet of residences, hospitals, and schools. Additional work hours would be added only if approved by the local residents.

- Project pipeline alignments would be routed primarily in developed public rights-of-way to minimize activity in undisturbed areas.

- Open Space Division, Environmental Land Use Committee land-use approval may require an environmental resource commitment. Commitments would be determined during the approval negotiations.

3.19 NOISE AND VIBRATION

3.19.1 Introduction

During DWP scoping, concerns about possible effects of construction activities on nearby residents and effects of WTP and pumping station noises during operations were raised. These and other potential project-related noise and vibration effects were evaluated as part of this FEIS.

The method of analysis used to evaluate noise and/or vibration effects involved investigating the areas around proposed project facility and conveyance/transmission corridor locations to identify proximate receptors considered sensitive to noise/vibration. Sensitive receptors were defined as schools, hospitals, libraries, and residences. Operation of diversion facilities, pump stations, and the WTP is expected to be in compliance with City noise ordinances.

Only the Middle Project Subarea, where all proposed facilities would be located, was evaluated for this resource category. There would be no noise or vibration effects from Upper Project Subarea water reservoir operations to deliver the City's SJC water, and there would be no noise or vibration effects from conveyance of the water in the Rio Chama and Rio Grande to the diversion point.

3.19.2 Affected Environment

In the proposed project impact areas, existing noise conditions fall into two categories. One category includes undeveloped open space, recreational, and agricultural areas that typically experience relatively low ambient (background) noise levels. The other category includes developed residential, commercial, light industrial, and transportation corridors commonly found throughout the City limits. These types of settings experience a wide range of noise generated from a variety of land uses and activities. The developed-land category experiences higher ambient background noise levels than the undeveloped-land category. City land-use and zoning information was used to identify noise-sensitive land uses (e.g., recreation, residential, schools, and medical facilities) in proximity to the project construction locations.

Streets and roads proposed as routes for buried water pipelines already experience construction noise from many different types of activities, including road repair and utility line installation and maintenance. The Chappell Drive WTP would be located in an area of existing gravel mining and cement-plant operation that is surrounded by other commercial operations.

Background noise levels tend to be relatively lower in residential and open space areas (such as parks and the river corridor) than along four lane streets and in business and commercial areas. Compliance with regulations governing noise was used in evaluating project impacts. These regulations and ordinances include the Federal Noise Control Act (PL 92-574), the City's (1997) *Development Process Manual* (City, 1997) and the City's (1981) Noise Ordinance (Albuquerque City Code [ACC] § 6-22).

3.19.3 Environmental Consequences

Noise-evaluation criteria are based on land-use compatibility and on the direction and magnitude of noise level changes. Annoyance effects are typically the primary consideration. Often, the magnitude of a noise level change is as important as the resulting overall noise level. A noticeable increase in noise levels often is considered a substantive effect by local residents, even if the overall noise level remains within land-use compatibility guidelines or complies with local ordinances. Conversely, noise levels that are not noticeable to most people are not considered significant, even if the overall noise level is somewhat above land-use compatibility guidelines or ordinance-specified levels. Direct and indirect effects may include noise from construction equipment, increased traffic noise from project-vicinity roadways, and noise from operation of pump stations and the WTP. Implementation of the DWP would not include vibration-causing activities that would affect the integrity of existing structures.

The following conditions would be considered environmental changes substantial enough to lead to potential noise and vibration effects:

- Project-related noise and vibration from construction activities that exceed City noise standards; and

- Long-term, chronic noise from pump stations or other operating equipment that exceeds City noise standards.

Effects from No Action Alternative

Under the No Action Alternative, new facilities would not be constructed, so there would be no project-related temporary construction or long-term operational noise or vibration effects. Noise from any construction of installing over 130 new ground water wells and ancillary equipment, or from operation of pumping stations, would be subject to compliance with local noise ordinances. Therefore, no direct adverse effects from noise or vibration would be expected under the No Action Alternative.

Long-term operation of any equipment in the Albuquerque metropolitan area would incrementally add to the ambient noise level. It is not expected that pumping from additional wells under the No Action Alternative would have a substantive cumulative effect on prevailing background noise levels.

Effects from Action Alternatives

Noise from construction activities would be expected for a short time during construction of the water diversion facility, pump stations, treatment plant, and conveyance/distribution pipelines. Noise and vibration effects would not be noticeable during construction at and near the Angostura Diversion site, Albuquerque Riverside Drain canal modification, and pump station because of the absence of nearby residential or other sensitive land uses. Construction of the Paseo del Norte Diversion dam or Subsurface Diversion subsurface collectors near Paseo del Norte Bridge in Albuquerque, and the related pump stations, would create noise and vibration effects noticeable to visitors to the bosque.

Under all three DWP action alternatives, new water pipeline routes would pass through a mix of residential and industrial areas and school zones. School zones and residential areas, where ambient noise levels are lower, are considered more sensitive to noise than industrial, roadway, and business areas, where noise levels are higher. The amount of pipeline to be installed in street ROWs within 500 feet of residences is approximately 91,000 linear feet. Because conveyance and transmission pipelines would be installed at the rate of 400 to 500 feet per day, noise and vibration effects at any site would be of short duration, lasting only 1 to 2 days. Noise attributable to water-transmission line construction is expected to be comparable to that associated with other utility line construction. However, construction of pipeline segments located along residential streets would potentially result in greater noise perceptions by more people than the same activities being conducted in undeveloped, open land. Construction would normally occur during daylight hours, and would be conducted in compliance with applicable noise ordinances and restrictions.

Project operation of the pump stations and WTP would be in compliance with City noise ordinances. Any potential for pump station or WTP noise would be addressed under ACC § 6-22, Article 9-9-7 (a), which applies to the operation of machinery, equipment, fans and air conditioners. Within the area of pump stations and WTP, noise cannot exceed 50 decibels (dB(A)) or 10 dB(A) above the ambient noise level, whichever is greater, as measured at a residential property line.

Long-term operation of any equipment in the Albuquerque metropolitan area would incrementally affect the ambient noise level. It is not expected that DWP pump station and WTP operation would have a substantive cumulative effect on prevailing background noise levels.

Summary of Environmental Consequences

All direct DWP construction noise and vibration effects would be temporary, and would cease as soon as the construction in those areas is complete. Construction and project operations would be conducted in compliance with pertinent ordinances to limit noise and vibration, with more stringent standards applied when project activities occur in proximity to sensitive noise-receptors. No long-term adverse effects associated with noise or vibration are expected when the DWP is implemented. There would be no permanent changes in ambient noise levels under the No Action Alternative. Project noise effects are summarized in Table 3.19-1.

TABLE 3.19-1
SUMMARY OF PROJECT EFFECTS FROM NOISE AND VIBRATION

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Number of expected cases when operations of project facilities exceed City noise or vibration standards	None	None	None	None
Number of expected cases when construction of project facilities exceeds City noise or vibration standards	None	None	None	None

The environmental design features and BMPs discussed in Section 3.19.4 are required by the City for all construction projects. When these features/practices are implemented, no long-term adverse effects from excessive noise levels or vibration would be expected from the project. Facilities within the ROI may have had noise and vibration effects associated with them during construction. Planned future operations or facilities, other than the DWP, may have some temporary noise and vibration effects if they involve construction or some other noise generating activity. The cumulative effect, if any, of noise and vibration attributable to the DWP within the Middle Project Subarea is very slight.

3.19.4 Proposed Mitigation Measures

The following project design features and construction BMPs would be required by the City for construction of the DWP. Compliance with these measures would be required to obtain City construction permits. These features, when implemented, would mitigate potential adverse effects from noise and vibration:

- The construction contractor would meet the requirements of noise ordinance ACC § 6-22 for noise control on construction equipment.
- The contractor would adhere to project work hour restrictions (work allowed between 7 a.m. and 10 p.m.) within 500 feet of residences, hospitals, schools, churches, and libraries. Additional work hours may be necessary on if approved by the local residents, unless otherwise approved by entities.
- The contractor would arrange the construction schedules to restrict work to five days within 500 feet of the same residences, hospitals, schools, churchs, and libraries. Additional work days would be added only if approved by the local residents, hospitals, schools, churches, and libraries.
- Project operating equipment (e.g., pumps) would be housed in structures designed to minimize radiated noise outside the structure, and would meet the City's noise-ordinance requirements.

Environmental design features for control of noise would be implemented in conjunction with measures for traffic control in order to avoid potential cumulative effects of traffic- and noise-control measures and project effects on traffic (i.e., work hour extensions or restrictions).

3.20 RECREATION

3.20.1 Introduction

Specific recreation concerns identified during the DWP scoping process were potential project effects on reservoir levels and recreational opportunities. Issues related to recreational fisheries are discussed in the aquatic life evaluation (Section 3.7), and rafting releases are discussed in Section 3.16.

Effects on recreational resources were assessed by categorizing water recreational areas and identifying trails and parks. A determination was then made of any loss of recreational opportunities that could occur as a result of the construction or operation of the DWP. All project subareas were evaluated for this resource because each subarea contains a segment of river corridor that provides potential recreational opportunities.

3.20.2 Affected Environment

In general, recreational resources can be divided into regional and local categories. The regional category includes recreational resources related to the Rio Grande corridor, including three water storage reservoirs located north of Albuquerque in the ROI (El Vado, Abiquiu, and Cochiti in the Upper Project Subarea), several miles of trails and bank-fishing opportunities extending along the Albuquerque reach of the Rio Grande (in the Middle Project Subarea), and a patchwork of multi-use areas that extend southward from Albuquerque toward Elephant Butte Reservoir headwaters (in the Lower Project Subarea). There are state parks at each of the reservoirs noted above. Other areas of limited recreational opportunities along the Rio Grande corridor have no public access.

The Rio Chama is a major tributary of the Rio Grande drainage basin, and it is co-managed by the BLM and the US Forest Service (Fogg *et al*., 1992). In 1988, approximately 25 miles of the Rio Chama, between El Vado and Abiquiu Reservoirs, was designated as a Wild and Scenic River (National Wild and Scenic Rivers System, 2001). This river segment also is considered a regional recreational resource.

The Rio Grande Valley State Park (RGVSP), which encompasses a 22-mile stretch of the Rio Grande corridor, is considered a local resource and is shown in Figure 3.20-1. This state park includes approximately 5,000 acres of bosque and surface water (river) that is managed to preserve and enhance its ecological diversity (City of Albuquerque, 1993). City Open Space has estimated that between 25,000 and 40,000 people annually use the hiking/biking trails along the Rio Grande at Alameda (Schmader, 1999). A parking lot for City open space users is located just east of the river south of Alameda. This parking lot contributes to the accessibility of the bosque in this area. There also are several miles of private recreational trails for bicycling, walking, hiking, jogging, and

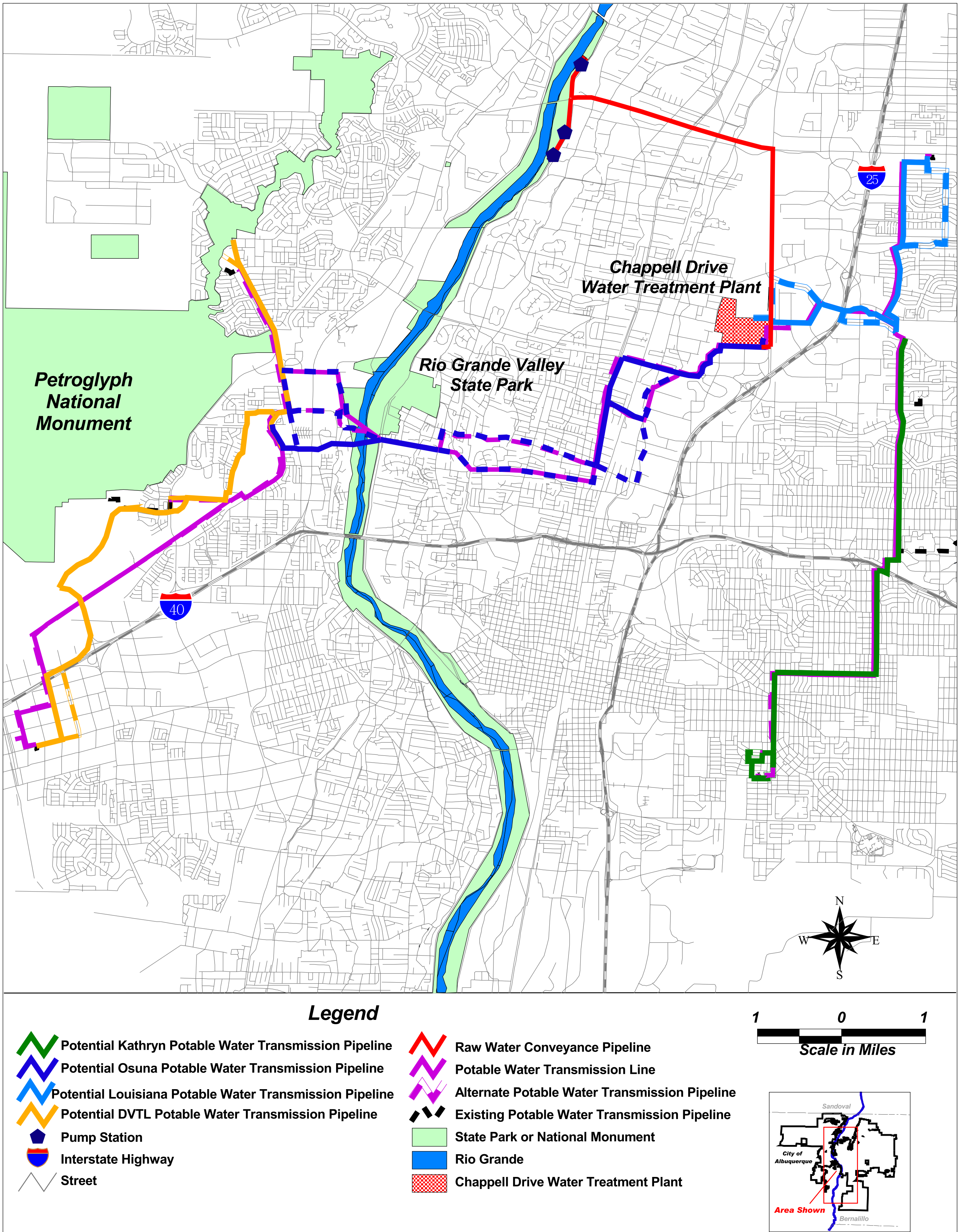

Figure 3.20-1
Rio Grande Valley State Park

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horseback riding located on San Felipe, Santa Ana, and Sandia Pueblo lands within the bosque.

There are two national wildlife refuges in the Lower Project Subarea. These include Sevilleta NWR and Bosque del Apache NWR. Sevilleta NWR is periodically open to the public and is a research facility. Bosque del Apache NWR is open to the public and hosts wildlife and bird watching, hiking and camping.

Other recreation areas in the ROI include Coronado State Park near the Town of Bernalillo, and La Joya and Bernardo Waterfowl Areas near the Town of Bernardo.

There are several City parks in the ROI in the Middle Project Subarea. Recreation opportunities include picnicking and playgrounds. Petroglyph National Monument is located on the west side of the Rio Grande in the Middle Project Subarea. Recreation includes hiking and viewing petroglyphs and wildlife.

3.20.3 Environmental Consequences

The following criteria were considered in evaluating the potential effects on recreational resources:

- A decline in the quality or quantity of existing recreational facilities or services.
- Any conflicts with known recreation planning standards.

Effects from No Action Alternative

Under the No Action Alternative there would be no disruption of existing trail use or visitor access to these areas. Under the No Action Alternative the City would discontinue its program of voluntary cooperation of release for winter fisheries and summer recreation.

Effects from Action Alternatives in Upper Project Subarea

Recreational areas, including reservoirs, rivers, parks, and NWRs, in the Upper and Lower Project Subareas would not be affected by construction or operation of the DWP action alternatives. With the DWP in operation, the City will continue with its historical practice of cooperating with Reclamation and BLM in the coordination of releases from Heron Reservoir to Abiquiu Reservoir to benefit winter fisheries. This program of voluntary cooperation is subject to the City's prerogative and ability to meet its water requirements.

Effects from Angostura Diversion in Middle Project Subarea

River related recreational activities such as canoeing, kayaking, and fishing would be temporarily disturbed in a short segment of the river during the construction phase of the diversion dam and the fishway. Construction of Angostura Diversion would temporarily affect bank-fishing opportunities near the Angostura Diversion Dam and along nearby irrigation canals (Atrisco). Approximately 5 miles of recreational opportunities such as walking, jogging, and bicycling along the NDC ROW would temporarily be affected by this action. Project construction or operation would not affect the approximately 14 miles of private recreational trails located on Pueblo lands in bosque areas from the Angostura Diversion Dam to the NDC pumping station location.

No boating or angler days at upstream reservoirs would be lost due to construction activities. This action would temporarily affect bank-fishing opportunities around the construction activities at the Angostura Diversion.

Effects from Paseo del Norte Diversion in Middle Project Subarea

Implementation of DWP Paseo del Norte Diversion would temporarily affect approximately 15 acres of bosque during construction of a new surface diversion dam, fishway, and approximately 5.5 miles of raw-water conveyance and utility corridors. Approximately 14.7 acres of bosque would be lost due to construction and operation of the fishway, pump station, sluiceway, and access roads from Alameda Boulevard. The placement of the sluiceway and pump station is located within designated City open space, and would temporarily disrupt recreational trails. Trails that are altered would be reestablished once construction is complete. Boating impacts from the proposed diversion dam are minimal, as boating opportunities within the Rio Grande near Albuquerque are very limited due to lack of adequate flows and the presence of numerous jetty jacks and other potential hazards.

Effects from Subsurface Diversion in Middle Project Subarea

During the construction phase of the Subsurface Diversion, 23.1 acres of bosque would be temporarily lost. The same approximately 5.5 miles of conveyance and utility corridors as proposed for Paseo del Norte Diversion would be used under this alternative. Construction of three pump stations in the bosque might require restoration of recreational trails within the bosque. Operation of the Subsurface Diversion would not disturb in–river recreation once construction is completed.

Once constructed, the Subsurface Diversion would have a minimal effect on the river channel regarding fish migration/movement and any recreational boat traffic. However, during the construction phase and/or in the event of any sub-surface collector repairs, the surrounding environment would suffer the greatest damage of any of the action alternatives. Effects on recreational activity would be minimal, and of a duration only as long as the construction period. After the implementation of proposed mitigation measures (see Section 3.20.4), there would be only temporary effects on recreation, primarily during construction within the Middle Project Subarea.

Summary of Environmental Consequences

The addition of 65 cfs of the City's SJC water relative to the No Action Alternative would have a positive benefit on fisheries of the Rio Chama below the upstream reservoirs, and could benefit recreational angling in the Upper Project Subarea. Under the action alternatives, without compensation, the City may discontinue its program of voluntary cooperation of release of summer recreational flows from Heron Reservoir to

Abiquiu Reservoir due to the increased evaporative losses resulting from additional storage of the City SJC water at Abiquiu Reservoir.

The direct effects from construction related to the action alternatives within the Middle Project Subarea would be restricted to temporary disruption of hiking, equestrian, and similar recreational uses of bosque areas and off-bank fishing near diversion facilities.

There are no effects on recreational resources due to construction or operation of the DWP in the Lower Project Subarea.

Past water resources projects have changed the natural character of the Rio Grande. The reservoirs have created recreational opportunities, while flood control has permitted the establishment of some park areas in the bosque. Foreseeable planned future projects, of largely operational and maintenance activities, would likely not disturb existing recreational features within the ROI. With the addition of City SJC water above the point of diversion, cumulative effects upon recreation would be positive. Any potential cumulative effect of removing or altering some acres of bosque would be offset by mitigation and environmental enhancement work to restore other areas of the bosque within the Middle Project Subarea. Table 3.20-1 summarizes anticipated project effects on recreation for each DWP alternative.

TABLE 3.20-1
SUMMARY OF PROJECT EFFECTS ON RECREATION

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Number of reservoir angling days that would be lost because of project operations or construction (Upper Project Subarea)	None	None	None	None
Loss or diminished quality of fishery based recreation caused by project construction or operations (all project subareas)	None	None. Possible positive effect from periodic additions of the City's SJC flow below reservoirs	None. Possible positive effect from periodic additions of the City's SJC flow below reservoirs	None. Possible positive effect from periodic additions of the City's SJC flow below reservoirs
Loss or diminished quality of bosque recreational activity (Middle Project Subarea)	None	Temporary modification of hiking trails and visual/auditory experience during construction; loss of about 8.2 acres of bosque due to construction of permanent facilities	Temporary modification of hiking trails and diminished visual/auditory experience during construction; loss of 14.7 acres of bosque due to construction of permanent facilities	Temporary modification of hiking trails and diminished visual/auditory experience during construction; loss of 23.1 acres of bosque due to construction of permanent facilities

3.20.4 Proposed Mitigation Measures

The following project design features and construction BMPs would minimize project effects on recreational areas and activities:

- During construction in parks or the bosque, the construction contractor would have to meet the City's noise-abatement requirements (City, 1981) for operating construction equipment.

- If bike or pedestrian trails are temporarily obstructed during construction, where possible a temporary pathway or rerouting would be arranged to allow passage. Access to the City's open space parking lot on Alameda Boulevard would be maintained during all phases of construction.

- With the DWP in operation, the City would continue with its historic practice of cooperating with Reclamation and BLM in the coordination of releases from Heron Reservoir to Abiquiu Reservoir to benefit winter fisheries. This program of voluntary cooperation is subject to the City's prerogative and ability to meet its water requirements.

3.21 RIPARIAN AREAS

3.21.1 Introduction

Concerns expressed during the DWP scoping process included general effects on riparian (i.e., bosque) plant and animal species and hydraulic changes that could affect the bosque (see Appendices B through D). Riparian areas consist of hydrophytic vegetation found along riverine systems.

The method of analysis used to determine riparian effects was to map all riparian areas, and to locate proposed facilities and water-conveyance/transmission corridors that would be constructed within those areas. Vegetation maps and field surveys were used to delineate the riparian areas where major facilities would be constructed, and the types and extent of riparian vegetation to be affected by project activities were estimated. Construction zones were estimated by adding 100-foot buffer areas around direct impact areas. The buffer zones would be temporarily affected during project construction, and the direct impact zones for above-grade facilities would be permanently affected (i.e., impacts could not be fully mitigated).

Hydraulic modeling was used to determine if a diversion of 47,000 ac-ft/yr from the Rio Grande would affect downstream riparian vegetation by lowering the water table. A Hydraulic Engineering Center – River Analysis System (HEC-RAS) model (USACE, 1997) was run to compare mean and maximum in-stream flows to ground water elevations in the Middle Project Subarea (depletion area), assuming a direct correlation between river flow and shallow ground water elevation at certain river stages. This assumption confirmed by methods from Dupuit Flow, states that hydraulic gradient is equal to the slope of the water table and for small water table gradients, the streamlines are horizontal and the equipotential lines or ground water flow field are vertical with basis from Darcy's Law (Fetter, 1980).

3.21.2 Affected Environment

Riparian forests are a predominant feature of the Albuquerque Reach of the Rio Grande and of portions of the Rio Chama within the Upper Project Subarea. These riparian forests have been altered as a result of human activities such as diversion and impoundment of surface water. Non-native tree species like Russian olive (*Elaeagnus angustifolia*) and salt cedar (*Tamarix* spp.) dominate much of the bosque today. However, the Middle Rio Grande riparian forest, or bosque, represents the largest cottonwood-gallery riparian forest in the southwestern U.S. (Whitney, 1996 and 1999).

There is diverse vegetation throughout the project area on the Rio Chama and the Rio Grande from Heron Dam outlet to the DWP diversion point. The riparian areas along the Rio Chama support several vegetation types, including Ponderosa pine-Douglas fir, piñon-juniper woodlands, Great Basin sagebrush, emergent wetland, scrub-shrub wetland (willow), and forested wetland. Wetland vegetation along the project corridor potentially is affected by high flows (Bullard and Wells, 1992). Riparian (cottonwood) woodlands require periodic high flows for regeneration. Large, older cottonwoods inhabit the higher floodplain sites, whereas trees aged 5 years or younger are present on the edges of point bars adjacent to the river (Fogg *et al*., 1992).

The cottonwood/coyote willow community type dominates the riparian vegetation along the Rio Grande from the Rio Chama confluence to the headwaters of Cochiti Reservoir. These moderately open-canopied forests develop diverse understories composed of shrubs such as black chokecherry, skunkbush, and Wood's rose, and mesic perennial grasses and forbs (Durkin *et al*., 1995).

From the City's proposed diversion to the SWRP outfall (Middle Project Subarea), the riparian zone is dominated by cottonwood (*Populus deltoides* spp. *wislizeni*), which form a sparse to dense canopy cover along the river (Crawford *et al*., 1993). This area is managed by the City Open Space Division for its ecological diversity and recreation. Figures 3.21-1a and 1b show the vegetation classifications from the Angostura Diversion Dam to I-25 (National Biological Survey, 1993). In the understory, native species include coyote willow (*Salix exigua*), seepwillow (*Baccharis salcicfolia*), false indigo bush (*Amorpha fruitcosa*), New Mexico olive (*Forestiera pubescens*), and others. Introduced species such as salt cedar and Russian olive have been increasing in number and are becoming the dominant species in the understory and overstory (Crawford *et al*., 1993).

The Rio Grande floodplain downstream from the SWRP outfall is also dominated by cottonwoods and has many of the same characteristics as the area described above. The non-native salt cedar is a co-dominant in this reach (Durkin *et al*., 1995; Reclamation, 2000a).

Studies suggest that cottonwoods and willows would decline in abundance or become replaced with upland or non-native species when the ground water table drops below 3 to

6 feet for more than 30 days/month during the growing season and this condition persists for at least 3 months (Stromberg 1996; Scott *et al*., 1999; Shafroth *et al*., 1999; and Stromberg, 1998).

Existing riparian vegetation obtains most of its water from saturated capillary-fringe soils directly above the floodplain water table. The vigor of the riparian plants, especially cottonwoods and willows, depends on maintaining ground water levels within the range of root growth. Although ground water levels fluctuate daily, seasonally, and annually with river flows, typical maximum depths to ground water in Fremont cottonwood communities rarely exceed 16.4 feet (Stromberg, 1993). Salt cedar has a competitive advantage over cottonwoods and willows on regulated rivers subject to altered seasonal timing of regeneration floods, reduced stream flows and overbank floods, lowered water tables, and increased salinities (Stromberg, 1998).

Riparian cottonwoods typically are restricted to alluvial soils with shallow ground water, and are sensitive to depletions of ground water resulting from pumping (Stromberg *et al*., 1996) and surface water diversions (Rood *et al*., 1995). Studies suggest that riparian cottonwood forest along sand-bed rivers in relatively arid regions of the U.S. are vulnerable to water table declines associated with channel incision (Scott *et al*., 1999 and 2000; Shafroth *et al*., 2000), and that declines of 5 feet or more produce mortality and loss of forest area in existing stands (Scott *et al*., 1999).

3.21.3 Environmental Consequences

Effects from No Action Alternative

Depletions resulting from continued ground water pumping would result in lowering the ground water table in the riparian area. The OSE Interim Ground Water Model for the Albuquerque Basin predicts a difference in water table elevation between the DWP and No Action Alternatives on the order of 0.5 (0.5 foot average difference, 0.01 foot minimum differences, 8.02 foot maximum difference over the entire Rio Grande reach, 1.96 foot average difference, 0.01 foot minimum difference, 9.06 foot maximum difference between drains, will get higher approaching the levies) in the vicinity of the Rio Grande. An area between the riverside drains of approximately 373 acres would experience a reduction of 3 feet or greater and 607 acres would experience a reduction of 1 to 3 feet in water table for the No Action Alternative as compared to the DWP action alternatives. This is supported by empirical evidence in Reclamation (1997a) which states, "…interior drains are the only surface water features dramatically showing the effects of municipal pumping on the shallow ground water system. With ever greater municipal pumping has come progressive drying up of drains at increasing distances from pumping centers. The easternmost drains were the first to dry up, and many are no longer acting as ground water drains because of the general lowering of the water table. The Alameda Drain along North Second Street exemplifies this condition. These drains still function as surface water channels for routing irrigation water and storm runoff, and they do provide some incremental recharge as a consequence." A slight reduction in flow below the SWRP after 2040 is *diminimus* and would not affect river stage or riparian vegetation in the Lower Project Subarea.

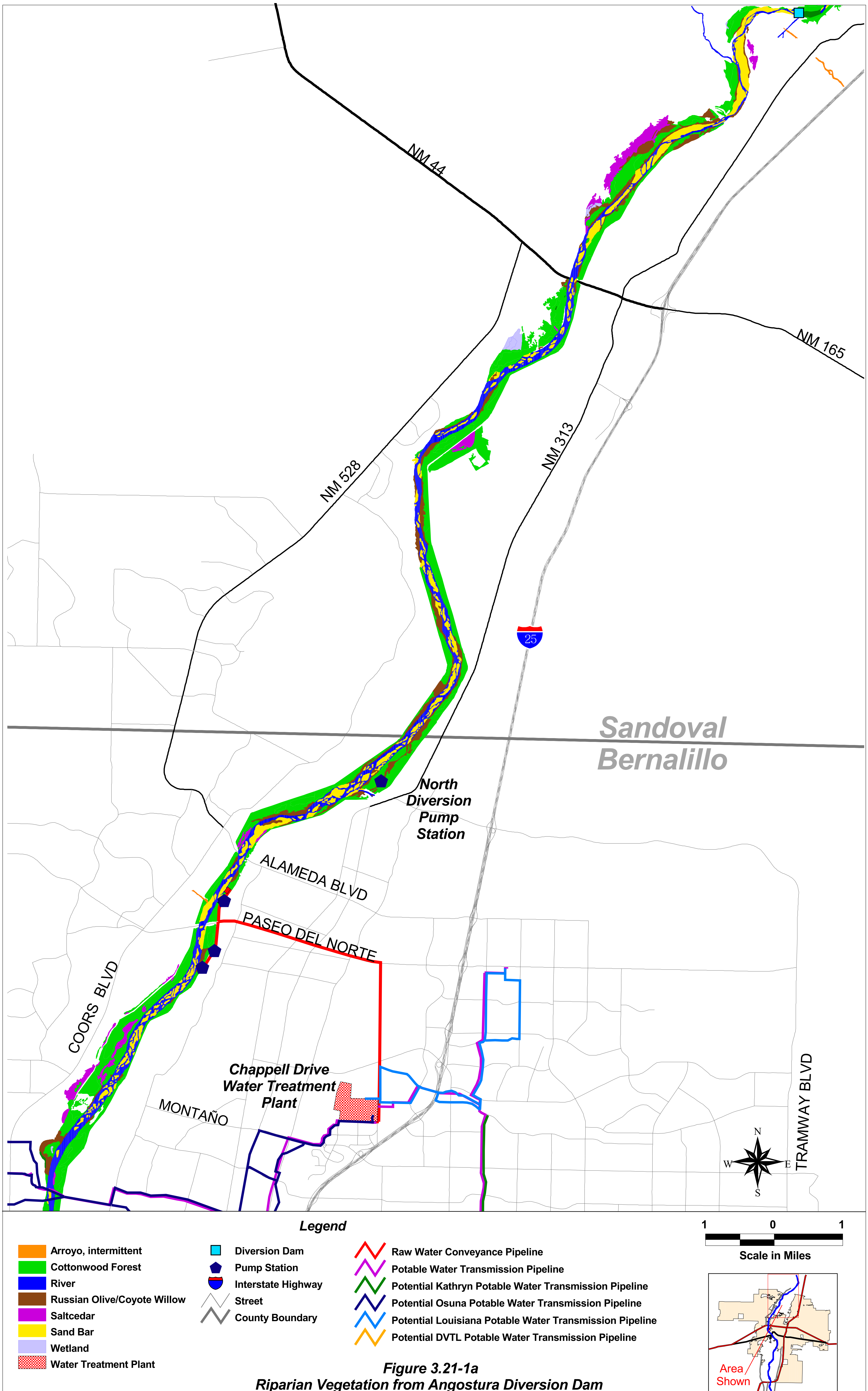

Figure 3.21-1a
Riparian Vegetation from Angostura Diversion Dam to Montaño Boulevard (Middle Project Subarea)

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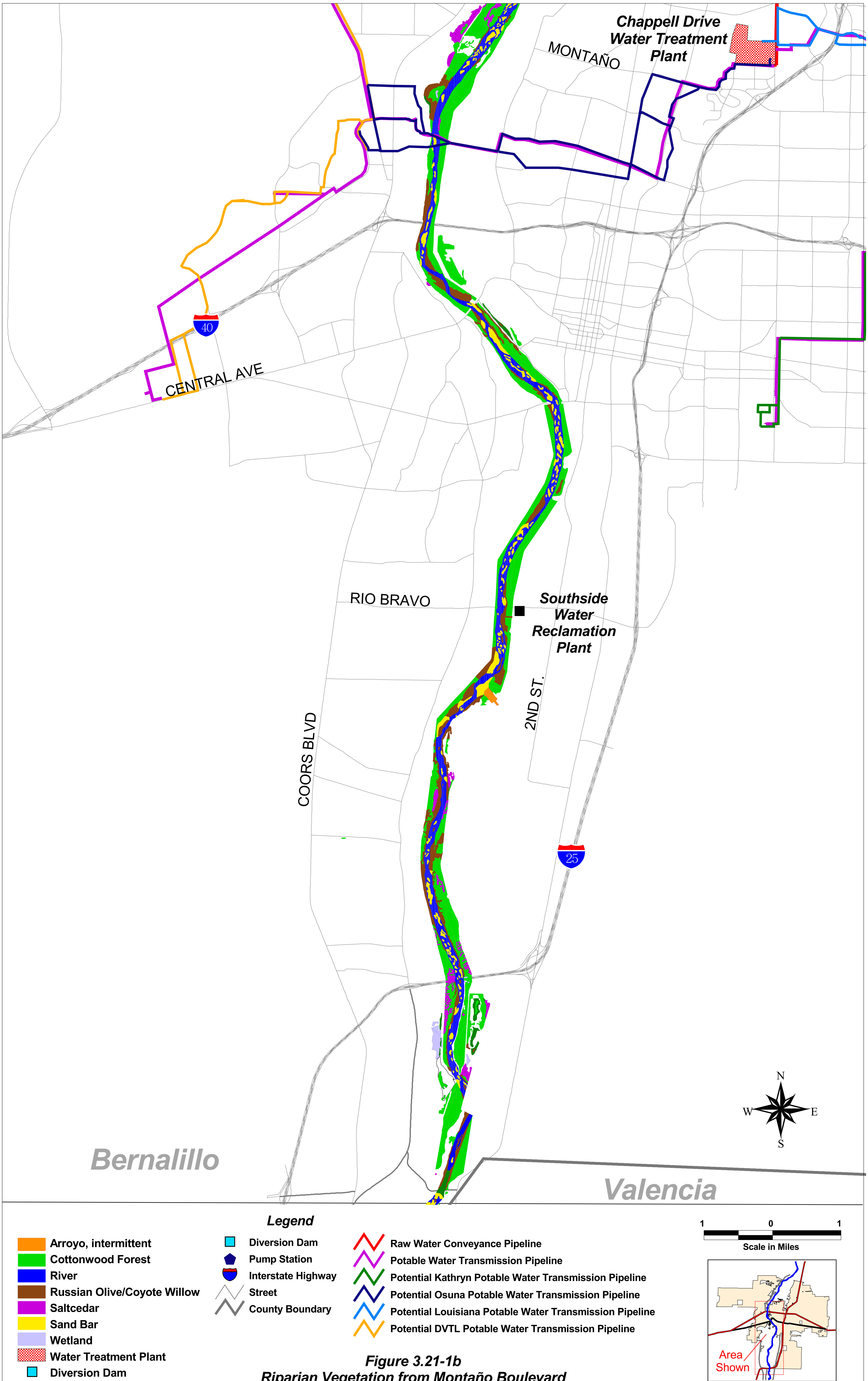

Figure 3.21-1b
Riparian Vegetation from Montaño Boulevard to Interstate 25 (Middle Project Subarea)

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Effects from Angostura Diversion

Temporary Construction Effects

Under the Angostura Diversion, construction of the fishway at the Angostura Dam would affect approximately 5.5 acres. Construction of the fish by-pass return pipe would affect approximately 2.4 acres and construction of the fish by-pass pipe (outfall) would affect approximately 0.3 acre. A total of approximately 8.2 acres of riparian habitat would be temporarily disturbed during modification of the Angostura Diversion Dam. The pump station for the Angostura Diversion does not affect riparian vegetation.

Under all three DWP action alternatives, a 1,000-foot-long segment of potable water distribution pipeline would be constructed through riparian areas and cross the river near Campbell Road. This pipeline may be up to 72 inches in diameter and would require an installation corridor about 6 feet wide. Assuming the 100-foot-wide construction buffer described in Section 3.21.1, approximately 2.4 acres of the bosque would be temporarily affected during pipeline construction.

Permanent Project Effects

Riparian losses associated with construction of permanent facilities at the diversion structure would include 1.7 acres for the fishway 0.1 acre for the fish-by-pass outfall; and the fish by-pass pipe. Because these losses would not be mitigated, the loss of a total of approximately 1.8 acres of riparian vegetation under Angostura Diversion would be considered permanent.

Operational Effects

Under all three action alternatives, the addition of 65 cfs (47,000 ac-ft/yr) relative to the No Action Alternative of the City's SJC water to the rivers would constitute a direct operational effect on the riparian corridor in the Upper Project Subarea from Heron Reservoir outlet works to the DWP diversion point. No measurable changes in water surface levels would result from the addition of this water (CH2M Hill, 2003). As a result no measurable changes to riparian vegetation would occur. Operational effects of Angostura Diversion on riparian vegetation would be the same as described below for Paseo del Norte Diversion.

Results of the HEC-RAS model show that the greatest changes in ground water elevation would be decreases of 0.38 foot during mean flows and 0.09 foot during maximum flows. These changes in ground water elevation would not be large enough to affect a change in riparian vegetation composition or to cause mortality of riparian vegetation. Differences in water table elevation for the curtailment flow of 130 cfs could not be calculated, though the riparian vegetation in the Middle Project Subarea has experienced such low flows during its lifetime, without significant, long-term consequences.

There would be no effects on riparian vegetation in the Lower Project Subarea due to the restoration of native flows via returns at the SWRP outfall.

In summary, direct effects of the Angostura Diversion on riparian vegetation in the Middle Project Subarea would include both temporary (8.2 acres) and permanent (1.8 acres) loss of riparian habitat. Temporary riparian habitat losses associated with construction and permanent riparian losses associated with the placement of Angostura Diversion structures in the bosque would be offset by the proposed mitigation measures (habitat restoration) discussed in Section 3.21.4. Reduced ground water levels for the Angostura Alternative or additional flow of SJC water from the Paseo del Norte or subsurface alternative will not impact the Pueblo of Sandia fish ponds set back from the river. In conclusion, DWP Angostura Diversion would not affect the riparian habitat in the Upper and Lower Project Subareas. Riparian vegetation in the Middle Project Subarea would experience some temporary and permanent effects that would be offset by proposed mitigation (Section 3.21.4).

Effects from Paseo del Norte Diversion

Temporary Construction Effects

Under Paseo del Norte Diversion, construction of the fishway, sluice channel, gravel access road, and pumping station in the Middle Project Subarea near Paseo del Norte would temporarily disturb approximately 14.7 acres of bosque. The temporary construction effect associated with the potable water pipeline, as described for Angostura Diversion, also would occur under Paseo del Norte Diversion.

Permanent Project Effects

Permanent loss of bosque would include 4.2 acres for access road, sluice channel, fishway, and pumping station construction.

There would be no measurable effects on riparian vegetation in the Upper Project Subarea due to operation of Paseo del Norte Diversion, and there would be no effects riparian vegetation in the Lower Project Subarea because of return flows at the SWRP.

Operational Effects

Results of the HEC-RAS model show that the greatest changes in ground water elevation would be decreases of 0.38 foot during mean flows and 0.09 foot during maximum flows. These changes in ground water elevation would not be large enough to affect a change in riparian vegetation composition or to cause mortality of riparian vegetation. Differences in water table elevation for the curtailment flows could not be calculated, though the riparian vegetation in the Middle Project Subarea has experienced such low flows during its lifetime, without significant, long-term consequences. Shallow ground water effects are presented in Section 3.16 within Figures 3.16-20 and 3.16-21. The historical range of fluctuations occurring in the river is more substantial than would occur from the project.

Direct effects of Paseo del Norte Diversion on riparian vegetation in the Middle Project Subarea would include both temporary and permanent loss of a minor amount of riparian habitat. These losses would be offset by the proposed mitigation measures discussed in Section 3.21.4. In conclusion, Paseo del Norte Diversion would not affect the riparian habitat in the Upper and Lower Project Subareas. This conclusion was reached based on the minor increase in flows in the Upper Project Subarea and resultant minor changes in hydrology (See Section 3.16) thus not affecting the riparian habitat. In the Lower Project Subarea, all native Rio Grande water will be returned to the river, re-establishing hydrologic conditions that exist without the DWP. Riparian habitat in the Middle Project Subarea would experience temporary and permanent effects that would be offset by the proposed mitigation measures noted below (Section 3.21.4).

Effects from Subsurface Diversion

Temporary Construction Effects

A total of approximately 23.1 acres of riparian habitat would be temporarily disturbed due to construction of the subsurface collectors, access roads, pipelines, and pump stations under Subsurface Diversion. Temporary effects from potable water pipeline construction would be as described for Angostura Diversion.

Operational Effects

Studies suggest that cottonwoods and willows would decline in abundance or become replaced with upland or non-native species when the ground water table drops below 3 to 6 feet for more than 30 days/month during the growing season and this condition persists for at least 3 months (Stromberg *et al.,* 1996; Scott *et al.* 1999; Shafroth *et al*., 1999; and Stomberg, 1998). Operational effects of Subsurface Diversion would result in ground water drawdowns greater than 3 feet in riparian habitat, which would result in the permanent loss of 10.6 acres of riparian habitat. Also, this area would see a 1.0- to 3.5-foot decline in ground water from project operations on both the east and west side of the river. Operational effects of Subsurface Diversion may result in substantial changes in overall plant-community structural composition resulting from ground water elevation declines of 1 to 3 feet during the growing season, which affects approximately 552 acres of riparian vegetation.

Permanent Project Effects

Permanent loss of bosque would include approximately 10.6 acres for construction of permanent diversion facilities, with the subsurface collectors (4.0 acres) and pump stations (6.0 acres) comprising the majority of these losses.

Operational effects of Subsurface Diversion would result in ground water drawdowns greater than 3 feet in riparian habitat, which would result in the permanent loss of 27.9 acres of riparian habitat. Also, this area would see a 1.0- to 3.5-foot decline in ground water from project operations on both the east and west side of the river. Operational effects of Subsurface Diversion may result in substantial changes in overall plant-community structural composition resulting from ground water elevation declines of 1 to 3 feet during the growing season, which affects approximately 552 acres of riparian vegetation.

There would be no measurable effects under Subsurface Diversion on riparian vegetation in the Upper Project Subarea, and no effects on the bosque in the Lower

Project Subarea. In conclusion, Subsurface Diversion would not affect riparian habitat in the Upper and Lower Project Subareas. This conclusion was reached based on the minor increase in flows in the Upper Project Subarea and resultant minor changes in hydrology (See Section 3.16) thus not affecting the riparian habitat. In the Lower Project Subarea, all native Rio Grande water will be returned to the river, re-establishing hydrologic conditions that exist without the DWP.

Direct effects of Subsurface Diversion on riparian vegetation in the Middle Project Subarea would include both temporary and permanent loss of riparian habitat. These seasonal losses attributable to drawdown of the water table would contribute to cumulative effects on the bosque from other development and diversion projects in the Middle Project Subarea, and from continued ground water pumping during parts of the year. These construction effects would be offset by proposed mitigation measures discussed below.

Summary of Environmental Consequences

Implementation of DWP action alternatives would result in the construction of permanent new structures in and near the Rio Grande. All action alternatives would result in the diversion of the same amount of water and would have minimal effects on riparian vegetation in the Upper Project Subarea. This conclusion is supported by information provided in Section 3.16, relating to changes in water depth and wetted channel width changes. Mitigation for the Subsurface Diversion would include a mix of the proposed measures discussed in Section 3.21.4. The bosque in the Lower Project Subarea would not be affected by any of the action alternatives. Effects in the Middle Project Subarea for the Angostura Diversion and the Paseo del Norte Diversion would include temporary and permanent loss of a minor amount of riparian habitat. Subsurface Diversion may result in adverse effects on 552 acres of riparian vegetation due to depression of the water table.

Cumulative effects from construction would include the permanent loss of riparian habitat under all three action alternatives, and the alteration of habitat conditions under the Subsurface Diversion. These effects would be offset by implementation of the proposed mitigation measures noted below (Section 3.21.4). Operational effects of all action alternatives would be minimal based on incorporation of the mitigation measures and environmental enhancements discussed in Section 3.21.4. No short-term or long-term effects would occur through implementation of Angostura Diversion and Paseo del Norte Diversion. Subsurface Diversion would result in the permanent loss of 27.9 acres of riparian habitat and the permanent alteration of 552 acres of riparian habitat. Mitigation for Angostura Diversion and Paseo del Norte Diversion are described extensively in Section 3.21.4, including measures that would replace areas permanently lost in the construction area or provide enhancements to other areas in coordination with Reclamation and USFWS. There are no short-term use versus long-term productivity concerns attributable to the Angostura Diversion or the Paseo del Norte Diversion. Long-term productivity losses associated with Subsurface Diversion would result if the 552 acres of riparian vegetation is substantially altered. Under the No Action Alternative 373 acres of riparian vegetation would be lost and an additional 607 acres affected by continued pumping. There are no irreversible and irretrievable commitments of resources with respect to riparian vegetation.

Cumulative effects from operation of the Angostura Diversion and Paseo del Norte Diversion would not occur. Cumulative effects from operation of Subsurface Diversion would include permanent loss and alteration of riparian habitat. These effects would be offset by implementation of the proposed mitigation measures noted below (Section 3.21.4). Effects on riparian vegetation for each DWP alternative are summarized in Table 3.21-1.

TABLE 3.21-1
SUMMARY OF PROJECT EFFECTS ON RIPARIAN AREAS

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Total length of riparian corridor likely to experience substantial changes in existing dominant plant structural composition (miles)	None	0	0.5	1.0
Riparian area temporarily lost due to diversion construction activities (acres)	None	8.2	14.7	23.1
Riparian area temporarily lost due to transmission pipeline construction (acres)	None	2.4	2.4	2.4
Riparian area permanently lost due to construction of new facilities (acres)	None	1.8	4.2	10.6
Riparian areas lost due to ground water elevation drawdown of > 3 feet below the existing average ground water depth for at least 1 month each year during the growing season (acres)	373	0	0	27.9
Riparian areas that would experience substantial changes in overall plant-community structural composition due to a ground water decline of 1 to 3 feet for at least 1 month per year (acres)	607	0	0	552

3.21.4 Proposed Mitigation Measures

Because City Open Space manages the riparian areas within the City as part of their responsibilities for the Rio Grande Valley State Park, mitigation for this resource area would include cooperation between the Public Works Department and Open Space Division (OSD). The following proposed mitigation measures would be made by the City to offset adverse project effects on the bosque in the Middle Project Subarea:

- Temporary materials- and equipment-staging areas at the water-diversion facility construction area would be reclaimed and revegetated with suitable native woody trees and shrubs.

- Project facilities to be located in the riparian corridor would be sited and sized to minimize the unnecessary loss of cottonwoods and other native vegetation.

- The City would restore the bosque and Rio Grande in the areas temporarily affected by the construction of the project to the original condition or complete environmental enhancements. During development of the technical plans and specifications for restoration of the Rio Grande channel, the City would coordinate with Reclamation, USACE, USFWS, and the ISC to design a channel section that could provide some area of potential habitat for the RGSM, and potential habitat for the southwestern willow flycatcher. If permits and approvals could not be obtained to construct the channel in such a manner, the City would construct the channel to match the existing section, as approved.

- The City would provide funding to continue to monitor and improve the AWRMS environmental enhancement program, including continuation of mammal, avian, and human-use studies for the bosque. Additional monitoring of amphibian/reptile populations and vegetation is needed in RGVSP within the Middle Project Subarea. Permanent transects have been established at 12 sites throughout the RGVSP to monitor these populations. The Bosque Action Plan mandates that these transects be monitored for changes every 3 to 5 years.

- Continue fuel reduction throughout the RGVSP utilizing the Inmate Work Camp Program through State Forestry under its current agreement with the OSD. Remove dead and downed material, thin and remove non-native species, treat stumps of non-native species so that they do not resprout, and replant with native cottonwood and understory species. The City is committed to improving the bosque and Rio Grande Valley State Park and will Coordinate annual programs with the Service. These programs, which include removing non-native plant species, will continue throughout the life of the project. In addition, the City began an extensive program in Fall of 2002 to remove non-native species from the riparian area within Albuquerque over the next five years. The City has already invested about $650,000 for equipment in this endeavor.

- Areas where fuel reduction or non-native species removal occurs will need to be replanted with native species, primarily the Rio Grande Cottonwood (*Populus deltoides* spp. *wislizeni*). Trees that are approximately 3 years old can be pole planted by placing them directly in contact with the shallow ground water. This is accomplished by digging a hole with an auger to the water table. Poles are then pushed through so that the root system is in contact with the water and the hole is refilled with dirt. Poles must be planted while they are dormant (i.e., from January through April of each year). Poles are usually wrapped with chicken wire to protect them from girdling by beavers. The pole-planting program has been in place for more than 10 years and has a success rate of approximately 80 percent in the RGVSP. Specific sites for plantings will be dependent upon fuel-reduction sites as well as areas that may need to be rehabilitated after a burn.

- The City has an ongoing program for improvements to the RGVSP. These programs, which include removing non-native plant species, will continue throughout the life of the project. In addition, the City began an extensive program in the fall of 2002 to remove non-native species from the riparian area within Albuquerque.

- A habitat mapping technical report has been developed to supplement the City's ongoing conservation measures to include opportunities for additional aquatic and riparian projects in the Albuquerque Reach of the river. This report included extensive field surveys mapping and ranking of potential sites within the Middle Rio Grande. Field efforts for this project were conducted in cooperation with the USFWS during February 2002.

- The proposed location for the habitat restoration mitigation activities is south of Paseo del Norte on the west side of the river and currently includes 160 acres (65 hectacres [ha]) of mixed bosque and 48 acres (19 ha) on the Montaño Oxbow. The work will include mechanical clearing of non-native vegetation to promote native species regeneration. The restoration of native vegetation will be done by either planting or re-establishing hydrologic connectivity. Individual cottonwood poles and willow whips, willow bundles/mats, individual shrubs, reseeding, or other planting methods at a density of 120 plant units per acre are potential methods that may be used to enhance flycatcher habitat.

- An overbank project of 10 acres (4 ha) will be created that will provide refuge for aquatic organisms, restoration of riparian vegetation, and re-establishment of a river channel/floodplain interaction. The newly created terraces will be placed in an area where the channel is relatively incised and the potential for overbank flows is minimal.

- Two high-flow side channels will be constructed to provide aquatic habitat at flows greater than 1,500 cfs (42.48 m^3s) and 2,000 cfs (56.63 m^3s), respectively. The functional purpose of the side channels is to provide backwater and slower velocity areas for aquatic and terrestrial species and increase the potential for overbank flooding and native species regeneration.

- Channel widening and bank destabilization will be promoted by the removal of 120 jetty jacks. Removal of the jetty jacks, in combination with clearing vegetation and bank lowering, will encourage native species reestablishment and the creation of shallower, slower velocity habitats for the RGSM.

- Two river bars will be enhanced by a combination of non-native species vegetation clearing, lowering, and pilot channel work. This project will also promote the creation of shallower, slower velocity habitats for the RGSM.

- Flow will be reestablished to the Montaño Oxbow by the construction of an additional high-side flow channel and non-native vegetation removal. This project will be designed to provide back-water and side channel habitat, adjacent and connected to, the river channel for RGSM habitat and restoration of native riparian vegetation.

- The City will be responsible for identifying and reporting the presence of all cottonwoods (seedlings through mature trees remaining inn the construction site to the City's Open Space Division. The City will plant 3 new plants for each plant removed smaller than 6 inches in diameter, and 10 new plants for each removed plant larger than 6 inches in diameter within the City's Open Space. These replacement ratios apply to native vegetation within those areas directly damaged by construction. Planting native vegetation near a disturbance area at a ratio of 1 native for every exotic species removed and 2 natives for every native plant removed will mitigate the loss of riparian vegetation.

To determine whether these projects are successful, baseline data will be collected, and both short-term and long-term objectives will be established. Examples of parameters that will be assessed under each of these categories are illustrated as follows:

Initial/Baseline Data

a. Number of acres in non-native vegetation
b. Number of acres in native vegetation
c. Number of acres in non-restored burned condition
d. Initial plant, insect and mammal species composition

- Immediate/Short-term objectives

a. Number of acres planted into native species or restored
b. Number of cottonwood pole plantings, willow whips or shrubs
c. Acreage of burned area cleared
d. Acreage of bank-lowering completed
e. Length of side channels created
f. Number of jetty-jacks removed
g. Changes in species composition

- Ongoing/Long-term Measures

a. Percent survival rate of cottonwood planting
b. Size of overbank lowering reclaimed to natural conditions
c. Survival rate of native species within overbank areas
d. Presence or increase of endangered or delivered species in restoration areas

e. Presence of indicator species showing habitat improvement

- Overall improvements in water or soil quality.

3.22 SOCIOECONOMICS

3.22.1 Introduction

Primary socioeconomic issues identified during DWP scoping were as follows:

- The project's effect on water bills for the average City resident;
- Who will bear the cost of the project, which is a component of the City's AWRMS; and
- Changes in construction and permanent employment as a result of project construction and operation.

This socioeconomic assessment identifies major social and economic benefits and costs of construction and operation of the DWP. The analysis area was Bernalillo and Sandoval Counties (in the Middle Project Subarea), because most project-related socioeconomic effects would be expected to occur in those areas. A 20-year cost analysis was performed for the No Action and action alternatives following industry standards. Beyond this period uncertainty exists regarding additional operation, maintenance and replacement costs that will occur. Quality of life considerations, evaluated by CH2M Hill (2001b) included assessing the compatibility of the project with assets and amenities, and adjacent land use aspects of the project.

3.22.2 Affected Environment

Bernalillo is one of 33 counties in New Mexico and is one of three counties in the Albuquerque Metropolitan Statistical Area (MSA). Its total population in 2000 was 556,678 (Census, 2000). The City of Albuquerque itself lies entirely within Bernalillo County. In 1999, Bernalillo County had a per-capita income of $27,287, which was substantially higher than the statewide average of $21,836 (BBER, 2001). During the 1990s, county per-capita income grew at a rate of 4.8 percent per year. The estimated median family income for the entire Albuquerque MSA in 2001 is $49,000 (U.S. Department of Housing and Urban Development, 2001). Annual average employment in Bernalillo County in 2000 was 307,709 individuals, and the unemployment rate averaged 3.2 percent (New Mexico Department of Labor, 2001). Employment by sector was greatest for services, government, and wholesale/retail trade, with approximately one-third of all employed individuals working in a service-related position in 2000.

The largest employers in the Albuquerque area are public schools (10,600 employees), the University of New Mexico (14,401 employees), Kirtland Air Force Base (8,967 individuals), and the City (9,000 persons). In 2000, there were 20,611 construction jobs in the county (Department of Labor, 2001). Surplus employment capacity exists for all public services, including police and fire protection, health care, education, and water and wastewater treatment facilities.

Sandoval County is also part of the Albuquerque MSA. Its 2000 population of 89,908 ranked fifth in the state. In 1999, Sandoval had a per-capita personal income of $20,747, which ranked 6th in the state, and was 96 percent of the state average ($21,836). The 1999 per-capita income reflected an increase of 1.4 percent from 1998. In 1999, Sandoval County had a total personal income of $1,872,519,000 which reflected an increase of 4.0 percent from 1998. Annual average employment in Sandoval County in 2000 was 24,133, and the unemployment rate was 3.3.

The AWRMS was adopted by the Albuquerque City Council on April 24, 1997. The total estimated cost for implementing the AWRMS was initially estimated at $180 million. AWRMS water-reclamation and -reuse projects were estimated to cost $32.4 million, or about 18 percent of the total. To date, approximately $37.4 million has been expended to implement three AWRMS projects: the Non-Potable Surface Water Project, the Industrial Water Reuse Project, and the Southside Water Reclamation Project.

Projects under the AWRMS are funded from a series of dedicated City water-rate increases, to be implemented over a 7-year period, beginning in 1998. The City has planned a series of small water-rate increases because they are easier to implement than a single, large increase. The City Administration and the City Council must authorize the rate increases each year.

The first rate increase of 4.7 percent went into effect on May 1, 1998. The second increase (also 4.7 percent) went into effect on May 1, 1999. The third proposed rate increase of about 7 percent was implemented on May 1, 2000. The fourth increase went into effect on May 1, 2001, the fifth, sixth and seventh increases were approved May, 2002. Because rate increases are staged, the effect on an annual basis would be relatively smaller.

3.22.3 Environmental Consequences

The following criteria were considered in evaluating the potential socioeconomic effects:

- Water-rate increases for implementation of the DWP that represent an economic hardship for City water customers (i.e., a monthly rate increase that exceeds either 10 percent of the current average annual water bill above what would occur under the No Action Alternative, or 1 percent of the average annual family income); and

- Businesses that are forced to close or relocate as a result of project construction.

The major financial impacts of the No Action and DWP Alternatives are summarized in the table below. This summary is modified from a financial analysis, originally prepared in 1997 (CH2M Hill, 1997c), to reflect the preferred DWP diversion alternative (surface diversion rather than infiltration gallery) and updated evaluations of possible costs related to arsenic treatment, subsidence and desalination based on latest (CH2M Hill, 2003) data. Opinions of the Facility Costs (including arsenic treatment) presented in the table represent net present value (NPV) during the period 2005-2025. A 4 percent discount factor is assumed. No attempt was made to estimate replacement costs for DWP or No Action major facilities between 2025 and 2060 due to uncertainties associated with the life expectancy of such facilities.

Estimated costs for subsidence and desalination provided in the table are rough NPV costs through 2060 using the previously stated assumptions and a 4 percent discount factor.

The total NPV for the three DWP alternatives through 2025 are estimated to range from about $485 to $527 million. The total NPV through 2025 for the No Action Alternative is estimated at $368 million. However, with potential costs associated with subsidence and desalination factored in, the estimated NPV costs of the No Action Alternative is about $630 million and could be higher than the DWP alternatives at $510 to $550 million (rounded).

While the estimated NPV costs for the No Action and action alternatives would appear to be similar, it is important to note that implementation of the DWP would result in a savings of more than 2.2 million ac-ft in aquifer storage (i.e., enhanced drought reserve) through 2060 because of reduced pumpage (CH2M Hill, 2003). Assuming such water was worth a conservative $1,000 per ac-ft, the value of the enhanced 2.2 million ac-ft drought reserve under the action alternatives would be several billion dollars. In addition the DWP provides a renewable sustainable water supply through this time period that will provide benefits well beyond this time period evaluated.

Effects from No Action Alternative

The No Action Alternative includes the construction and operation of ground water wells. Table 3.22-1 shows the total estimated cost (net present value [NPV]) through 2025) of the No Action Alternative is $634 million, which includes capital costs and labor (CH2M Hill, 2002a). This includes $166 million as an estimate of potential damages due to subsidence and $100 million for desalination required as a result of deteriorating ground water quality. The construction cost for the No Action Alternative would be paid through water-rate increases. The No Action Alternative would also have potentially long-term adverse socioeconomic consequences because it would not address the AWRMS objectives of reducing the City's reliance on decreasing supplies of potable ground water and creating a ground water drought reserve. The total estimated construction cost of arsenic compliance without the proposed surface water treatment plant (no action) is approximately $200 million.

TABLE 3.22-1
TOTAL COST OF NO ACTION ALTERNATIVE (IN MILLIONS OF DOLLARS)

Alternative	Construction Costs, NPV through 2025	O&M Costs, NPV Through 2025	Arsenic Treatment and O&M Costs, NPV through 2025	Total Costs, NPV through 2025	Potential Subsidence Costs – NPV through 2060	Potential Desalination Costs – NPV through 2060	Total No Action
No Action							
Diversion, Treatment, and Transmission	n/a	n/a	n/a	n/a			
Ground water Facilities	53	115	200	368	166	100	634
Total	**53**	**115**	**200**	**368**	**166**	**100**	**634**

Source: CH2M Hill, 2002a.

The estimated operations and maintenance costs for the arsenic treatment facilities is $2.85 million per year. This equates to an O&M present worth (6 percent for 20 years) of around $2 million. The total present worth is approximately $200 million as shown on Table 3.22-1. The proposed surface water treatment plant will allow the City to remove the high arsenic wells from service, thus eliminating the need for treatment at these wells.

Continued depletion of this non-renewable resource would ultimately have adverse effects on the quality of life as indicated by economic vitality and opportunity in the Albuquerque area, and on the cost of supplying potable water to the City's water service area. Implementation of the No Action Alternative also eventually would result in higher water rates to cover the costs of constructing additional ground water wells, and possibly treatment of ground water to meet more stringent drinking-water standards. There would be short-term economic benefits associated with the construction of additional wells and treatment facilities.

Other economic and social costs of the No Action Alternative would be associated with continued ground water depletion, subsequent water shortages, and possible economic costs associated with land subsidence and damages to infrastructure. In addition to these costs, a no-action strategy could eventually have an economic effect on the City's tax base, as some businesses decide to relocate, and new business cannot be attracted to the area. These costs have not been estimated, but a recent independent analysis concluded, "a constrained water supply will undermine the economic progress that Albuquerque has achieved in the last 20 years" (McDonald, 2001). The costs of the No Action Alternative could ultimately exceed the development costs of the DWP. These costs would typically be reflected as higher property taxes, high water rates, and increased cost of living.

Effects from Angostura Diversion

Table 3.22-2 shows the total estimated cost for Angostura Diversion (total cost NPV through 2025) is $538 million, which includes capital costs and labor (CH2M Hill, 2002a). This also includes $36 million for the cost of arsenic treatment and $26 million for potential damage caused by subsidence. In this analysis, it was assumed that the AWRMS budget would be increased to cover the combined costs of the Non-Potable Surface Water Project, the Industrial Water Reuse Project, the Southside Water Reclamation Project, and the DWP. Much of this money would be spent within the local economy, which would benefit many different wholesale and retail businesses.

Potential socioeconomic consequences would be associated with facility construction and operation, and payment for the project through water rate increases. Project construction would have largely beneficial consequences. Beneficial effects would be associated with local purchases of material, equipment, and supplies, and the creation of temporary jobs for construction workers.

TABLE 3.22-2
ANGOSTURA DIVERSION COSTS (IN MILLIONS OF DOLLARS)

Alternative	Construction Costs, NPV through 2025	O&M Costs, NPV Through 2025	Arsenic Treatment and O&M Costs, NPV through 2025	Total Costs, NPV through 2025	Potential Subsidence Costs –NPV through 2060	Potential Desalination Costs – NPV through 2060	Total Cost Angostura Alternative
Angostura Diversion							
Diversion Treatment, and Transmission	216	208		424			
Ground water Facilities	16	36	36	88	26		
Total	**232**	**244**	**36**	**512**	**26**		**538**

It is estimated that the Angostura Diversion, project construction would take 27 months. Construction would require approximately 1.2 million labor hours, provided by an average workforce of about 250 persons, with a peak of about 420 workers. It is estimated that approximately 20 percent of all construction workers (about 85 workers on-peak) would temporarily move to the area from outside Bernalillo or Sandoval Counties. This estimate was based on the large number of construction workers already residing or working in the area.

Increases in the number of construction jobs, and increased expenditure of worker salaries on goods and services in the metropolitan area, would be major benefits for the local economy. Construction workers, consisting of engineers, electricians, carpenters, concrete workers, heavy-equipment operators, and laborers, are expected to earn $36.7 million based on an average salary of about $30 per hour (CH2M Hill, 2001c). Worker salaries would be spent locally, generating additional regional income. For every direct wage dollar spent in the local area, an additional one to two indirect dollars would potentially be generated. Such a benefit would occur as retail sales increase and more service jobs are created. Over time, the combined revenue effect of direct and indirect payments from DWP construction jobs could exceed $100 million.

Because only about 85 workers would be expected to temporarily move to the area during construction of the Angostura Alternative, effects on public services and infrastructure would likely be short-term and minor. No additional police officers, firefighters, doctors, or teachers would be required as a result of project implementation, and the existing housing supply would easily accommodate this small, temporary population increase. Non-local workers would be expected to leave the area after construction is completed. Construction of the proposed Angostura diversion facilities, pump station, and raw-water conveyance facilities to the WTP would not adversely affect any existing local businesses. The potable water-distribution pipelines would cross through some commercial/industrial districts in the City; however, no businesses would be forced to close or relocate as result of this component of the project because pipeline construction would generally take place within existing utility rights-of-way, and no individual business location would be affected by construction for more than 2 days (based on a pipeline installation rate of 400 to 500 linear feet per day).The effects of DWP project operation would be positive, and would create 10 to 15 long-term jobs to operate and maintain and monitor the facilities. These employees would generally be hired from the local area. The City would also consider training some qualified applicants to operate or maintain all facilities

Effects from Paseo del Norte Diversion

Table 3.22-3 shows the total estimated cost for Paseo del Norte Diversion (total cost NPV through 2025) is $511 million, which includes capital costs and labor (CH2M Hill, 2002a). This also includes $36 million for the cost of arsenic treatment and $26 million for potential damage caused by subsidence. In this analysis, it was assumed that the AWRMS budget would be increased to cover the combined costs of the Non-Potable Surface Water Project, the Industrial Water Reuse Project, the Southside Water Reclamation Project, and the DWP.

Construction of this alternative would involve a peak workforce of 382 individuals and an average workforce of 220. The temporary in-migration on peak would be about 75 workers. Existing public services and housing in the Albuquerque area would easily accommodate this small temporary population increase. The total labor cost is projected to be $32.4 million, and the construction schedule for Paseo del Norte Diversion would be 27 months. The construction cost for this alternative would be paid through water-rate increases.

No businesses would be forced to close or relocate as a result of diversion facility, pump station, or water line construction under Paseo del Norte Diversion. The socioeconomic effects of closing these businesses would be as described for Angostura Diversion.

Effects from Subsurface Diversion

Table 3.22-4 shows the total estimated cost for Subsurface Diversion (total cost NPV through 2025) is $553 million, which includes capital costs and labor (CH2M Hill, 2002a). This also includes $36 million for the cost of arsenic treatment and $26 million for potential damage caused by subsidence. In this analysis, it was assumed that the AWRMS budget would be increased to cover the combined costs of the Non-Potable Surface Water Project, the Industrial Water Reuse Project, the Southside Water Reclamation Project, and the DWP.

The socioeconomic effects of Subsurface Diversion would be similar to those described for the other action alternatives. Implementation of this DWP alternative would involve a peak construction workforce of 446 individuals and an average workforce of 263 persons. The temporary in-migration on peak would be about 90 construction workers. Existing public services and housing in the Albuquerque area would easily accommodate this small, temporary population increase. The total projected construction labor cost for Subsurface Diversion is $38.5 million, and the construction schedule for Subsurface Diversion would be 27 months (the same as for the other alternatives). The construction cost for this alternative would be paid through water-rate increases.

Summary of Environmental Consequences

There would be direct and indirect short-term economic benefits associated with the construction of the DWP in the form of new jobs for construction workers, and the influx of worker salaries into the local economy. Approximately 15 permanent jobs would be created for operation of the DWP facilities.

TABLE 3.22-3
PASEO DEL NORTE DIVERSION COSTS (IN MILLIONS OF DOLLARS)

Alternative	Construction Costs, NPV through 2025	O&M Costs, NPV Through 2025	Arsenic Treatment and O&M Costs, NPV through 2025	Total Costs, NPV through 2025	Potential Subsidence Costs –NPV through 2060	Potential Desalination Costs – NPV through 2060	Total Paseo del Norte Diversion
Paseo del Norte Diversion							
Diversion, Treatment, and Transmission	194	203		397		n/a	
Ground water Facilities	16	36	36	88	26	n/a	
Total	**210**	**239**	**36**	**485**	**26**	**n/a**	**511**

TABLE 3.22-4
SUBSURFACE DIVERSION COSTS (IN MILLIONS OF DOLLARS)

Alternative	Construction Costs, NPV through 2025	O&M Costs, NPV Through 2025	Range in Arsenic Treatment and O&M Costs, NPV through 2025	Total Costs, NPV through 2025	Potential Subsidence Costs –NPV through 2060	Potential Desalination Costs – NPV through 2060	Total Subsurface Diversion
Subsurface Diversion							
Diversion Treatment, and Transmission	235	204		439		n/a	
Ground water Facilities	16	36	36	88	26	n/a	
Total	**251**	**240**	**36**	**527**	**26**	**n/a**	**553**

Water-rate increases that would be implemented by the City to subsidize the DWP costs would not pose a hardship on the average water user in the City's water service area. There also would be an overall positive effect on the social and economic conditions of the metropolitan area due to ensuring a reliable potable water supply and sustaining the quality of life. Under the No Action Alternative, these positive effects would not be realized, and the cost of living could increase while the quality of life decreases if alternative water supplies are not identified. Past water resources projects within the ROI are generally perceived as having benefited some members of the regional economy. This has been accomplished by irrigation for agriculture and flood control. These economic benefits would be expected to continue with implementation of the DWP.

Planned projects within the ROI are generally of an operational or maintenance type. These actions may improve the management and functions of the river. Regarding socioeconomics, where the economic costs are borne by City ratepayers, no cumulative socioeconomic effects to others in the ROI would be expected. The anticipated project-related socioeconomic effects are summarized by alternative in Table 3.22-5.

TABLE 3.22-5
SUMMARY OF PROJECT EFFECTS ON SOCIOECONOMIC CONDITIONS

	Alternative			
Evaluation Criterion	**No Action**	**Angostura Diversion**	**Paseo del Norte Diversion**	**Subsurface Diversion**
Total number of permanent new jobs gained because of the project	0	15 to 20	15 to 20	15 to 20
Total number of temporary or seasonal new jobs gained because of the project	0	420	380	446
Average number of construction jobs gained during the period of DWP construction	0	250	220	263

3.22.4 Proposed Mitigation Measures

The following project design features would minimize potential DWP effects on socioeconomic conditions.

- Use existing road and utility rights-of-way as much as possible to reduce permitting and land acquisitions cost and to reduce disruption of commercial facilities.
- Hire local construction personnel to build the project.
- Hire and train local professional or service personnel to operate and maintain facilities so direct and secondary spending remains in the local economy.

3.23 SOILS

3.23.1 Introduction

Concerns about soil impacts identified during project scoping included erosion (by wind and water), and the emission of fugitive dust during construction. Dust emissions related to construction are considered under the air-quality evaluation (see Section 3.6).

Evaluation methods for soil included mapping and describing soil types within the Middle Project Subarea, where the raw-water diversion would occur and the DWP facilities would be constructed. Soils and their erosional and drainage characteristics were identified using existing soil maps and other published materials.

3.23.2 Affected Environment

Soil structure in the project area is a function of past geomorphic processes, and most DWP features would be constructed in the Rio Grande channel or on surrounding floodplain and gravel terraces. Entisols occur on the Rio Grande floodplain. Derived primarily from transported sediments that historically were deposited by overbank flooding, these soils are relatively rich in minerals and have supported agriculture for centuries (USDA, 1977). Terraces along the margins of the floodplain have silty/sandy to gravelly soils, with areas of commercially exploited sand and gravel deposits.

Based on available reference materials, no highly erodible soils or difficult to revegetated soils were located within the project construction areas. No prime farmland soil exists within the immediate areas proposed for DWP construction under action alternatives. Prime farmlands are formally defined in and regulated under PL 97-98, the Farmland Protection Policy Act (CEQ, 1980; USDA, 1992).

The Angostura Diversion would include construction of a pumping facility near the NDC, which would be located on Vinton loamy sand. This soil has a moderate to severe hazard of blowing, and can be used for pasture, wildlife habitat, community development, as well as row-crop production (USDA, 1977). The new diversion facilities proposed under Paseo del Norte Diversion and Subsurface Diversion would be constructed within 1,600 feet and from 2,500 to 4,500 feet, respectively, north of the Paseo del Norte Bridge. Soil types that would be affected by construction activities in this area are Vinton and Brazito soils; surficial soils range from sand to clay and are dominantly sandy (i.e., loamy sand or sandy loam). This area is unprotected by levees, and the soils, stabilized by vegetation, are subject to flooding. Runoff and erosion hazards are slight, except during periods of flooding. This soil type is typical of wildlife habitat and recreation use along the river corridor, and has a potential for producing wood products (USDA, 1977).

3.23.3 Environmental Consequences

For this evaluation, degradation or loss of prime farmland or other unique soil type, or creation of long-term, uncontrolled soil stability or severe erosional conditions were considered to be changes significant enough to cause a project-related soil impact. Anticipated project effects on soils are reviewed for the No Action and action alternatives in the following subsections.

Effects from No Action Alternative

Limited project-related construction of additional ground water wells would take place under the No Action Alternative. Any stability concerns related to installation of new ground water wells to meet future potable water demands would be short term, and would be addressed through standard engineering practices and construction BMPs. An indirect effect of the No Action Alternative could be the issue of surface soil instability related to subsidence in areas where the water table is dramatically lowered as a result of continued pumping of the aquifer at rates that exceed the recharge capacity.

Effects from Action Alternatives

Sandy soil (60 to 80 percent sand) is present along the banks of the Rio Grande near the Angostura Diversion Dam and north of the Paseo del Norte Bridge. Short-term construction impacts along the river would include erosion and slope-stability issues. No highly-erodible soils would be altered by diversion-structure construction or operation. However, the sandy soil types located in the construction areas have severe stability limitations for excavations. Soil properties are very unfavorable for open excavations, and difficulty would be expected in maintaining a safe slope on excavation laybacks. Significant amounts of soil would not be disturbed by construction.

Summary of Environmental Consequences

There would be no direct or indirect long-term adverse effects on soils from implementation of any of the DWP alternatives (including No Action). Short-term construction effects on erosion and slope-stability would be controlled by the proposed mitigation measures outlined in Section 3.23.4. There would be no loss or degradation of unique soils, so there is no consideration of short-term use versus long-term productivity of soils in the Albuquerque area. Nor would there be any irreversible and irretrievable commitment of soil resources. Past water resources projects in the ROI have had effects to site specific soils, particularly during construction activities, where soils have been removed, disturbed or inundated by water. The soils potentially affected by the DWP are not rare or of agricultural value. Future planned projects within the ROI are mainly those of an operational or maintenance type. The levee maintenance projects may disturb some soils. Cumulative effects to soil resources in the ROI attributable to this project are very minimal. Project effects on soils are summarized in Table 3.23-1.

3.23.4 Proposed Mitigation Measures

The following project engineering controls would be implemented during DWP construction, in accordance with City construction permit requirements. Compliance with these measures would be required for safe working conditions during excavation.

- The construction contractor would have to meet Occupational Safety and Health Administration and City requirements for slope stability during construction.

TABLE 3.23-1
SUMMARY OF PROJECT EFFECTS ON SOILS

	Alternative			
Evaluation Criterion	**No Action**	**Angostura Diversion**	**Paseo del Norte Diversion**	**Subsurface Diversion**
Loss or degradation of prime farmland or unique soils (acres)	None	None	None	None
Creation of long-term uncontrolled erosion or unstable soil conditions	Potential for unstable soils due to subsidence related to aquifer depletion	None	None	None

- The contractor would have to comply with construction permit requirements and local ordinances governing the generation of fugitive dust, control of run-on and run-off, and site restoration (e.g., re-vegetation or seeding) to prevent erosion.

3.24 THREATENED AND ENDANGERED SPECIES

3.24.1 Introduction

Concerns about threatened and endangered species expressed during DWP scoping included protection of threatened and endangered species and their habitats in the project area. Particular concerns were expressed for impacts on the Rio Grande silvery minnow (RGSM) and the Southwestern willow flycatcher (see Appendices B through D).

Methods used to assess potential DWP effects on this resource category involved identifying all threatened and endangered species that could potentially occur in the DWP ROI, identifying suitable habitat for these species, and determining where project conditions could alter these habitats. Habitat changes were then assessed in terms of their potential to adversely affect threatened and/or endangered species, and the magnitude of such effects.

3.24.2 Affected Environment

Lists of special-status species, including federally and state-listed endangered, threatened, and candidate species, and species of concern for Rio Arriba, Los Alamos, Santa Fe, Sandoval, Bernalillo, Valencia, Socorro and Sierra Counties, were obtained from the USFWS New Mexico Ecological Services Office (USFWS, 2002) and from NMDGF. The list of sensitive plants species maintained by the New Mexico Forestry and Resources Conservation Division (NMFRCD, 1995) for the Bernalillo County (Middle Project Subarea) also was reviewed. Federally listed and candidate species are summarized in Table 3.24-1. Table 3.24-2 presents the state-listed threatened and endangered species. All three project subareas were evaluated for this resource category.

TABLE 3.24-1
FEDERALLY LISTED ENDANGERED, THREATENED, AND CANDIDATE SPECIES FOR PROJECT AREA COUNTIES

Common Name	Scientific Name	Federal Status [a/]	Critical Habitat	County Listed [c/]	Habitat
Alamosa springsnail	*Tryonia alamosae*	E	No	7	Thermal springs.
Bald eagle	*Haliaeetus leucocephalus*	T	No	All	Rivers, reservoirs with large trees or cliffs near the water.
Black-footed ferret	*Mustela nigripes*	E	No	All	Grassland plains surrounding mountain basins to 10,500 ft elevation. Usually found in association with prairie dogs, which serve as their primary food source and provide the ferrets with abandoned burrows for shelter.
Black-tailed prairie dog	*Cynomys ludovicianus*	C	No	7	Grassland plains surrounding mountain basins to 10,500 ft elevation.
Boreal western toad	*Bufo boreas boreas*	C	No	1	Lives near springs, streams, ponds and lakes in foothill woodlands, mountain meadows, and moist subalpine forest to 10,500 ft.
Canada lynx	*Lynx canadensis*	T	No	1	In the west, lynx live in subalpine/coniferous forests.
Chiricahua leopard frog	*Rana chiricahuensis*	PT	No	7, 8	Occurs from 3,300-8,500 ft elevations and in a variety of permanent aquatic habitats where adequate depth provides escape from predators. These habitats include montane springs, streams, ponds, lakes, marshes, stock ponds, and plunge pools of canyon streams.
Chupadera springsnail	*Pyrgulopsis chupaderae*	C	No	7	Thermal springs.
Gila trout	*Oncorhynchus gilae*	E	No	8	Headwater streams of the Gila and San Francisco Rivers in New Mexico.
Interior least tern	*Sterna antillarum athalassos*	E	No	1, 7	Bare or nearly bare ground on alluvial islands or sandbars, the availability of food (primarily small fish), and the existence of favorable water levels during the nesting season so the nests are not inundated. Preferred nesting sites are salt flats, broad sandbars, and barren shores along wide, shallow rivers.
Mexican spotted owl	*Strix occidentalis lucida*	T	Yes	All	Mature montane forest and woodland, shady wooded canyons, and steep canyons.
Mountain plover	*Charadrius montanus*	PT	No	2, 4-6	Arid shortgrass prairie, which is dominated by blue grama and buffalo grass with scattered clumps of cacti and forbs.

TABLE 3.24-1 (Continued)
FEDERALLY LISTED ENDANGERED, THREATENED, AND CANDIDATE SPECIES FOR PROJECT AREA COUNTIES

Common Name	Scientific Name	Federal Status [a/]	Critical Habitat	County Listed [c/]	Habitat
Northern aplomado falcon	*Falco femoralis septentrionalis*	E	No	7, 8	Open grassland terrain with scattered yucca mesquite and an abundance of small to medium-sized birds.
Pecos sunflower	*Helianthus paradoxus*	T	No	6	Permanently saturated soils; along the lower part of Rio San Jose.
Piping plover	*Charadrius melodus*	T	No	7	Nesting sites include sandy beached along the ocean.
Rio Grande silvery minnow	*Hybognathus amarus*	E	Yes	All	Found in main channel habitats, with low to moderate water velocities over silt, sand, or gravel bottom.
Socorro isopod	*Exosphaeroma thermophilus*	E	No	7	Thermal springs.
Socorro springsnail	*Pyrgulopsis neomexicana*	E	No	7	Thermal springs.
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	Yes [b/]	All	Riparian areas along streams, rivers, and other wetlands where dense willow, cottonwood, buttonbush, and arrowweed are present.
Todsen's pennyroyal	*Hedeoma todsenii*	E	Yes	8	Steep, north-facing slopes of loose, gravelly, gypseous-limestone at elevations between 6100-7300 ft. Associated species include one-seeded juniper, pinion pine, and Muhly grass.
Whooping crane	*Grus americana*	E (NE)	No	All	Marshes, shallow river bottoms, potholes, prairies, and cropland.
Yellow-billed cuckoo	*Cozzycus americanus occidentalis*	C	No	All	Riparian areas along streams, rivers, and other wetlands where cottonwood are present.

[a/] T = Threatened; E = Endangered; C = Candidate; P = Proposed; NE = non-essential/experimental.

[b/] No critical habitat is located within the Rio Grande Basin.

[c/] 1 Rio Arriba County; 2 Santa Fe County; 3 Los Alamos County; 4 Sandoval County; 5 Bernalillo County; 6 Valencia County; 7 Socorro County; 8 Sierra County

**TABLE 3.24-2
STATE-LISTED ENDANGERED AND THREATENED SPECIES FOR PROJECT AREA COUNTIES**

Common Name	Scientific Name	State Status [a/]	County Listed [b/]
Alamosa springsnail	*Tryonia alamosae*	E	7
American marten	*Martes americana origenes*	T	1, 2, 4
Bald eagle	*Haliaeetus leucocephalus*	T	All
Bell's vireo	*Vireo bellii*	T	7, 8
Boreal owl	*Aegolius funereus*	T	1
Boreal western toad	*Bufo boreas boreas*	E	1
Broad-billed hummingbird	*Cyanthus latirostris magicus*	T	3, 4
Brown pelican	*Pelecanus occidentalis carolinensis*	E	8
Common ground-dove	*Columbia passerina pallescens*	E	8
Desert bighorn sheep	*Ovis canadensis mexicana*	E	8
Gila trout	*Oncorhynchus gilae*	E	8
Gray vireo	*Vireo vicinior*	T	2, 4-8
Interior least tern	*Sterna antillarum athalassos*	E	1, 7
Jemez Mountains salamander	*Plethodon neomexicanus*	T	3, 4
Lilljeborg's pea-clam	*Pisidium lilljeborgi*	T	2
Lucifer hummingbird	*Calothorax lucifer*	T	8
Mineral creek mountain snail	*Oreohelix pilsbryi*	T	8
Neotropic cormorant	*Phalacrocorax brasilianus*	T	5-8
New Mexican jumping mouse	*Zapus hudsonius luteus*	T	4-7
Northern aplomado falcon	*Falco femoralis septentrionalis*	E	7, 8
Organ Mountains Colorado chipmunk	*Tamias quadrivittatus australis*	T	7
Piping plover	*Charadrius melodus*	T	7
Rio Grande silvery minnow	*Hybognathus amarus*	E	All
Socorro isopod	*Exosphaeroma thermophilus*	E	7
Socorro springsnail	*Pyrgulopsis neomexicana*	E	7
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	All
Spotted bat	*Euderma maculatum*	T	1,3-7
Varied bunting	*Passerina versicolor*	T	8
Violet-crowned hummingbird	*Amazilia violiceps ellioti*	T	7
White sands pupfish	*Cyprinodon tularosa*	T	8
White-tailed ptarmigan	*Lagopus leucurus altipetens*	E	1, 2
Whooping crane	*Grus americana*	E	All

[a/] E = Endangered; T = Threatened.

[b/] 1 Rio Arriba County; 2 Santa Fe County; 3 Los Alamos County; 4 Sandoval County;5 Bernalillo County; 6 Valencia County; 7 Socorro County; 8 Sierra County

Species of concern include those for which further biological research and field studies are needed to resolve their conservation status. Candidate species and species of concern have no legal protection under the ESA and are included in this document for planning purposes only. The New Mexican jumping mouse (*Zapus hudsonius luteus*), Rio Grande sucker (*Catostomus plebeius*), and flathead chub (*Platyogobio gracilis*) may also be found in the project area and are species of concern for the USFWS.

Information on species that occur in the DWP impact areas and that are afforded protection under the ESA including one candidate species is reviewed in the following subsections. Table 3.24-1 lists information on the 22 species, including their scientific and common names, their current status, whether critical habitat has been designated, and the species typical habitat. State-listed species are noted in Table 3.24-2, but are not discussed in the effects determination unless also federally listed. For each listed species, descriptions of its biology, current status and distribution, and reasons for decline are provided in this section. Species found within the project action area are discussed in more detail than those not found in the action area. Three of the 22 listed species, including the candidate yellow-billed cuckoo, had an effect analysis other than No Effect. Descriptions of these four species are included in this section.

Critical Habitats

As shown in Table 3.24-1, critical habitat has been designated for four of the threatened and endangered species. However, the ROI for the DWP does not occur within designated critical habitat for the southwestern willow flycatcher along the Rio Grande (USFWS, 1997).

The status of critical habitat for the RGSM has been affected by recent legal decisions. In 1999, USFWS designated critical habitat for the RGSM in a reach of the Rio Grande from Cochiti Dam downstream to the headwaters of Elephant Butte Reservoir (USFWS, 1999b). This critical habitat encompassed 163 miles of the main stem of the Rio Grande from the downstream side of the New Mexico Highway 22 Bridge (crossing the Rio Grande immediately downstream of Cochiti Dam), to the crossing of the AT&SF Railroad near San Marcial, New Mexico. In 2001, the critical habitat designation for the RGSM was remanded for reconsideration of its effects to the USFWS by a federal court (USFWS, 2001a).

Critical habitat for the RGSM has been designated within the *Federal Register* Vol. 67, No. 109/Thursday June 6, 2002/Proposed Rules.

Bald Eagle

Status and Distribution

Historically, the bald eagle ranged throughout North America except in northern Alaska and Canada and central and southern Mexico. Bald eagles nest on both coasts from Florida to Baja California in the south, and from Labrador to the western Aleutian Islands, Alaska in the north. World population estimates range as high as 80,000 bald eagles (Stalmaster, 1987). The USFWS (1999c) estimated that the breeding population exceeded 5,748 occupied breeding areas in 1998. The bald eagle population has essentially doubled every 7 to 8 years during the past 30 years.

Mid-winter surveys conducted annually by the NMDGF show that the number of bald eagles wintering in New Mexico have steadily increased since the late 1970s, from an annual average of 220 birds then, to 450 by the mid-1990s. Only three pairs of bald eagles nested in the state in 1999 (NMDGF, 2000).

In 1978, in response to declining population and reproductive success, the USFWS (1978) listed the bald eagle throughout the lower 48 states as endangered except in Michigan, Minnesota, Wisconsin, Washington, and Oregon, where it was designated as threatened. In the 23 years since it was listed, the bald eagle population has increased in number, and its range has expanded. These improvements are a direct result of the banning of DDT and other persistent organochlorine pesticides, habitat protection, and other recovery efforts (USFWS, 1995a). On August 11, 1995, USFWS reclassified the bald eagle from endangered to threatened in the lower 48 states. This reclassification also included the southwestern population, which was determined not to be reproductively isolated, as was previously believed (USFWS, 1995a).

The bald eagle was proposed for removal from the list of endangered and threatened wildlife in the lower 48 states in 1999 (USFWS, 1999c). The eagle was to have been removed in 2000; however, USFWS has delayed de-listing until questions on how to manage current populations and habitat are resolved.

The species is primarily water-oriented, and the majority of populations occurring in New Mexico are found near streams and lakes. There are, however, some dry land areas where eagles regularly occur, most notably in the region between the Pecos valley and the Sandia, Manzano, Capitan, and Sacramento Mountains, as well as on the Mogollon Plateau.

In 1993, Hawkwatch International (1993) noted 28 bald eagles in the Corrales Unit of the Middle Rio Grande bosque. This unit of bosque is located upstream from the City along the west side of the Rio Grande. Bald eagles have been reported in and around the City of Albuquerque, usually in areas away from the center of the City (e.g., above Alameda Bridge or below the Rio Bravo Bridge) (Stahlecker and Cox, 1997). However, eagles roost and reside along the river during the winter. The Christmas Bird Count (CBC) conducted on December 17, 2000 in Albuquerque noted nine adult and one immature bald eagles (Birdsource, 2001). This is an increase from previous CBCs, which recorded 6 bald eagles in 1997, 5 in 1998, and 6 in 1999 (including adults and immatures) (Birdsource, 2001).

For purposes of this FEIS analysis, it is assumed that bald eagles could winter in any of the project subareas. Nesting pairs have not been documented in any of the three project subareas. Because the ESA considerations for bald eagle in the Middle Rio Grande are focused on disturbance of winter roosting birds, proposed mitigation measures (i.e., no disturbance of roosting bald eagles) listed in Section 3.24.4 are considered adequate for protection of this species.

Life History and Ecology

The bald eagle is a large, powerful brown raptor with a white head and tail. Bald eagles do not reach full adult plumage until they are 4 to 6 years of age. Immature birds younger than 4 years old are primarily brown with some mottling. They prey mainly on fish, but also eat birds, mammals, and carrion.

Bald eagles build their nests in the tops of tall trees or on cliffs. Nests can be 6 feet across and 6 to 8 feet high. Eagles are philopatric; a pair of eagles will use the same nest year after year. Typically, clutches contain two eggs, which hatch after approximately 35 days. It may be up to 12 more weeks before fledging occurs, and parents care for young for 4 to 6 additional weeks.

Habitat Description

The bald eagle frequents estuaries, large lakes, reservoirs, major rivers, and some seacoast habitats. In winter, bald eagles often congregate at specific wintering sites that generally are close to open water and offer good perch trees and night roosts (USFWS, 1994b). Key habitat areas in New Mexico include winter roost and concentration areas, such as at Navajo Lake, the Chama valley (Rio Arriba County), Cochiti Lake (Sandoval County), the northeastern lakes (Raton to Las Vegas), the lower Canadian Valley, Summer Lake, Elephant Butte Reservoir, Caballo Lake, and the upper Gila Basin (Hubbard, 1985). The bald eagle is also considered a rare spring and fall transient in the Sandia and Manzanita Mountains within the Cibola National Forest in Bernalillo County (Schwarz, 1995).

Bald eagles frequent all major river systems in New Mexico from November through March, including the Rio Chama and Rio Grande. Bald eagles favor fish, waterfowl, and small mammals as prey. For this reason, eagles prefer to roost in large trees in close proximity to water. Potential roost sites in the project vicinity are large cottonwoods located at the stream periphery. Bald eagles can be sensitive to human perturbations, and will often avoid areas of human activity.

Reasons for Decline

Principal threats to bald eagles in New Mexico are loss or degradation of wintering habitat (including declines in prey and in roost-site availability), disturbance (particularly of nesting pairs), environmental contamination, and illegal killing (NMDGF, 2000). Bald eagles are subject to direct and indirect mortality from human activities. Shooting, poisoning, smuggling, and electrocution on power lines are still threats to bald eagles today. Death and reproductive failure resulting from exposure to pesticides and secondary lead poisoning are well documented (USFWS, 1999c).

Rio Grande Silvery Minnow

Status and Distribution

The RGSM (*Hybognathus amarus*) was formerly one of the most widespread and abundant species in the Rio Grande Basin in New Mexico, Texas, and Mexico. One of seven species in the genus *Hybognathus* found in the United States (Pflieger, 1980), it was first described by Girard (1856).

Historical populations of RGSM were documented in the Rio Grande upstream from present day Cochiti Reservoir; in the downstream portions of the Chama and Jemez

Rivers; throughout the middle and lower Rio Grande to the Gulf of Mexico; and in the main stem of the Pecos River from Sumner Reservoir downstream to the confluence with the Rio Grande (Bestgen and Platania, 1991; Broderick, 2000; Sublette *et al*., 1990; Platania, 2000). Historical distribution of RGSM as described above, included some or all of the DWP Upper, Middle, and Lower Project Subareas. In the Upper Project Subarea, RGSM occurred at least in the lower portions of the Rio Chama (as noted above) and downstream of the confluence of the Rio Chama and Rio Grande through all of the Middle Project Subarea and Lower Project Subarea. Figures 3.2-1, 3.2-2 and Figures 3.2-3 identify these areas within the Project ROI.

Recent investigations document presence of the RGSM in less than 5 percent of its historic range. It is restricted to the reach from Cochiti Dam to the headwaters of Elephant Butte (Platania and Bestgen, 1988; Bestgen and Propst, 1996). Reduction in the range of the RGSM to 5 to 10 percent of historical distribution, and threats to its continued existence in the Middle Rio Grande were central to this species being listed as endangered (USFWS, 1994a). In the *Federal Register* notice, USFWS (1993a) lists the dewatering of portions of the Middle Rio Grande below Cochiti Dam through water regulation activities, the construction of main stem dams, the introduction of non-native competitor/predator species, and the degradation of water quality (Hiebert, 1990; Winter, 1996; Carter, 1997) as possible causes for declines in RGSM abundance.

Recent sampling efforts for the RGSM have been conducted with funding by Reclamation and USFWS, confirming this reduced population status (Bestgen and Platania, 1989). Population catch data is described in relation to portions of the Middle Rio Grande and delineated by the upstream diversion structure as follows:

- Cochiti Reach extends from Cochiti Dam to Angostura Diversion Dam,
- Angostura Reach is from Angostura Diversion Dam to Isleta Diversion Dam,
- Isleta Reach is from Isleta Diversion Dam to San Acacia Diversion Dam, and
- San Acacia Reach is from the San Acacia Diversion Dam to the headwaters of Elephant Butte Reservoir.

The Cochiti Reach, and other areas of the Rio Grande from the Santa Clara Pueblo to the LFCC were sampled by Reclamation between 1995 and 1999 (Reclamation 2001b). No RGSM were reported for any of these samples for the Santa Clara, San Ildefonso, Cochiti, or San Felipe locations. RGSM were captured in the Santa Ana, Paseo, Rio Grande Escondida and LFCC sample locations. Current RGSM status in this reach is unknown. However, past and recent sampling by the USFWS (2000, 2002) has confirmed that the RGSM is rare in the Angostura and Isleta Reaches.

Other authors report similar densities (Platania, 1993b; Lang and Altenbach, 1994; Hoagstrom, 1996; Platania and Dudley, 1996; USACE, 1996; Dudley and Platania, 1997, 1999, and 2000). During fall 2000 and early spring 2001, RGSM were collected in the Rio Jemez (USFWS, 2000). Downstream from Angostura Dam, RGSM population monitoring has indicated a continual decline. This decline has been attributed to sediment- and water-regime modifications caused by Cochiti Dam (Bestgen and Platania, 1991). Alternatively, the decline is more likely the result of a complex interaction between changes to the hydrograph brought about by the closure of Cochiti Dam and the associated change in sediment distribution with complicating factors related to the ecology of the RGSM, it spawning habits and the physical status of the river, including the presence of previously existing diversion dams. Using approximate figures for historic range, calculations of the relationship between historic and current range can be developed. Assuming a range in the Rio Grande from near Española to the Gulf of Mexico and a range in the Pecos River from near Fort Sumner, a total of approximately 2,000 miles of riverine habitat was historically available. Recent collections of RGSM (Reclamation, 2001b) in the mid-1990s found no RGSM in reaches below Cochiti Dam. RGSM has been documented from Angostura to Elephant Butte Reservoir, a distance of approximately 150 miles. This is a range reduction to less than 8 percent of historic. It is 65 miles from San Acacia to Elephant Butte, a range reduction to approximately 3.5 percent.

The density of RGSM recorded during past and recent sampling efforts are summarized in Table 3.24-3.

Parsons (2000 and 2001) reviewed and annotated information regarding the RGSM and its ecological relationships in the Middle Rio Grande. This information has been used in the preparation of the EIS.

TABLE 3.24-3
DENSITY OF RIO GRANDE SILVERY MINNOW IN THE ANGOSTURA AND ISLETA REACHES

	Minnow Density by Year of Sampling Effort (# of minnows/m^2)						
Reach	**1987-88**	**1992**	**1997**	**1999**	**2000**	**2001** [a/]	**2002** [b/]
Angostura	0.03	0.13	0.06	<0.01	<0.01	<0.01/0.06	0.009
Isleta	0.29	0.01	0.04	0.01	<0.001	<0.01 / 0.05	0.023
San Acacia	-	-	-	-	-	-	0.051

[a/] Data for 2001 reflect collections by Reclamation and USFWS in April 2001/June 2001.

[b/] Data for 2002 reflect collections by Reclamation in January-March 2002.

Past and recent RGSM sampling efforts funded by Reclamation, USFWS and the City confirm the RGSM's reduced population status from historic high numbers. Surveys conducted by the City with support from USFWS in January 2002 resulted in the collection of only 35 RGSM with a total effort of 8,507.7 m^2, an average density of 0.004 RGSM. No RGSM were captured at the sampling location immediately below Angostura Diversion Dam. Overall, fish density was 0.097 fish/m^2 in the City's 2002 collections. Both the RGSM density and the overall fish density were higher than in 2001, when no RGSM were collected and 2000 when density was 0.001 (Reclamation, 2001b). Attribution of these numbers to increases in overall density of RGSM in the Angostura Reach, or to increased numbers of RGSM overall, is tenuous.

Reclamation sampling efforts have been completed for three periods in 2002. Sampling results are available for January, February, and March, 2002 for the 20 sites between Angostura Diversion Dam and Bosque del Apache National Wildlife Refuge.

Fish captures, including RGSM, are presented in Table 3.24-4. This data is not definitive with respect to densities of RGSM over the three-month sampling period reported, although numbers of RGSM reported are generally lower in the upper reaches of the sample area and no RGSM were captured at Angostura.

TABLE 3.24-4
RGSM AND OTHER FISHES DENSITY, 2002 COLLECTION DATA

Location and Date	Total Fish Captured	RGSM Captured	Effort (m^2)	CPU	
				Total	RGSM
Rio Grande @ Bosque del Apache (1/02)	42	8	571.0	0.0736	0.01401
(2/020)	36	1	661.0	0.0545	0.00151
(3/02)	123	0	659.0	0.1867	0.0
R G @ LFCC (1/02)	110	2	815.8	0.1348	0.00245
(2/02)	36	1	661.0	0.0545	0.001513
(3/02)	123	0	659.0	0.1867	0.0
R G @ San Marcial RR Bridge (1/02)	68	5	701.8	0.0969	0.00712
(2/02)	297	8	663.3	0.4478	0.0121
(3/02)	315	14	755.5	0.4169	0.0185
R G @ E. of Bosque del Apache (1/02)	78	13	762.5	0.1023	0.01705
(2/02)	255	8	737.5	0.3458	0.0108
(3/02)	548	4	756.8	0.7341	0.0053
R G @ US HWY 380 (1/02)	138	78	655.5	0.2105	0.119
(2/02)	111	7	608	0.1826	0.0115
(3/02)	482	17	633.5	0.761	0.0268
R G @ Upstream of 380 (1/02)	50	12	848.8	0.0589	0.0
(2/02)	40	7	703.3	0.0569	0.0099
(3/02)	928	23	593.3	1.564	0.0388
R G @ East of Socorro (LFCC) (1/02)	70	53	700.0	0.1	0.0757
(2/02)	182	28	782.5	0.2326	0.0358
(3/02)	504	7	775.0	0.6503	0.0090
R G @ Downstream of San Acacia (1/02)	153	61	637.8	0.2399	0.0956
(2/02)	182	103	428.3	0.4249	0.2405
(3/02)	367	18	552.0	0.6649	0.0326

TABLE 3.24-4 (Continued)
RGSM AND OTHER FISHES DENSITY, 2002 COLLECTION DATA

Location and Date	Total Fish Captured	RGSM Captured	Effort (m^2)	CPU	
				Total	RGSM
R G @ San Acacia Dam (1/02)	190	109	451.8	0.4205	0.2413
(2/02)	54	37	479.0	0.1127	0.0722
(3/03)	761	37	453.0	1.68	0.0817
R G @ Upstream of San Acacia (1/02)	88	4	739.5	0.119	0.0054
(2/02)	277	11	720.3	0.3846	0.0153
(3/02)	195	0	718.3	0.2715	0.0
R G @ 3.5 miles Downstream HWY 60 (1/02)	301	13	691.5	0.4353	0.0188
(2/02)	213	2	686.0	0.3105	0.0029
(3/02)	155	1	712.0	0.2177	0.0014
R G @ HWY 60 Bernardo (1/02)	99	1	833.5	0.0088	0.0012
(2/02)	274	1	821.3	0.3336	0.0012
(3/02)	473	4	726.8	0.6508	0.0055
R G @2.2 Upstream of HWY 346 (1/02)	261	12	740.5	0.3525	0.0162
(2/02)	466	6	786.8	0.5923	0.0076
(3/02)	852	5	792.8	1.075	0.0063
R G @ Upstream of HWY 6 Belen (1/02)	274	79	732.0	0.3743	0.1079
(2/02)	401	7	801.0	0.5066	0.0087
(3/02)	808	11	680.8	1.187	0.0162
R G @ Los Lunas Bridge (1/02)	1245	54	560.0	2.223	0.0964
(2/02)	699	42	528.8	1.19	0.0721
(3/02)	1745	21	744.8	2.343	0.0282
R G @ Rio Bravo, Alb. (1/02)	73	0	716.8	0.1018	0.0
(2/02)	39	0	693.8	0.0562	0.0
3/02)	75	0	767.0	0.098	0.0

TABLE 3.24-4 (Continued)
RGSM AND OTHER FISHES DENSITY, 2002 COLLECTION DATA

Location and Date	Total Fish Captured	RGSM Captured	Effort (m^2)	CPU	
				Total	RGSM
R G @ Central Bridge (1/02)	49	13	734.0	0.0668	0.0177
(2/02)	19	3	704.0	0.027	0.0043
(3/02)	41	0	654.0	0.0627	0.0
R G @ Downstream 4 mi HWY 44 (1/02)	125	19	790.8	0.1581	0.02403
(2/02)	84	6	682.0	0.1232	0.0088
(3/02)	290	5	678.0	0.4277	0.0074
R G @NM HWY 44, Bernalillo (1/02)	141	13	784.8	0.1798	0.0166
(2/02)	161	28	472.0	0.3411	0.0593
(3/02)	181	0	540.3	0.335	0.0
R G @ Angostura Dam (1/02)	7	0	554.3	0.0126	0.0
(2/02)	0	0	619.3	0.0	0.0
(3/02)	4	0	601.0	0.0067	0.0

In a letter dated April 19, 2001, USFWS (2001b) made the following observations:

> "Rio Grande silvery minnow remain rare within seine collections. A total of nine (9) Rio Grande silvery minnow have been collected since January 1, 2001 (both reaches; total seine hauls = 2,408; total effort = 460,000 ft^2). They were present in 0.3 percent of seine hauls (0.1 percent in January, 0.2 percent in February, and 0.9 percent in April). April 2001 sampling effort was less than in January and March 2001 but Rio Grande silvery minnow density was slightly greater. However, Rio Grande silvery minnow density remains very low in both reaches (Angostura and Isleta reaches)."

Upper Project Subarea

In the Angostura portion of the Upper Project Subarea, sampling by the USFWS (2001b) has confirmed that the minnow is very rare in this reach. No documentation of RGSM above Cochiti Dam has occurred since prior to closure of that structure in the mid-1970s. Suitable habitat for RGSM is limited in the Upper Project Subarea due to depth and velocity conditions.

Middle Project Subarea

Between Angostura and the SWRP or between Paseo del Norte and the SWRP, sampling has been conducted both by the Reclamation and the USFWS. In all cases, occurrence of RGSM in this reach is low and has exhibited a general decline. Recent Reclamation data on RGSM captures at selected locations can be found on the web site www.uc.usbr.gov. Suitable habitat for RGSM is limited in the Middle Project Subarea due to depth and velocity conditions.

Lower Project Subarea

Between the SWRP and the headwaters of Elephant Butte Reservoir, RGSM are considered rare in the reach below the Isleta Diversion Dam (USFWS, 2001b). The majority of the RGSM population, perhaps up to 95 percent of the surviving wild population, occurs below San Acacia Dam. Suitable habitat is present in the Lower Project Subarea. However, this area is subject to intermittent drying annually during the period between March and October as a result of irrigation diversions at Isleta and San Acacia Diversion Dams.

Life History and Ecology

The RGSM is the only surviving endemic fish species of the Rio Grande in New Mexico (Bestgen and Platania, 1990). Historic populations of RGSM were known or presumed to be present throughout most of the Rio Grande Basin. Past collections document the occurrence of RGSM in portions of the Rio Grande and Pecos River in New Mexico and the Rio Grande, Texas, near Big Bend National Park and downstream of Amistad Reservoir (Bestgen and Platania, 1991).

Historically, RGSM occurred in the Pecos River drainage downstream from Santa Rosa, in the Rio Grande downstream from Velarde, and in the Chama River downstream from Abiquiu Reservoir. Currently, the species occurs only in the perennial segments of the Rio Grande and in irrigation canals of the valley in the general area from Cochiti to Socorro (Sublette *et al*., 1990).

The species is a pelagic spawner. Individual females may produce more than 3,000 semi-buoyant, non-adhesive eggs during a spawning event (Platania, 1995b; Platania and Altenbach, 1996). Adults spawn during about a 1-month period in late spring-early summer (May-June) in apparent response to spring runoff. Smith (1998) collected eggs in the middle of May, late May, early June, and late June in 1997. These data suggest multiple spawning events, and it appears likely that the RGSM spawns multiple times during the summer, concurrent with flow spikes. The majority of the spawning fish are 1 year old: 2-year-old fish comprise less than 10 percent of the spawning population. High reproductive potential of this fish appears to be one of the primary reasons that it has not been extirpated from the Middle Rio Grande. Life history adaptations of the RGSM include the ability to survive extreme water fluctuations or periodic droughts.

Habitat Description

Aquatic habitats in the Rio Grande drainage in New Mexico exhibit a gradient from small, cold, high-elevation streams with large substrate particles and salmonid-dominated fish communities to channels that are 17 to 83 feet wide, sandy, and support warmwater fish communities. Downstream from Albuquerque, the Rio Grande changes from a usually perennial system with mixed substrate types to an ephemeral, predominantly sand substrate river. Diminished flows have contributed to extensive sand deposition in the Rio Grande. Habitat in warmwater reaches is mostly shallow runs about 3 feet deep; pools and riffles are less common. From Cochiti Reservoir downstream to Elephant Butte Reservoir, the Rio Grande is partially channelized, but it meanders in a somewhat natural fashion between levee banks (Bestgen and Platania, 1990). Habitat availability at low to intermediate flows is discernibly different in the reach from Angostura to San

Acacia compared to the reach from San Acacia to the headwaters of Elephant Butte Reservoir with the lower reach being notably more braided and meandering.

The RGSM travels in schools and tolerates a wide range of habitats (Sublette *et al*., 1990). Generally, it prefers shallow (less than 16 inches deep), low-velocity (less than 0.325 ft/sec) areas with silt or sand substrate associated with braided runs, backwaters, or isolated pools (Bestgen and Platania, 1991; Dudley and Platania, 1997). Adults are most commonly found in shallow and braided runs over sand substrate; while young-of-the-year (YOY) occupy shallow, low-velocity backwaters with sand-silt substrates (Bestgen and Platania, 1991; Dudley and Platania, 1997).

Dudley and Platania (1997) reported that the RGSM was most commonly collected in habitats with depth less than 8 inches or between 12 and 16 inches, and were not collected in habitats with water depths greater than 20 inches. More than 85 percent were collected from low-velocity habitats (flows of less than 0.325 ft/sec). Habitat for the RGSM includes stream margins, side channels, and off-channel pools where water velocities are low or reduced from main-channel velocities. Areas with detritus and algal-covered substrates are preferred. Lee sides of islands and debris piles often serve as good habitat. Stream reaches dominated by straight, narrow, incised channels with rapid flows typically are not occupied by the RGSM (Sublette *et al*., 1990; Bestgen and Platania, 1991). During the winter, the RGSM tends to concentrate in low-velocity areas in conjunction with vegetation for cover, such as debris piles (Dudley and Platania, 1996).

Habitat attributes described by Bestgen and Platania (1991) are as follows:

- The Middle Rio Grande, New Mexico, from present-day Cochiti Reservoir downstream to Elephant Butte Reservoir historically contained RGSM. Specimens were most abundant in collections in the last decade made just downstream of diversion dams, and collections of more than 100 specimens from such locations were common.

- RGSM occurred regularly in collections downstream of Bernalillo in main stream habitats of the Rio Grande. Generally, however, fewer than 20 adult specimens per collection were taken at sites from Bernalillo downstream to Isleta. Despite the presence of adequate habitat, the RGSM was usually absent in collections made in or just downstream of Albuquerque, and the fish fauna there was relatively depauperate.

- Flow conditions influenced the habitat in which RGSM was found. Typical habitat was shallow and braided runs over shifting sand substrate. During extreme low-flow periods, RGSM was found in short, flowing reaches below diversion dams or was restricted to a few isolated pools. Habitat below diversion dams was usually more than 3 feet deep, and had mixed sand, gravel, and cobble substrate. Isolated pools that supported fish were typically more than 3 feet deep and adjacent to undercut, shaded stream banks.

- Habitat below diversion dams is an extremely important refugium for fishes of the Rio Grande during periods of low flow. According to Koster (1957), RGSM and other species of fish were found seasonally to be extremely abundant below diversion dams. Fishes seemingly moved up stream into habitat below diversion dams during periods of low flow. During periods of higher flows and in winter, densities of fish below diversion structures were much lower and similar to upstream and downstream reaches. The extent of such presumed movements is unknown, but this interesting and presumably important phenomenon needs investigation.

- Habitats which historically supported small, outlier populations of RGSM (e.g., upstream reaches of the Rio Grande and Pecos River, New Mexico, Big Bend area, Texas) may have relied on continuous ingress from upstream and downstream reaches to supplement populations. The RGSM was historically present but has not been collected since 1949 in the Rio Chama. When these dispersal mechanisms were cut off by dams or desiccated streambeds, populations dwindled and were eventually extirpated (Pecos River). Habitat dissection may be an especially important mechanism in the extirpation of fishes from arid-land stream ecosystems, and the capability of dispersing to secure habitats may be critical to survival.

Habitat Availability

Habitat availability for the RGSM has been documented only at selected and limited sites within the formerly designated critical habitat (Dudley and Platania, 1997). Therefore, inferences based on these limited data are subject to interpretation, as noted in the following sections. Researchers (Dudley and Platania, 1996, 1997, 1999, and 2000) report habitat availability at two sampling locations (representing the upper and lower reaches of the former critical habitat designation). The majority of depth measurements reflected depths less than 15.7 inches, although 18.7 percent were greater than 31.5 inches. Depths greater than 47.2 inches were rarely encountered. Areas of moderately high water velocity (greater than 1.64 ft/sec) comprised 41.6 percent of all measured velocity points. Sand was the most frequently encountered substrate, comprising 67 percent along habitat transects. Silt, gravel and cobble each comprised about 10 percent of the available habitat.

Habitat selected by RGSM was not that most commonly available; mean depths and flow velocities occupied by RGSM were significantly (less than 0.01) different from availability (Dudley and Platania, 1997). RGSM most commonly selected habitats with depths less than 8 inches or from about 12 to 16 inches. RGSM were abundant (86.5 percent) in areas of low or no water velocity (flow less than 0.325 ft/sec) and occasionally present (11 percent) in areas of velocities in the range of 0.36 ft/sec to 0.98 ft/sec. Few (0.8 percent) were taken in habitats with water velocities greater than 1.31 ft/sec.

Relationships between depth and velocity habitat elements available to RGSM and those actually used by RGSM are reported by Dudley and Platania (1997) for the Rio Rancho and Socorro sampling locations. Effects of the DWP were evaluated using these data as the basis for RGSM habitat preference. Analysis of these effects is presented for each DWP alternative in Section 3.24.3.

Reasons for Decline

Completion of Cochiti Dam at RM 232.6 in 1973 led to subsequent hypolimnetic (deep, cool water) releases with little sediment load, which scoured the river channel downstream and decreased water temperature, changing the nature of in-channel habitat from warmwater, sand-bed habitat that was ideal for RGSM to gravel-sand habitat that favors species such as non-native white sucker (Bestgen and Platania, 1991; USFWS, 1999a). The Cochiti, Angostura, and Isleta reaches suffer from flow-regime alteration, urbanization and agricultural impacts, and river channel degradation, all of which have changed habitat and water quality conditions (USFWS, 1999a). These factors are to some extent related to the presence of the Angostura, Isleta, and San Acacia Diversion Dams in the Middle Rio Grande that have historically blocked migration of RGSM and other fishes as well as diverted adults and propagules into the irrigation systems and fields. The Isleta Diversion Dam also has similar effects; however, if the Isleta Diversion Dam is operated with multiple gates open during the low flow or non-irrigation season, it is not a barrier to fish passage.

Legal Actions Under the ESA

Legal actions that have occurred with respect to the status of the RGSM and its critical habitat under the ESA are summarized below:

- On March 1, 1993, the USFWS (1993a) proposed to list the RGSM as an endangered species with critical habitat (58 *Federal Register* [FR] 11821).

- On July 20, 1994, USFWS (1994a) published the final rule to list the RGSM (59 *Federal Register* 36988), but found that critical habitat was not determinable.

- On February 22, 1999, the U.S. Federal Court for the District of New Mexico, in Forest Guardians and Defenders of Wildlife versus Bruce Babbitt (CIV 97-0453 JC/DIS), ordered the USFWS to publish a final determination regarding critical habitat.

- On July 6, 1999, USFWS (1999b) designated critical habitat for the RGSM (64 FR 36274) as the area of the Rio Grande between the State Highway 22 Bridge just downstream of Cochiti Dam to the crossing of the AT&SF Railroad Bridge near San Marcial, New Mexico, a distance of 163 miles. This designation included an economic analysis (ECONorthwest, 1996).

- In 1999, the USFWS published a RGSM recovery plan (USFWS, 1999a), outlining reasons for decline of the species and recovery goals and objectives.

- On November 21, 2000, Senior U.S. District Court of New Mexico Judge Edwin Mechem, writing on the Middle Rio Grande Conservancy District v. Bruce Babbitt, *et al*. CIV 99-870, 99-872 and 99-1445M/RLP (Consolidated), ordered that the final rule designating critical habitat for the RGSM be declared invalid and that the Defendants (USFWS) prepare an environmental impact statement on the effects of the critical habitat designation.

- On March 21, 2001, Judge Mechem issued a ruling that set aside the designated critical habitat for the RGSM (CIV 99-870, 99-872 and 99-1445M/RLP).

- On April 5, 2001, the USFWS (2001a) published a notice of intent in the *Federal Register* announcing the preparation of a FEIS on critical habitat designation for the RGSM. Associated public scoping meetings were held in New Mexico and Texas.

- Critical habitat was re-designated for the RGSM in *Federal Register*/Vol. 67, No. 109/Thursday, June 6, 2002/Proposed Rules.

Southwestern Willow Flycatcher

Status and Distribution

The southwestern willow flycatcher (*Empidonax traillii extimus*) was placed on the federal endangered species list on February 17, 1995 (USFWS, 1995b), and critical habitat was designated on July 22, 1997 (USFWS, 1997). There currently is no recovery plan in place. The southwestern willow flycatcher is classified as endangered (Group 1) by NMDGF (Table 3.24-2). Historically, the southwestern willow flycatcher was widely distributed and fairly common throughout its range, especially in southern California and Arizona (Unitt, 1987). However, southwestern willow flycatcher populations have apparently declined. In 1993, USFWS (1993b) estimated that only 230 to 500 nesting pairs existed throughout its entire range. In New Mexico, NMDGF estimated that fewer than 200 pairs remained in 1988. Surveys conducted in 1993 through 1995 found only about 100 pairs, with some 75 percent occurring in one area. Critical habitat was designated in 1997 (USFWS, 1997); however, no critical habitat occurs in the Rio Grande Basin. A draft recovery plan was published in April of 2001 (USFWS, 2001c).

As of the 1999 breeding season, the approximate confirmed numbers of southwestern willow flycatchers was just over 900 territories. In New Mexico, the species has been observed in the Rio Grande, Rio Chama, Zuni River, San Francisco River, and Gila River drainages. There were 91 territories identified in the Rio Grande Basin in 1999. A summary of surveys for each project subarea is provided below.

Upper Project Subarea

Surveys for presence/absence and habitat suitability along the Rio Chama below Abiquiu Dam in 1994 identified no southwestern willow flycatchers and found only small areas of potential habitat (Eagle Ecological Services, 1994). Several flycatcher territories have been identified each breeding season from 1993 through 1995 in the Rio Chama drainage near Parkview, above Heron Reservoir (Cooper, 1995 and 1996). However, suitable willow flycatcher habitat along the Rio Chama is very limited, resulting in few occurrences of the species in this drainage. During a 1996 NMDGF flycatcher survey in three areas along the Rio Chama, six territories and one nesting pair were identified (Cooper, 1997). Surveys conducted in 2000 identified 2 territories near Velarde and 15 territories near the San Juan Pueblo along the Rio Grande (Reclamation, 2001a).

Middle Project Subarea

No flycatchers were detected in the reach of the Rio Grande in the Middle Project Subarea, particularly where the construction of the proposed project features would occur. A 1994 survey conducted in the Corrales Bosque area detected no willow flycatchers (Mehlhop and Tonne, 1994). Surveys for willow flycatchers in the greater Albuquerque metropolitan area were conducted at the Interstate 40, Central Avenue, and Montaño Bridges; Tingley Beach; Zoo Sidebar; and Calabacillas Islands in 1995 and 1996 by Reclamation and the USFWS. No flycatchers were detected during these surveys (Cooper, 1996 and 1997). Surveys performed in 2001 at the proposed diversion site did not detect any nesting flycatchers in the construction areas along the Rio Grande (EMI, 2001).

Lower Project Subarea

Flycatcher territories have been identified along the Rio Grande at Isleta Pueblo, the Sevilleta NWR, the Bosque del Apache NWR, and San Marcial. Reclamation has been conducting surveys at in the Lower Project Subarea since 1995. The San Marcial area supported a total of 12 flycatcher territories during the 1999 breeding season, from which 10 young are believed to have fledged. Four flycatcher territories were detected within the Sevilleta NWR in the 1999 season. Nesting was confirmed at three of the four pair territories (Reclamation, 2000a). Reclamation conducted surveys during 2000 and found 14 territories near Isleta Pueblo, 8 near Sevilleta NWR, 2 at Bosque del Apache NWR, 8 territories north of the San Marcial Bridge and 23 south of the San Marcial Railroad Bridge (Reclamation, 2001c).

Life History and Ecology

The southwestern willow flycatcher (Order Passerifomes; Family Tyrannidae) is a subspecies of one of the 10 North American species in the genus *Empidonax*. The *Empidonax* flycatchers are renowned as one of the most difficult groups of birds to distinguish by sight. Phillips (1948) described the southwestern willow flycatcher in 1948. It is generally paler than other willow flycatcher subspecies, although this difference is indistinguishable without considerable experience and training. The southwestern species also differs in morphology (primarily wing formula) but not overall size. The willow flycatcher's diet is composed mainly of aerial insects. Flycatchers catch their food on the wing and will glean from leaves. Foraging occurs within and above dense riparian vegetation, water edges, backwaters, and sandbars, adjacent to nest sites. Details on specific prey items are not currently known (Tibbitts *et al*., 1994).

Southwestern willow flycatchers begin arriving along the Rio Grande before breeding in mid-May. Southwestern willow flycatcher territory size, as defined by song locations of territorial birds, probably changes with population density, habitat quality, and nesting stage. Early in the season, territorial flycatchers may move several hundred yards between singing locations. It is not known whether these movements represent polyterritorial behavior or active defense of the entire area encompassed by singing locations. However, during incubation and nestling phases, territory size, or at least the activity centers of pairs, can be restricted to an area of less than 1.2 acres. The estimated breeding territory size was 0.5 acre for a pair of flycatchers occupying a 1.5 acres patch on the Colorado River (Sogge *et al*., 1997). Activity centers may expand after young are fledged, but while they are still dependent on adults.

Once a territory and a mate are defined, nest building and egg laying will occur. The nest-site plant community typically is even-aged, structurally homogenous, and dense (Brown, 1988). Nests are usually found in the fork of a shrub or tree from 4 to 25 feet above the ground (Unitt, 1987; Tibbitts *et al*., 1994). Nests are typically made of a collection of grasses and forbs lined with small fibers. Typically, only one clutch of three to four eggs is laid. If the first clutch is lost (due to parasitism or loss of young), another clutch may be laid later in the season. The female will incubate the eggs for approximately 12 days, and the young fledge (i.e., are fully feathered) approximately 13 days after hatching (King, 1955). The young fledge by late June or early July (Tibbitts *et al*., 1994). Flycatchers begin to migrate back to their winter habitat around September.

Habitat Description

The southwestern willow flycatcher breeds in dense riparian habitats along rivers, streams, or other wetlands. Vegetation can be dominated by dense growth of willows (*Salix* sp.), seepwillow (*Baccharis* sp.), or other shrubs and medium sized trees. Almost all southwestern willow flycatcher breeding habitats are within close proximity (less than 20 yards) of water or very saturated soil. Nesting habitat for the willow flycatcher varies greatly by site and includes such species as cottonwood, willow, tamarisk, box elder, and Russian olive. Species composition, however, appears less important than plant and twig structure.

Four main types of preferred habitat have been described. They are as follows (adapted from Sogge *et al*., 1997):

- Monotypic high - elevation willow: nearly monotypic stands of willow, 10 to 23 feet in height with no distinct overstory layer; often associated with sedges, rushes, nettles and other herbaceous wetland plants; usually very dense structure in the lower 7 feet; live foliage density is high from the ground to the canopy.

- Monotypic non-native - nearly monotypic, dense stands of non-natives such as salt cedar or Russian olive, 13 to 33 feet in height forming a nearly continuous, closed canopy (with no distinct overstory layer); the lower 7 feet often is difficult to penetrate due to branches; however, live foliage density may be relatively low 3 to 7 feet above ground, but increases higher in the canopy; canopy density uniformly high.

- Native broadleaf-dominated - composed of single species or mixtures of native broadleaf trees and shrubs, including cottonwood, willows, boxelder, ash, alder, and buttonbush from 10 to 50 feet tall; characterized by trees of different size classes; often a distinct overstory of cottonwood, willow, or other broadleaf tree, with recognizable subcanopy layers and a dense understory of mixed species; non-native/introduced species may be a rare component, particularly in the understory.

- Mixed native/non-native - Dense mixtures of native broadleaf trees and shrubs mixed with non-native/introduced species such as salt cedar or Russian olive; non-natives are often primarily in the understory, but may be a component of overstory;

> the native and non-native components may be dispersed throughout the habitat or concentrated as a distinct patch within a larger matrix of habitat; overall, a particular site may be dominated primarily by natives or non-natives, or be a roughly equal mixture.

There is no designated southwestern willow flycatcher critical habitat in the Rio Grande Basin (USFWS, 1997).

Reasons for Decline

The most significant historical factor in the decline of the southwestern willow flycatcher is the extensive loss, fragmentation, and modification of riparian breeding habitat. Large-scale losses of southwestern wetlands have occurred, particularly the cottonwood-willow riparian habitats of the southwestern willow flycatcher (Johnson *et al*., 1987, Unitt, 1987). Changes in the riparian plant community have reduced, degraded and eliminated nesting habitat for the willow flycatcher, curtailing its distribution and numbers (Cannon and Knopf, 1984; Taylor and Littlefield, 1986; Unitt, 1987).

Habitat losses and changes have occurred (and continue to occur) as a result of urban, recreational, and agricultural development, brood parasitism water diversion and impoundment, channelization, livestock grazing, and replacement of native habitats by introduced plant species (USFWS, 1993b; Tibbitts *et al.*, 1994; USFWS, 2001c). Hydrologic changes, natural or man-made, can greatly reduce the quality and extent of flycatcher habitat. Although riparian areas are often not considered to be fire-prone, several sites with relatively large numbers of breeding willow flycatchers were recently destroyed by fire (Paxton *et al*., 1996), and many others are at risk for similar catastrophic loss. Fire danger in these riparian systems may be exacerbated by conversion from native to non-native vegetation (e.g., salt cedar), diversions or reductions of surface water, and drawdown of local water tables.

Yellow-billed Cuckoo

Status and Distribution

The yellow-billed cuckoo (*Coccyzus americanus*) was added to the candidate species list on July 25, 2001 (USFWS, 2001e) on a 12-month finding that the petitioned action is warranted, but precluded by higher priority listing actions. The breeding range of the yellow-billed cuckoo formerly included most of North America from southern Canada to the Greater Antilles and northern Mexico. Based on historical accounts the yellow-billed cuckoos were locally common in a few river reaches in New Mexico.

Biologists have generally distinguished western (*Coccyzus americanus occidentalis*) and eastern (*Coccyzus americanus americanus*) subspecies. The USFWS recognized the western and eastern populations to be discrete in physical (geographical area), morphological, physiological, behavioral and genetic characteristics (USFWS, 2001e)

Yellow-billed cuckoos were recorded in the Middle Project Subarea of the action area in the 1984 Hink and Ohmart study and a more recent 1997 study (Stahlecker and Cox, 1997).

Life History and Ecology

The yellow-billed cuckoo is about 12 inches long and slender in profile. They weigh about two ounces. They are brownish and have white undersides and their tail is very long and marked with large black dots that are visible when the bird is in flight. The yellow-billed cuckoo's bill is stout, slightly down-curved, and generally blue-black. The species is named for the striking yellow base of the lower mandible.

Western yellow-billed cuckoos are obligate riparian nesters, especially those areas dominated by willow and cottonwood stands. These areas of riparian forest used by the cuckoos are relatively large patches usually 25 to 100 acres in extent (USFWS, 2001e).

Yellow-billed cuckoos are mainly insectivores with the majority of their diet consisting of grasshoppers and caterpillars. The yellow-billed cuckoo is unique among birds in its ability to eat toxic hairy and spiny caterpillars including the hairy tent caterpillar.

Yellow-billed cuckoos arrive on their western breeding grounds in mid-June and leave for South America by late August. They typically lay two or three large, heavy, blue eggs. Fledgling occurs approximately 17 days after egg-laying. After leaving the nest the fledglings are fed by their parents another 3 to 4 weeks before beginning their migration to South America. Yellow-billed cuckoos time their nesting around localized outbreaks of cicadas and tent caterpillars (Laymon, 1998; Center for Biological Diversity, 2001).

Reasons for Decline

Riparian habitat degradation and/or loss of cottonwood regeneration are likely occurring in some areas. Principal causes of riparian habitat losses are conversion to agricultural and other uses, dams and river flow management, stream channelization and stabilization, and livestock grazing (USFWS, 2001e). Along the Rio Grande, water and flood control projects have altered flow regimes and river dynamics, inhibiting regeneration of cottonwood-willow riparian habitats (USFWS, 2001e). Estimates of riparian habitat losses include 90 percent for New Mexico (UWFWS, 2001e). Other factors that may contribute to the decline of the yellow-billed cuckoo include human disturbance, pesticides, and non-native species invasion/encroachment (Laymon, 1998).

3.24.3 Environmental Consequences

The following criteria are considered in evaluating the potential effects for threatened and endangered species:

- Loss or substantial degradation of supporting habitat.
- Loss of individual members of a population of a listed species.
- Loss or modification of critical habitat.

Potential DWP effects on this resource category are discussed by species for each of the project alternatives in the following subsections. Table 3.24-5 shows the summary of project effects to threatened and endangered species. Three of the 22 federally listed species are potentially affected by the City's DWP; the bald eagle, Rio Grande silvery minnow, and southwestern willow flycatcher. The candidate yellow-billed cuckoo was also considered as being potentially affected. The remaining 18 species are not discussed because they do not occur in the ROI.

**TABLE 3.24-5
SUMMARY OF PROJECT EFFECTS ON THREATENED AND ENDANGERED SPECIES**

Evaluation Criterion	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Loss of individual members of a population of a listed species	None	No bald eagle or southwestern willow flycatcher will be lost. Individual Rio Grande silvery minnow eggs and larvae would be impinged on or entrained thru fish screens	No bald eagle or southwestern willow flycatcher will be lost. Individual Rio Grande silvery minnow eggs and larvae would be impinged on or entrained thru fish screens	None
Loss or substantial degradation of supporting habitat	373 acres of riparian habitat affected by continued ground water pumping	A permanent loss of 1.8 acres of riparian habitat No Rio Grande silvery minnow habitat would be substantially lost or degraded	A permanent loss of 4.2 acres of riparian habitat 0.2 acres of Rio Grande silvery minnow habitat would be substantially lost or degraded	A permanent loss of 27 acres of riparian habitat as a result of facility placement and operation. No Rio Grande silvery minnow habitat would be substantially lost or degraded
Loss or modification of RGSM critical habitat (acres)	0	0	0.2 acres of critical habitat lost or modified	0

Bald Eagle

Analysis Methods

Bald eagle habitat occurs throughout the riparian corridor and bald eagles migrate along the river and frequently use tree stumps and other features as roosts. To protect the bald eagle, construction-specific mitigation measures are listed in Section 3.24.4. Within the project area, some riparian habitat will be impacted. However, mitigation measures will lessen this impact. There are no specific operations impacts upon the bald eagle from the DWP.

Effects from No Action Alternative

Under the No Action Alternative the construction and operation of ground water wells would not affect bald eagles or their habitat. There would be 373 acres of riparian habitat affected by continued ground water pumping in the Middle Project subarea. No Action Alternative depletions in the Lower Project Subarea would not affect the bald eagle or its habitat.

Effects from Action Alternatives

Potential effects on the bald eagle from implementation of DWP action alternatives would be limited to temporary disruptions during construction of project components in the Middle Project Subarea; there would be no construction effects on this species in the Upper or Lower Project Areas. Construction would occur in riparian areas along the Rio Grande (see Figures 2.5-1 through 2.5-6). These areas provide winter habitat for the bald eagle, but are not known to provide breeding habitat for the bald eagle.

Bald eagles have been observed along the Middle Rio Grande during the winter months, and wintering eagles may be disturbed during river-side construction of the action alternatives. However, nesting pairs, chicks, and juvenile eagles would not be disturbed or threatened during construction activities, and temporary effects on wintering eagles would not cause adverse impacts.

Operational effects of the Angostura Diversion and Paseo del Norte Diversion would not affect bald eagle habitat in the Upper, Middle, or Lower Project Subareas. Operational effects of Subsurface Diversion would include the alteration of 552 acres of riparian habitat (see Section 3.21). This alteration of habitat may affect preferred bald eagle roosting sites (large cottonwood trees). This habitat impact could indirectly affect bald eagles.

Summary of Environmental Consequences

There would be no adverse effects on the bald eagle under the No Action Alternative. Under the action alternatives, temporary disturbance of wintering eagles could occur during construction activities along the Rio Grande in the Middle Project Subarea. Because sightings of bald eagles near construction zones would trigger the implementation of mitigation measures (see Section 3.24.4), no direct or indirect construction effects are anticipated for the bald eagle. Pole plantings and other bosque mitigation measures would benefit bald eagles that occur along the Rio Grande near Albuquerque. There would be no anticipated impacts on the bald eagle from DWP operations under action Angostura Diversion and Paseo del Norte Diversion. Action Subsurface Diversion would alter up to 552 acres of potential bald eagle habitat (see Riparian Section 3.21), but would not contribute to the loss of individual bald eagles. This loss of habitat would be replaced with tree and land replacement mitigation activities which would offset the bald eagle habitat loss.

In summary, construction activities would have only minimal short-term, local, direct effects on the bald eagle. Long-term effects of implementation of any of the DWP action alternatives would be minimal and local. With implementation of the mitigation measures noted in Section 3.24.4, there would be no temporary, long-term, or cumulative effects on bald eagles. There would be no short-term use versus long-term productivity concerns associated with the bald eagle. There are no known irreversible and irretrievable commitments of resources associated with the bald eagle.

The Service has completed a biological opinion, dated February 13, 2004, with a concurrence of Reclamation's finding of "may affect, is not likely to adversely affect" the bald eagle.

Rio Grande Silvery Minnow

Analysis Methods

To assess changes in the availability of RGSM habitat due to DWP operations in the Middle Project Subarea, USACE (1997) HEC-RAS models were developed for the reach of the Rio Grande from Angostura Diversion Dam to just upstream from Rio Bravo Bridge. Cross-sectional velocity and depth analyses were used to define hydraulic characteristics at selected points in the project area. River cross-sections were evaluated in the immediate area of the proposed project locations, as well as throughout the area potentially affected by changes in flows associated with implementation of the project. Hydrology data developed by CH2M Hill (2003) were used as input for the hydraulic models, which incorporated estimated water-flow rates in the ROI based on the San Felipe and Central Street (Albuquerque) stream gages. Maximum and mean flows were defined from this data. To quantify the changes associated with alteration of flows in the Middle Project Subarea, and their potential effects on RGSM and other fish species, the following assumptions were used:

- RGSM actively select habitat types defined by water depth, water velocity, and substrate type, and do not occur uniformly at a given location with respect to depth, velocity, or substrate type.
- The majority of RGSM occur in depths less than 8 inches or at depths of about 12 to 16 inches.
- More than 90 percent of RGSM have been captured in areas where water velocity was less than 1 ft/sec. RGSM were most abundant (86.5 percent) in areas where velocity was 0.325 ft/sec or less.

Effects of the action alternatives were assessed based on analysis using HEC-RAS computer modeling and 1996 Rio Grande field cross-sections for the Middle Project Subarea. DWP effects on RGSM were assessed by evaluating the relationships between availability of RGSM preferred habitat depths and velocities over a range of flow conditions. Ranking criteria were developed to quantify these relationships. Table 3.24-6 presents the depth and velocity characteristics and the ranking criteria for the velocity and depth characteristics selected for analysis. Dudley and Platania (1997) reported that the majority of the RGSM were present in velocities less that 0.325 ft/sec at depths less than 8 inches. These characteristics were assigned the highest rank of 1. Rankings 2 through 6 reflect habitat characteristics that provide decreasing habitat suitability or preference. A "0" ranking reflects the fact that, while RGSM were found in habitat with no velocity, they were not present in habitat with no depth (i.e., dry). Only the top three criteria (1,2, and 3) were used to define suitable RGSM habitats.

TABLE 3.24-6
RGSM HABITAT-SELECTION CRITERIA

Criterion Ranking [a/]	River Depth (feet)	Flow Velocity (ft/sec)
1	> 0.10 and < 0.66	< 0.325
2	< 0.66	< 1.0
3	>0.66	< 0.325

[a/] Based on data from Dudley and Platania (1997).

HEC-RAS is a one-dimensional model with the ability to calculate potential velocities distributed across the cross-section. The importance of this output is to determine velocities and depths that may be acceptable as RGSM habitat. The general cross-section output can show the distribution of flow in up to 45 situations. Each flow element has information on flow discharge, area, wetted perimeter, percentage of conveyance, hydraulic depth, and average velocity. Examples of cross-section and the velocity distribution for each model. Figures 3.24-1 through 3.24-6 show low, mean and max flow cross-sections for both Angostura Diversion and the Paseo del Norte Diversion.

In addition to the depth and velocity characteristics important to RGSM preferred habitat, the geomorphology of cross-sections representing each reach of the river is also a factor in determining habitat availability. Availability of preferred habitat was estimated from the HEC-RAS models of the Middle Rio Grande cross-sections based on historical and simulated flows at the DWP diversion locations and at the Central gage. Calculations were made for a low (operational) flow and simulated maximum and mean flows. For each flow rate, the model defined the total linear feet of wetted perimeter and associated water-surface elevation (depth) to calculate the habitat area available and the total linear feet of stream channel that met the preferred habitat criteria. These values are expressed as total area (square feet) at each cross-section meeting the preferred-habitat criteria. Habitat area was calculated by multiplying the wetted perimeter distance by the depth of water for each flow rate and cross-section. Calculations were completed for the months of April through October, which corresponds to the irrigation season, and consequently the period of greatest diversions from the river.

Because of limitations in the available data sets for physical and biological data, the following assumptions must be kept in mind when interpreting information presented in this section:

- Operation of the project will not substantively alter the sediment regime in the project area with respect to availability or movement (CH2M Hill, 2003).
- Loss-rate relationships for the project area are represented by calculating differences in flow between the San Felipe and Albuquerque gages during the irrigation season (April through October).

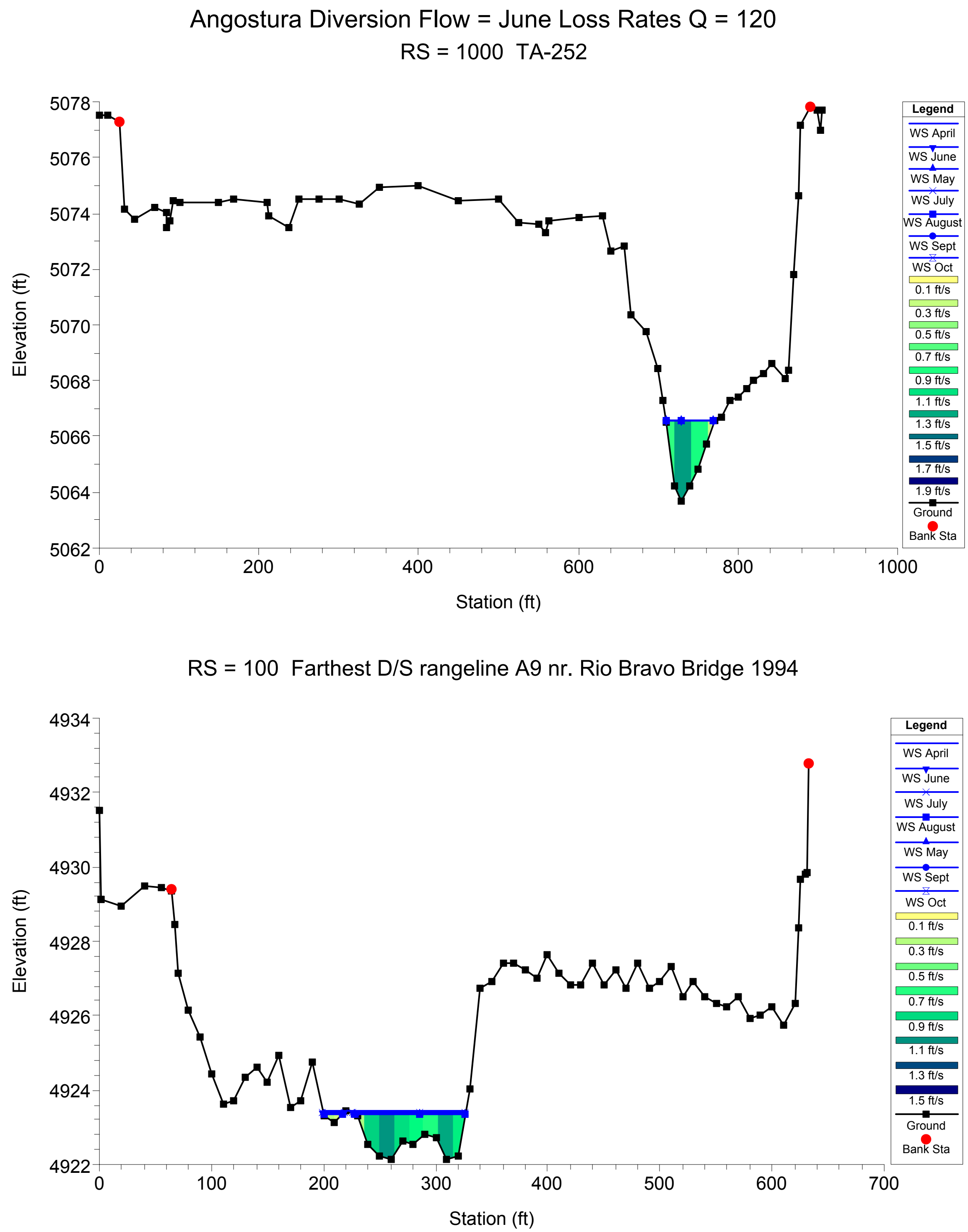


Figure 3.24-1

HEC-RAS Model Representation of Operational Low Flow (Q = 120 cfs) at Angostura Diversion Dam (Upper Figure near Angostura Diversion Dam; Lower Figure near Rio Bravo Boulevard)

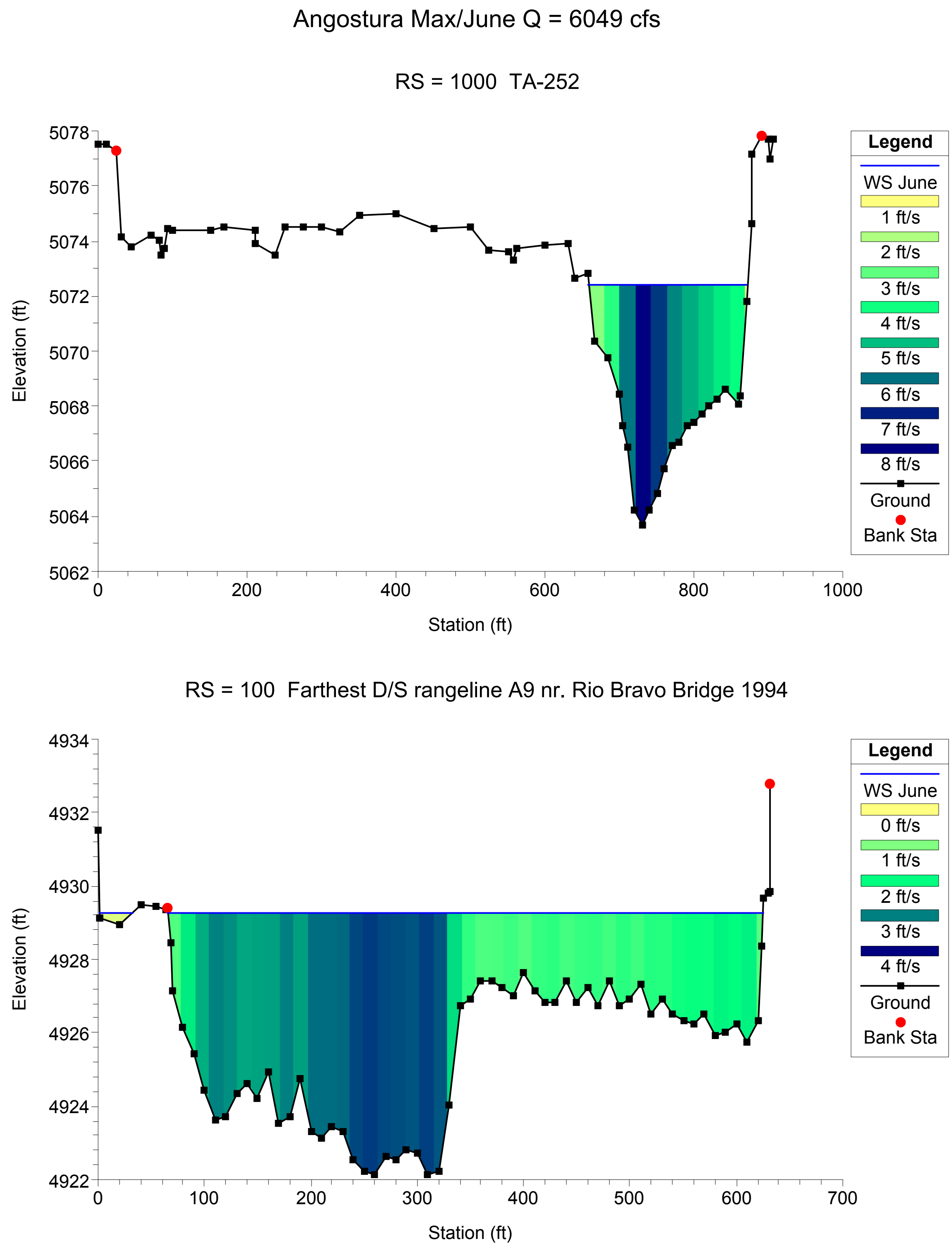
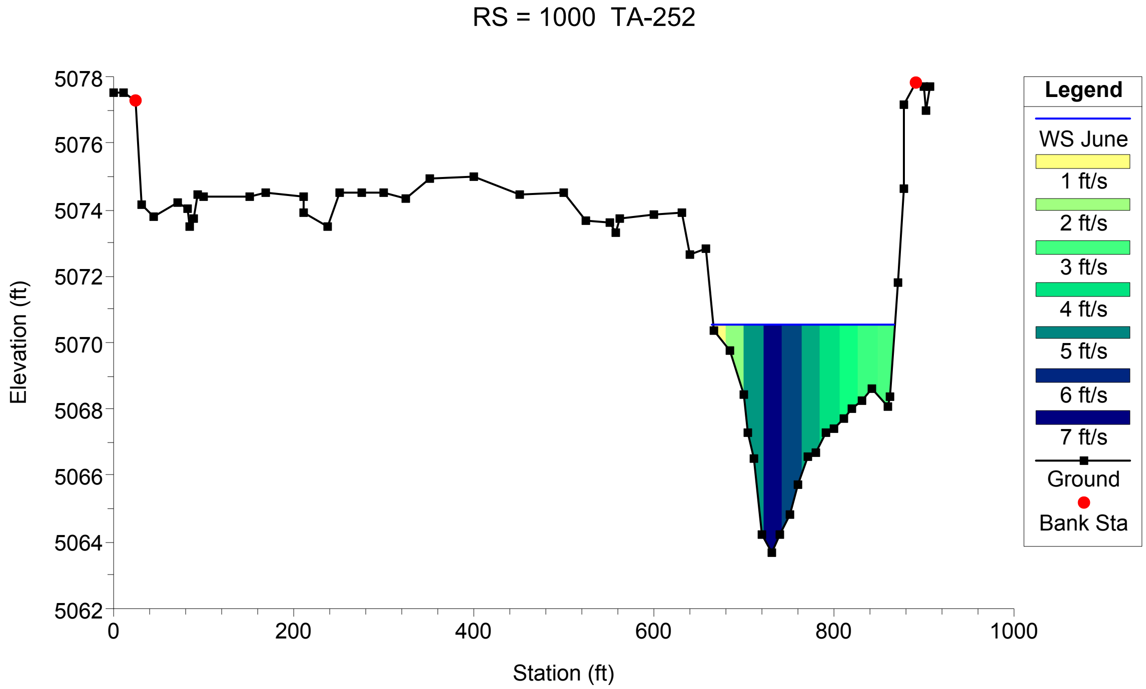


Figure 3.24-2

HEC-RAS Model Representation of Maximum Flow (Q = 6049 cfs) at Angostura Diversion Dam (Upper Figure near Angostura Diversion Dam; Lower Figure near Rio Bravo Boulevard)

Angostura Mean/June (Q = 2756 cfs)



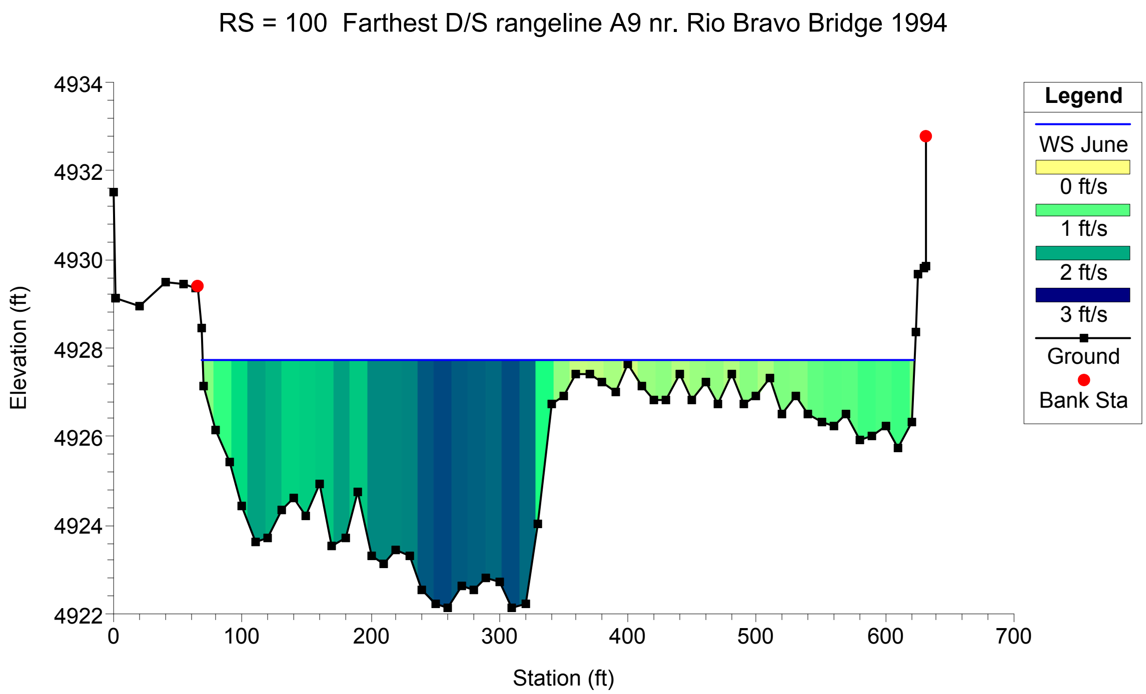


Figure 3.24-3

HEC-RAS Model Representation of Mean Flow (Q = 2756 cfs) at Angostura Diversion Dam (Upper Figure near Angostura Diversion Dam; Lower Figure near Rio Bravo Boulevard)

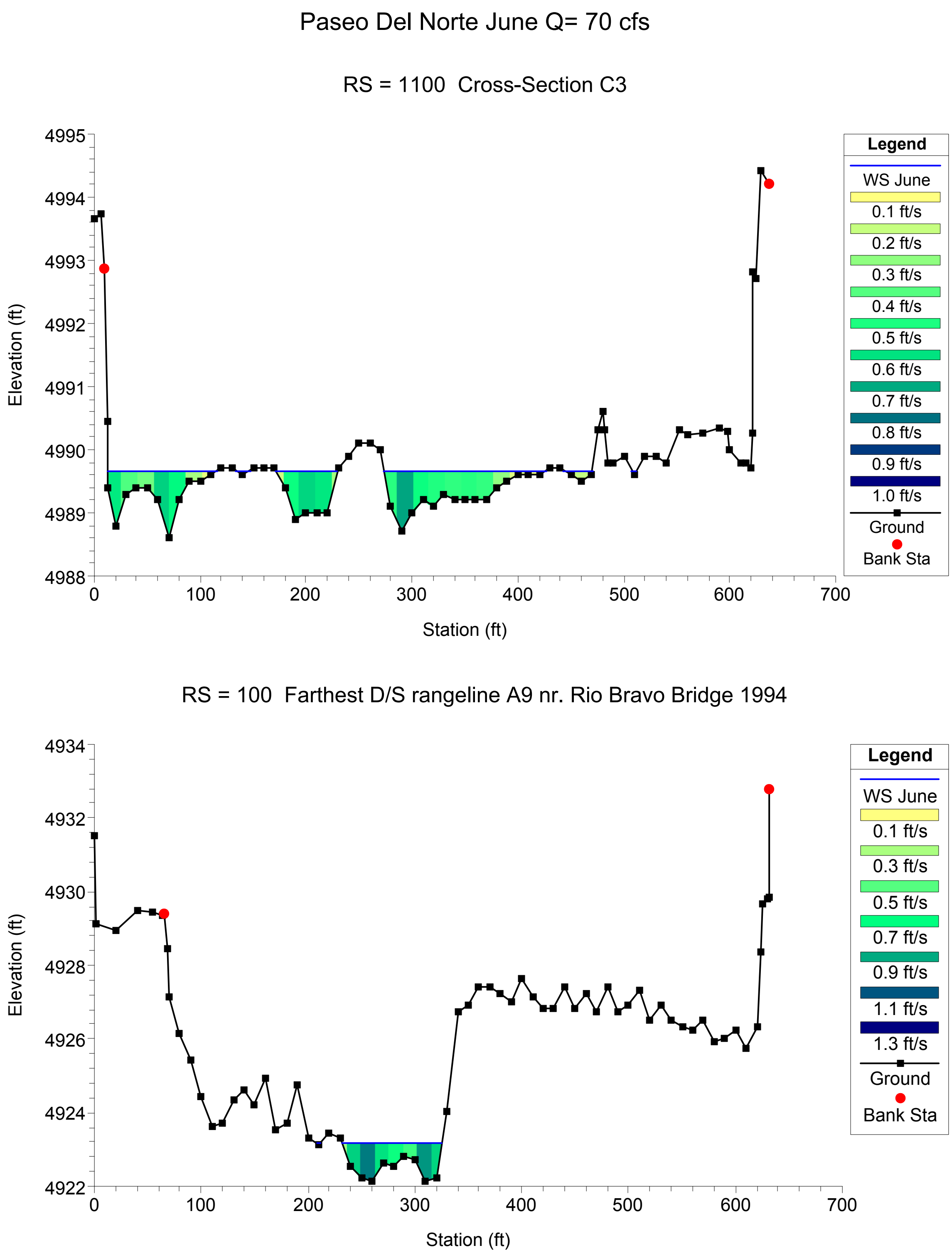


Figure 3.24-4

HEC-RAS Model Representation of Operational Low Flow (Q = 70 cfs) for Paseo del Norte diversion (Upper Figure near Paseo del Norte Bridge; Lower Figure near Rio

Bravo Boulevard)

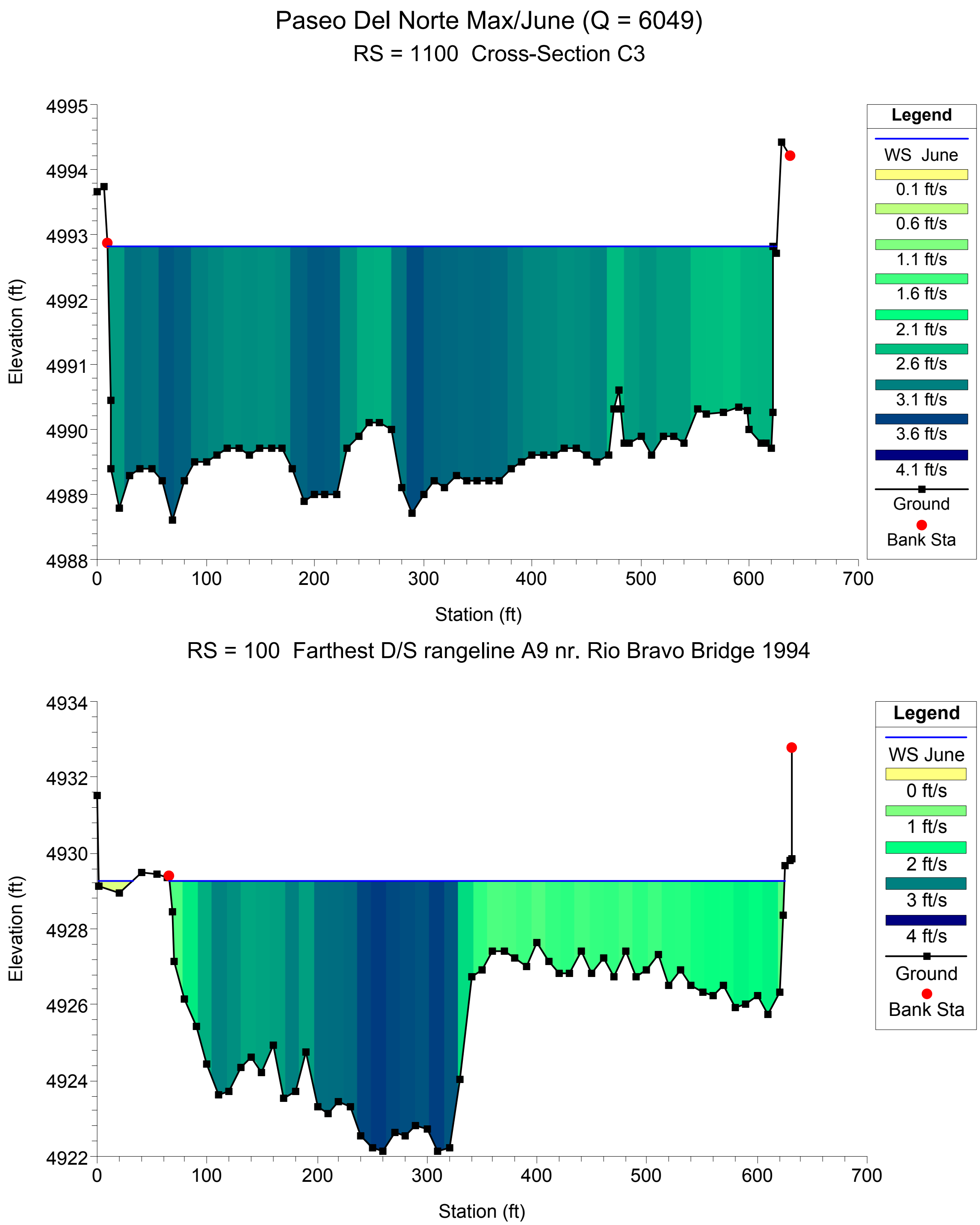


Figure 3.24-5

HEC-RAS Model Representation of Maximum Flow (Q =6049 cfs) at Paseo del Norte (Upper Figure near Paseo del Norte Bridge; Lower Figure near Rio Bravo Boulevard)

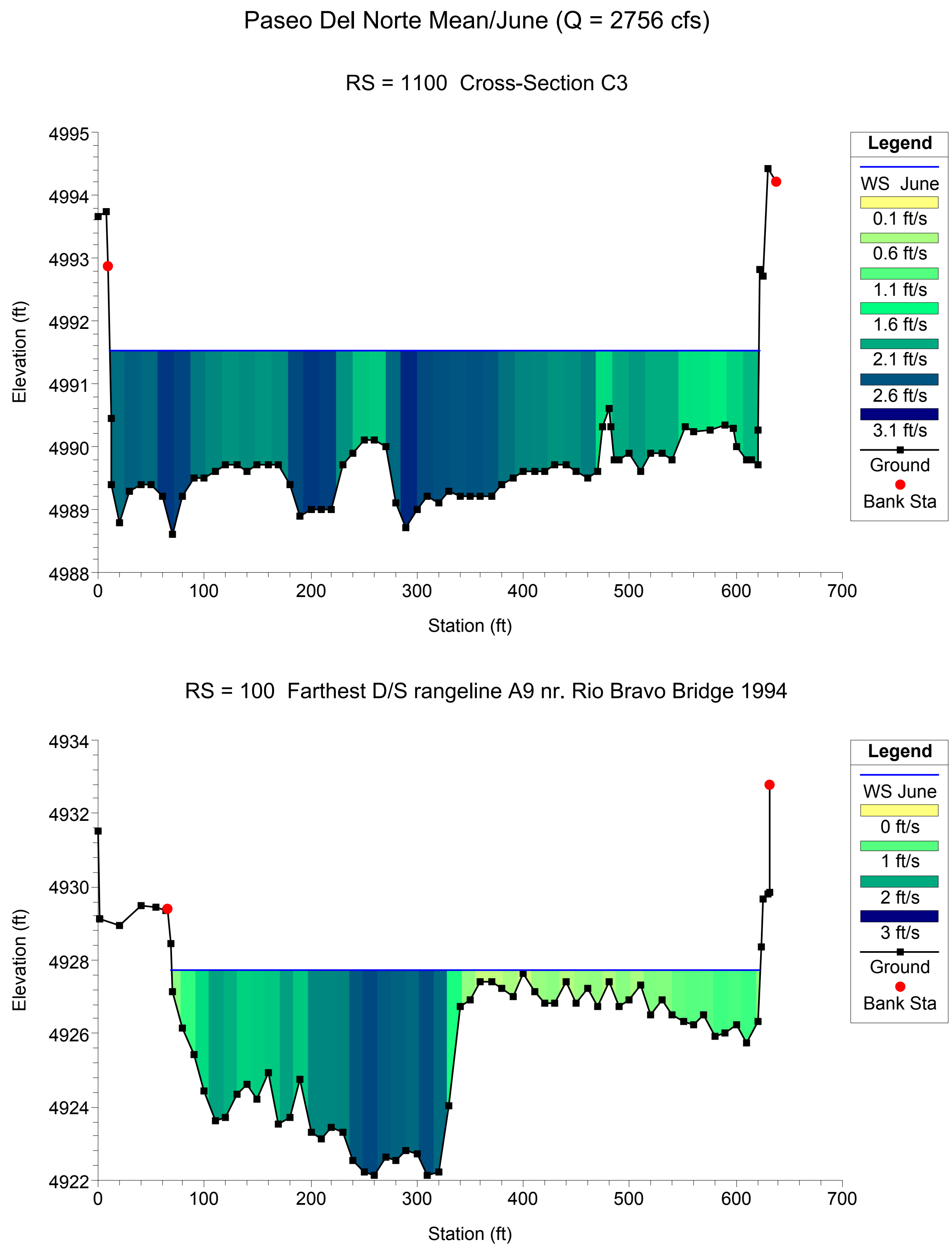


Figure 3.24-6
HEC-RAS Model Representation of Mean Flow (Q = 2756) at Paseo del Norte (Upper Figure near Paseo del Norte Bridge; Lower Figure near Rio Bravo Boulevard)

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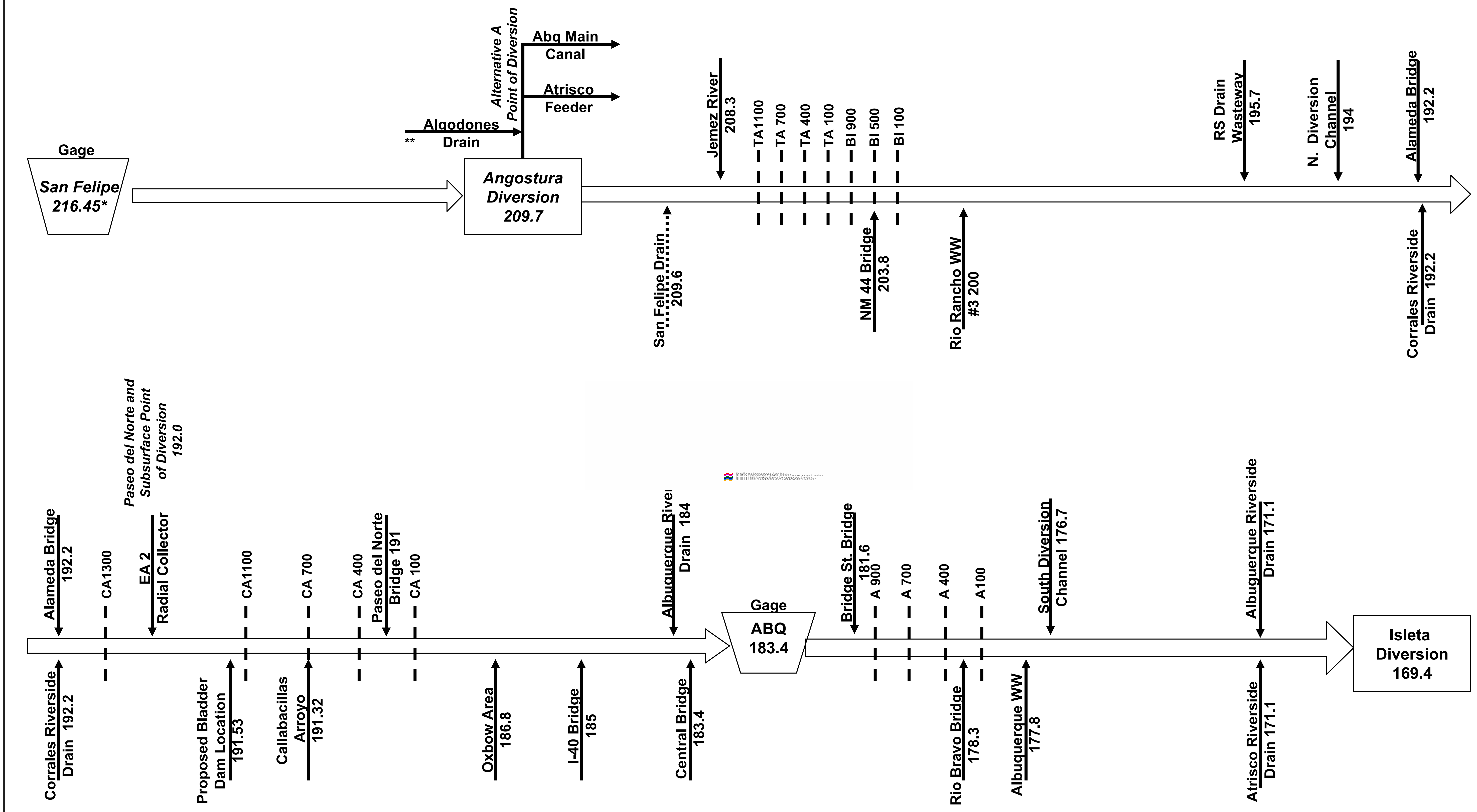

* Numbers represent river miles measured upstream from Caballo Dam
** Arrows show direction of water flow

Cross-section Line Reference

Figure 3.24-7
Schematic of River Features and Cross-sections in the Rio Grande (Middle Project Subarea)

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- Field cross-sections used in this analysis represent the most current data available for this reach of the river. The Rio Grande is a dynamic, sand-bottom river within the Middle Project Subarea; therefore, the cross-sectional depictions are representative of the reach in which they occur, but may not be representative of current conditions (additional information on hydraulic conditions is presented in Appendix O).

- Ecological-preference data for the RGSM are representative of habitat used by the RGSM.

Application of the habitat criteria to varied flow rates produced a series of habitat suitability values (in square feet) for each cross-section. Table 3.24-7 provides information on the relationship between the cross-section lines, river miles, and prominent features on the Rio Grande between Angostura and Rio Bravo. Figure 3.24-7 shows the relative locations of these river features, the DWP diversion point, and the cross-section lines.

Habitat availability and corresponding suitability for RGSM were defined as "marginal" for migration or residence if total habitat at a cross section approximated 10 ft^2. Cross-sections with greater than 10 ft^2 of habitat are defined as "adequate" for migration or residence. Marginal habitat of less than 10 ft^2 was not downgraded if both the upstream and downstream adjoining cross sections met the "adequate" classification.

Effects from No Action Alternative

Under the No Action Alternative the construction and operation of ground water wells would not affect the RGSM or its habitat. Under the No Action Alternative, no construction of new barriers would occur and the existing barriers on the MRG Project (Angostura, Isleta, and San Acacia) remain for the near future.

For the No Action Alternative the City would compensate for its ground water pumping effects using its varied water sources. By the year 2040, the river depletion due to continued and increased ground water pumping will exceed the City's ability to compensate with its water sources (native water rights, storage, etc.). This exceedance would cause a decrease in flow below the SWRP (CH2M Hill, 2003). This reduction in flow could also cause the river to recede quicker in dry years resulting in longer dry river reaches in the Lower Project Subarea (see Hydrology Section 3.16).

Effects from Angostura Diversion

The existing Angostura Diversion Dam is a barrier to the movement of aquatic life in the Rio Grande. Angostura Diversion would include construction of a new 50 feet wide, 1,500-foot-long, rock-lined fishway on the western side of the dam (See Figures 2.5-1, 2.5-3 and 2.5-5 for conceptual drawings of the action alternative diversions). This proposed fishway would be designed to enhance aquatic habitat by providing a route around the existing dam. The dam also would be equipped with a V-shaped, 250-foot-long fish screen in the existing concrete-lined channel immediately below the diversion dam (see Figure 2.5-1). As noted in the DWP Conceptual Design Report (CH2M Hill, 2001c), concepts presented for the fishway and fish screens are provisional; adjustments will be made as appropriate during final design to incorporate any new findings from the ongoing fish passage and fish swim speed studies by the City and Reclamation. The City is an active participant in the RGSM swimming-speed research effort, and is conducting tests at the Albuquerque BioPark. Both the by-pass and fishway would constitute aquatic habitat enhancements of an existing structure.

Operation of the Angostura Diversion would result in increased flow of approximately 65 cfs relative to the No Action Alternative from the outlet works at Abiquiu to the diversion point at Angostura Diversion Dam. Addition of this volume to the baseline flows of the Rio Chama and Rio Grande, within the nominal flows of the two rivers, would have no direct effect on the RGSM in the Upper Project Subarea. Return flows from the SWRP would restore native flows such that only a small depletion would occur through 2020. Therefore, there would be no direct effects on the RGSM from DWP operations in the Lower Project Subarea.

Potential changes in availability of RGSM habitat were not analyzed for the Upper Project Subarea or Lower Project Subarea. This is because the hydrologic effects in the Upper and Lower Project Subareas are minimal (See Section 3.16).

In the Middle Project Subarea, analysis of the potential operational effects of the proposed project on the RGSM involved two elements. One element was related to "take" of RGSM (in the context of the ESA) resulting from water diversions under Angostura Diversion, and the other element was based on the habitat elements of depth and velocity (as described in Section 3.24.2). Each of these elements is discussed below.

TABLE 3.24-7
PROMINENT RIO GRANDE FEATURES AND REFERENCE POINTS IN THE DRINKING WATER PROJECT ROI

Rio Grande Prominent Features	Rio Grande Reference Points	
	River Mile	Model Line Reference [a/]
Angostura Diversion Dam	209.7	TA Lines
Jemez River confluence	208	TA Lines
New Mexico Highway 44 Bridge	203.8	BI Lines
AMAFCA North Diversion Channel	194	--
Alameda Bridge	192.2	CA Lines
Proposed bladder dam location	191.53	CA Lines
Paseo del Norte Bridge	191	CA Lines
Montaño Bridge	187.92	--
Montaño Oxbow area	186.8	--
I-40 Bridge	185	--
Central Street Bridge	182.7	--
Tingley Beach area	182.1	--
Bridge Street Bridge	180	A Lines
Rio Bravo Bridge	178.3	A Lines
SWRP	177.0	--

[a/] The cross-section designations ("TA," "CA," and "A") were assigned by Reclamation.

Openings in the stainless steel fish screen would measure 1.75 millimeters (mm) (0.07 inch) in order to prevent entrainment of RGSM in the diverted water. At extrusion, RGSM eggs are approximately 1 mm (0.04 inch) in diameter, and rapidly swell to 3 mm (0.12 inch). Recently hatched larval fish measure about 0.15 inch (3.7 mm) in standard length, and grow about 0.005 inch (0.15 mm) per day during the larval stages. Post-larval RGSM, which have very limited swimming ability, grow rapidly. Adults range to over 3 inches long (Platania and Altenbach, 1998). These figures formed the basis for assessment of "incidental take" (primarily of eggs and non-motile RGSM). Based on comparison of RGSM egg and larvae sizes with the proposed fish screen opening dimensions, it is apparent that eggs and non-motile post-larvae individuals entrained in the diverted water would pass through the fish screen and not survive. Eggs and non-motile individuals larger than the screen opening could become impinged on the screen and not survive.

The data developed by Dudley and Platania (1997) is currently accepted as the definition of preferred habitat for the RGSM. This was used as the basic parameter for determination of effects within the FEIS. The habitat availability/suitability areas of 10 square foot are representative of an area that would be adequate for a cyprinid fish under most flow conditions. Using the Dudley and Platania (1997) criteria, fish with those low conditions, would seek preferred habitats. Different flow amounts would create different habitat availability amounts.

The use of HEC-RAS, with existing cross-sections, and using literature definitions of RGSM preferred habitat is appropriate for an analysis. Conclusions are made from the graphical, tabular, and statistical data derived from existing government established cross-sections, flow modeling and literature interpretations are interpreted in the context of 15 or 32.7 (Angostura Alternative) miles of river depletion area. RGSM habitat remains available under any of the action alternatives. The habitat also will vary naturally with different flows that occur over the course of a year.

Construction within the river is necessary at Paseo del Norte for those two alternatives and within the edge of the river for the Angostura Alternative. Most in-river construction would occur in winter, or low flow months. Peak spawning for RGSM occurs during periods of high flow in the river. The exact schedule is impacted by contract requirements and economic considerations of construction. The mitigation requirements for in-river construction are summarized in Appendix O.

Initial cross-section model runs to assess habitat availability were completed assuming a discharge of 180 cfs just below the Angostura Diversion Dam for the months of April through October. The 180-cfs value was used as low-flow representation of conditions when the City's diversion project would not be operating (CH2M Hill, 2003). Table 3.24-8 presents the results of this initial model run for Angostura Diversion. Habitat areas at each represented cross-section were calculated for each section of water computed to have a different velocity. Suitable habitat areas presented in Table 3.24-8 are the sum of the areas of habitat meeting ranking criteria 1, 2, or 3 (as defined in Table 3.24-5). Graphic illustrations in the far right column of Table 3.24-8 represent the geomorphology and water-surface elevations for the cross-sections. These illustrations can be used to visually compare the areas of ranked habitat at each cross-section location.

TABLE 3.24-8
PROJECTED LOW-FLOW RIO GRANDE SILVERY MINNOW HABITAT AVAILABILITY – DWP ANGOSTURA DIVERSION

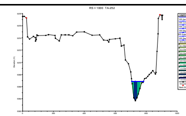
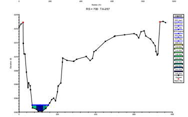
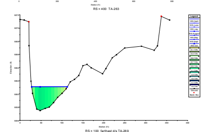
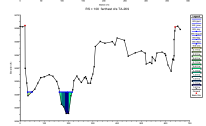
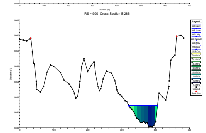
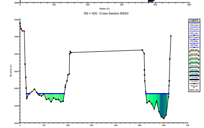
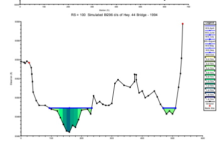
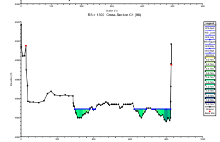
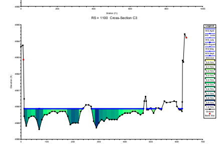
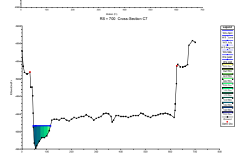
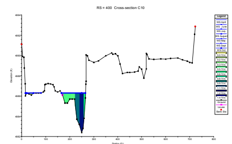
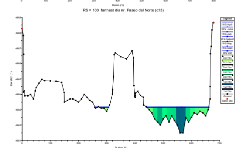
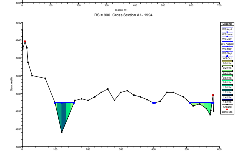
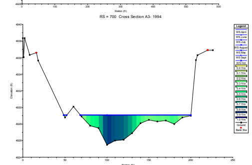
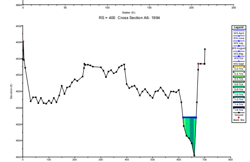
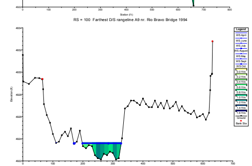
Cross Section Reference	Useable Habitat Available [a/] at Assumed Flow of 180 cfs Below Angostura Dam (square feet)							
	April	May	June	July	Aug	Sept	Oct	Cross-Section
TA Line 1100	6.01	5.94	5.97	5.95	5.94	5.93	5.93	
TA Line 700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TA Line 400	2.48	2.42	2.45	2.43	2.43	2.42	2.41	
TA Line 100	5.14	4.82	5.02	4.94	4.88	4.82	4.80	
BI Line 900	6.35	6.10	6.23	6.16	6.12	6.09	6.06	
BI Line 500	28.31	27.30	27.87	27.55	27.40	27.27	27.12	
BI Line 100	32.39	31.09	31.78	31.41	31.22	31.05	30.91	
CA Line 1300	43.20	38.81	40.02	39.67	38.85	38.41	38.17	
CA Line 1100	100.66	105.81	106.71	106.41	105.97	105.53	104.48	
CA Line 700	5.69	5.16	5.36	5.34	5.17	5.10	5.07	

TABLE 3.24-8
PROJECTED LOW-FLOW RIO GRANDE SILVERY MINNOW HABITAT AVAILABILITY – DWP ANGOSTURA DIVERSION

Cross Section Reference	Useable Habitat Available [a/] at Assumed Flow of 180 cfs Below Angostura Dam (square feet)							
	April	May	June	July	Aug	Sept	Oct	Cross-Section
CA Line 400	5.57	13.61	2.99	2.93	13.63	13.41	13.24	
CA Line 100	37.53	31.79	34.60	34.33	31.83	31.34	41.94	
A Line 900	22.40	17.57	18.94	18.76	17.59	16.86	16.46	
A Line 700	22.65	27.93	28.71	28.65	28.09	36.06	36.04	
A Line 400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
A Line 100	11.66	8.94	9.62	9.56	8.97	8.58	8.43	

a/ For each cross-section, useable habitat available is the sum of all areas with criteria rankings of 1, 2 or 3 (see Table 3.24-5).

TABLE 3.24-9
PROJECTED MAXIMUM-FLOW RIO GRANDE SILVERY MINNOW
HABITAT AVAILABILITY – NO ACTION, ANGOSTURA DIVERSION OR PASEO DEL NORTE DIVERSION

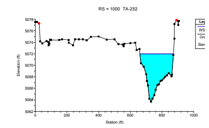
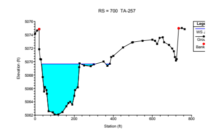
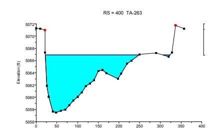
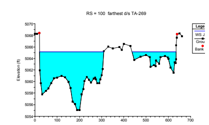
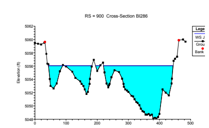
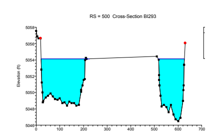
Cross-Section Reference	Useable Habitat Available at Simulated Maximum Flow (cfs) at Central Gage No Action/ Angostura Diversion or Paseo del Norte Diversion (square feet) [a/]							Cross-Section
	April	**May**	**June**	**July**	**August**	**Sept**	**Oct**	
Maximum Flow No Action/DWP	6312/6287	6255/6241	6076/6049	5400/5372	3417/3388	1522/1494	1766/1752	
TA Line 1100	0.0/0.0	0.0/0.0	0.0/0.0/0.0	0.6/0.6	0.0/0.0	4.46/4.23	0.0/0.0	
TA Line 700	17/16.5	43.8/43.2	41.9/40.7	19.0/17.6	0.0/0.0	4.0/3.5	8.5/8.0	
TA Line 400	23.5/22.8	20.6/20.3	25.6/24.8	6.0/5.6	1.5/1.4	9.3/8.4	11.6/10.9	
TA Line 100	5.3/5.1	8.6/8.5	3.7/3.6	12.3/12.0	21.9/21.1	2.2/2.0	4.5/4.2	
BI Line 900	3.9/3.7	12.5/8.4	8.1/7.9	17.0/13.8	6.9/6.6	17.7/16.7	7.8/7.4	
BI Line 500	114.7/114.7	76.7/91.8	88.2/85.4	95.4/0.1	0.0/0.0	2.0/1.7	4.89/3.7	

TABLE 3.24-9 (Continued)
PROJECTED MAXIMUM-FLOW RIO GRANDE SILVERY MINNOW HABITAT AVAILABILITY – NO ACTION, ANGOSTURA DIVERSION OR PASEO DEL NORTE DIVERSION

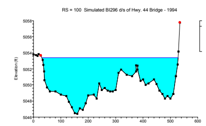
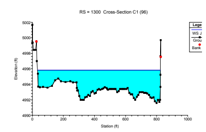
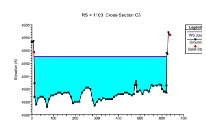
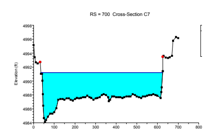
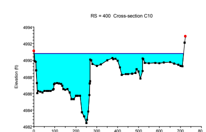
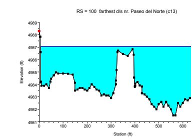
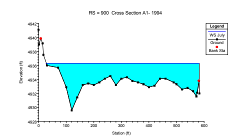
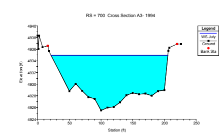
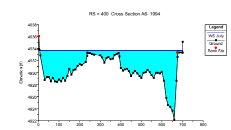
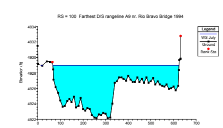
Cross-Section Reference	Useable Habitat Available at Simulated Maximum Flow (cfs) at Central Gage No Action/ Angostura Diversion or Paseo del Norte Diversion (square feet) [a/]							
	April	**May**	**June**	**July**	**August**	**Sept**	**Oct**	
Maximum Flow No Action/DWP	6312/6287	6255/6241	6076/6049	5400/5372	3417/3388	1522/1494	1766/1752	**Cross-Section**
BI Line 100	3.5/3.2	0.5/1.5	1.2/1.0	3.6/0.0	9.2/11.0	14.6/13.7	5.4/4.7	
CA Line 1300	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	23.5/23.1/0.0	18.7/16.7/55.4	36.0/34.5/59.54	
CA Line 1100	0.6/0.0/0.5	0.3/0.0/0.3	0.3/0.3/0.3	0.1/0.0/0.0	0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	
CA Line 700	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	
CA Line 400	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	82.8/79.6/79.6	31.2/28.5/28.5	51.8/50.0/50.0	

TABLE 3.24-9 (Continued)
PROJECTED MAXIMUM-FLOW RIO GRANDE SILVERY MINNOW HABITAT AVAILABILITY – NO ACTION, ANGOSTURA DIVERSION OR PASEO DEL NORTE DIVERSION

Cross-Section Reference	Useable Habitat Available at Simulated Maximum Flow (cfs) at Central Gage No Action/ Angostura Diversion or Paseo del Norte Diversion(square feet) [a/]							
	April	**May**	**June**	**July**	**August**	**Sept**	**Oct**	
Maximum Flow No Action/DWP	6312/6287	6255/6241	6076/6049	5400/5372	3417/3388	1522/1494	1766/1752	**Cross-Section**
CA Line 100	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	8.0/29.4/29.4	0.0/0.0/0.0	28.7/27.0/27.0	42.7/41.3/41.3	
A Line 900	5.5/5.4/5.4	5.4/5.3/5.3	4.5/4.4/4.4	8.0/14.7/14.7	0.5/0.4/0.4	25.5/35.8/35.8	12.4/12.1/12.1	
A Line 700	0.2/0.2/0.2	0.0/0.2/0.2	0.1/0.1/0.1	2.0/1.9/1.9	1.2/1.1/1.1	2.6/1.3/1.3	0.2/0.2/0.2	
A Line 400	0.2/0.2/0.2	0.0/0.0/0.0	0.1/0.1/0.1	35.7/34.8/34.8	14.4/21.5/21.5	28.5/21.5/21.5	31.5/30.0/30.0	
A Line 100	9.6/9.2/9.2	9.6/9.4/9.4	6.5/6.2/6.2	0.3/0.2/0.2	0.0/0.0/0.0	25.3/22.3/22.3	34.6/22.0/22.0	

[a/] For each cross-section, useable habitat available is the sum of all areas with criteria rankings of 1, 2, or 3 (see Table 3.24-5).

TABLE 3.24-10
PROJECTED MEAN FLOW RIO GRANDE SILVERY MINNOW
HABITAT AVAILABILITY – NO ACTION, ANGOSTURA DIVERSION OR PASEO DEL NORTE DIVERSION

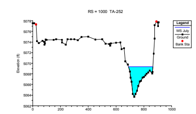
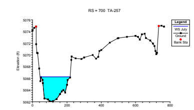
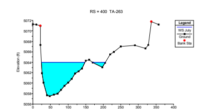
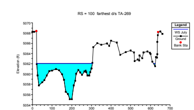
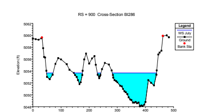
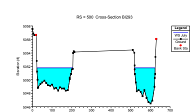
Cross-Section Reference	Useable Habitat Available at Simulated Mean Flow at Central Gage No Action/Angostura Diversion or Paseo del Norte Diversion (square feet) [a/]							
	April	May	June	July	August	Sept	Oct	Cross-Section
Mean Flow (cfs) No Action/DWP	1927/1906	3089/3072	2775/2756	1444/1423	662/644	478/465	427/412	
TA Line 1100	0.0/0.0	0.0/0.0	4.62/4.43	0.0/0.0	13.3/12.0	3.26/2.88	13.9/13	
TA Line 700	3.6/3.4	0.0/0.0	0.0/0.0	5.5/5	1.6/1.4	0.13/0.09	0.0/0.0	
TA Line 400	6.9/11.3	1.5/1.4	0.9/0.8	11.7/10.8	3.3/3.3	3.0/2.7	3.8/6.5	
TA Line 100	6.8/6.5	21.5/20.9	15.3/14.7	2.8/2.6	39.4/38.6	30.1/27.0	1.0/33.4	
BI Line 900	5/4.7	6.5/6.3	16.2/15.8	19.6/18.8	17.8/16.4	9.9/15.6	11.5/10.1	
BI Line 500	5.2/5.0	0.0/0.0	0.0/0.0	2.4/2.2	2.7/2.6	1.6/11.4	10.1/9.5	

TABLE 3.24-10 (Continued)
PROJECTED MEAN FLOW RIO GRANDE SILVERY MINNOW HABITAT AVAILABILITY – NO ACTION, ANGOSTURA DIVERSION OR PASEO DEL NORTE DIVERSION

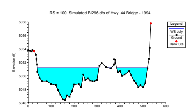
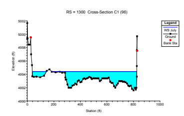
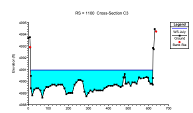
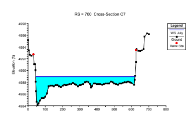
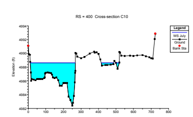
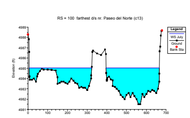
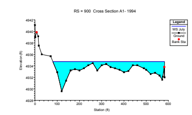
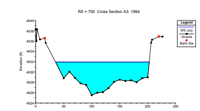
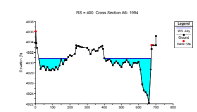
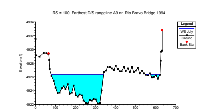
Cross-Section Reference	Useable Habitat Available at Simulated Mean Flow at Central Gage No Action/Angostura Diversion or Paseo del Norte Diversion (square feet) [a/]							
	April	**May**	**June**	**July**	**August**	**Sept**	**Oct**	
Mean Flow (cfs) No Action/DWP	1927/1906	3089/3072	2775/2756	1444/1423	662/644	478/465	427/412	**Cross-Section**
BI Line 100	10.8/9.9	10.8/10.6	16.5/16.1	1.8/7.5	20.0/18.5	32.3/30.9	34.4/40.5	
CA Line 1300	46.8/20.1/45.2	21.0/0.0/20.8	17.4/0.0/17.1	17/54/15.64	93.9/112.3/89	95.2/90.9/88.5	97.8/121.8/89.9	
CA Line 1100	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	60.3/67.8/67.8	87.2/104.1/104.1	115.3/110.2/110.2	
CA Line 700	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	100.6/48.7/48.7	64.8/57.8/57.8	40.5/33.8/33.8	
CA Line 400	24.9/35.5/35.5	56.0/53.8/53.8	21.8/18.1/18.1	28.3/26.5/26.5	7.5/18.7/18.7	18.3/17.3/17.3	13.8/12.3/12.3	
CA Line 100	24.9/35.5/35.5	0.0/0.0/0.0	0.0/0.0/0.0	26.4/25/25	62.6/81.4/81.4	47.9/43.4/43.4	36.2/32.3/32.3	

TABLE 3.24-10 (Continued)
PROJECTED MEAN FLOW RIO GRANDE SILVERY MINNOW
HABITAT AVAILABILITY – NO ACTION, ANGOSTURA DIVERSION OR PASEO DEL NORTE DIVERSION

Cross-Section Reference	Useable Habitat Available at Simulated Mean Flow at Central Gage No Action/Angostura Diversion or Paseo del Norte Diversion (square feet) [a]							
	April	**May**	**June**	**July**	**August**	**Sept**	**Oct**	
Mean Flow (cfs) No Action/DWP	1927/1906	3089/3072	2775/2756	1444/1423	662/644	478/465	427/412	**Cross-Section**
A Line 900	14.2/13.9/13.9	0.2/0.2/0.2	0.1/0.1/0.1	31/39/39	41.4/38.7/38.7	69.9/74.8/74.8	64.2/59.4/59.4	
A Line 700	0.5/0.4/0.4	0.4/0.3/0.3	3/3/3	2.2/2.1/2.1	1.6/1.4/1.4	4.7/4.2/4.2	8.3/7.6/7.6	
A Line 400	15.4/14.9/14.9	10.1/9.8/9.8	22.9/22.2/22.2	31.4/30.1/30.1	29.1/36.0/36.0	26.3/20.4/20.4	0.7/0.5/0.5	
A Line 100	32.6/29.0/29.0	21.5/21.1/21.1	44.7/43.7/43.7	22.8/20.3/20.3	13.9/21.7/21.7	24.8/23.2/23.2	18.5/24.7/24.7	

[a] For each cross-section, useable habitat available is the sum of all areas with criteria rankings of 1, 2, or 3 (see Table 3.24-5).

For TA Lines 1100, 700, 400 and 100 (near the Angostura Diversion Dam), near BI Lines 900 and 100, near CA Line 700, and near A Line 700, all provide insufficient water depth and flow velocity to meet the RGSM evaluation criteria. In the case of TA Lines 1100, 700, 400, and 100, there is essentially no habitat present that meets the criteria. However, it is important to note that even at TA Line 100, where there is a total absence of habitat that meets the RGSM habitat evaluation criteria, there is more than a 60 ft^2 cross-section of flowing water at that point (*i*.e., the river does not dry). Based on these model evaluations at these cross sections, flowing water provides continuous habitat from New Mexico Highway 44 to the Rio Bravo Bridge (Figure 3.24-2), albeit under depth and velocity conditions outside the ranges preferred by RGSM.

Data for simulated maximum and mean flows at the Central Avenue gage are presented in Tables 3.24-9 and 3.24-10, respectively. Both the Angostura Diversion and the proposed bladder dam at Paseo del Norte Diversion are reflected in these tables. As shown in these tables, there is very little difference between RGSM habitat availability with and without implementation of the DWP. While specific cross-sections provide varying amounts of preferred habitat over time, no drying effects on the Rio Grande can be attributed to the proposed project (See Figure 2.5-1 for a conceptual drawing of Angostura Diversion).

It is also noted that these square footage values refer to and represent only the preferred habitat of RGSM based on depth and velocity preferences discussed above. Flowing water present at a particular cross-section might not meet those criteria but still provide water (and therefore continuous flows) at that cross-section. A “drying effect” as used in this discussion is defined as discontinuous flow where pooled water is separated by areas of non-wetted bottom/substrate.

Because no deleterious hydrologic effects are anticipated for the Upper Project Subarea, based on projected flow and hydrologic changes (CH2M Hill, 2003), no analysis on RGSM habitat effects was completed.

The USFWS identifies an anticipated take of no more than 100,000 RGSM propagules each year through entrainment at the three existing diversion facilities on the river (Angostura, Isleta and San Acacia Diversion Dams) (USFWS, 2001d). Using these figures, an assumed maximum take of 33,000 propagules per dam (100,000 RGSM propagules/3 dams) is used for irrigation diversions. Over the last fifteen years, MRGCD has diverted an average of 120,000 ac-ft/yr at Angostura. The Angostura Diversion would divert an additional 94,000 ac-ft/yr from Angostura Diversion. This is a 78 percent increase in the total amount of water diverted. Using a ratio approach of propagules taken under current conditions to the additional DWP diversion, it is estimated that Angostura would incur an additional take of 26,100 propagules.

Effects from Paseo del Norte Diversion

The approximately 600-foot-long dam would consist of inflatable bladder structures mounted in a concrete base across the active river channel. Gates on the east side of the dam would route water to an inlet structure, on top of which would be a pump station. The new diversion dam would include fish screens and a fishway facility. Construction of the bladder dam would affect approximately 1.8 acres of river channel. (See Figure 2.5-3 for a conceptual drawing of Paseo del Norte Diversion).

Construction of a new surface dam would directly affect the RGSM by diverting portions of the river during construction and by operation of heavy equipment in the riverbed. These direct effects would be mitigated by the salvage of all fish species affected by dewatering and diversion, the use of cofferdams during construction, and other environmental commitments discussed in Section 3.24.4. During installation of the diversion facility, the City would require the construction contractor to maintain an open channel with a velocity of less than 3.0 ft/sec in the Rio Grande for fish passage. Construction of the diversion facility would be initiated during the winter low-flow period from September through March, to avoid to the extent possible the spring snow melt and summer monsoon seasons of high flows.

Conceptual design for the proposed Paseo del Norte Diversion has been completed to incorporate several features designed for conservation of RGSM and aquatic species. Specifically, the diversion structure will be a low-head device, which when not in operation, will lie approximately six inches above the riverbed. In addition, a fishway has been incorporated into the design. This feature, located on the west shore will provide flows of 50 cfs during all operational periods of the diversion structure. Additionally, fish screens and a fish by-pass are incorporated into the diversion structure on the east shore.

Entrainment of adult RGSM and other aquatic species during downstream movement is anticipated to be minimal. Flows of 50 cfs through the west-side fishway will provide access for individuals both upstream and downstream. On the east side, the fish by-pass provides a mechanism for individuals in that portion of the channel to successfully avoid the diversion inlets. During periods when the diversion structure is deflated and lie approximately 6 inches above the river bottom, aquatic organisms, including adult RGSM, will be able to freely access upstream or downstream locations adjacent to the diversion structure.

Operation of Paseo del Norte Diversion would result in an increase in flow of approximately 65 cfs from the outlet works at Heron Reservoir to the diversion point at Paseo del Norte relative to the No Action Alternative. Addition of this flow to the baseline flows of the Rio Chama and the Rio Grande, within the nominal flows of the two rivers, would have no direct effect on RGSM in the Upper Project Subarea. Return flows at the SWRP outfall would "make the river whole," and there would be no direct effects from operation of Paseo del Norte Diversion in the Lower Project Subarea. Assumptions presented for operational aspects of Angostura Diversion, above, would apply for Paseo del Norte Diversion, except as noted in the following discussions.

Fish passages and fish screens for the proposed action are summarized in Section 2.5.2, Section 3.7 and 3-24. Design drawings are provided in CH2M Hill (2001c) *Drinking Water Project Conceptual Design Report*. Additional conceptual design information that will be added to the FEIS is presented within CH2M Hill (2001g), *Fish Passage Engineering Design Considerations*.

Both upstream and downstream fish passage are provided by the diversion structures, fishways and sluice channels. Fish are protected at the raw water intakes by flat plate stainless steel fish screens. The technologies proposed for the DWP have been used with success at other sites for similar species. At conceptual design, there were no criteria available from state or federal fisheries resource agencies related to fish screens for the RGSM. Designers used the same fish screen criteria used by the State of California, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service for the delta smelt, which is similar in body size and swimming ability to the RGSM. These criteria are:

- Approach velocity, 0.20 feet per second (fps),
- Sweeping velocity, at least 2 times the approach velocity, and
- Screen opening, 1.75 mm (0.069 inch).

As research continues, the state and federal agencies should be able to provide the City and the design engineer more specific approach velocity design criteria. The proposed designs have been successfully used at locations in California, Washington and Oregon.

A slope of 0.004 feet per foot has been found by Bestgen et al. (2003) to allow for upstream passage of Rio Grande silvery minnow. The proposed fishway design incorporates this criteria. The average water velocity through the fishway would be approximately 2 feet per second at an average flow rate of 50 cfs. The final design will incorporate the research being conducted by other entities.

The studies that would be used in a final design for the fishway incorporate ongoing studies at Reclamation's Denver laboratory, RGSM flume studies conducted by the City, and other data from migration and movement studies being completed in the Rio Grande. The target base flow of 50 cfs within the channel would vary as flows within the river change. There are structures (boulders, etc.) within the fishway that would allow resting positions and cover within the fishway, so the fish could use burst, or darting behaviors to move up and down the channel. The flow velocity of 0.325 ft/sec, is where the RGSM is most frequently encountered. Riverine fishes can tolerate and move through a large range of flows within the river and different habitat components (main channel, riffles, pools, etc.) towards a preferred location. Because RGSM spawning occurs during high flows, the ability to lower the inflatable dam during high flows allows for RGSM eggs to pass down stream.

In the Middle Project Subarea, analysis of the potential operational effects of DWP Paseo del Norte Diversion on the RGSM involved assessment of two elements: take (as defined under the ESA) resulting from water diversions at Paseo del Norte, and project hydrologic effects on RGSM habitat. The Paseo del Norte Diversion fish screens are designed for a maximum approach velocity of 0.2 ft/sec at the peak diversion rate of 142 cfs to avoid pinning fish against the screens. The sluice channel would narrow from the upstream end to the downstream end in order to maintain a sweeping velocity through the fish screens of at least five times the normal approach velocity. The fish screens are designed to protect the RGSM and other fishes. The intake would consist of 10 reinforced-concrete intake compartments (see Figure 2.5-3 for a conceptual drawing of Paseo del Norte Diversion).

A 7.1-foot-wide by 10-foot-long, stainless steel fish screen panel with 0.07-inch openings would be installed across the entrance to each compartment. The screens would be angled to provide sufficient surface area across the intake openings. Based on the dimensions of RGSM eggs and larvae presented in the discussion for Angostura Diversion, which formed the basis for evaluation of incidental take (primarily of eggs and non-motile RGSM), it is apparent that eggs and non-motile larvae entrained in the diverted water would pass through the fish screens and not survive. As noted in the *DWP Conceptual Design Report* (CH2M Hill, 2001c), concepts presented for the fish screens are provisional; adjustments would be made as appropriate during final design to incorporate any new findings from the ongoing fish passage and fish swim speed studies being conducted by the City, ISC, and Reclamation.

A fishway would be constructed within the riparian area on the west side of the river, adjacent to the bladder dam, to allow fish to swim past the dam when the adjustable-height crest gates are raised. The fishway would be a 50-foot-wide, low-gradient, ‘V’-shaped, roughened channel constructed of riprap laid on filter fabric. The high boundary roughness resulting from the riprap channel, combined with rock boulders located along the channel, would create flow conditions suitable for fish passage. A 250-foot-long by 100-foot-wide “backwater” area would be located at the center of the fishway. The average water velocity through the fishway would be approximately 2 ft/sec at an average flow rate of 50 cfs. Average water depth at the center of the channel would be approximately 1.6 feet. This design element is intended to protect RGSM and other fishes (See Figure 2.5-3 for conceptual design).

The second element of operational effects evaluation involved possible changes in available RGSM habitat. Table 3.24-11 presents the results of the model run assuming a flow of 130 cfs immediately downstream of the proposed bladder dam at Paseo del Norte. For CA Lines 1300 and 1100, adequate habitat exists to allow migration or local residence of RGSM and other fish species. Near CA Line 700, habitat availability for either migration or local residence is marginal. Near CA Line 400, habitat availability for either migration or local residence is adequate. This effect is moderated by the presence of adequate habitat above and below CA Line 400. Near CA Line 100, habitat availability for either migration or local residence is adequate. Near A Line 900, habitat availability for either migration or local residence is adequate. Near A Line 700, habitat availability for either migration or local residence is adequate. Near A Line 400, habitat availability for either migration or local residence is not present. Near A Line 100, habitat availability for either migration or local residence is marginal (Table 3.24-11). The conclusion of this analysis is that there is no difference between habitat availability between the No Action and any of the three action alternatives. This conclusion is supported by the tabular, graphic and text provided.

TABLE 3.24-11
PROJECTED LOW-FLOW RIO GRANDE SILVERY MINNOW HABITAT AVAILABILITY –PASEO DEL NORTE DIVERSION

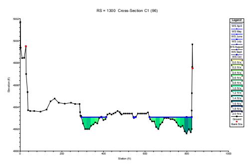
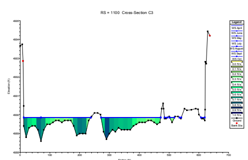
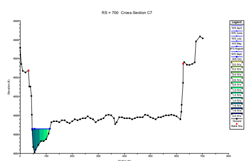
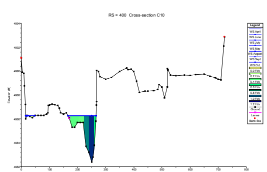
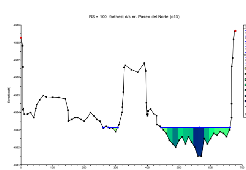
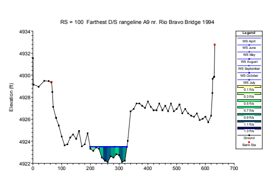
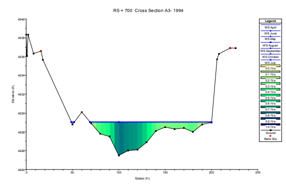
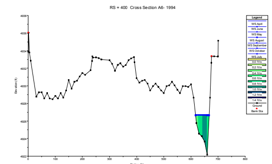
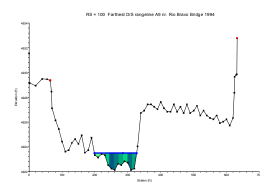
Cross Section Reference	Useable Habitat Available [a/] at Assumed Flow of 130 cfs Below Paseo del Norte Dam (square feet)							Cross-Section
	April	May	June	July	Aug	Sept	Oct	
CA Line 1300	42.89	42.89	42.89	42.89	42.89	42.89	42.89	
CA Line 1100	102.85	102.43	102.58	102.43	102.43	102.43	102.43	
CA Line 700	5.01	4.99	5.00	5.00	4.99	4.99	4.98	
CA Line 400	13.15	13.04	13.08	13.06	13.04	13.01	12.99	
CA Line 100	31.13	30.79	30.95	30.88	30.79	30.69	30.69	
A Line 900	23.32	20.76	21.92	19.29	20.76	20.16	20.10	

TABLE 3.24-11 (Continued)
PROJECTED LOW-FLOW RIO GRANDE SILVERY MINNOW HABITAT AVAILABILITY –PASEO DEL NORTE DIVERSION

Cross Section Reference	Useable Habitat Available [a/] at Assumed Flow of 130 cfs Below Paseo del Norte Dam (square feet)							Cross-Section
	April	May	June	July	Aug	Sept	Oct	
A Line 700	35.24	38.33	38.95	42.44	38.31	42.99	42.99	
A Line 400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
A Line 100	7.53	6.15	6.80	5.68	6.13	5.90	5.82	

a/ Useable habitat available is the sum of all areas with criteria rankings of 1, 2, or 3 rankings (see Table 3.24-6) for each cross-section.

Marginal habitats would include those areas where only approximately 10 ft^2 of RGSM preferred habitat was present at the stated flow conditions. Habitat that was marginal but acceptable includes those areas where approximately 10 ft^2 of RGSM preferred habitat would be present at one cross-section but the adjoining cross-sections provide adequate habitat. It is also noted that these conditions represent the conservative classes of habitat that are defined by the depth and velocities preferred by RGSM, not all flow conditions; that is, even in situations where the RGSM preferred habitat.

The Service has completed a biological opinion, dated February 13, 2004, stating that the proposed action "is not likely to jeopardize the continued existence of the silvery minnow, and will not adversely modify its critical habitat." Specific mitigation and conservation measures for the RGSM are detailed within the biological opinion.

Effects from Subsurface Diversion

The Subsurface Diversion would result in diversion of the same amount of water from the Rio Grande as Angostura Diversion and Paseo del Norte Diversion. However, water would be diverted through subsurface collectors, eliminating the need for a surface water diversion structure located in the river channel. Implementation of the Subsurface Diversion would require the construction of a horizontal collector system beneath the riverbed. No fishways, fish passage, or fish screens would be constructed for the Subsurface Diversion, as all water-diversion structures would be located beneath the riverbed.

Construction of a subsurface facility would directly affect the RGSM by diverting portions of the river during construction and operation of heavy equipment in the riverbed. These direct effects would be mitigated by the salvage of all fish species affected by dewatering, the use of coffer dams during construction, and other environmental commitments (see Section 3.24.4). During installation of the diversion facility, the City would require the construction contractor to maintain an open channel with a flow velocity of less than 3 ft/sec in the Rio Grande for fish passage. Installation of the diversion facility would be initiated during the river's winter low-flow period from September through March, to avoid to the extent possible the spring snow melt and summer monsoon seasons of high flows.

Implementation of the Subsurface Diversion would result in an increased flow of approximately 65 cfs from the outlet works at Heron Dam to the diversion point near Paseo del Norte Bridge relative to the No Action Alternative. Addition of this 65 cfs to the baseline flows of the Rio Chama and Rio Grande relative to the No Action Alternative, within the nominal flows of the two rivers, would have no direct effect on the RGSM in the Upper Project Subarea. Return flow at the SWRP outfall would "make the river whole," and there would be no direct effects from operations in the Lower Project Subarea.

Depletion of flows in the Middle Project Subarea resulting from implementation of the Subsurface Diversion duplicate the effects of water diversion associated with the Paseo del Norte Diversion (Table 3.24-10), spread over a distance of several hundred feet, rather than at an individual point. Operation of the subsurface diversion would have no other direct or indirect effects on the RGSM. This conclusion is based on the absence of "in-river" surface features for the Subsurface Diversion.

Summary of Environmental Consequences

Angostura Diversion would result in the modification of an existing permanent structure in the Rio Grande. The Paseo del Norte Diversion would result in the construction of permanent, new surface-diversion structures in the Rio Grande, and the Subsurface Diversion would involve construction of new subsurface-diversion facilities in the river. The Angostura Diversion and Paseo del Norte Diversion would provide for upstream and downstream passage via a fishway for the RGSM; such features would not be required under the Subsurface Diversion, as movement of fish would not be impeded. Fishway, fish screens and fish by-pass features for the Angostura Diversion and Paseo del Norte Diversion are in the conceptual design stage. Ongoing research by the City and Reclamation will be used to design all fishway features during the final design stage. This leaves a degree of uncertainty in the sizing and alignment of the fishway and fish by-pass features that would be resolved using the best design concepts. Construction effects for all DWP action alternatives would be minimal, short-term, and local. Operation of the Angostura Diversion and Paseo del Norte Diversion with implementation of the mitigation measures and environmental commitments reviewed in Section 3.24.4, would have no long-term, local direct effects on RGSM.

While there may be loss of individuals under any of the action alternatives, the effect of those individual losses, when coupled with the mitigation proposed, will not adversely affect RGSM populations in the Middle Rio Grande, and will in all probability, result in increased population numbers over the life of the City project. A slack water pool may help develop areas of habitat enhancement for the RGSM. The pool may provide some limited over bank flooding, thus providing water to fish nesting and nursery areas. The pool may also provide a variety of depth and flow conditions to riverine fishes, particularly along the edges of the river.

In conclusion, direct and indirect effects on RGSM from any action alternative would be minimal, varying depending on application and effectiveness of the proposed mitigation measures noted below. There will be direct loss of RGSM and slightly depleted flows. The City intends to mitigate these adverse affects but the fish screens and fishway are unproven technologies; therefore, there will be uncertainty regarding impacts to the RGSM. No substantial temporary or long-term adverse effects on the RGSM would result from implementation of the action alternatives. Because any identified direct or indirect effects associated with operation under either the action alternatives would be mitigated through either environmental design features of direct mitigation and enhancement, no cumulative effects on RGSM would occur. This conclusion was reached because the action alternatives would not directly or indirectly affect resources associated with the RGSM, and because extensive environmental design features and mitigation measures, would be included in the project design. There would therefore be no short-term use versus long-term productivity concerns, nor are there any known irreversible and irretrievable commitments of resources with respect to the RGSM. Any potential cumulative effects could be offset by the proposed mitigation measures noted in Section 3.24.4.

Southwestern Willow Flycatcher

Analysis Methods

A survey for the flycatchers was conducted in the construction area for the preferred alternative and no birds were found. The riparian corridor may serve as a migratory area for the flycatcher, as they have been observed above and below the Middle Rio Grande Subarea. The riparian habitat within the project area that would be impacted by construction and operation of the project will be mitigated.

Effects from No Action Alternative

Under the No Action Alternative, the construction and operation of ground water wells would not affect the southwestern willow flycatcher or its habitat. The implementation of the No Action Alternative would have no direct, indirect or cumulative effects on the southwestern willow flycatcher.

Effects from Angostura Diversion and Paseo del Norte Diversion

Because there is no designated southwestern willow flycatcher critical habitat in the Rio Grande Basin, the DWP action alternatives would have no effect on designated critical habitat of the southwestern willow flycatcher. Construction of Angostura Diversion and Paseo del Norte Diversion would require removal of 8.2 and 14.7 acres riparian vegetation, respectively. This riparian habitat loss could affect the flycatcher by destroying future potential suitable habitat. However, none of this riparian habitat currently meets critical-habitat hydrology (overbank flooding), plant-species composition, habitat structure, or saturated soil requirements for the southwestern willow flycatcher. Initial construction would occur during the non-breeding months (September through March), which would protect potential nests, eggs, chicks, and adults from direct construction impacts. No loss of individuals of the southwestern willow flycatcher population would occur as a result of the Angostura Diversion and Paseo del Norte Diversion

Operation of the Angostura Diversion and Paseo del Norte Diversion would cause minimal ground water elevation drawdowns as a result of surface water diversion. Results of the HEC-RAS modeling show that the greatest changes in surface water elevation which are directly correlated with ground water elevation would be 0.38 foot during mean flows and 0.09 foot during maximum flows. In conjunction with the mitigation measures and environmental commitments noted in Section 3.24.4, direct and indirect effects on the southwestern willow flycatcher would be minimal.

Effects from Subsurface Diversion

Construction and operation of the Subsurface Diversion would permanently remove approximately 31 acres of native and non-native riparian vegetation. Structures would replace approximately 10 acres, while ground water elevation drawdowns of more than 3 feet would affect approximately 27.9 acres. Initial construction would occur during the non-breeding months (September through April), which would protect potential nests, eggs, chicks and adults from being directly harmed or harassed. Operation of the Subsurface Diversion may alter the vegetation composition in approximately 552 acres of riparian habitat due to drawdown of the water table. This could result in long-term indirect and cumulative effects on the flycatcher through degradation of potential habitat along the Rio Grande.

It is difficult to forecast what the effects of alteration of 552 acres of riparian habitat would mean to the flycatcher. This could be detrimental to the flycatcher in that non-native plant species would be replacing native species at a greater rate than already occurs. This type of habitat degradation is unfavorable.

Summary of Environmental Effects

The Angostura Diversion and Paseo del Norte Diversion would have minimal local direct effects on the southwestern willow flycatcher. Subsurface Diversion would produce indirect and cumulative moderate impacts on the southwestern willow flycatcher through alteration and destruction of future potential habitat in the area affected by the project.

Direct and indirect effects on southwestern willow flycatchers would be minimal to moderate, depending on the application and effectiveness of mitigation measures and environmental commitments. No substantial temporary or long-term adverse effects on the southwestern willow flycatcher would result from implementation of the action alternatives. Potential cumulative effects of habitat degradation would be offset by the extensive environmental commitments noted below. There are no short-term use versus long-term productivity concerns attributable to any of the action alternatives for the southwestern willow flycatcher, nor are there any known irreversible and irretrievable commitments of resources with respect to this species in the ROI.

The Service has completed a biological opinion, dated February 13, 2004, with a concurrence of Reclamation's finding of "may affect, is not likely to adversely affect" the southwestern willow flycatcher.

Yellow-billed Cuckoo

Analysis Methods

The riparian habitat within the project area that would be impacted by construction and operation of the project will be mitigated. During frequent surveys of the riparian corridor for the analysis of wildlife and riparian vegetation, this bird was not observed.

Effects from No Action Alternative

Operational effects of the No Action Alternative would include the alteration of 373 acres of riparian habitat (see Section 3.21). This alteration of habitat may affect preferred yellow-billed cuckoo habitat (large cottonwood trees). This habitat impact could indirectly affect yellow-billed cuckoos.

Effects from Action Alternatives

Potential effects on the yellow-billed cuckoo from implementation of DWP action alternatives would be limited to temporary disruptions during construction of project components in the Middle Project Subarea; there would be no construction effects on this species in the Upper or Lower Project Areas. Construction would occur in riparian areas along the Rio Grande (see Figures 2.5-1 through 2.5-6).

Yellow-billed cuckoos have been observed along the Middle Rio Grande during the summer months, and nesting cuckoos may be disturbed during river-side construction of the action alternatives.

Operational effects of the Angostura Diversion and Paseo del Norte Diversion would not affect yellow-billed cuckoo habitat in the Upper, Middle, or Lower Project Subareas. Operational effects of the Subsurface Diversion would include the alteration of 552 acres of riparian habitat (see Section 3.21). This alteration of habitat may affect preferred yellow-billed cuckoo habitat (large cottonwood trees). This habitat impact could indirectly affect yellow-billed cuckoos.

Summary of Environmental Consequences

The Angostura Diversion and Paseo del Norte Diversion would have minimal local direct effects on the yellow-billed cuckoo. Subsurface horizontal collectors would produce indirect and cumulative moderate impacts on the yellow-billed cuckoo through alteration of potential habitat in the area affected by the project.

Direct and indirect effects on yellow-billed cuckoos would be minimal to moderate, depending on the application and effectiveness of mitigation measures and environmental commitments. No substantial temporary or long-term adverse effects on the yellow-billed cuckoo would result from implementation of the action alternatives. Potential cumulative effects of habitat degradation would be offset by the extensive environmental commitments noted below. There are no short-term use versus long-term productivity concerns attributable to any of the action alternatives for the yellow-billed cuckoos, nor are there any known irreversible and irretrievable commitments of resources with respect to this species in the ROI.

3.24.4 Proposed Mitigation Measures

The City proposes to implement the following mitigation measures and environmental enhancements to offset project impacts on threatened and endangered species that could be affected by DWP construction or operations:

- Monitor habitat restoration efforts, other mitigation measures, diversion impacts, and fish and wildlife enhancement measures for success and suspend unsuccessful projects/practices. This will be an adaptive process with evaluation of methods and practices that are successful and unsuccessful. This monitoring will be carried out for five years upon completion of each mitigation or restoration effort.

    - The City will provide the USFWS with an annual report describing the status of the proposed conservation measures by February 15 of each year. This report will describe activities carried out during previous years and projects planned for the upcoming year(s).

    - The City will provide the USFWS with an annual report describing egg collection directly upstream of the diversion dam by September 1 of each year. In 2003, the City organized and coordinated RGSM egg collection efforts for the purposes of propagation.

    - The City will coordinate with the USFWS when developing and implementing the habitat restoration projects described in the proposed action. Consultation with the USFWS has occurred under the auspices of the Endangered Species Act concerning all potential effects to threatened and endangered species. As a result of the consultations, selected conservation measures have been developed (see Appendix I).

- Fishway: A fishway, for either Angostura Diversion or Paseo del Norte Diversion, would be designed to enhance aquatic habitat by providing a route around the MRG Project existing Angostura Diversion (see Figures 2.5-1 and 2.5-3).

- Fish screens: The Angostura Diversion also would be equipped with a V-shaped, 250-foot long fish screen in the existing concrete-lined channel immediately below the diversion dam (see Figure 2.5-1). The sluice channel for the Paseo del Norte Diversion would be equipped with fish screens as well (see Figure 2.5-3). These screens are designed to prevent adult fish from being diverted and transported to the WTP. Maintain fish screens at all times. Any structural or mechanical failures associated with the fish screens shall be reported to the USFWS within one hour when the problem is identified.

- Operational criteria: Water diversions would be curtailed, when necessary, when flows fall below 180 cfs downstream of Angostura and 130 cfs downstream of the Paseo del Norte Diversion.

- During construction in the river, any fish stranded by construction of the facility would be salvaged and relocated to a different portion of the river. By agreement, USFWS staff would be available to move individual specimens of the RGSM, if members of this species inadvertently become separated from the main river channel by construction activities. Coordinate with the USFWS when isolated pools form during installation of the coffer dam and seine isolated pools as the river recedes. The sampling protocol developed by NMESFO will be used. The USFWS will coordinate data collection, and salvage/rescue of the silvery minnows. This will minimize take by rescuing silvery minnows to the maximum extent practicable.

- During installation of the subsurface water diversion facility, the City would require the construction contractor to maintain an open channel (velocity of less than 3 ft/sec) in the Rio Grande for fish passage around the construction site at all times.

- Initial installation of the water-diversion facility would be conducted during the river's low-flow period from September through March to avoid to the extent possible the spring snowmelt and summer monsoon seasons of high flows in the river, and in accordance with Clean Water Act (CWA) Section 404 permit special conditions.

- The City would restore the bosque and Rio Grande in the area affected by the construction of the DWP to the original condition or complete environmental enhancements. During development of the technical plans and specifications for restoration of the Rio Grande channel, the City would coordinate with the USACE, USFWS, and ISC to design a channel section that could provide some area of potential habitat for the RGSM. If permits and approvals cannot be obtained to construct the channel in such a manner, the City would construct the channel to match the existing section, as approved.

- During installation of the water-diversion facility, the City would require the construction contractor to use appropriate BMPs to minimize and contain the discharge of suspended sediments into the Rio Grande.

- When developing release schedules for its SJC water, the City would work with USFWS, OSE, and ISC such that releases can be made to provide incidental benefits to threatened and endangered species. However, the City's releases must be consistent with state and federal laws, and must be approved by OSE. The City's SJC water would be released from storage from Abiquiu Reservoir in accordance with the conditions set forth in the approved OSE permit. The source of the water is the City's contract with the U.S. Secretary of the Interior for SJC water from the SJC Project. The application for diversion of the City's SJC water for this project was submitted in May 2001.

- The City will provide funding to develop projects that enhance the habitat of the RGSM in the Albuquerque Reach of the Middle Rio Grande. The shallow water habitats for the RGSM will be developed and monitored in cooperation with the biologists at the Albuquerque Biopark.

- Continued support for the RGSM Naturalized Refugium for 10 years from the date of the corresponding biological opinion (Appendix I). This may consist of rearing, research, and maintenance of experimental populations. In the year 2002, the City provided $150,000 to the Albuquerque Aquarium for construction, staffing, and monitoring of RGSM rearing facilities to raise eggs to the young-of-year (YOY) stage before the fish are relocated to transplant locations upstream from the San Acacia Diversion Dam. The City is supporting and funding ongoing research to increase the understanding of the RGSM life cycle at the Albuquerque Zoo and Naturalized Refugium. These studies will contribute to the understanding of spawning behavior, swimming capabilities, and habitat needs. If additional information becomes available prior to completion of the final design of the project, it can be used in the design of facilities and more effective monitoring strategies.

- The City will provide funding to develop projects that provide for the continued enhancement and health of the bosque in coordination with the Bosque Action Plan through the OSD (City, 1993).

- The general concept of destabilization was discussed under the proposed AOP Phase II. This concept can also be applied on a smaller scale to destabilize banks enough to allow overbank flooding without manipulating a large site as described in the AOP. Non-native vegetation, jetty jacks, and root structures along the banks should be removed. Sites will be identified through the study phase.

- There are a few remaining areas in the Rio Grande Valley State Park (RGVSP) where the bank meets the river and natural channels occur. Cutting channels into the terrace to allow for flow through or backwater flows to occur can mimic this natural pattern, which would encourage a more permanent water supply in these bosque areas, and would possibly create additional habitat suitable for the southwestern willow flycatcher and the yellow-billed cuckoo. It would also allow for a better connection between the river and the floodplain.

- Woody debris from bosque fuel-reduction programs can be placed into the river to allow for greater braiding and return of organic materials. This could create additional habitat for juvenile fish especially the RGSM. Sites will need to be determined based on fuel reduction sites.

- The City OSD recently finished acquiring properties in the Montaño Oxbow for protection as Major Public Open Space. This area is a 58-acre wetland that supports bosque upland and wetland plant species. A number of projects have been determined as needed in order to restore and protect this wetland including: channelization to insure water flow through the system, control of cattail populations, control of beaver populations, creating open water areas, removal non-native species, and replanting with native species. Phasing of these projects has begun and will continue depending on funding.

- If a bald eagle is observed within 0.25 mile from the active project construction site on any morning before construction starts, or following breaks in construction activity, the contractor would be required to suspend all activity until the bird departs the area on its own volition. However, if an eagle arrives during construction activities or if an eagle is observed at a distance greater than 0.25 mile from the construction area, construction need not be interrupted.

- Specific tasks that the City has committed to do during project construction/restoration include:

  - Construction site visits.

  - Map and document with photos or drawings construction progress and compliance with mitigation and monitoring requirements.

  - Training and explanation of environmental requirements to contractors and designers.

  - Progress meetings and completing progress memos.

  - Assist and train field monitoring personnel.

  - Insure compliance with permits and stipulations of the EIS for mitigation and monitoring.

  - Maintain mitigation plan checklist and update periodically by verification.

  - Collection and analysis of environmental data as needed to insure mitigation and monitoring steps are accurate and completed in a timely manner.

  - Development and implementation of adaptive management procedures.

- Monthly and annual reporting to the USFWS and Reclamation.

- Replace non-native vegetation with native vegetation that will provide habitat for the flycatcher. This may occur in coordination with other projects proposed by others. In addition, there may be opportunities to combine RGSM habitat restoration activities with flycatcher habitat restoration.

- The City will restore the bosque and Rio Grande in the areas temporarily affected by the construction of the project or complete environmental enhancements at an offsite location. During development of the technical plans and specifications for restoration of the Rio Grande channel, the City will coordinate with Reclamation, USACE, the USFWS, and the ISC to design a channel section that could provide potential habitat for the RGSM and flycatcher. If permits and approvals could be obtained, the City will construct the channel to match the existing section, as approved.

- The City will develop an adaptive management plan as soon as practicable after the first monitoring periods for the restoration sites and fish monitoring. The adaptive management plan will address modifications of the mitigation plan and outline monitoring schedules. This plan will be based on the results from initial monitoring efforts. Monitor habitat restoration efforts, other minimization methods, diversion impacts, and fish and wildlife enhancement measures for success and suspend unsuccessful projects/practices. This will be an adaptive process with evaluation of methods and practices that are successful and unsuccessful. This monitoring will be carried out for five years upon completion of each minimization or restoration effort.

- The City will continue to provide funds for utilities, staffing, and equipment for the captive breeding program at the Albuquerque Aquarium for a period of ten years beginning on the date of the corresponding biological opinion (Appendix I). The program has been expanded, in partnership with the Interstate Stream Commission, to include a naturalized refugium. Funding will be provided in the amount of no more than $165,000 per year. RGSM raised from the captive breeding program will be reintroduced to the wild in coordination with the New Mexico Fishery Resources Office (NMFRO) and the New Mexico Ecological Services Field Office (NMESFO).

- The City will provide funding to continue to monitor and improve the Albuquerque Water Resources Management Strategy mitigation measures program, including continuation of mammal, avian, and human-use studies for the bosque. Additional monitoring of amphibian/reptile populations and vegetation is needed in Rio Grande Valley State Park. Permanent transects have been established at 12 sites throughout the Rio Grande Valley State Park to monitor these populations. The Bosque Action Plan mandates that these transects be monitored for changes every 3 to 5 years.

- For the first 10 years of the project, as determined and requested by the USFWS, the City will cease operations of the diversion during a 24-hour period once a year during the RGSM spawn to reduce the take of eggs. After 10 years, the need for this conservation measure will be assessed and if deemed necessary by mutual agreement, may continue. This requirement does not apply if the City's diversion is not in operation during the spawn. The USFWS will notify the City in writing within one week of the requested shutdown when flows are managed to manufacture the spawn. For natural spawning flows, the USFWS will coordinate closely with the City to determine when the benefits to the RGSM from the 24-hour operational shutdown can be maximized, realizing that: (1) the City needs at least 48 hours to shutdown, and (2) natural flow spikes cannot be predicted.

- During the spawning period, the City will monitor and collect RGSM eggs. This egg collection will consist of 1 egg collector for 2 hours per day from May 1 – 31 each year for the first 10 years of the project. The monitoring and collection sites will be identified in coordination with the USFWS and should be located near the diversion structure (either in the sluice channel or directly upstream of the water intake structures) to reduce the amount of entrainment associated with the diversion of flows and to more accurately monitor incidental take.

- The City has proposed to cease their river diversions for a 24-hour period each year in coordination with the USFWS in an effort to reduce incidental take of RGSM eggs during peak spawning periods.

- The City signed an Interim Memorandum of Understanding with federal, state, and local entities to continue to support the development and implementation of the long-term program entitled the ESA Workgroup Collaborative Program. The City has assisted in obtaining significant federal funding for short and long-term conservation measures via their participation in the Collaborative Program.

- The City has provided personnel and funding for RGSM monitoring and habitat surveys in the Middle Rio Grande during late 1999, early 2000, and 2002. In addition, the City completed a flycatcher survey during May, June, and July 2001. The City has committed to conducting annual winter fish monitoring surveys for the first 10 years of the project. After 10 years, the need for additional fish monitoring will be assessed and, if deemed necessary by mutual agreement between the City and the USFWS, may continue.

- The City has an agreement to provide personnel, operation and maintenance costs, and other construction improvements for the Naturalized Refugium project at the Albuquerque Biopark. The refugium will expand the current captive rearing and breeding program, including the construction of a natural habitat for the fish. This project is intended to supplement populations of the RGSM by approximately 25,000 fish per year. The City will continue to support these activities for 10 years from the date of the Biological Opinion, February 13, 2004.

- The City will conduct egg collection activities just upstream of the Paseo del Norte diversion, or in the sluice channel using sampling protocols developed by the Service. This egg collection will consist of 1 egg collector for 2 hours per day from May 1 – 31 each year for the first 10 years of the project. After the first 10 years of the project, the need for continued egg collection will be assessed and may continue for an additional time period if USFWS and City cooperatively agree that it is necessary.

- Construction activities will not occur in the Rio Grande or bosque during the flycatcher nesting and breeding season.

- The City will participate in an inter-agency group that includes Reclamation, the USFWS, Office of the State Engineer, New Mexico Game and Fish Department, and the Interstate Stream Commission to monitor and manage the effectiveness of both current and long-term environmental enhancement measures described above. This group will identify and recommend to the City and the USFWS necessary management changes to address environmental issues that are uncertain or unforeseen as a results of the project.

- The City will provide the USFW with an annual report describing the status of the proposed conservation measures by February 15 of each year. This report will describe activities carried out during previous years and projects planned ofr upcoming years. The City will provide the USFWS with an annual report describing egg collection directly upstream of the diversion dam by September 1 of each year. The city will coordinate with the USFWS when developing and implementing the habitat restoration projects described in the proposed action.

3.25 TRAFFIC AND CIRCULATION

3.25.1 Introduction

The project related traffic and circulation environmental issues identified during scoping activities include concerns about effects of construction activities on traffic and the locations of buried pipelines in neighborhood streets. Traffic conditions were assessed by determining possible effects of construction on existing traffic and transportation networks in the Middle Project Subarea. Pipeline routes along two- and four-lane streets were mapped, and current traffic and circulation patterns and volumes were researched.

3.25.2 Affected Environment

Pipeline corridors required for implementation of the DWP would fall within existing street ROWs, and would intersect two– and four–lane streets, Interstates 25 and 40, and AT&SF railroad grades (Figure 3.25-1). The majority of affected existing streets would be located in residential and commercial areas. City streets likely to be affected by DWP pipeline construction are listed in Table 3.25-1. In addition, ROWs along the north side of Paseo del Norte and along the AMAFCA NDC would be affected. A memorandum of understanding with AMAFCA would be required to use the NDC ROW. The potable

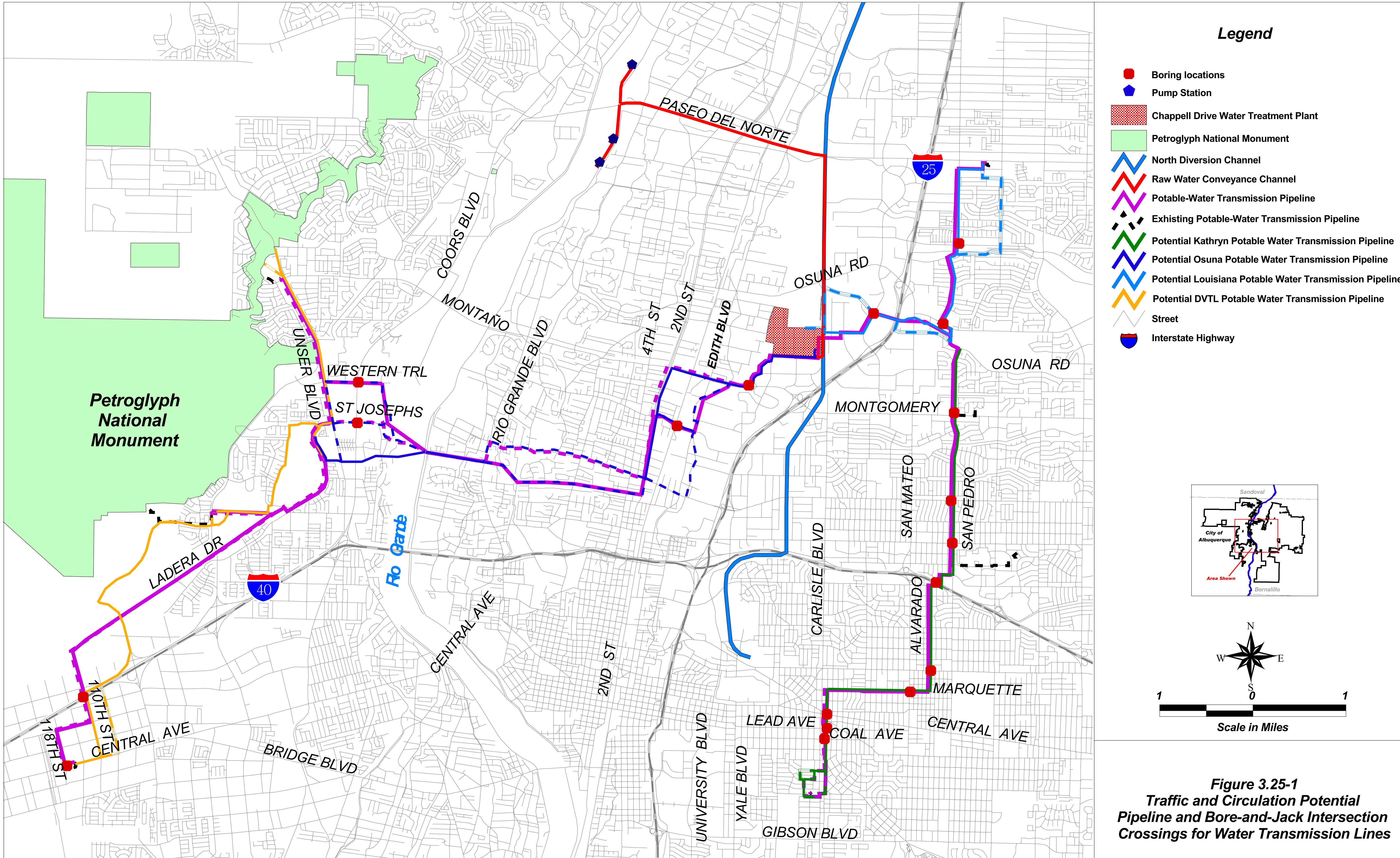


Figure 3.25-1
Traffic and Circulation Potential Pipeline and Bore-and-Jack Intersection Crossings for Water Transmission Lines

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water distribution line to the westside water service area also would cross the Rio Grande near Campbell Drive.

TABLE 3.25-1
CITY STREETS POTENTIALLY AFFECTED BY WATER TRANSMISSION LINE INSTALLATION

• Chappell Drive	• Ridgecrest Drive
• Mission Avenue	• Parkland Circle
• Commons	• Alexander Boulevard
• Office Boulevard	• Montaño Road
• Singer Boulevard	• Edith Boulevard
• Jefferson Street	• Griegos Road
• San Pedro Boulevard	• Campbell Road
• Palomas Avenue	• St. Joseph
• Forest Hills Drive	• Western Trail
• McKinney Drive	• Namaste Road
• Academy Road	• Ladera Drive
• Osuna Road	• Atrisco Drive
• Taylor Avenue	• 110th Street
• Alvarado Drive	• Avalon
• Marquette Avenue	• Unser Boulevard
• Hermosa Drive	

Construction of DWP water diversion facilities and pump stations would require construction or improvement of access roads near the Angostura Diversion Dam and Paseo del Norte. Construction of the WTP along Chappell Drive would affect this roadway as well as nearby arterials.

3.25.3 Environmental Consequences

Other than short-term (less than one month) disruptions of street traffic and intersections during waterline construction, highway and local roadway capacities, and the levels of service at intersections and existing parking areas would not be affected by the DWP. Railroad service and public transportation would not be affected. Direct impacts would be localized traffic disruptions, of a temporary nature, while the path of construction crosses existing traffic corridors, or temporarily disrupts road ROWs. Additional, temporary effects would localize increases in noise (see Section 3.19) and air pollutant emissions (see Section 3.6) during construction.

The City has established limits on the acceptable level of traffic delays or level-of-service impacts related to construction projects (City, 1997). Project construction activities that cause traffic delays that exceed City requirements would be considered changes substantial enough to lead to an effect on traffic or circulation patterns.

The water lines are not constructed into Petroglyph National Monument, and tie into existing lines near the Monument. The routes for new conveyance lines are described within Section 2, under description of alternatives. Very little undisturbed surface area is harmed by water line construction, as existing rights of way and utility easements are used. The small amount of disturbed vegetation impacted, and the mitigation measures for the vegetation are described within Section 3-26, Upland Vegetation. The "Northwest Spur" is an existing water line that ties into the proposed project line at the intersection of Unser and Montaño. Revised potable water transmission line alternatives could potentially, if selected, be emplaced with planned road transportation corridors through the petroglyphs (Section 2.3.2). This would occur only after appropriate environmental documentation and assessment for the transportation corridors. Otherwise, these alternatives will not be used to transport water.

Effects from No Action Alternative

No Action Alternative related construction includes the drilling of ground water wells and possible water transmission lines, however no effects on prevailing traffic patterns to levels of service would be expected under this alternative.

Effects from Action Alternatives

Conveyance of raw water to the WTP from the points of diversion would involve use of existing open conveyance canals and construction of new subgrade pipelines. Treated water from the proposed WTP site on Chappell Drive would be distributed via underground pipeline in four directions. The major branching would be in an east/west configuration, with spur lines branching north and south off of the major east-west line (see Figure 3.25-1). On the east side of the WTP site, the underground pipeline would follow Chappell Drive, meaning trenching underground through the pavement. On the west side, coming out of the WTP, the proposed pipeline would start on Mission Street.

For all three DWP action alternatives, it was estimated that 60 percent of the combined length of conveyance and transmission pipeline routes would be along two-lane streets, and 40 percent would be within four+-lane street ROWs. Major intersections, such as divided four-lane intersections and railroad crossings, may be bored and jacked so as not to disrupt the flow of travel in these areas. Figure 3.25-1 shows potential bore and jack pipeline crossings throughout the City. Major intersections that would possibly be bored and jacked are as follows:

- Intersection of San Pedro and San Antonio,
- Intersection of Academy and McKinney,
- Intersection of San Pedro and Montgomery,
- Intersection of San Pedro and Candelaria,
- Intersection of San Pedro and Menaul,
- Intersection of San Pedro and I-40,
- Intersection of Alvarado and Lomas,
- Intersection of San Mateo and Marquette,
- Intersection of Hermosa and Central Avenue (jog in intersection),

- Intersection of Lead and Hermosa (one-way),
- Intersection of Coal and Hermosa (one-way),
- Intersection of Arroyo del Oso and Jefferson,
- Intersection at Montaño overpass at Alexander,
- Railroad crossing on Griegos between Edith Boulevard and Second Street,
- Intersection of Coors and St. Joseph,
- Intersection of Coors and Western Trail,
- I-40 at 118th street, and
- Central Avenue (66) near 114th and at 118th on west side.

Construction of the project pipelines would not be expected to have substantial effects on traffic because construction contractors would be required to comply with City ordinances that are intended to minimize traffic congestion and delays. Construction times will vary depending upon design and location and pavement/ROW conditions.

Summary of Environmental Consequences

The project design features and BMPs discussed in Section 3.25.4 would be required by the City for all aspects of the construction projects. Direct construction effects on traffic would be temporary. There would be no indirect or cumulative effects on traffic and circulation from any of the project alternatives (including No Action) because of the small number (less than 500 trips) to the WTP by plant workers, and the temporary, and very site specific nature of the planned construction of project facilities. The City has no plans to disturb major traffic intersections, disrupt utility service, or disturb railroad traffic. At those locations, the water lines may be bored and jacked. Any disruption of traffic patterns would be temporary as the lines move through a location. There are no plans to prohibit access to businesses or residences during construction. Congestion should be of a very short duration, if noticeable at all, likely no more than that associated with a line maintenance episode. A summary of the anticipated effects of the proposed project and the No Action Alternative is provided in Table 3.25-2.

3.25.4 Proposed Mitigation Measures

The following project design features and BMPs would minimize or eliminate potential adverse project effects on traffic and circulation:

- Pipelines would be routed in existing road or utility ROWs to minimize the length and width of potential interference with traffic.

- Pipeline installations would be bored under major intersection crossings to minimize traffic disruption.

TABLE 3.25-2
SUMMARY OF PROJECT EFFECTS ON TRAFFIC AND CIRCULATION

		Alternative		
Evaluation Criterion	**No Action**	**Angostura Diversion**	**Paseo del Norte Diversion**	**Subsurface Diversion**
Number of street/highway/railroad intersection crossings (constructed or bored).	Some possible	18	18	18
Length of pipeline to be installed in 2-lane streets (linear feet).	Some possible	56,600	56,600	56,600
Length of pipeline to be installed in 4+-lane streets (linear feet).	Some possible	37,800	37,800	37,800

- The construction contractor would be required to meet City requirements for preparing an impedance analysis and traffic/barricade plan, where necessary, and would be required to implement appropriate work measures to ensure an adequate level of service on affected streets. Compliance with this measure would be required to obtain City construction permits.
- Limit the amount of trench that would be open at any time.
- Existing road and utility rights-of-way would be used as much as possible to reduce permitting and land-acquisitions cost and to reduce disruptions to commercial facilities.

Traffic-control plans would be prepared in conjunction with measures for noise control. This approach would help ensure that measures that facilitate traffic flow, such as work-hour extensions or restrictions, do not produce adverse noise effects, such as nighttime construction noise in residential areas.

3.26 UPLAND VEGETATION

3.26.1 Introduction

No specific resource concerns were identified with respect to upland vegetation resources during the DWP scoping process. Issues related to potential impacts on floodplain/riparian and wetland vegetation are addressed in Sections 3.21 and 3.28, respectively.

The method of analysis used to determine any project effects on upland plant communities involved mapping vegetation types in the Middle Project Subarea, where all proposed construction activities would occur, and superimposing the locations of proposed, new structures onto the vegetation map. The locations of proposed structures were field surveyed to confirm upland vegetation species. The amounts of undisturbed, non-riparian vegetation that could be affected by DWP pipeline and facility construction were calculated (in linear feet and acres) for each action alternative.

3.26.2 Affected Environment

Effects of the proposed action on upland vegetation would occur primarily along water-transmission and -conveyance routes, all of which are confined to Bernalillo and Sandoval Counties in the Middle Project Subarea. Most of the pipeline routes are associated with unvegetated road ROWs; unlined, channelized arroyos; or developed commercial and industrial properties. However, some of the pipeline routes would cross relatively undisturbed (vegetated) areas within the largely urbanized Albuquerque water service area.

Figure 3.26-1 shows that undisturbed upland areas in the Middle Project Subarea are characteristic of a desert shrub-grassland plant community. Dominant plants in these areas include sand sagebrush (*Artemisia filifolia*), four-wing saltbrush (*Atriplex canescens*), broom snakeweed (*Gutierrezia sarothrae*), and sand dropseed (*Sporobolus cryptandrous*). No tree species were identified in these areas. The list of sensitive plant species from the NMFRCD (1995) was also reviewed. No sensitive desert scrub plants listed for Bernalillo County were documented in any project impact areas.

3.26.3 Environmental Consequences

Damage or destruction of unique plant communities, or specimens of rare or sensitive plant species, would be considered resource changes substantial enough to lead to potential adverse project effects on upland vegetation.

Effects from No Action Alternative

Under the No Action Alternative, no DWP construction or operation would occur. Construction of new ground water wells and pump stations could result in damage of small areas of upland vegetation, though these effects would not be expected to affect rare or sensitive plants or plant communities. Therefore, there would be no direct or indirect effects on non-riparian vegetation under the No Action Alternative.

Effects from Action Alternatives

Construction of the diversion facilities for all three action alternatives would not affect upland vegetation. The location of the diversions is in the floodplain or riparian area and is not dominated by upland vegetation. Operation of the DWP would, after mitigation, not affect upland vegetation. The WTP site is located in an area currently used for gravel mining and cement production, and construction in this area would not affect upland vegetation.

The same potable water distribution pipeline routes would be used under all three action alternatives. Pipeline construction impacts on upland vegetation would affect approximately 26,000 linear feet of upland vegetation. This linear corridor excludes unpaved areas where no vegetation occurs (e.g., arroyos and roadways). Construction of the 26,000 linear feet of pipeline, including staging areas and general construction disturbances, would result in disturbance of approximately 57 acres of upland vegetation. Pipeline construction impacts would be temporary and localized, and disturbed areas would be restored (reseeded) following installation of the below-grade pipeline.

Summary of Environmental Consequences

Construction of the DWP and associated conveyance pipelines would result in temporary disturbance of approximately 57 acres of upland vegetation. There would be no long-term or cumulative effects attributable to the DWP on non-riparian, upland vegetation resources because of the limited amount of non-riparian vegetation disturbed (26,000 linear feet) which would be re-vegetated with native species after pipeline construction. There is no conflict between short-term uses of the environment, as reflected by the temporary disturbance of upland vegetation, and long-term productivity. Disturbed vegetation would be replaced with native species as noted in proposed mitigation measures (Section 3.26.4). There are no irreversible and irretrievable commitments of resources with respect to upland vegetation. Project effects on upland plants are summarized in Table 3.26-1.

3.26.4 Proposed Mitigation Measures

Proposed mitigation measures include:

- Project pipeline alignments have been routed primarily in developed public rights-of-way to minimize activity in undisturbed areas. Those undeveloped areas that are disturbed during construction would be replanted with appropriate native upland vegetation.

3.27 WATER QUALITY

3.27.1 Introduction

Project related water quality issues identified during DWP scoping activities included effects of injecting river water into the aquifer (ASR program); possible differences in taste between ground water and treated surface water; risks of chemical or microbial contamination of potable water; effects of river water on the WTP; and the effects of upstream wastewater treatment plant discharges on river water quality. In addition, chlorine residues and possible radionuclides in stormwater runoff from the Los Alamos National Laboratory were scoping issues. With the exception of non-conventional pollutants (e.g., pharmaceuticals and hormones), all of the above issues are regulated under the CWA, the Safe Drinking Water Act (SDWA), EPA's primary and secondary drinking-water standards, and EPA's standards for disinfectants.

Water quality parameters potentially affecting the proposed WTP were assessed by collecting and analyzing water samples from the Rio Grande. Anticipated raw-water quality parameters were then compared to the proposed WTP treatment standards and treated-water quality. The in-stream water quality of primary concern relative to the DWP would be the quality of surface water in the Rio Grande just upstream from the

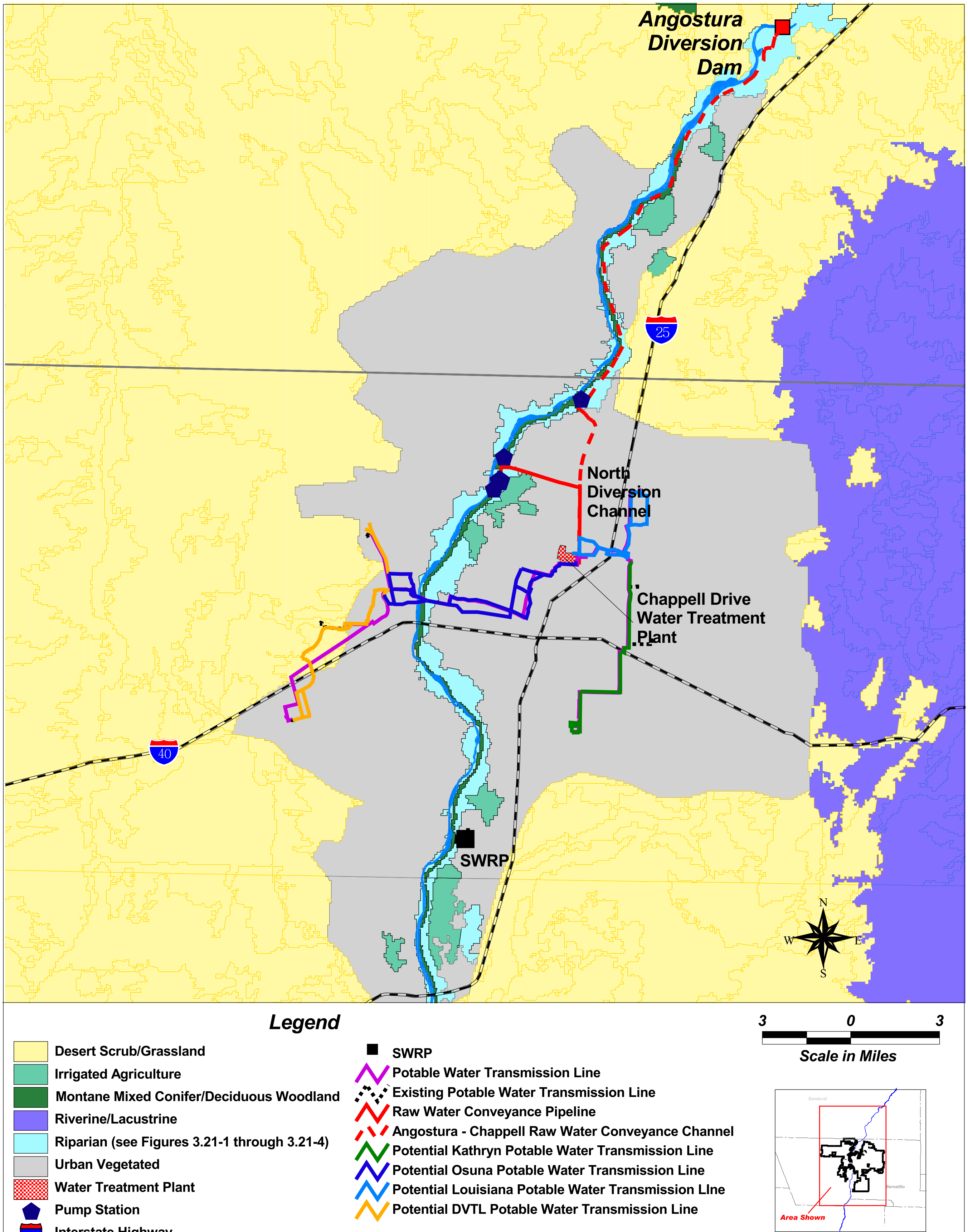

Figure 3.26-1
Upland Vegetation in Relation to Pipelines

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TABLE 3.26-1
SUMMARY OF PROJECT EFFECTS ON UPLAND VEGETATION

	Alternative			
Evaluation Criterion	**No Action**	**Angostura Diversion**	**Paseo del Norte Diversion**	**Subsurface Diversion**
Number of unique upland plant communities affected by construction or operation of the DWP	0	0	0	0
Number of rare or sensitive upland plant species affected by construction or operation of the DWP	0	0	0	0
Upland vegetated areas to be permanently converted to non-vegetated areas (acres)	0	0	0	0
Total length of unpaved route with upland vegetation to be disturbed by construction (approximate linear feet)	0	26,000	26,000	26,000
Total length of ditch corridor of mixed riparian/upland vegetation disturbed by construction (linear feet)	0	76,600	Minimal	Minimal

proposed surface water diversion points, and at the SWRP outfall, where treated effluent will be returned to the Rio Grande.

Regardless of the action alternative selected, City SJC water and an equal amount of native Rio Grande water (total of 94,000 ac-ft/yr) would be removed from the Rio Grande, conveyed to the DWP WTP and distributed to City customers. Wastewater will be collected by the existing City system and conveyed to the SWRP where it would be treated to meet New Mexico and EPA standards as described under existing NPDES permits. SWRP discharges currently meet NPDES permit requirements.

3.27.2 Affected Environment

The City owns and operates the SWRP located south of the Rio Bravo Bridge. The SWRP is a state-of-the-art wastewater treatment plant combining physical, chemical, and biological processes to treat municipal wastewater from the City. The plant has recently undergone an extensive upgrade to include biological nutrient removal in addition to conventional secondary treatment. A simplified diagram of the process is shown in Figure 3.27-1. Large trash and grit are removed in the headworks. Organic matter is settled in the primary clarifiers. Biological reactions in the aeration basin remove soluble organic matter biochemical oxygen demand (BOD), ammonia (NH_3) and nitrate (NO_3). Biomass produced as a result of growth of microorganisms in the aeration basin are removed in the secondary clarifiers. Finally, the effluent is disinfected with chlorine, the chlorine is then removed with sulfur dioxide (SO_2), and the effluent is discharged to the river. Solids from the primary and secondary clarifiers are pumped to anaerobic digesters which stabilize them and then they are sent to the City's Soil Amendment Facility.

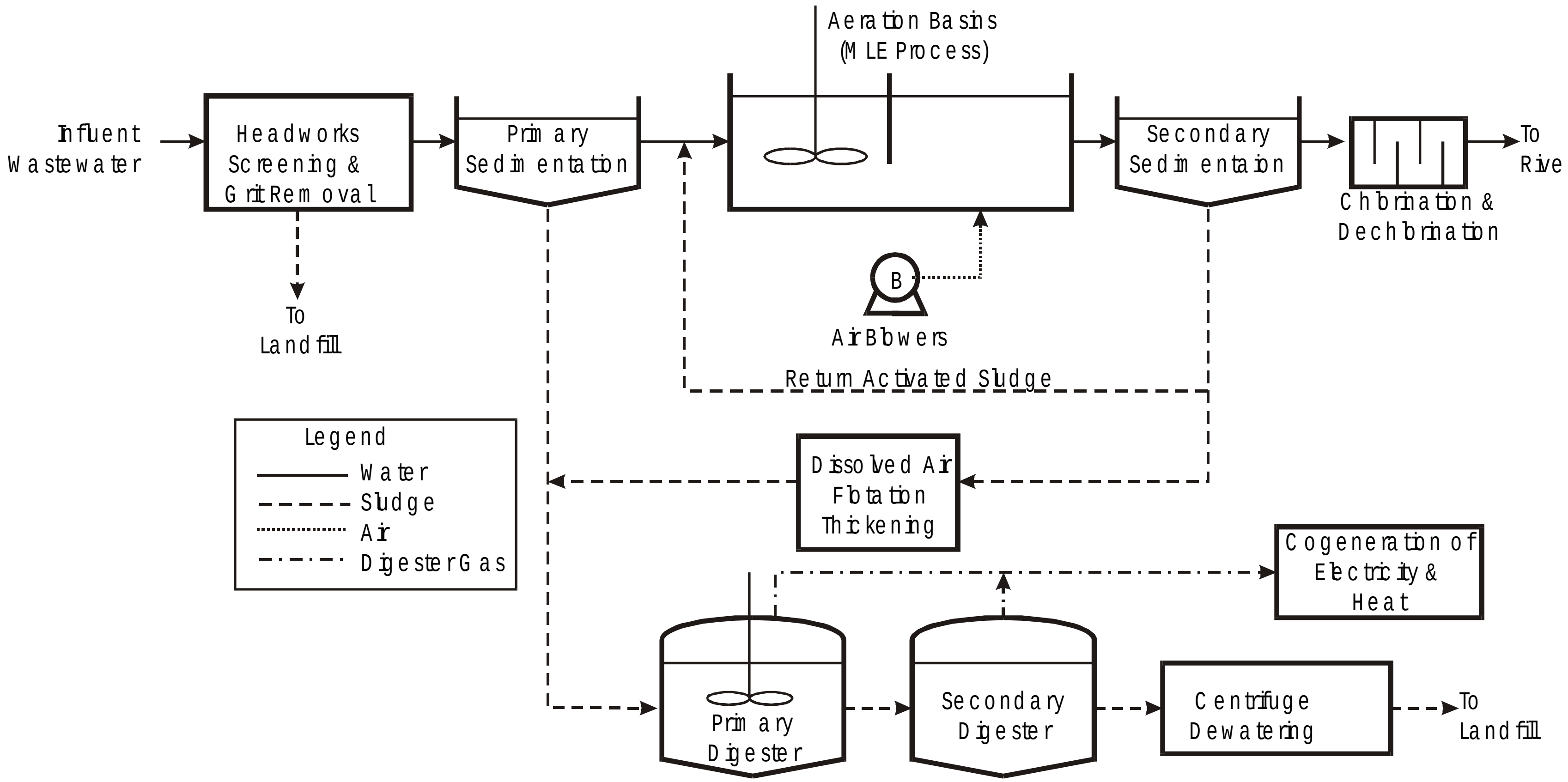

Figure 3.27-1 Flow Diagram of Southside Water Reclamation Plant (SWRP)

**TABLE 3.27-1
COMPARISON OF SOUTHSIDE WATER RECLAMATION PLANT AVERAGE EFFLUENT QUALITY WITH NPDES DISCHARGE PERMIT CONDITIONS FOR 2001-2002**

	NPDES Permit Conditions (30-day average)	Average Monthly Effluent Quality	Monthly Maximum Effluent Quality
Flow	76 mgd	51.7 mgd	52.7 mgd
Aluminum*	60-86 µg/L	61.0 µg/L	240 µg/L
Arsenic	13.7	6.4	7.7 µg/L
Total Cyanide	Monitor	<4.0 µg/L	24.3 µg/L
Carbonaceous BOD	10 mg/L	3.01 mg/L	4.0 mg/L
Total Suspended Solid	30 mg/L	9.99 mg/L	19.0 mg/L
Fecal Coliform Bacteria	100 cfu[b/]/100 mL	13.6 cfu/100 mL	56 cfu/100 mL
Silver	3.75 µg/L	<2 µg/L	<2 µg/L
Minimum Dissolved Oxygen*	2-4 mg/L	4.84 mg/L	4.09 mg/L
Total Ammonia*	1-3 mg/L	0.85 mg/L	2.12 mg/L
Nitrate	8-26 mg/L	7.96 mg/L	13.5 mg/L

* Numeric criteria are dependent of river flow with the most stringent criteria applicable during low flow conditions.

[b/] cfu = coliform fecal units.

The anaerobic digesters produce gas containing methane which is used to power engine generators that produce electricity and heat for the plant.

Effluent from SWRP is treated to a very high level. It is discharged under authority of an NPDES permit issued by the EPA which contains effluent standards and requires frequent monitoring of the treated effluent. A comparison of the NPDES permit conditions and average plant effluent quality is presented in Table 3.27-1. Although there have been a few exceedances of permit conditions in the past, this table shows that effluent from the SWRP meets the permit conditions by a comfortable margin for all regulated parameters. Note that the standards for aluminum, dissolved oxygen, ammonia and nitrate depend on flow within the river. Under low flow conditions, there is less dilution, hence more stringent standards apply, nevertheless, monitoring data demonstrate that the effluent meets even these most stringent criteria.

Some sense of the variability in effluent quality can be gained by examining the maximum monthly effluent quality (fourth column, Table 3.27-10). This shows that the effluent quality is very uniform, although during a couple of months in early 2001, the biological nutrient removal process was not functioning well, hence effluent ammonia and nitrate were well above the average values. Water used for domestic purposes accumulates between 100 and 200 mg/L of dissolved solids through the addition of salt from water softeners, soaps, detergents, cooking ingredients, and human waste. The TDS concentration of the SWRP effluent is shown graphically in Figure 3.27-2.

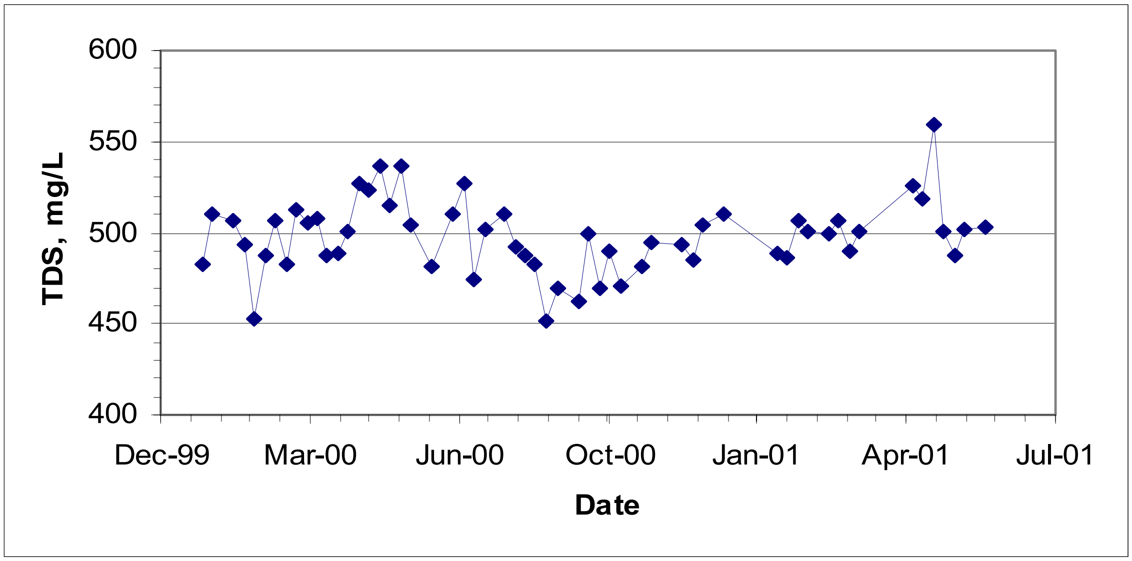

Figure 3.27-2 Total Dissolved Solids Concentrations in the Treated Effluent from the Southside Water Reclamation Plant, 1999 through 2001.

The flow-weighted average TDS concentration of the SWRP effluent was approximately 498 mg/L over the period of December 1999 to June 2001. Comparing the effluent TDS concentration (498 mg/L) to the drinking ground water supply (283 mg/L), shows an increase in the TDS concentration of about 215 mg/L.

The arsenic concentrations of the SWRP effluent is presented graphically in Figure 3.27-3.

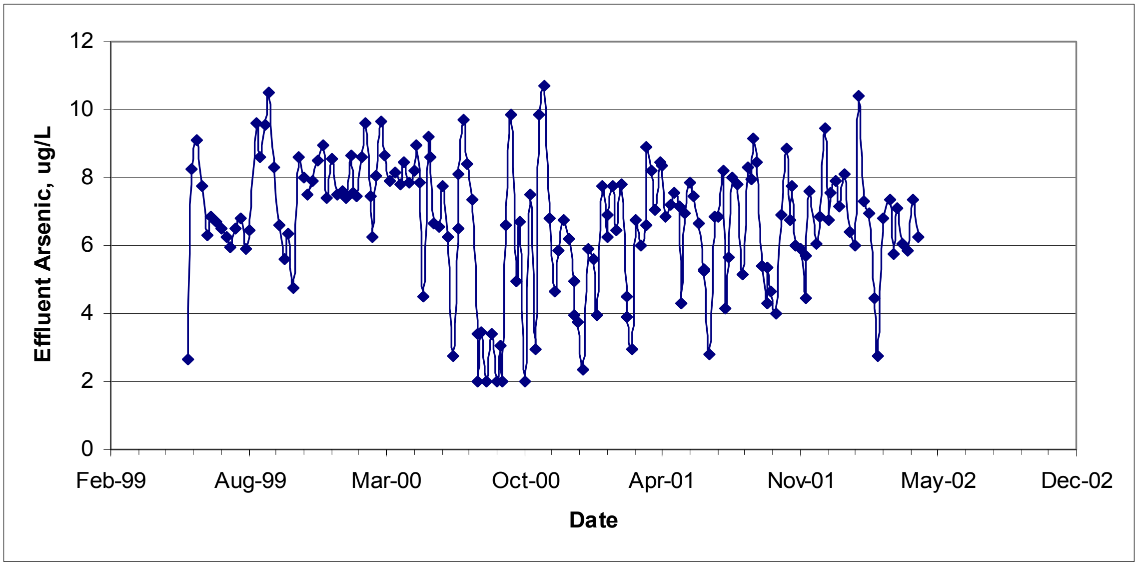

Figure 3.27-3 Arsenic Concentration in the Treated Effluent from the Southside Water Reclamation Plant, 1999 to 2001

The average SWRP effluent arsenic concentration was 6.4 µg/L over the period July 1, 2001 to June 2002. Comparing the SWRP effluent arsenic with the ground water supply arsenic, it is seen that there is a reduction of 4.4 µg/L. This reduction equates to around 40 percent removal of arsenic which is removed with the primary and secondary sludge. This sludge is dried and ultimately disposed at the City's Soil Amendment Facility.

In recent years there has been some concern about the possible presence of trace anthropogenic compounds in receiving waters. These compounds include industrial chemicals such as solvents, pesticides and herbicides, pharmaceuticals and drug residues, and compounds from human wastes such as caffeine and hormones. The USGS has conducted sampling for many years in the Rio Grande at Isleta for synthetic organic compounds including semi-volatile organic compounds (SVOCs) and volatile organic compounds (VOCs). The results are summarized in Table 3.27-2 for some of the more common organic compounds frequently detected in environmental samples.

TABLE 3.27-2
COMPARISON OF ORGANIC COMPOUNDS DETECTED IN THE RIO GRANDE AT ISLETA, NM (1980-2002 WITH EFFLUENT FROM SWRP (2000-2001)

	Effluent from SWRP		Rio Grande at Isleta	
Parameter	No. Samples	Avg. Conc (µg/L)	No. Samples	Avg. Conc. (µg/L)
SVOCs & Pesticides				
Alachlor	3	ND[a/]	21	<.002
Aldrin	5	ND	21	<.01
Anthracene	3	ND		
Atrazine	3	ND	21	<.001
Benzoic Acid	3	ND		
Chlordane	2	ND	17	<.1
Diazinon	5	ND	21	.027 (8 ND)
Dibrnsofuran	3	ND		
1,2-Dichlorobenzene	3	ND		
Dieldrin	5	ND	21	<.001
Endrin	5	ND	17	<.01
Heptachlor	5	ND	17	<.01
Hexachlorobenzene	3	ND		
Methoxychlor	3	ND	17	<.01
Pentachloroprophenol	3	ND		
Phenanthrene	3	ND		
Phenol	3	ND		
Toxaphene	2	ND	17	<1.0
VOCs				
Benzene	8	ND	1	<3.0
Bromodichloromethane	8	2.3	1	<3.0
Bromoform	8	ND	1	<3.0
Carbon tetrachloride	8	ND	1	<3.0
Chlorobenzene	8	ND	1	<3.0
Chloroform	8	1.7	1	<3.0

TABLE 3.27-2 (Continued)
COMPARISON OF ORGANIC COMPOUNDS DETECTED IN THE RIO GRANDE AT ISLETA, NM (1980-2002 WITH EFFLUENT FROM SWRP (2000-2001)

	Effluent from SWRP		Rio Grande at Isleta	
Parameter	No. Samples	Avg. Conc (µg/L)	No. Samples	Avg. Conc. (µg/L)
1,1-Dichloroethane	8	ND	1	<3.0
Ethylbenzene	8	ND	1	<3.0
Naphthalene	8	ND		
Styrene	8	ND		
Tetrachloroethene	8	.4 (5 ND)	1	<3.0
Toluene	8	.5 (5 ND)	1	<3.0
Trichloroethene	8	ND	1	<3.0
Vinyl chloride	8	ND	1	<3.0
Total xylenes	8	0		
Total Trihalmethanes	8	ND		

[a/] ND = Nondected.

The NPDES discharge permit for the SWRP contains no limits for synthetic organic compounds and the City is not required to monitor them. However, as part of its industrial pretreatment program, the City collected five influent and effluent samples in January 2001 and July 2002 and had them analyzed by the State of New Mexico Scientific Laboratory Division for a suite of 89 SVOCs, 64 VOCs, and 26 pesticides and herbicides. Only nine SVOCs and 12 VOCs were detected in three or more of the influent samples, and those that were detected were all found at very low concentrations. No pesticides were detected in the plant influent samples. No SVOCs or pesticides were detected in the plant effluent, and only three VOCs were found in three of more of the effluent samples. As with the influent samples, the few compounds that were detected were found at very low concentrations. This is a testimony in part to the effectiveness of the City's pretreatment program which is designed to prevent industrial chemicals from being discharged to the sewer system, and in part to the effectiveness of the treatment process.

The NMED conducted a one-time sampling program of drinking, surface, and ground waters throughout the state for pharmaceutically active compounds (PAC) and drug residues. Analysis of a single sample three miles downstream from the SWRP detected caffeine at 1.5 µg/L and estrone at a concentration of 140 nanograms per liter (ng/L). Estrone is a metabolite of 17 β–estradiol, an estrogenic hormone. These are very low concentrations, and neither compound was detected in river water samples collected near Belen. The NMED suspects that the estrone degraded quickly in the open environment. No PACs were detected at any of eight other sampling locations along the Rio Grande between Cochiti and Elephant Butte reservoirs. It is important to note that the environmental effects of PACs are not known, and it must be emphasized that these compounds are not regulated by the EPA or the State of New Mexico.

The DWP will divert water from the river and treat it to drinking water standards using the most powerful oxidant that can be used in water treatment – ozone. In addition, granular activated carbon will follow the ozone to adsorb organic compounds that are not oxidized by the ozone. The DWP WTP will oxidize and adsorb organic compounds such as PACs that may be found in the Rio Grande surface water.

Regardless of whether the DWP is implemented or not, the discharges from the SWRP will not be impacted. In other words, the flow in the river below the SWRP will be the same with or without the DWP and the concentration of anthropogenic contaminants from the SWRP effluent will remain the same. As such, the DWP will not cause the concentration of other PACs in the effluent of the SWRP to change.

Upper Project Subarea

In the Upper Project Subarea, water quality effects were analyzed for effects on the riverine environment from Heron Reservoir outlet works to the proposed point of diversion. Total dissolved solids (TDS) were used as a general indicator of surface water quality. The general trend of this parameter is increasing TDS concentrations with increasing distance downstream from Heron Reservoir outlet works. Water quality in Abiquiu Reservoir generally is good. Imported SJC water averages about 140 milligrams per liter (mg/L) TDS, is of excellent quality, and improves the quality of Rio Grande Basin water (USACE, 1995). The mean TDS concentration at the Chamita Gage on the Rio Chama is 203 mg/L (USGS, 2000) and Rio Grande at San Felipe gage is 213 mg/L. The potential occurrence of radionuclides in the Upper Project Subarea has been raised in comments on the FEIS. Radionuclides are typically attached to particulates that will generally be captured in upstream reservoirs.

Middle Project Subarea

Issues Related To Ground Water Quality

Currently the ground water the City of Albuquerque delivers to City customers is of high quality and meets all drinking water standards. The federal Safe Drinking Water Act sets standards for drinking water, establishing maximum contaminant levels for 83 contaminants. Since the water supply is currently taken from wells, contaminants are primarily from erosion of volcanic deposits and decay of natural deposits.

Drinking water provided by the Water Utility Division currently meets all federal drinking-water standards as it has for the past twenty-five years. As seen in Table 3.27-3, all contaminants are well below maximum contaminant levels. Below the table are lists of regulated substances and unregulated substances for which the City tests but which have not been detected in the City's water.

**TABLE 3.27-3
CITY OF ALBUQUERQUE – DETECTED DRINKING WATER QUALITY DATA: SAFE DRINKING WATER ACT**

	Sample Year	Units	Detection	City-Wide Values	Maximum Contaminant Level (MCL)	MCL Goal
Metals						
Arsenic	2000	ppb	Average Range	12 ND-48	10 (see Note A)	0
Barium	2000	ppm	Average Range	ND ND-0.3	2	2
Chromium	2000	ppb	Average Range	2 ND-22	100	100
Thallium	2000	ppb	Average Range	ND ND-1	2	0.5
Nutrients						
Nitrate + Nitrite	2001	ppm as N	Average Range	0.6 ND-3.8	10	10
Organics						
Di(2-ethylhexyl)phthalate	2000	ppb	Average Range	0.07 ND-1.8	6	0
Minerals						
Fluoride	2000	ppm	Average Range	0.9 0.6-1.1	4	4
Radionuclides						
Gross Alpha Particle Activity	1999	pCi/L	Average Range	2.9 1.6-6.1	15	0
Radium 226	1999	pCi/L	Average Range	0.05 ND-0.21	5	0

Note A: These arsenic values are effective January 23, 2006. Until then, the MCL is 50 PPB and there is no MCL goal. Heath Effects Language: Some people who drink water containing arsenic in excess of the new MCL over many years could experience skin damage or problems with their circulatory system, and may have an increased risk of getting cancer. ppb = parts per billion; ppm = parts per million; pCi/L = picocuries per liter.

The EPA promulgated the Arsenic Rule on February 22, 2002 and set a maximum contaminant level (MCL) for arsenic at 10 micrograms per liter (µg/L). This new arsenic standard will have significant ramifications on the City of Albuquerque and many water supply systems in New Mexico. The EPA has given water systems until January 23, 2006 to be in compliance.

Ground water quality is monitored by the City through regular sampling of the City's production wells. The sampling frequency varies by well from quarterly to yearly. The flow-weighted average TDS and arsenic concentrations for all City production wells over the 1999-2001 period are shown in Table 3.27-4. These data represent the average water quality provided to City customers. The major ion characteristics as represented by TDS is slightly higher than the river concentrations, while the average arsenic concentration is higher than river concentrations by a factor of four.

TABLE 3.27-4
ANNUAL CITY-WIDE AVERAGE CONCENTRATIONS OF TOTAL DISSOLVED SOLIDS AND ARSENIC IN CITY OF ALBUQUERQUE DRINKING WATER

Year	TDS	Arsenic (μg/L)
1999	283	10.2
2000	281	11.0
2001	285	11.3
Average	283	10.8

Source: City of Albuquerque.

The City of Albuquerque operates around 92 production wells, of these, it is expected that 40 wells will not be in compliance with the 10 μg/L arsenic standard. The City of Albuquerque system wide arsenic concentration shown in Table 3.27-4 is typically 10-12 μg/L. However, some wells have arsenic levels approaching 50 μg/L.

The drinking water project will utilize water from the Rio Grande which is naturally low in arsenic. As such, the DWP will provide the City of Albuquerque with a cost effective method of compliance with the Arsenic Rule.

The ASR component of the DWP would meet all federal and state drinking-water standards. No water would be introduced into the ground water aquifers that did not meet SDWA requirements.

Issues Related to Surface Water Quality

The Rio Grande receives water from several inputs within the Middle Project Subarea including discharge of treated effluent or stormwater runoff from City streets. This section describes the raw water suitability as a drinking-water source and water quality inputs from stormwater and effluent discharges in the Middle Project Subarea.

Surface water samples were taken from various locations along the Rio Grande in 1998 and 1999 to characterize the raw water quality from both surface and subsurface sources. The sampling locations included sites near Alameda, Montaño, I-25, Central, and Rio Bravo, and were selected to allow assessment of any water quality variations along the Rio Grande. The samples were analyzed for numerous parameters for which Maximum Contaminant Levels (MCL) have been established by EPA under the SDWA. In addition, analysis of 81 EPA-listed contaminants was completed on samples collected during three sampling events. These analyses were intended to identify potential organic contaminants, including pesticides and herbicides. The sampling results are listed in the *City of Albuquerque Conceptual Water Treatment Plant Technical Memorandum* (CH2M Hill, 2001a).

Results for CH2M Hill's (1999) raw water investigation found no synthetic organic chemicals detected in concentrations requiring treatment for drinking water. Volatile and synthetic organic compounds were also below detection levels. Bacteria (total coliform and *E. coli)* were present in Rio Grande water. *Giardia* and *Cryptosporidium* were below the detection limit. Inorganic constituents detected all were below MCL limits. Radiological sampling results were below MCL limits as well. Therefore, no MCLs for any inorganic, organic, or radionuclide constituents were exceeded in Rio Grande surface water.

Based on river water sampling results, the anticipated raw water quality of the influent into the proposed WTP is presented in Table 3.27-3 (CH2M Hill, 2001a).

As reflected by the 1998 and 1999 sampling data, baseline Rio Grande raw water quality is good. The data presented in Table 3.27-5 were assumed to be representative of influent water quality at the WTP under the DWP.

Initial baseline arsenic and other constituent samples were taken during 1998-2000 sampling events. However, it was determined that the long-term sampling conducted by the USGS would be more representative of long-term variability. The 1998-1999 sampling program showed arsenic concentrations ranging from 1.8 to 4.8 μg/L in the Rio Grande with an average value of 3.3 μg/L and a median value of 3.1 μg/L. Flow conditions in the Rio Grande were near average at each of the sampling events, Thomson and Chwirka (2002).

TABLE 3.27-5
ANTICIPATED RAW WATER QUALITY AT PROPOSED WATER TREATMENT PLANT (FROM CH2M HILL, 2001A)

Parameter [a/]	Units [b/]	Concentration		
		Average	**Minimum**	**Maximum**
TOC	mg/L	3.10	1.78	5.15
TDS	mg/L	232	NA	NA
Turbidity	NTU	69.33	3.20	290.00
Color	--	100.94	3.10	400.00
PH	SU	8.31	7.95	8.70
Alkalinity [c/]	mg/L	103.33	86.00	124.00
Iron (Total)	mg/L	2.24	NA [d/]	NA
Manganese	mg/L	0.07	NA	NA
Hardness	mg/L	107.93	88.5	149.25
Chloride	mg/L	7.388	5.78	9.68
Sulfate	mg/L	53.46	29.8	89.2

[a/] TOC = total organic carbon; TDS = total dissolved solids.
[b/] mg/L = milligrams per liter; NTU = nephelometric turbidity units; SU = standard units.
[c/] Alkalinity measured as calcium carbonate.
[d/] NA = not available.

Arsenic is a dissolved constituent present in Rio Grande water that has received considerable public attention in the last several years. Arsenic is a naturally occurring element that is found in some water supply wells in the middle Rio Grande basin. It is also found in some hot springs that feed tributaries to the Rio Grande, most notably the Jemez River. There are only limited measurements of arsenic concentrations in Rio Grande water near Albuquerque since 1990 and much of the available data were collected during a special study of river water quality in 1995. This data shows that arsenic in the Rio Grande water is relatively constant throughout the year (Table 3.27-6). The average arsenic concentration is 2.5 µg/L.

The USGS continues to operate a limited water quality sampling program at a few locations along the Rio Grande. Their major sampling location in the middle Rio Grande is at Isleta, NM, downstream from the SWRP. In addition, a limited number of samples have been collected near the Alameda Bridge which is immediately upstream from the proposed diversion, although this sampling was discontinued and no data is available after 1995. Water quality data for both sample locations is available from the USGS through the National Water Information System (http://waterdata.usgs.gov/nm/nwis/). A comparison of TDS and arsenic concentrations at the two locations is presented in Table 3.27-7. This data shows that there is a slight increase in the TDS and arsenic concentrations of the river, most likely due to elevated TDS in the treated effluent from the SWRP.

TABLE 3.27-6
TOTAL DISSOLVED SOLIDS AND ARSENIC CONCENTRATIONS IN THE RIO GRANDE NEAR ALAMEDA (USGS OPEN-FILE REPORT 97-667)

Date	TDS (mg/L)	Arsenic (µg/L)
10/25/1994	239	3
02/08/1995	223	3
05/01/1995	232	3
08/22/1995	235	2
10/02/1995	218	2
02/13/1996	233	2
05/19/1996	206	2
08/26/1996	238	3
Average	228	2.5
Standard Deviation	11.46	0.53

TABLE 3.27-7
SUMMARY OF USGS SAMPLING PROGRAM FOR THE RIO GRANDE AT ALAMEDA AND ISLETA SAMPLING SITES
(Concentrations are reported as averages with standard deviations in parentheses)

	Sampling Site	
Parameter	Alameda	Isleta
TDS (mg/L)	22.8 (10.0)	254.3 (40.8)
Arsenic (µg/L)	2.9 (0.7)	3.4 (0.7)
No. of Samples for TDS/Arsenic	12/21	62/40
Time Period	1980-1995	1990-2002

Lower Project Subarea

In the Lower Project Subarea water quality effects were analyzed for effects on the riverine environment due to discharges from the SWRP. The SWRP operates in compliance with a NPDES permit that is based on existing stream aquatic standards.

Table 3.27-8 shows the discharge limitations for the effluent characteristics based on a minimum low flow of 162.5 million gallons per day (mgd) in the Rio Grande. Effluent data from 1999 is used to compare standards and effluent output. The maximum values are compared and are used as a worst case scenario on a daily output basis. The greatest average monthly values are also included in the table. The greatest monthly average values are a better representation of the total monthly output of constituents into the Rio Grande. The NPDES permit also states that the effluent shall contain no measurable total residual chlorine (TRC) at any time. There were two constituents, ammonia and fecal coliform, in which their daily maximum exceeded the monthly average standard. Fecal coliform are not a priority pollutant in that they do not harm aquatic life (*i*.e., the Rio Grande silvery minnow) (EPA, 1986). The exceedence of ammonia for a single day is still within state and EPA regulations, which are protective of aquatic life (Table 3.27-8).

Twenty-one chemical constituents of SWRP effluent are sampled on a daily or weekly basis (Table 3.27-7). The period of record for these data is 1995 through present. However, due to recent improvements (76 mgd design flow and Nitrogen Removal Program) to the reclamation plant only June 1999 to July 2000 data were used in the description of the proposed action and the effects determinations in this document. Fifteen of the twenty-one constituents were not detected (have a less than (<) symbol in front of them) in 1999-2000.

TABLE 3.27-8
1999 EFFLUENT DISCHARGES COMPARED TO THE CITY OF ALBUQUERQUE'S EXISTING NPDES PERMIT (ISSUED 1994)

Effluent Characteristic	NPDES Permit Standard 30-day Average	Greatest Average Value for Year 1999 [b/]	Maximum Value for Year 1999 [a/]
Flow (Facility)	Flow must be monitored in mgd	58.13 mgd	64.23 mgd
Carbonaceous Biochemical Oxygen Demand (5-day)	25 mg/l	4.5 mg/l	13 mg/l
Total Suspended Solids	30 mg/l	11.7 mg/l	22.5 mg/l
Total Ammonia	2 mg/l	< 1 mg/l	2.8 mg/l
Dissolved Oxygen (minimum)	2 mg/l	4.38 mg/l	2.4 mg/l (minimum value)
Fecal Coliform Bacteria (colonies/100ml)	100 colonies	28 (minimum)	19,200 colonies
Total Aluminum	Monitor	88.1 µg/l	149 µg/
Total Arsenic	13.7 µg/l	2.02µg/	10.5 µg/
Total Cyanide	Monitor	0 µg/l	0 µg/l
Total Silver	3.72 mg/l	<2 mg/l	<2 mg/l
Nitrate	24 mg/l	13.02 mg/L	17.4 mg/l
Chlorine	0.011 mg/l	0.05 mg/l	> 0.05 mgL

a/ Maximum chemical constituent values for the Year 1999 from the SWRP effluent. These values represent the highest output for any given day during the NPDES monitoring of the SWRP effluent.

b/ The greatest average value represents the largest monthly average value for a chemical constituent for the Year 1999.

All of the constituents noted below in Table 3.27-9 are sampled on a monthly basis. Average daily discharge from the SWRP, for 1999-2000 was 55 mgd. All of the constituents noted in Table 3.27-10 are below State of New Mexico and Pueblo of Isleta surface water quality standards.

TABLE 3.27-9
SOUTHSIDE WATER RECLAMATION PLANT EFFLUENT MONITORING RESULTS FOR REPORTING YEAR JULY 1, 1999 THROUGH JUNE 30, 2000 WITH EPA ACUTE WATER QUALITY STANDARDS PROTECTIVE OF AQUATIC LIFE

Metals, Cyanide and Phenols *	Minimum Detection Limit µg/L	1999-2000 Monthly Average Effluent µg/L	Monthly Average Effluent Limit µg/L [b/]	EPA Acute Standard [a/] µg/L
Aluminum	40	53.5		--
Antimony	2	<2.0		9,000
Arsenic	5	7.4	13.7	72
Beryllium	5	<1.0		130
Boron	50	405.3		--
Cadmium	2	<2.0		12
Chromium	2	<2.0		4.3
Chlorine	50	<50		710
Copper	2	<2.0		13.0
Cyanide	20	<20.0		4.2

TABLE 3.27-9 (Continued)
SOUTHSIDE WATER RECLAMATION PLANT EFFLUENT MONITORING RESULTS FOR REPORTING YEAR JULY 1, 1999 THROUGH JUNE 30, 2000 WITH EPA ACUTE WATER QUALITY STANDARDS PROTECTIVE OF AQUATIC LIFE

Metals, Cyanide and Phenols *	Minimum Detection Limit µg/L	1999-2000 Monthly Average Effluent µg/L	Monthly Average Effluent Limit µg/L [b]	EPA Acute Standard [a] µg/L
Fluoride	0.1	1.7		--
Lead	2	<2.0		65.0
Mercury	0.5	<0.5		0.2
Molybdenum	25	<25		--
Nickel	5	8.1		56
Selenium	2	<2.0		35
Silver (dissolved)	0.05	<0.05		--
Silver (total)	2	<2.0	3.7	1.2
Sulfide	0.5	<0.5		2
Thallium	2	<2.0		1,400
Zinc	20	31.5		41
Phenol Total	100	<100.0		10,200

*All Total Values

a/ U.S. Environmental Protection Agency. 2000. Quality criteria for water 1986. EPA 440/5-86-001. Washington, DC.

b/ Note that the City operates a chlorination and dechlorination processes at the SWRP. Monitoring of chlorine levels is continuous. No exceedences outside the permit requirements occurred during 1999 and 2000.

-- = No Standard

TABLE 3.27-10
ACUTE WATER QUALITY STANDARDS FOR CONSTITUENTS OF CONCERN

Constituent	New Mexico	EPA[b]	Pueblo[c]
Ammonia (mg/l as nitrogen)[d]	4.4	8.4	-- [e]
Dissolved solids (mg/l)	1,500	NS	500
Total phosphorus (mg/l)	NS	NS	1.0
Dissolved cadmium (µg/L)[f]	2.83	4.3	2.83
Dissolved copper (µg/L) [f]	13.51	13.0	14.64
Dissolved lead (µg/L) [f]	56.59	65.0	56.59
Dissolved silver (µg/L) [f]	2.48	2.48	2.48
Dissolved zinc (µg/L) [f]	91.69	120.0	91.69
Temperature (°C/°F)	32.2/90.0	NS	32.2/90.0
pH	6.6-9.0	6.5-9.0	6.0-9.0

a/ Source: New Mexico Administrative Code, 1995.

b/ Source: US Environmental Protection Agency, 1999.

c/ Source: Isleta, Pueblo of, 1991.

d/ Values for the standards were calculated from wastewater chemistry based on a pH of 8.1 and a temperature of 21 °C per Section M of NM Administrative Code.

e/ -- = No standard.

f/ Standard for receiving water was calculated based on a hardness value of 75,144 µg/L.

Priority pollutant scans were performed for semi-volatiles and volatiles in July 1999 and again in January 2000. Both semi-volatiles and volatiles detected are below the acute EPA standard for aquatic life.

3.27.3 Environmental Consequences

The following criteria were considered in evaluating the potential effects of the project on water quality:

- The use of surface water would cause differences in taste in water delivered to City water customers.
- The removal of Rio Grande surface water that would degrade water quality in the depleted reach of the river.
- The removal and use of surface water would pose a risk of providing contaminated water to City customers.
- The potential compliance with more stringent MCL for arsenic for surface and ground water use.
- Number of federal or state water quality standards exceeded.

Effects from No Action Alternative

There would be no anticipated change in river water quality in the Upper Project Subarea under the No Action Alternative, as the City's SJC water would not be released into the river system. In the Middle Project Subarea continued reliance on ground water as a drinking-water source would likely require pumping from deeper wells, which may alter the quality of the water extracted for potable use. A more stringent MCL for arsenic has been adopted by EPA. A portion of the ground water may no longer meet SWDA requirements without additional treatment. In the Lower Project Subarea there would no anticipated change in water quality, as the SWRP would continue to meet its NPDES permit requirements.

Effects from Action Alternatives

Upper Project Subarea

Effects of the DWP on surface water quality would vary among the affected reaches of the rivers. The reach from the outlet works of Heron Reservoir to the selected diversion facility (the Upper Project Subarea) would not be expected to experience any adverse changes in water quality as a result of project construction or operations. This reach would receive additional, good quality SJC water under each of the action alternatives. There are no known water-quality problems in this reach that would be exacerbated by the addition of good-quality SJC water.

The addition of SJC water will have a minimal to slightly positive effect on water quality in the Rio Grande upstream of the diversion. Water quality will be the same under scenarios downstream of the diversion. Water quality of the City's effluent will be slightly better with respect to TDS and associated conservative species such as chlorine. However, under average flow conditions, improvements in water quality in the Rio Grande downstream of the City's SWRP outfall due to the Drinking Water Project will be minimal.

Under low flow conditions, when the curtailment strategy is in effect, water quality will be similar upstream of the diversion, downstream of the diversion, and slightly improved downstream of the City's SWRP outfall. Improvements downstream of the outfall will be due to an increase in overall flow under the action alternatives when compared to the No Action Alternative.

The DWP will divert water from the river and treat it to drinking water standards using ozone and granular activated carbon. Discharges from the SWRP will not be impacted. The DWP will oxidize and adsorb any pharmaceutically active compounds. The reach of the Rio Grande through the City of Albuquerque presently complies with all stream standards established by New Mexico and the Pueblo of Isleta, except for high fecal coliform bacteria counts in urban runoff during storm events.

Middle Project Subarea

The reach of the Rio Grande in the Middle Project Subarea (from the diversion point to the SWRP outfall) would not be expected to experience long-term adverse water-quality effects as a result of project operations, though temporary increases in turbidity could occur during construction activities in and near the river. Net reductions in flow in the Rio Grande within the Middle Project Subarea would be small relative to the normal volume of river flow, and these reductions would not result in adverse water-quality impacts on aquatic life or other designated beneficial uses downstream from the diversion point since intervening return flows from City stormwater outfalls as described previously are generally good and are able to support aquatic organisms and other uses. Under Subsurface Diversion, temporary settling ponds would be built to control turbidity during the in-river construction of the subsurface collectors. Downstream turbidity levels would be monitored during all in-river construction activities to ensure that controls are effective in minimizing water-quality impacts.

The quality of treated water from the proposed WTP would meet all current state and federal drinking-water standards, and would be expected to meet the anticipated revised arsenic standard of 10 ppb. The DWP will provide water to the distribution system that is very low in arsenic. The Rio Grande typically has arsenic concentrations ranging from 2 µg/L to 3 µg/L. The DWP water treatment process will utilize ferric chloride as a coagulant, and thus remove any arsenic from the Rio Grande to less then 2 µg/L on a consistent basis. As such, the DWP will significantly reduce the arsenic levels in Albuquerque's drinking water and will allow for high arsenic wells to be shut off. Under normal conditions, the treated surface water will be able to replace the water reduced from the high arsenic wells. However, during a drought, it may be necessary to curtail the use of the surface water supply and return to full ground water supply. Based on historic flow records, it is anticipated that curtailment of the surface water will not be for lengths of time exceeding 6 months. As such, it would be possible to still meet the arsenic MCL of 10 µg/L even if high arsenic water needed to be used for a short period of time.

For the majority of time, no arsenic treatment at the wells will be required when the proposed WTP is in service. However, during drought conditions when the operation of the WTP will be curtailed, it may be necessary to operate wells to supply the City's water demands. The wells on the west side of the Rio Grande have greater arsenic concentrations than those that are on the east side of the river. During curtailment periods, it will be possible to pump the low arsenic wells on the east side and convey that water to the west side. However, as demands increase and existing wells are taken out of service because they have reached their useful life, it will be necessary to add arsenic treatment to the well fields on the west side of the river. From an operational standpoint, when the WTP is curtailed, the low arsenic wells on the east side of the river will be sufficient to supply the demands.

Compliance with the Arsenic Rule will be based on a quarterly running average not exceeding 10 µg/L with no single sample exceeding 40 µg/L. As such, it may also be possible to supply higher arsenic water on the west side for short periods of time, say 3 months, without exceeding the arsenic maximum contaminant level.

The addition of SJC water will have a minimal to no effect on water quality in the Rio Grande upstream of the diversion. Water quality will be the same under scenarios downstream of the diversion. Water quality of the City's effluent will be slightly better with respect to TDS and associated conservative species such as chlorine. However, under average flow conditions, improvements in water quality in the Rio Grande downstream of the City's SWRP outfall due to the Drinking Water Project will be minimal.

Under low flow conditions, when the curtailment strategy is in effect, water quality will be similar upstream of the diversion, downstream of the diversion, and slightly improved downstream of the City's SWRP outfall. Improvements downstream of the outfall will be due to an increase in overall flow under the action alternatives when compared to the No Action Alternative.

The DWP will divert water from the river and treat it to drinking water standards using ozone and granular activated carbon. Discharges from the SWRP will not be impacted. The DWP will oxidize and adsorb any pharmaceutically active compounds. The reach of the Rio Grande through the City of Albuquerque presently complies with all stream standards established by New Mexico and the Pueblo of Isleta, except for high fecal coliform bacteria counts in urban runoff during storm events.

The treatment process would also be designed to minimize taste and odor in the water, minimize the generation of disinfection byproducts, provide potable water with chemical characteristics similar to those of the ground water currently being used, and would not be corrosive to the distribution piping (CH2M Hill, 2001a). The estimated finish water quality is presented in Table 3.27-11. The production of disinfection byproducts created through chlorination of organic compounds during water treatment was a concern raised during DWP scoping. Organic materials in water (from both natural and anthropogenic sources) are measured as total organic carbon (TOC). The TOC levels observed in Rio Grande surface water samples ranged from around 3 mg/L to 5 mg/L (CH2M Hill, 2001a). TOC levels in the subsurface water that is tributary to the Rio Grande were from about 0.5 mg/L to 2 mg/L lower than those measured in surface water samples. Treatment processes to optimize TOC removal, thereby minimizing disinfection byproducts, would be incorporated into the WTP design.

TABLE 3.27-11
EXPECTED QUALITY OF TREATED WATER

Parameter [a/]	Units [b/]	Average Concentration
TOC	mg/L	< 2.0
TDS	mg/L	200 to 250
Turbidity	NTU	<0.1
Color	--	< 5
pH	SU	8.1 to 8.5
Alkalinity	mg/L	80 to 100
Iron (Total)	mg/L	< 0.1
Manganese	mg/L	< 0.03
Hardness (as $CaCO_3$)	mg/L	100 to 120
Chloride	mg/L	30 to 40
Sulfate	mg/L	50 to 60

[a/] TOC = total organic carbon; TDS = total dissolved solids, $CaCO_3$= calcium carbonate.
[b/] mg/L = milligrams per liter; NTU = nephelometric turbidity units; SU = standard units.

Concerns were raised about possible radionuclide contamination from the upstream Los Alamos National Laboratories, both before and after the Cerro Grande fire of 2000. Analysis of river water samples collected during the design study (CH2M Hill, 2001a) and of earlier samples collected by the City showed that *alpha*, *beta*, and *gamma* radiation in the water are at background levels, and are well below current SDWA limits.

Recent public concern has been expressed over pharmacologically active compounds that could cause disruption of the endocrine system. EPA is evaluating thousands of compounds to determine which compounds may be endocrine disrupters. The effectiveness of treatment processes for removal of unknown or unidentified potential endocrine disrupters has not been determined. Research is planned in the coming years to determine if drinking water is affected by endocrine disrupters. Because endocrine-disrupting compounds are organic in nature, the use of ozone as a strong oxidant, followed by GAC filtration, as is proposed for the Chappell Drive WTP, may be an effective means of removing these compounds should they be present.

Any water injected into the aquifer under the Aquifer Storage and Recovery Project, would be in compliance with NMED requirements. This would be protective of existing ground water quality.

No water quality parameters would be exceeded in the Middle Project Subarea as a result of depleting the river. This is because the City is not currently violating any permitted discharge points and would not change due to the action alternatives.

Lower Project Subarea

Under the DWP action alternatives, construction or operations would not affect treated effluent to be discharged into the Rio Grande from the SWRP and would not adversely affect water quality in the river because discharged water would continue to meet EPA's NPDES discharge requirements. Water will be treated to meet all SDWA regulated substances and will be similar to the ground water currently pumped from the aquifer. The SWRP would continue to meet its NPDES permit requirements. Therefore, water sent to the SWRP would not change in chemical composition, and treatment of the water at the SWRP would not change either. This means that the effluent discharged into the Rio Grande would not change because the City relies more on surface rather than ground water. Total dissolved solids (TDS) discharged from the SWRP would be approximately 450 mg/L. Arsenic discharged from the SWRP would be less than 2 μg/L (CH2M Hill, 2002b).

The addition of SJC water will have a minimal to no effect on water quality in the Rio Grande upstream of the diversion. Water quality will be the same under scenarios downstream of the diversion. Water quality of the City's effluent will be slightly better with respect to TDS and associated conservative species such as chlorine. However, under average flow conditions, improvements in water quality in the Rio Grande downstream of the City's SWRP outfall due to the Drinking Water Project will be minimal.

Under low flow conditions, when the curtailment strategy is in effect, water quality will be similar upstream of the diversion, downstream of the diversion, and slightly improved downstream of the City's SWRP outfall. Improvements downstream of the outfall will be due to an increase in overall flow under the action alternatives when compared to the No Action Alternative.

The DWP will divert water from the river and treat it to drinking water standards using ozone and granular activated carbon. Discharges from the SWRP will not be impacted. The DWP will remove or destroy any pharmaceutically active compounds. The reach of the Rio Grande through the City of Albuquerque presently complies with all stream standards established by New Mexico and the Pueblo of Isleta, except for high fecal coliform bacteria counts in urban runoff during storm events.

Development of the surface water diversion will substantially reduce demands on ground water in the Middle Rio Grande Basin. Therefore, most of the water conveyed to the SWRP will have water quality characteristics derived from the surface water, rather than from ground water. The difference in water quality between ground water and surface water will have a very small influence on the water quality of the SWRP discharge.

Generally, as evidenced by the data in Figure 3.27-4, the surface water from the Rio Grande is of better quality than the ground water being pumped in Albuquerque in terms of aggregate inorganic parameters which constitute TDS. This is also true for arsenic which is the only constituent in the Albuquerque water supply that is close to the drinking water maximum contaminant level (MCL). In short, the ground water has higher TDS and arsenic concentrations than does the river water. The reduced concentration of inorganic constituents in the drinking water will result in reduced concentrations of these parameters in the SWRP effluent. Therefore, switching to surface water as the principal source of supply results in a small but measurable improvement in the inorganic water quality of the river downstream from the SWRP. Water quality upstream from the SWRP will not change as a result of the DWP.

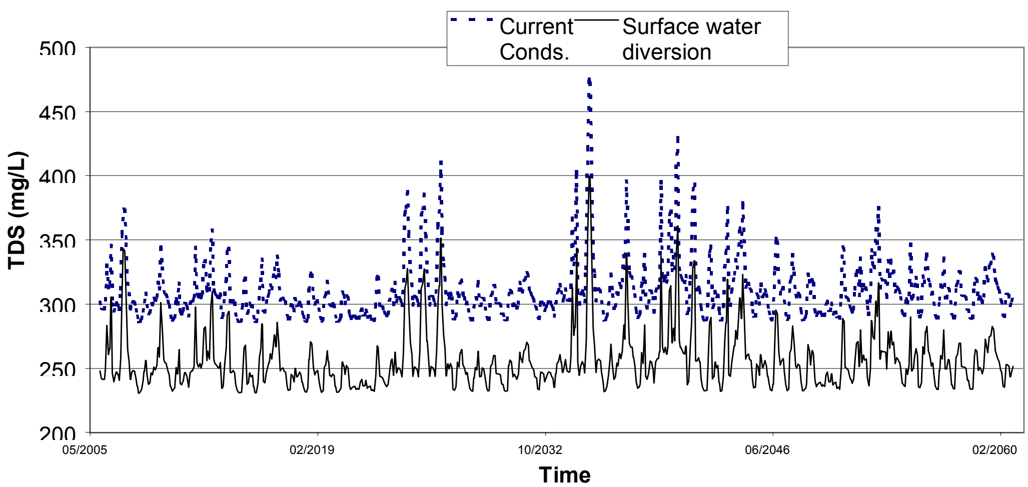

Figure 3.27-4 Comparison of TDS Concentrations in the River Below the SWRP for Current Conditions and Following Development of a Surface Water Diversion as Described in the DWP

The impacts of the DWP as compared to current reliance on ground water were estimated using data from ground water modeling. A mass balance analysis was performed to calculate the water quality impacts on the Rio Grande below the SWRP for both alternatives. Figure 3.27-4 presents a comparison of TDS concentrations below the SWRP for both current conditions and for implementation of the proposed DWP.

In all cases, the TDS will be lower below the SWRP following implementation of the DWP than for current conditions. Utilization of river water for municipal supply will reduce the TDS concentration in the river by about 50 mg/L on average. The difference in river TDS between current conditions and following development of the surface diversion is presented in Figure 3.27-5.

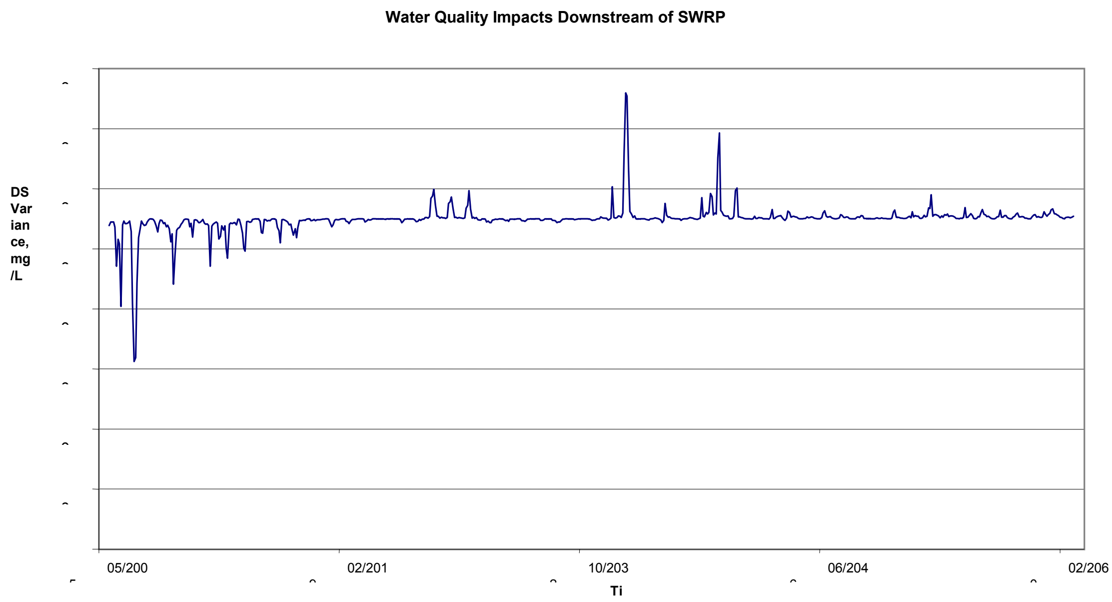

Figure 3.27-5 Reduction of TDS Concentrations in the River Below the SWRP for Current Conditions and Following Development of a Surface Water Diversion as Described in the DWP

Switching to surface water will have an even greater impact on arsenic concentrations in the river for two reasons. First, the river water has lower arsenic concentrations than Albuquerque ground water. Second, the treatment plant will removed essentially all of the arsenic present in the river water. Figure 3.27-6 compares the arsenic concentrations in the river for current conditions and following implementation of the DWP

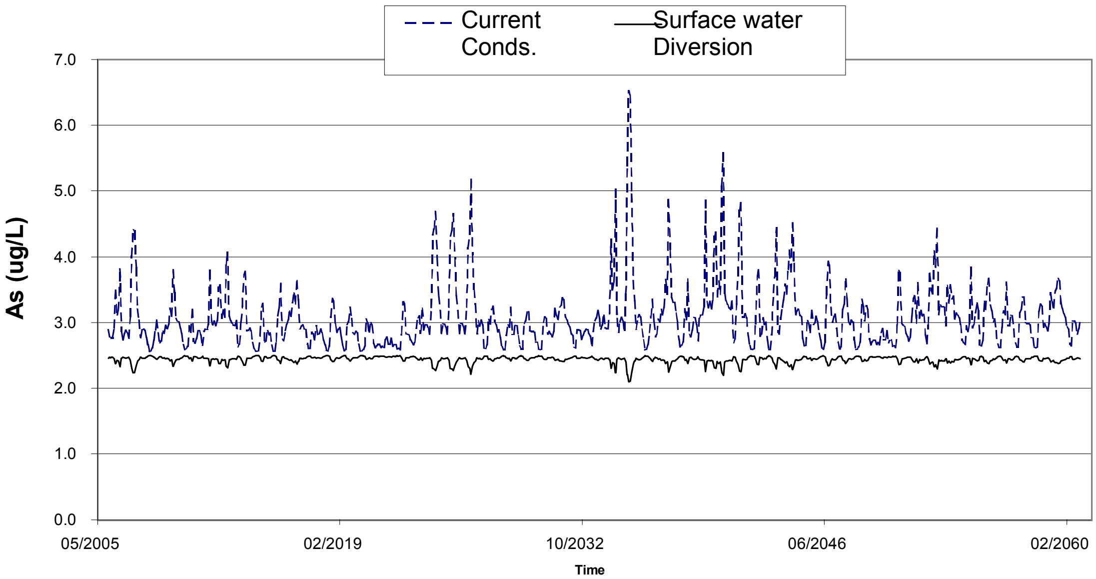

Figure 3.27-6 Comparison of Arsenic Concentrations in the River Below the SWRP for Current Conditions and Following Development of a Surface Water Diversion as Described in the DWP

The reduction in arsenic concentrations due to switching to surface water is presented in Figure 3.27-7. Depending upon river flow, the DWP will lower the arsenic concentration in the Rio Grande below the SWRP by a range of 0.1 to over 4 µg/L. The greatest reduction in arsenic will occur when treated river water containing virtually no arsenic, is used for municipal supply.

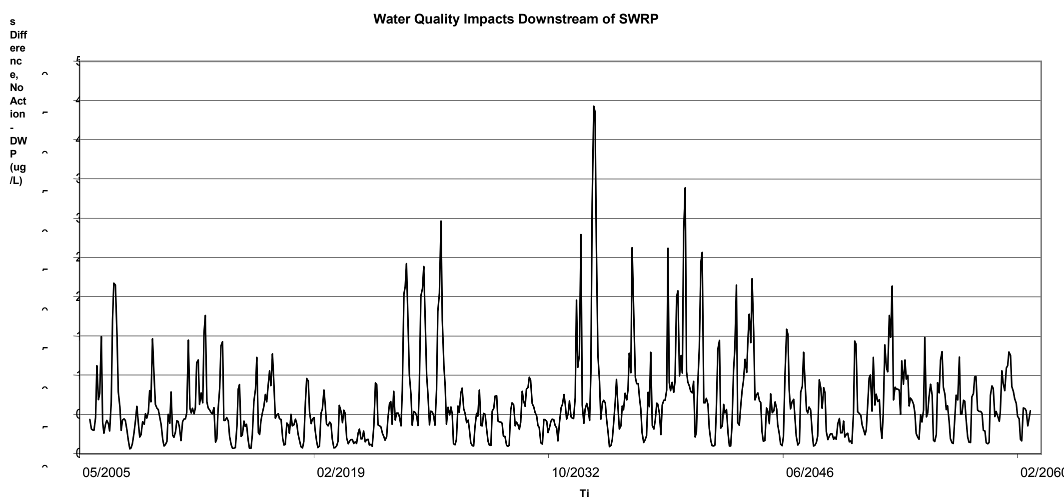

Figure 3.27-7 Reduction of Arsenic Concentrations in the River Due to Implementation of the DWP

Summary of Environmental Consequences

Continued depletion of the aquifer associated with the No Action Alternative could result in changes in the quality of extracted water, and treatment of these waters may become necessary to meet drinking-water standards. Arsenic levels in existing City wells would require individual treatment if the ground water source exceeds 10 ppb arsenic concentration to meet the proposed standard. This condition could exist under any of the action alternatives or the No Action Alternative. Implementation of the DWP action alternatives would have short-term effects on turbidity in the Rio Grande downstream from in-river construction sites. These temporary effects would be controlled using measures outlined in Section 3.27.4. There would be no long-term adverse effects on water quality in the Rio Chama and Rio Grande from implementation of the DWP, nor would there be adverse effects on potable water quality based on the current WTP design and influent raw-water quality parameters. Design features of the water treatment plant would ensure potable water quality meet current NMED and EPA requirements under the SDWA. Any particulate not captured upstream would either then be settled out in the sedimentation basins or filtered in the filters.

Arsenic compliance with the DWP is completed primarily by relying on wells with arsenic concentrations below the EPA standard. When necessary wells exceeding the standard will be used by blending the water with lower arsenic water to meet the standard. During annual peak production, it may be necessary to provide treatment of some higher arsenic wells to meet supply. In contrast, because the No Action Alternative must meet all demands all of the time with groundwater, it has less flexibility to use different wells. Employing a strategy similar to the DWP would result in excessive drawdowns in the lower arsenic wells, thus requiring more arsenic treatment. Whereas, because the DWP employs surface water most of the time, the lower arsenic wells are not required on a continuous basis and therefore use can be limited to a relatively short-term basis.

This analysis has shown that the water quality of the Rio Grande will be slightly improved by implementation of the DWP. This will be due to a slight decrease in the concentration of TDS and arsenic in the effluent from the SWRP because the concentration of these constituents will be less in the drinking water supplied to City customers. The reach of the Rio Grande through the City of Albuquerque presently complies with all stream standards established by the State and the Pueblo of Isleta, except for high fecal coliform bacteria counts in urban runoff during storm events. The bacterial quality in the treated effluent from the SWRP is well below the State of New Mexico and Pueblo of Isleta stream standards for this parameter. The DWP will have no effect on this parameter. Effluent from the SWRP is of very high quality and meets all NPDES permit requirements. Furthermore, effluent from the plant has very low fecal coliform concentrations and non-detectable concentrations of all but three synthetic organic chemical pollutants. Switching from ground water to surface water will have no impact on the performance of the SWRP.

The effects of the DWP alternatives on water quality are summarized in Table 3.27-12. There would be no long-term water-quality effects associated with the DWP that would require implementation of other mitigation measures. There would be no cumulative effects on water quality attributable to the project due to the diversion and treatment of river water.

TABLE 3.27-12
SUMMARY OF PROJECT EFFECTS ON WATER QUALITY

Evaluation Criterion	Alternative			
	No Action	**Angostura Diversion**	**Paseo del Norte Diversion**	**Subsurface Diversion**
Degradation of water quality in the Rio Grande due to in-river construction	None	Temporary turbidity effects downstream from construction sites	Temporary turbidity effects downstream from construction sites	Temporary turbidity effects downstream from construction sites
Degradation of water quality in the Rio Grande due to project operations	None	None	None	None
Reduction in the quality or taste of potable water treated at the proposed WTP	--	None	None	None

3.27.4 Proposed Mitigation Measures

The following project design features and BMPs would minimize or eliminate potential DWP effects on water quality:

- The City would perform periodic sampling of raw-water WTP influent and treated water to ensure compliance with the SDWA, state requirements, and City WTP operating procedures.

- The WTP would be operated and maintained in accordance with the O&M procedures to be detailed in a plant-specific manual.

- During in-river construction activities, the City would require the construction contractor to use appropriate BMPs to control turbidity and minimize and contain the discharge of suspended sediments into the Rio Grande.

- A plan to monitor the turbidity levels in the river during in-river construction would be developed and implemented. The plan will be submitted to the USFWS for approval prior to construction activities taking place.

- The City would implement measures to address Section 401 water-quality certification conditions and Section 404 discharge limitations.

- The treated surface water may be conditioned with hydrated lime (calcium hydroxide) to create treated surface water that is compatible with the ground water.

- The City would implement necessary spill prevention and containment methods and training during construction and in the long-term operations and maintenance of facilities. The City will provide the USFWS with a copy of the spill prevention and containment plan for the proposed action prior to construction beginning. Notify the USWS of any spills or contamination associated with construction or maintenance within one hour of occurrence. The Service will determine whether silvery minnow salvage is appropriate, water quality testing is necessary, and assess the effects of the spill on the silvery minnow. The City will ensure that all construction workers have received spill prevention and containment training prior to construction beginning.

3.28 WETLANDS/NON-WETLAND WATERS

3.28.1 Introduction

Project-related issues identified during scoping with respect to wetlands were part of general natural resources concerns but specifically related to requirements for Section 404 permits for jurisdictional wetlands and other waters under the CWA. The USACE (1987) defines a wetland as those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support and under normal circumstances to support a prevalence of vegetation typically adapted for life in saturated soils conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

The method of analysis used to determine any wetland resource effects was to locate existing identified wetland areas, and then to superimpose the locations of proposed DWP structures on the wetland maps to identify potential impact areas. Field surveys were performed where facilities would be constructed for the three action alternatives.

3.28.2 Affected Environment

There are wetland areas located in the Upper Project Subarea along the Rio Chama. The Chama River, its various channels, and adjacent intermittent streams are part of the Chama riverine system. It is not known if these areas are delineated jurisdictional wetlands.

There is one jurisdictional wetland in the Middle Project Subarea. In addition, field personnel surveyed a significant portion of the Middle Project Subarea for wetlands and all of the areas within 1.5 miles of the center of each of the proposed construction locations for the action alternatives. Field investigations completed to date in areas proposed for DWP construction or fill activities have not identified the presence of wetlands that would be regulated by Section 404 of the CWA. No hydric soils or evidence of wetland hydrology was evident in these areas. The wetlands at the North Diversion Channel (NDC) are jurisdictional. The South Diversion Channel (SDC) is a regulated water of the United States. As such, any discharge of dredged or fill material to these areas will require a Section 404 permit.

A Section 404 permit was submitted for the City of Albuquerque Non-Potable Water Reclamation Project in May 2000. The proposed construction area for this project is about 2000 feet north of the Paseo del Norte and Subsurface Alternatives. A wetlands delineation was completed at and near the location for the non-potable diversion, and it did not contain jurisdictional wetlands. Surface soil and vegetation characteristics are similar within the proposed construction areas of the Paseo del Norte and Subsurface Alternatives. No standing water or saturated soil were present at these locations during several field visits, nor were these conditions observed at the area of the existing Angostura Diversion Dam. The surface area at this location including the proposed construction area has been disturbed, and very little vegetation of any type is present. Proposed construction activities in the active channel would result in the discharge of fill material into the jurisdictional waters of the U.S. These proposed activities would require authorization under provisions of Section 404 of the Clean Water Act. Any activities affecting water in the Albuquerque Riverside Drain may require authorization under provisions of the Clean Water Act.

Wetland vegetation characteristic of marshes and other areas of permanent, slow moving water in the Rio Grande bosque of the Middle Project Subarea includes cattail, bulrush, sedges, spikerush, flatsedge, scouring rush, common reed, coyote willow, and other species (Hink and Ohmart, 1984). Emergent species grow at the margins of permanent water, rooted in wet soils but with leaves and flowering structures primarily above the water's surface. The NDC is a jurisdictional wetland, and is a water of the United States to the ordinary high water mark, while the SDC is a regulated water of the United States. As such, any discharge of dredged and fill material into these areas will require a Section 404 permit. These wetlands are supported by Rio Grande backflows and City stormwater runoff (Crawford *et al.*, 1993).

The Oxbow is an area that potentially includes jurisdictional wetlands. This area is connected hydraulically to the river but receives its principal water sources from agricultural return and stormwater (via San Antonio Arroyo) flows. It is considered an adjacent wetland. Modification of flows in the Rio Grande will not affect this area or the un-delineated wetlands within it.

Sandy soil (60 to 80 percent) is present along the banks of the Rio Grande near the Angostura Diversion Dam and the Paseo del Norte Bridge. Entisols occur within the Rio Grande floodplain. The Angostura Diversion would include the construction of a pumping facility near the NDC, which would be located on Vinton loamy sand. Soil types near the Paseo del Norte and Subsurface Diversion include Vinton and Brazito soils. Throughout all three alternative construction sites, the soils are alluvial and predominately sandy. Based upon test pits completed for the non-potable project, soils vary from fine to very fine sands, with some silt. An occasional sandy loam is encountered at depths greater than 10 inches in some locations.

Vegetation at all three proposed locations is within the riparian zone, which is dominated by cottonwood and forms a sparse to dense canopy along the river. In the understory, native species include coyote willow, seep willow, New Mexico olive and others. Introduced salt cedar, Russian olive and some upland species are established throughout the riparian area. Surface vegetation at the Angostura Diversion is primarily grasses and weeds within the construction area. There are some large cottonwood trees near the planned outfall structure that could be avoided. On the west side of the river, where the fish passage is proposed, both cottonwood and willow are encountered.

Vegetation at the proposed location of the Paseo del Norte Diversion consists of bare ground, some grasses, and salt cedar. Willows are encountered near the channel. Cottonwoods are encountered near the levee and the proposed pump station. On the west side of the channel, where the fishway would be located, salt cedar and Russian olive dominate. Vegetation is more diverse near the Subsurface Alternative. In general, construction areas are represented by open areas, grasses and salt cedar/Russian olive mix, with willows encountered in small stands throughout the construction area and near the channel. During several field visits to these areas, no standing water has been observed, nor have saturated soils been encountered at any of the alternative locations.

Wetland resource areas are present along the Isleta Marsh in the Lower Project Subarea. There also are wetland areas where emergent and aquatic vegetation have become established around the LFCC and the Elephant Butte delta (Crawford *et al*., 1993). These may also be jurisdictional wetlands.

Non-wetland waters encountered in this proposed action are drainage arroyos and constructed channels. The proposed action would require crossing these arroyos at 18 locations. Only two, Bear Arroyo, near Jefferson, and San Antonio Arroyo, on the west side, feature a "natural channel." The substrate of both is gravel and weedy vegetation. Table 3.28-1 lists these pipeline crossings. There are two areas where the potable transmission line parallels arroyos or drainage features. These are along Bear arroyo near Jefferson to I-25 and along the Gallegos Lateral and Alameda Drain. Both of these areas have previously disturbed surface areas.

3.28.3 Environmental Consequences

The following criteria are considered in evaluating the potential effects on wetlands:

- Damage or destruction of jurisdictional wetlands would be considered resource changes substantial enough to lead to potential adverse project effects on wetland systems.

Effects from No Action Alternative

Under the No Action Alternative, there would be no substantive change in the current surface water hydrology of the Rio Chama and Rio Grande in the Upper Project Subarea. There would be continued reliance on ground water for potable water that would further depress the water table in the Middle Project Subarea. In the Middle Project Subarea, there are no direct, indirect, or cumulative effects on known jurisdictional wetlands from the No Action Alternative. In the Lower Project Subarea the No Action Alternative depletions would not substantively affect surface or ground water levels which may affect potential jurisdictional wetlands.

The width of the Bear Arroyo crossing (potable transmission line heading north) is 90 feet wide with an ordinary high water mark of 2 feet. The San Antonio arroyo is 65 feet wide with an ordinary 20-inch high water mark. The substrate of both is weedy vegetation with a gravel and sand bottom, both crossings near concrete lip structures at bridge/street crossings. Both crossings would likely be completed using an open trench,

TABLE 3.28-1
NON-WETLAND WATERS CROSSED BY TRANSMISSION LINE CONSTRUCTION, WITH ORDINARY HIGH WATER LINE WHERE APPROPRIATE

		Ordinary High Water Line	
Feature	**Substrate**	**Width**	**Height**
North Diversion Channel	Concrete Lined Channel	N/A	N/A
Bear Arroyo	Gravel, weedy vegetation	90’	2’
North Leg San Bernadino Arroyo	Concrete Lined Channel	N/A	N/A
North Pino Arroyo	Concrete Lined Channel	N/A	N/A
Pino Arroyo	Concrete Lined Channel	N/A	N/A
Borealis Arroyo	Concrete Lined Channel	N/A	N/A
Bear Canyon (downstream from Arroyo del Oso Golf Course	Concrete Lined Channel	N/A	N/A
South Leg Grantline Channel	Concrete Lined Channel	N/A	N/A
North Hahn Arroyo	Concrete Lined Channel	N/A	N/A
Hahn Arroyo	Concrete Lined Channel	N/A	N/A
Channel by I-40	Concrete Lined Channel	N/A	N/A
West of River, Mirehaven Diversion at Unser	Man-made diversion, gravel	N/A	N/A
San Antonio Arroyo	Gravel, weedy vegetation	65’	20”
La Cueva Arroyo	Concrete Lined Channel	N/A	N/A
Domingo Baca Arroyo	Concrete Lined Channel	N/A	N/A
North Pino Inlet	Concrete Lined Channel	N/A	N/A
Pino Inlet	Concrete Lined Channel	N/A	N/A
Bear Arroyo Inlet	Concrete Lined Channel	N/A	N/A

then repair of the natural surface, with re-planting over the trench line. In general, construction is permitted within AMAFCA facilities only during non-rainy seasons. The remaining pipeline crossings are all concrete or man-made crossings. They would be replaced to original condition as permitting and access from AMAFCA stipulates.

Effects from Action Alternatives

In the Upper Project Subarea, operational effects of the DWP would include a flow increase of 65 cfs relative to No Action. Wetlands along the rivers from Heron Dam to the diversion site would not be affected by the addition of the City’s SJC water to the Rio Chama or Rio Grande. An increase in 65 cfs translates to no more than one tenth of a foot increase in river stage elevation.

In the Middle Project Subarea construction would not affect any known jurisdictional wetlands. A flow reduction in the Middle Project Subarea would not affect any seasonal non-jurisdictional wetlands found along the river’s edge. Some of the vegetated islands in the channel may qualify as jurisdictional wetlands. In the Upper Project Subarea, existing wetlands would not be affected by the action alternatives because of the minor (i.e., 0.3 ft) fluctuations predicted for the action alternatives (CH2M Hill, 2003).

In the Lower Project Subarea, the river will be made whole by the return flows at the SWRP. There will therefore be no hydraulic effects below the SWRP; thus no effects on wetlands in the area would occur.

For all three action alternatives, there would be approximately 1.5 acres of aquatic habitat temporarily affected for the potable water transmission line construction and crossing near Campbell. There would be some de-watering for the trench line, which would be recovered once the pipeline is completed. A side channel, with flow, would be maintained for fish passage (see Section 3.7). In-river and associated construction effects are backfill areas, access roads, and the construction of temporary coffer dams removed upon completion. There would be temporary access ways, settling ponds, low berms and other earth-moving activities. Stranded fish would be salvaged and moved downstream. Appropriate BMPs to minimize and contain the discharge of suspended sediments would be used. A plan to monitor turbidity levels in the river during construction would be required. The disturbed bosque and riverbed areas would be returned to pre-construction condition.

Within waters of the United States (the Rio Grande channel), relating to 404 Permit considerations for the Angostura alternative, there is little in-river construction. Sandia Pueblo is the water quality 401 certification authority. Some construction would occur near both ends of the fishway and some for the outfall structure for the fish screen. Approximately 0.5 acres of in-river construction would be temporarily required for renovation of portions of the existing dam, and connecting the fishway and fish screen outfall to the river. Construction would consist of removing some soils and bank side vegetation to physically connect the river to these facilities. There should not be any substantive spoilage or spilling of sediment into the river, and it may be feasible to operate machinery from the shore. For any in-river construction, no impacts upon water quality are anticipated. Settling ponds will be used to control turbidity levels in water from de-watering operations (primarily two compartment settling ponds with controlled inflow/outflow).

With the Paseo del Norte diversion, the 401 water quality certification authority is the NMED, 0.2 acres of aquatic habitat would be permanently lost due to dam installation. Temporary loss of 1.8 acres of aquatic habitat would occur during in-river construction of the sluiceway, dam and fishway. Construction activities would consist of de-watering, access road building, installing and removing temporary coffer dams, settling pond construction and backfill areas, and trench construction and maintenance.

At the Subsurface Diversion Alternative, the 401 water quality certification authority is the NMED, approximately 100 acres of aquatic habitat would be temporarily disturbed due to in-river construction of the subsurface arms to divert the river water. Construction activities would consist of de-watering, access road construction, installing and removing temporary coffer dams, settling pond construction and backfill areas, and trench construction and maintenance.

Construction within the river at any of the three action alternatives would require a completion of Section 402 – Stormwater Discharges Associated with Construction Activities and Part 4 – Stormwater Pollution Prevention Plans.

Summary of Environmental Consequences

Construction of the DWP would result in the construction of permanent structures in and near the Rio Grande. However, there would be no direct, indirect, or cumulative effects on wetlands due to construction or operation of the DWP. This conclusion is based on the lack of wetlands in the immediate construction areas. The No Action Alternative would also not have any effect due to the absence of wetlands in the Middle Project Subarea. Anticipated DWP effects on wetlands are summarized by alternative in Table 3.28-2.

TABLE 3.28-2
SUMMARY OF PROJECT EFFECTS TO WETLANDS/NON-WETLANDS WATERS

Evaluation Criteria	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Number of wetlands affected by construction or operation of the DWP	0	0	0	0

3.28.4 Proposed Mitigation Measures

There would be no effects on known or potential jurisdictional wetlands as a result of construction or operation of the DWP. However, creation of wetlands would be a mitigation effort undertaken to enhance habitats for wildlife and threatened and endangered species. See Appendix O for mitigation measures of wetland systems and non-wetland waters in the project area. This appendix also includes mitigation measures for the aquatic life, hydrologic, riparian area, threatened and endangered species, and water quality aspects of the proposed action.

3.29 WILDLIFE

3.29.1 Introduction

The wildlife issues identified during DWP scoping were related to the potential for the project to disturb or modify wildlife habitat. The method of analysis was to conduct site visits for all direct impact zones in the Middle Project Subarea to determine the status and overall condition of the habitat and wildlife species using these areas. Bird species encountered were noted. Winter/early spring field surveys were conducted to facilitate identification of arboreal nests while leaves were not on trees to obstruct views. Spring surveys also determined whether a nest was occupied or not. Potential impacts on wildlife within all project subareas were considered; however, construction effects would be restricted to the Middle Project Subarea. Additional discussion of fish and wildlife resources is presented within Appendix J, the Fish and Wildlife Coordination Act Report.

3.29.2 Affected Environment

This section addresses the issues related to amphibians, reptiles, birds, and mammals, collectively referred to as wildlife species, within the project areas. Potential effects on threatened and endangered species are addressed in Section 3.24.

Numerous bird species use the river corridors in the DWP ROI. Birds commonly sighted along the Rio Chama in the Upper Project Subarea include cliff swallow (*Petrochelidon pyrrhonota*), spotted sandpiper (*Actitis macylaria*), western tanager (*Piranga ludoviciana*), and mountain chickadee (*Poecile gambeii*) (USDA, 1990). Abiquiu Dam and Reservoir lie within the Great Basin scrub biome, and the uplands surrounding the reservoir are located within the Great Basin Conifer Woodland. Waterfowl, shorebirds, wading birds, and some raptors use this reservoir. Additionally, mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), and coyotes (*Canis latrans*) are present in the reservoir area. Small mammals present near the reservoir include desert cottontail (*Sylvilganus auduboni*), Ord's kangaroo rat (*Dipodomys ordii*), piñon mouse (*Peromyscus truei truei*), rock squirrel (*Spermophilus variegatus*), white-throated wood rat (*Neotoma albigula*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), stripped skunk (*Mephitis mephitis*), Bota's pocket gopher (*Thomomys bottae*), and bobcat (*Lynx rufus*) (USACE, 1995). Abiquiu Reservoir and downstream areas such as adjacent wetlands, oxbows, and braided channels, provide habitat for waterfowl and shorebirds.

Amphibians associated with the Rio Grande bosque include northern leopard frogs (*Rana pipiens*), chorus frogs (*Pseudacris spp*.), and bullfrogs (*Rana catesbeiana*). Hink and Ohmart (1984) documented 3 turtle species, 17 lizard species, and 18 snake species along the Middle Rio Grande. Many of these are upland species, and are uncommon in the bosque. Of reptiles that are common in the bosque, the plateau lizard (*Sceloporus undulatus*) and the New Mexico whiptail (*Cnemidophorus neomexicanus*) are the most widespread and frequently observed lizards. Common turtle species are the painted turtle (*Chrysemys picata*), spiny softshell turtle (*Trionyx spiniferus*), red-eared slider (*Trachemys scripta*), and the common snapping turtle (*Chelydra serpentina*). Great Plains skinks (*Eumeces obsoletus*) and gartersnakes (*Thamnophis* sp.) also favor moist riparian habitats (Hink and Ohmart, 1984).

Wildlife inventories conducted by Cole (1978), Raitt *et al*. (1981), Hink and Ohmart (1984), Hoffman (1990), and Campbell (1990) have confirmed the vertebrate species along the Rio Grande. Many species are obligate (depending entirely on the immediate riparian zone), while most are facultative. The linear riparian corridors provide migration and dispersal routes, and serve as connectors among upland habitats (Brinson *et al*., 1981).

Several waterfowl species have been recorded in the Middle Rio Grande valley. Sandhill cranes winter from October to February in the Middle Rio Grande valley. Hink and Ohmart (1984) recorded 15 species of ducks, with mallards (*Anas platyrhynchos*) being the most common species. Mallards breed in the riparian zone adjacent to the river. Sandbars are important to shorebirds for roosting and foraging especially during migration (Crawford *et al*., 1993). In addition to being opportunistically used by large numbers of bird species, cottonwood-dominated community types also are preferred habitat for a large proportion of these species, particularly during the breeding season.

The Migratory Bird Treaty Act (MBTA), Title 16, Code of Federal Regulations, Chapter 7, protects all migratory wild birds found in the U.S. except the house sparrow, European starling, feral pigeon, and resident game birds. In New Mexico, resident game birds are managed by NMDGF. The MBTA makes it unlawful for anyone to kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird, including feathers, parts, nests, and eggs.

The Rio Grande is a main corridor for migratory birds moving from wintering grounds to breeding grounds and vice versa. Many migratory birds such as raptors, warblers, and other passerines (songbirds) use the bosque to nest and raise young. The breeding season for many birds in the Middle Project Subarea is from February to August. To avoid violation of the MBTA, DWP construction activities in the bosque should not occur during the breeding season.

Three raptor nests were observed within the Rio Grande bosque, 250 to 500 feet north of Paseo del Norte Bridge. One nest was occupied by a pair of Cooper's hawks (observed on March 21, 2001). Another pair of Cooper's hawks was noted on the west side of the river just south of Alameda. These birds are protected under the MBTA. Other pairs also were noted, but actual nest sites were not discovered. A pair of adult bushtits was observed building a nest (cup) in the area proposed for construction of the DWP Subsurface Diversion facilities. Several other bird species also were noted. A coyote also was observed in the project area during the March 2001 survey.

3.29.3 Environmental Consequences

The following evaluation criteria were considered in evaluating the potential effects on wildlife:

- The destruction or modification of riparian or upland habitat such that wildlife populations would be adversely affected; and

- Violation of the MBTA due to project activities.

Effects from No Action Alternative

Under the No Action Alternative, there would be 373 acres of riparian habitat affected by continued ground water pumping. It is unlikely that new wells would be sited in wildlife habitat areas.

Effects from Action Alternatives

Construction of the DWP action alternatives would occur only within the Middle Project Subarea. Construction of diversion facilities at the existing Angostura Diversion would result in the permanent loss of 1.8 acres of bosque habitat, including 1.7 acres for a fishway. Any vegetation damaged or destroyed outside the footprint of permanent structures would be replanted. No raptor or other large nests were noted in Angostura Dam area.

Construction of the Paseo del Norte Diversion would result in the loss of 4.2 acres of riparian vegetation. All project structures would be permanent. Several large stick nests were noted in this area, and one known active Cooper's hawk nest would be destroyed by this alternative.

Construction of the Subsurface Diversion would replace 27.9 acres of riparian wildlife habitat with permanent facilities (three pump stations and associated roads). Up to three raptor nests would be lost due to construction activities associated with the Subsurface Diversion.

Operation of action alternatives would include the addition of 65 cfs in the Upper Project Subarea relative to the No Action Alternative, the net diversion of 65 cfs of native Rio Grande water in the Middle Project Area, and no change in river hydrology in the Lower Project Subarea. There would be no operational effects on wildlife or riparian habitat in the Upper or Lower Project Subareas. Approximately 33 RMs would be affected by the diversion of native flow under Angostura Diversion, and approximately 15 RMs would be affected under Paseo del Norte Diversion and Subsurface Diversion. Operation of Paseo del Norte Diversion and Subsurface Diversion would not affect riparian habitat downstream from the diversion points. However, the operation of the Subsurface Diversion would alter approximately 552 acres of riparian plant community (bosque) structure due to draw down of the local water table. This habitat alteration would result in a substantial cumulative effect on the riparian habitat, and therefore an indirect effect on wildlife that rely on this habitat (also see Section 3.21).

Summary of Environmental Consequences

The direct effects (from facility construction) on wildlife resources, after implementation of the mitigation measures discussed in Section 3.29.4, would be minimal, as most of the habitat temporarily affected would be restored. Permanent construction effects, as measured by the loss of songbird riparian habitat, would include 1.8 acres under Angostura Diversion, 4.2 acres under Paseo del Norte Diversion, and 27.9 acres under Subsurface Diversion. One known raptor nest near Paseo del Norte would be lost during implementation of Paseo del Norte Diversion, and three known raptor nest sites would be lost during implementation of Subsurface Diversion.

Operational effects of the DWP under Angostura Diversion and Paseo del Norte Diversion would be negligible in all project subareas. Indirect operational effects on wildlife using the bosque would result from implementation of Subsurface Diversion because up to 552 acres of riparian habitat structure would be altered by the local drawdown of the ground water elevation. Individual members of wildlife species would not be affected, and likely would re-locate during construction activities. The cumulative effect of operations under Subsurface Diversion is the alteration of 552 acres of riparian wildlife habitat. Short-term use versus long-term productivity would not be a concern with either the proposed action alternatives or the No Action Alternative, considering the benefits of implementing the proposed action versus any potential long-term loss of productivity from the wildlife habitat. There are no known irreversible or irretrievable commitments of wildlife resources associated with the DWP alternatives. Project effects on wildlife are summarized by alternative in Table 3.29-1.

3.29.4 Proposed Mitigation Measures

Mitigation measures are described in Appendix O. Environmental design features and best management practices would alleviate most of the construction effects. Enhancements made for threatened and endangered species, which would also benefit most wildlife species found in the areas, are in Appendix O. The loss of riparian habitat as a result of temporary construction losses and siting of pump stations would be mitigated in other areas of the bosque along the Rio Grande within City limits.

TABLE 3.29-1
SUMMARY OF PROJECT EFFECTS ON WILDLIFE

Evaluation Criterion	Alternative			
	No Action	Angostura Diversion	Paseo del Norte Diversion	Subsurface Diversion
Number of high-use waterfowl areas that would be lost due to project operations	0	0	0	0
Productive songbird riparian habitat that would be permanently lost due to project construction (acres)	0	1.8	4.2	10.6
Number of active raptor nests that would be lost because of construction	0	0	1	3
Number of active raptor nests that would be lost because of the close proximity of project structural facilities and associated human presence	0	0	1	3
Amount of riparian wildlife habitat that would be permanently altered due to project operations (acres)	373	0	0	552
Number of birds protected under the Migratory Bird Treaty Act that would be lost as a direct result of project construction or operations	0	0	0	0

3.30 CUMULATIVE EFFECTS

Cumulative effects are defined as impacts upon the environment resultant from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions. It does not matter what agency or person undertakes these actions. Cumulative effects can result from individually minor, but collectively significant actions taking place over time.

This section describes activities that could contribute to cumulative effects when combined with the resource specific effects of the DWP, as described in Section 3 of the

FEIS. Cumulative effects are described only for those resources for which it was determined that such effects could reasonably occur. Table 3.30-1 lists the pertinent past, ongoing and planned projects that were considered in the analysis.

To assess cumulative impacts on affected resources, the steps noted below were completed. Readers are encouraged to review the information in Section 2 on alternatives and the resource specific information presented earlier in Section 3, particularly those sections describing the affected environment and environmental consequences for each resource area.

- A list of past, ongoing, and reasonably foreseeable projects within the DWP ROI was developed.
- Each of these projects was evaluated by Interdisciplinary Team Members for potential interactions with the DWP.
- All 25 resource categories were reviewed for potential interactions with each of the listed projects.
- Three resource areas, hydrology, threatened and endangered species , and riparian vegetation. were considered to have the potential for cumulative effects between the project list and the DWP.
- All listed projects were reviewed and evaluated for potential effects for the selected resource categories. A table of effects between the resource categories and the listed projects was constructed.

Cumulative effects of the proposed action were evaluated from two perspectives. The first evaluation considered incremental effects of the DWP added to the effects of recent City reclamation projects, North I-25 Industrial Recycling Project, and the Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque. The second perspective involved a review of these three projects relative to projects of others that also affect the RGSM (Tables 3.30-2 and 3.30-5), hydrology (Tables 3.30-3 and 3.30-6) and riparian ecology (Tables 3.30-3 and 3.30-7). Effects determination includes consideration of all proposed mitigation measures, thus the following tables reflect "net" effect following mitigation. Within Tables 3.30-2 through 3.30-7 a value of 0 indicates no effect, + indicates a beneficial effect, and – indicates a negative effect.

The purpose of this section is to describe the associated cumulative effects expected from the 60-year timeframe for the project as addressed by this FEIS. A comparison of past, present and future projects is considered, and then compared to the additive effects illustrated in the previous tables. The DWP action alternatives would divert City SJC water from the Rio Grande with a like amount of native water. After consumptive use of the SJC water, the native water is returned to the river via the SWRP. There would be a depletion "zone" or stretch of the river that would be affected by the operations of the project. The net effects of the project including mitigation and environmental enhancements, are not injurious to the resource areas considered in the tables above.

Past projects (primarily the main stem dams and diversion structures) have obviously changed the characteristics of the river. From an additive standpoint (adding cumulative effects from the previous tables to other past projects), the cumulative net effect of the

TABLE 3.30-1
SUMMARY OF PAST, PLANNED OR ONGOING PROJECTS IN THE RIO GRANDE BASIN

Project and Date of Initiation	Description
City of Albuquerque - North I-25 Industrial Recycling Project 1999	This project is a component of the AWRMS. Construction was recently completed, and it is currently coming online. It is the first step in the implementation of engineering projects designed to reduce ground water use and implement a sustainable water-supply/use pattern. Treated effluent from local industrial processes will be used for turf irrigation and other non-potable uses. The expected volume of effluent available from these industrial sources is approximately 896 ac-ft/yr. Net impacts to surface and ground water hydrology are 448 ac-ft/yr. This water will eliminate the need for existing and future ground water pumping for these activities.
City of Albuquerque - Non-Potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque 2000	This project, which includes the Non-potable Surface Water Reclamation Project and Southside Water Reclamation Plant Reuse Project, is a component of the AWRMS. The Non-potable SJC projects uses a portion of the City's SJC water (approximately 1,700 ac-ft/yr), which will be diverted near Alameda Boulevard. This project will supply approximately 3,038 ac-ft/yr water is for non-potable uses (primarily turf irrigation). Approximately 2,455 ac-ft/yr of reclaimed effluent from the City's SWRP is also recovered, treated, and used for turf irrigation. Construction has started on this project, but it is not yet in operation. Net impacts to surface and ground water hydrology of these projects are 1,434 ac-ft/yr.
City of Albuquerque - Actions to address water quality in the Rio Grande below Central Avenue Bridge	The City discharges treated effluent into the Rio Grande at an average rate of about 80 cfs.
U.S. Bureau of Reclamation – Middle Rio Grande Project -1934	This project includes: El Vado Dam and Reservoir, three diversion dams. Located on the Rio Chama, El Vado was built by the MRGCD in 1934-38. It is owned by MRGCD and operated by agreement with Reclamation. Native waters stored and then released from El Vado are subject to provisions of the Rio Grande Compact. The maximum storage capacity is 209,330 ac-ft. Angostura Diversion Dam is operated by the MRGCD, and completed in 1934, with a diversion capacity of 650 cfs. The facility is located 5 miles north of the Town of Bernalillo, New Mexico. Isleta Diversion Dam is operated by the MRGCD, and is located downstream of the City's SWRP. Diversion capacity is 1,070 cfs. Serves the Belen Division of the MRGCD. San Acacia Diversion Dam operated by the MRGCD for the Socorro division. Located north of Socorro, the diversion capacity is 283 cfs.[1]
U.S. Army Corps of Engineers - Jemez Dam and Reservoir 1953	Completed in 1953 by the USACE, Jemez Dam is located on the Jemez River, just upstream of the confluence with the Rio Grande. Jemez Dam functions as a sediment control reservoir and reduces the downstream sediment load. The Jemez River enters the Rio Grande just downstream of Angostura Diversion Dam.

TABLE 3.30-1 (Continued)
SUMMARY OF PLANNED OR ONGOING PROJECTS IN THE RIO GRANDE BASIN

Project	Description
U.S. Bureau of Reclamation-Low-Flow Conveyance Channel and Rio Grande Floodway FEIS	Reclamation is preparing a FEIS to reevaluate the operation and configuration of the Low-Flow Conveyance Channel and Rio Grande floodway between San Acacia Diversion Dam and Elephant Butte Reservoir. A preliminary FEIS was released in 2000 (Reclamation, 2000a). It addresses proposed realignment of the river and LFCC in the San Marcial area but does not address operations, which are part of the Upper Rio Grande Water Operations Review. The FEIS was officially released for public review and comment in September 2000.
U.S. Army Corps of Engineers - Abiquiu Dam and Reservoir 1963	Located 32 miles above the confluence with the Rio Chama and Rio Grande. Operated by USACE. Total storage capacity is 1,541,024 ac-ft. The City and other entities at the discretion of the City, that contract for SJC water, can store up to 200,000 ac-ft in Abiquiu.
U.S. Army Corps of Engineers - Cochiti Dam and Reservoir 1970	Cochiti Dam is an earthfill dam and is operated by the USACE, for flood control. The reservoir has a capacity of 596,499 ac-ft. It was completed in 1970.
Santa Ana Bosque Restoration Project 1996 - ongoing	The Bosque Restoration Program has been on-going since 1996. The program involves the restoration of the six mile reach of the Rio Grande through the Santa Ana reservation and the adjacent native Cottonwood Forest ("Bosque"). The Rio Grande through the reservation has been altered by more than 50 years of flood control and river channelization activities (dams, levees, jetty jack fields…). These activities have altered the river from a broad, shallow multi-braided system to a narrow, deep single channel river. These changes have likely diminished habitat for two endangered species: the Rio Grande silvery minnow and the southwestern willow flycatcher. The changes in the river have also negatively impacted the adjacent Bosque by eliminating overbank flooding and lowering the water table.
U.S. Army Corps of Engineers - Belen Levee Project 1999 - ongoing	USACE (1999) distributed a draft supplemental FEIS/limited reevaluation report for public review in the spring of 1999. This levee-rehabilitation project extends from Isleta Pueblo to Belen, New Mexico, on both the east and west banks of the Rio Grande. The project would rehabilitate the existing spoil-bank levee to withstand higher and longer-duration floods, and would allow for the safe release of higher flows from upstream flood-control reservoirs. The San Marcial railroad bridge limits higher spring releases from upstream reservoirs.
Sandia Pueblo Bosque Restoration 2000	This is in the initial stages of planning and development. Similar activities to Santa Ana Pueblo project. The initial 20-acre project was completed in May 2001. The Pueblo is actively restoring an additional 80 acres of riparian habitat. In addition, the Pueblo is actively restoring natural wetlands adjacent to the existing levee system.
Middle Rio Grande Collaborative Program	On going cooperative effort between several agencies to identify, fund, and implement and monitor river restoration projects. The Santa Ana and Sandia projects mentioned above are examples.

TABLE 3.30-1 (Continued)
SUMMARY OF PLANNED OR ONGOING PROJECTS IN THE RIO GRANDE BASIN

Project	Description
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U.S. Bureau of Reclamation-River maintenance activities (ongoing)	Reclamation maintains the river channel for the Middle Rio Grande Project from Velarde, New Mexico to Caballo Dam. The goals of the project are to: 1) provide for the effective transport of water and sediment to Elephant Butte Reservoir; 2) conserve surface water in the Rio Grande Basin; 3) reduce the rate of aggradation in the Rio Grande; and 4) protect certain riverside structures and facilities. River maintenance activities include bank stabilization/bioengineering/habitat enhancement techniques, river training works, sediment removal, vegetation control, levee maintenance, and access and construction requirements. Current projects include activities to restore native habitat, conserve threatened and endangered species, maintain bosque functions and values, minimize adverse water-quality effects of river management and point-source and non-point-source discharges, and allow fluvial processes to occur to the extent possible.
U.S. Bureau of Reclamation - Acquisition of supplemental water (ongoing)	Since 1996, Reclamation has acquired water to provide for the survival and recovery of the endangered Rio Grande silvery minnow. SJC project water has been provided for use by the MRGCD, thereby allowing the MRGCD to by-pass native flows which supplement Rio Grande flows in the middle valley to benefit the RGSM. The majority of supplemental water has been made available through contracts with the City of Albuquerque (up to 30,000 ac-ft/yr during 1997-1999). Reclamation continues to pursue other means to acquire the use of water for supplementing streamflow. The *Final Programmatic Assessment and Finding of No Significant Impact for the Rio Grande Supplemental Water Program* (Reclamation, 2001c) was completed in March 2001.
City of Santa Fe - County of Santa Fe, Las Campanas Buckman Diversion Project FEIS (planned)	The U.S. Forest Service, Bureau of Land Management are lead federal agencies for a FEIS to address a new diversion at the Buckman well field to meet water demands by the three applicants. Both SJC and native Rio Grande water would be diverted and treated for municipal needs. A DEIS is planned to be released in 2004.
U.S. Fish and Wildlife Bosque del Apache National Wildlife Refuge Restoration Project (on-going)	Many cottonwood and willow bosques that once lined the Rio Grande have been lost to human developments. Salt cedar or "tamarisk," originally introduced as an ornamental plant and for erosion control, has taken over vast areas and has low wildlife value. Salt cedar is being cleared and areas planted with cottonwood, black willow, and understory plants to restore native bosques that have higher value for wildlife.

TABLE 3.30-1 (Continued)
SUMMARY OF PLANNED OR ONGOING PROJECTS IN THE RIO GRANDE BASIN

Project	Description
U.S. Army Corps of Engineers - San Acacia Levee Project (ongoing, various activity)	USACE recently distributed a draft supplemental FEIS/limited re-evaluation report that is currently undergoing public review. USACE previously received a jeopardy biological opinion from the USFWS for potential effects of the project on the Rio Grande silvery minnow and the southwestern willow flycatcher. This levee rehabilitation project on the east bank of the Rio Grande extends from the San Acacia Diversion Dam to just north of the Tiffany Area above the San Marcial railroad bridge. The project will rehabilitate the existing spoil-bank levee to withstand higher and longer-duration floods, relocate and increase the underflow capacity of the San Marcial railroad bridge, and reintroduce the Tiffany area to the active floodplain. The project will allow for the safe release of higher flows from upstream flood-control reservoirs. Currently, the San Marcial railroad bridge is restricting higher spring releases from upstream reservoirs. Raising the bridge would increase the potential to pass higher peak flows, and may result in better channel dynamics and a healthier riparian community.
U.S. Bureau of Reclamation and U.S. Army Corps of Engineers - Upper Rio Grande Basin Water Operations Review FEIS (ongoing)	USACE and Reclamation, in partnership with the State of New Mexico, will review water-storage and -delivery operations, and may modify operations of federal river and reservoir facilities within the Upper Rio Grande Basin and develop an integrated plan. There is a need for updated NEPA and ESA compliance and a need to define procedures and protocols for review, coordination, consultation, and public involvement in water-operations decisions. The notice of intent was published and public scoping meetings began in 2000. The FEIS is currently scheduled for release in December 2004. There will be intensive coordination with the City of Albuquerque's projects.
Middle Rio Grande Ecosystem Restoration Project (ongoing)	Includes habitat restoration efforts for the RGSM and other endangered species involving a variety of federal, state, and local agencies and non-government organizations.

[1] Storage in El Vado Reservoir is subject to Article VII of the Rio Grande Compact. Pursuant to 1928 legislation, a contract between the Bureau of Reclamation and the Middle Rio Grande Conservancy District, water is stored in El Vado to serve specified prior and paramount rights of the six Middle Rio Grande Pueblos. Article XVI of the Rio Grande Compact provided that the Compact does not infringe or impair the treaty or other rights of Indian tribes.

TABLE 3.30-2
CUMULATIVE EFFECTS OF THE AWRMS ON THE SURFACE AND GROUND WATER HYDROLOGY (AFTER PROPOSED MITIGATION MEASURES)

Project Name	Subarea			Cumulative Effect
	Upper	Middle	Lower	
City of Albuquerque - North I-25 Industrial Recycling Project	0	0	448 ac-ft/yr	448 ac-ft/yr
City of Albuquerque - Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque	0	0	1,434 ac-ft/yr	1,434 ac-ft/yr
City of Albuquerque – Drinking Water Project	0	19,500 ac-ft/yr	0	19,500 ac-ft/yr
Cumulative Effect	**0**	**19,500 AC-FT/YR**	**1,882 AC-FT/YR**	

TABLE 3.30-3
CUMULATIVE EFFECTS OF THE AWRMS ON THE RIO GRANDE SILVERY MINNOW (AFTER PROPOSED MITIGATION MEASURES)

Project Name	Subarea			Cumulative Effect
	Upper	Middle	Lower	
City of Albuquerque - North I-25 Industrial Recycling Project 1999	0	0	0	0
City of Albuquerque - Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque 2000	0	0	0	0
City of Albuquerque – Drinking Water Project 2005	0	+	0	+
Cumulative Effect				+

**TABLE 3.30-4
CUMULATIVE EFFECTS OF THE AWRMS ON
RIPARIAN ECOLOGY (AFTER PROPOSED MITIGATION MEASURES)**

Project Name	Subarea			Cumulative Effect
	Upper	Middle	Lower	
City of Albuquerque - North I-25 Industrial Recycling Project 1999	0	0	0	0
City of Albuquerque - Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque 2000	0	0	0	0
City of Albuquerque – Drinking Water Project	0	0	0	0
(Acres of Riparian Vegetation) Cumulative Effect				0

TABLE 3.30-5
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON SURFACE AND GROUND WATER HYDROLOGY

Project Name	Subarea			Cumulative Effect with DWP	Analysis
	Upper	Middle	Lower		
City of Albuquerque - North I-25 Industrial Recycling Project 1999	0	0	–	–	There is an accumulation of 448 ac-ft less stream flow per year, each year the project is in operation; however, this does accumulate an equivalent volume of saved ground water each year.
City of Albuquerque - Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque 2000	0	0	–	–	There is the net accumulation of 1,434 ac-ft less stream flow per year downstream of the SWRP each year the project is in operation; however, when added to the incremental effects of the North I-25 Industrial Recycling project, about 6,389 ac-ft/yr of high quality, deep aquifer ground water occurs.
City of Albuquerque - Actions to address water quality in the Rio Grande below Central Avenue Bridge (ongoing)	0	0	0	0	The City continues to comply with all pertinent regulations and permits, and works on improving water quality in all City operations. The DWP has no impact upon these activities. Water quality in the river is slightly enhanced with implementation of the project.
U.S. Bureau of Reclamation - River maintenance activities (ongoing)	+	+	+	+	The improvement of levees and other water facilities, by the potential savings of water, improved delivery and other opportunities is a positive cumulative effect upon basic hydrology within the project area.
U.S. Bureau of Reclamation - Acquisition of supplemental water (ongoing)	0	+	+	+	To the extent this occurs, and water may be made available for environmental purposes, this is a positive benefit from a cumulative effect standpoint to hydrology.
U.S. Bureau of Reclamation – Middle Rio Grande Project 1934	–	–	–	–	The DWP will have a negative cumulative effect from an additive viewpoint upon the operations of the Middle Rio Grande Project. The SJC water is from another basin; however, overall, there would be less water available for other potential purposes after City consumptive use of the SJC water.

TABLE 3.30-5 (Continued)
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON SURFACE AND GROUND WATER HYDROLOGY

Project Name	Subarea			Cumulative Effect with DWP	Analysis
	Upper	Middle	Lower		
U.S. Army Corps of Engineers - Jemez Dam and Reservoir 1953	–	–	–	–	There is a slight change to hydrology within the depletion area from diversion to SWRP within the Rio Grande. Past harmful effects of the Jemez Dam and Reservoir are not improved or modified by the DWP.
U.S. Bureau of Reclamation-Low-Flow Conveyance Channel and Rio Grande Floodway FEIS 1960	0	0	–	–	There are no cumulative effects upon the Upper and Middle Project Subareas as the channel could not be impacted by SJC water in the channel in these areas. A negative effect overall and to the Lower Project Subarea occurs prior to the DWP as the channel has modified natural flows in the area of the low flow channel. Past harmful effects from the channel are not improved or modified by the DWP.
U.S. Army Corps of Engineers - Abiquiu Dam and Reservoir 1963	–	–	–	–	There remains a negative effect upon natural flows and conditions within the Chama River and the Rio Grande, attributable to conditions prior to the DWP. Past harmful effects from the dam and reservoir are not improved or modified by the DWP.
U.S. Army Corps of Engineers - Cochiti Dam and Reservoir 1970	–	–	–	–	The DWP may have a negative cumulative effect upon Cochiti Dam and Reservoir operations as there may be less SJC water in the basin available for other purposes after the City consumptively uses its SJC water. There is a slight change to hydrology within the depletion area from diversion to SWRP within the Rio Grande. Past harmful effects of the Cochiti Dam and Reservoir are not improved or modified by the DWP.
U.S. Army Corps of Engineers – Belen Levee Project 1999	0	0	0	0	There is no cumulative effect, additive, or interactive, to hydrologic resources from improving levees that are the responsibility of the USACE. There is no modification of flows or other operational impact from the DWP that contributes to any impact.

TABLE 3.30-5 (Continued)
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON SURFACE AND GROUND WATER HYDROLOGY

Project Name	Subarea			Cumulative Effect with DWP	Analysis
	Upper	Middle	Lower		
Santa Ana Pueblo Bosque Restoration Project 1999	0	+	0	0	There is a slight positive benefit to the Middle Project Subarea because of the addition to the Rio Grande of the City San Juan-Chama water to the system, primarily from the Paseo del Norte and Subsurface alternatives. This is not a significant positive effect. There would be no effect from this project cumulatively with the DWP in the other subareas or overall.
Sandia Pueblo Bosque Restoration 2000	0	0	0	0	The DWP has no cumulative effect, either additive or interactive hydrologically with this bosque restoration project. Development and maintenance of the restoration project is not impacted by the DWP.
U.S. Army Corps of Engineers - San Acacia Levee Project (ongoing)	0	0	–	0	There is a slight negative effect from the construction of the levee project within the Lower Project Subarea to hydrologic resources during construction. The DWP does not contribute to this, and there are no cumulative effects to or from the DWP overall by this USACE project.
U.S. Bureau of Reclamation and U.S. Army Corps of Engineers - Upper Rio Grande Basin Water Operations Review FEIS (ongoing)	+	+	+	+	There is a positive cumulative effect as the improved water operations and management of the river system will benefit all water users. The City is cooperating with other users, and proposed mitigation associated with the DWP will help improve water operations and reliability throughout each subarea and cumulatively.
City of Santa Fe - Water Management and Restoration Strategy FEIS (planned)	–	0	0	0	Within the Upper Project Subarea, there is a negative cumulative effect as the City of Santa Fe may begin to divert their supply of San Juan – Chama water (less overall amount of water available). In the other subareas, and overall cumulatively, the hydrology is not impacted as there are no substantive changes to flows associated with the DWP project.
U.S. Fish and Wildlife Bosque del Apache National Wildlife Refuge Restoration Project (on-going)	0	0	+	+	There is no impact from or to the restoration project attributable to San Juan – Chama water in the Upper Project Subarea. Within the Lower Project Subarea, because of a slight improvement in water quality, and the restoration of flows to the subarea from the SWRP, there is a positive cumulative effect hydrologically.

TABLE 3.30-6
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON THE RIO GRANDE SILVERY MINNOW

Project Name	Subarea			Cumulative Effect with DWP	Analysis
	Upper	Middle	Lower		
City of Albuquerque - North I-25 Industrial Recycling Project 1999	0	0	0	0	This project removes a small amount of overall flow from the river. Associated mitigation measures helped insure there was no direct or indirect effect upon the RGSM from the project, so there is no additive impact.
City of Albuquerque - Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque 2000	0	0	0	0	This project removes a small amount of overall flow from the river. Associated mitigation measures will help insure there is no direct or indirect effect upon the RGSM from the project, so there is no additive or interactive impact.
City of Albuquerque - Actions to address water quality in the Rio Grande below Central Avenue Bridge (ongoing)	0	0	0	0	Any improvements to river water quality are seen as positive impacts. There would be slight improvement to water quality from the DWP operating, which also would be considered beneficial. Overall, there are no cumulative impacts associated with the DWP and attempted or actual improvements to water quality.
U.S. Bureau of Reclamation – Middle Rio Grande Project 1934	–	–	–	–	This project has impacted the RGSM through the construction of dams without passage facilities, and has modified natural conditions within the river and the floodplain. While the DWP has mitigation features to lessen any effects from the DWP, an overall cumulative negative impact to the RGSM from the Middle Rio Grande Project remains.
U.S. Army Corps of Engineers - Jemez Dam and Reservoir 1953	–	–	–	–	This project has impacted the RGSM through the construction of a dam without passage facilities, and has modified natural conditions (sediment) within the river and the floodplain. While the DWP has mitigation features to lessen any effects from the DWP, an overall negative impact to the RGSM from the Jemez Dam and reservoir remains. Operation of the dam is not impacted by the DWP, so no new impacts attributable to the DWP would be expected.

TABLE 3.30-6 (Continued)
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON THE RIO GRANDE SILVERY MINNOW

Project Name	Subarea			Cumulative Effect with DWP	Analysis
	Upper	Middle	Lower		
U.S. Bureau of Reclamation-Low-Flow Conveyance Channel and Rio Grande Floodway FEIS 1960	0	0	–	–	River maintenance, when tied to habitat restoration or analysis efforts, would be a positive effect upon the RGSM. This would be accomplished through possible over bank flooding and the improvement of riparian habitats. These activities are considered positive within each subarea and cumulatively for the species.
U.S. Army Corps of Engineers - Abiquiu Dam and Reservoir 1963	0	0	0	0	This project has impacted the RGSM through the construction of a dam without passage facilities, and has modified natural conditions (sediment) within the river and the floodplain. While the DWP has mitigation features to lessen any effects from the DWP, an overall negative impact to the RGSM from the Abiqui Dam and reservoir remains. Operation of the dam is not impacted by the DWP, so no new impacts attributable to the DWP would be expected.
U.S. Army Corps of Engineers - Cochiti Dam and Reservoir 1970	–	–	–	–	This project has impacted the RGSM through the construction of a dam without passage facilities, and has modified natural conditions (sediment) within the river and the floodplain. While the DWP has mitigation features to lessen any effects from the DWP, an overall negative impact to the RGSM from the Cochiti Dam and reservoir remains. Operation of the dam is not impacted by the DWP, so no new impacts attributable to the DWP would be expected.
U.S. Army Corps of Engineers - Belen Levee Project 1999	0	0	0	0	Construction and modification of the levees protecting the floodplain would not be expected to modify the present status of the RGSM, or present a cumulative impact to habitat or the existing population.
Santa Ana Pueblo Bosque Restoration Project 1999	0	+	0	+	Efforts to restore riparian vegetation and improve stream habitats are a positive cumulative effect.

TABLE 3.30-6 (Continued)
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON THE RIO GRANDE SILVERY MINNOW

Project Name	Subarea			Cumulative Effect with DWP	Analysis
	Upper	Middle	Lower		
Sandia Pueblo Bosque Restoration 2000	0	+	0	+	Efforts to restore riparian vegetation and improve stream habitats are a positive cumulative effect.
U.S. Bureau of Reclamation - River maintenance activities (ongoing)	+	+	+	+	Overall, cumulative effects are positive as water delivery and streamside vegetation would likely be improved.
U.S. Bureau of Reclamation - Acquisition of supplemental water (ongoing)	0	+	+	+	The potential development of water leases or purchases for endangered species purposes is a positive cumulative effect.
U.S. Army Corps of Engineers - San Acacia Levee Project (ongoing)	0	0	0	0	There is no cumulative effect upon the RGSM from work within and on this levee as there is no direct or indirect effect.
U.S. Bureau of Reclamation and U.S. Army Corps of Engineers - Upper Rio Grande Basin Water Operations Review FEIS (ongoing)	+	+	+	+	Overall, the cumulative effect of improved water supply, and operations of the existing federal facilities to improve delivery and response to environmental requirements, is positive.
City of Santa Fe - Water Management and Restoration Strategy FEIS (planned)	–	0	0	0	In terms of cumulative effects upon RGSM, this project has no effect as it occurs within the upper subarea, and is unlikely to present a direct effect to the RGSM. Indirectly, if there is some potential habitat restoration activity associated with this project, those may be of a positive benefit to the RGSM.
U.S. Fish and Wildlife Bosque del Apache National Wildlife Refuge Restoration Project (ongoing)	0	0	+	+	Within the lower subarea, habitat and water management improvements within the refuge would have a positive direct effect upon RGSM. Thus, a positive cumulative effect is indicated.
Middle Rio Grande endangered species collaborative program	+	+	+	+	Habitat restoration efforts, fish re-introduction programs, and rescue operations within all subareas are cumulatively positive for the recovery program of the RGSM.

TABLE 3.30-7
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON RIPARIAN ECOLOGY

Project Name	Subarea			Cumulative Effect with DWP	Analysis
	Upper	Middle	Lower		
City of Albuquerque - North I-25 Industrial Recycling Project 1999	0	0	0		There are no direct or indirect effects to the riparian areas of any subarea from operations of the recycling project. No acreage is added, removed or improved upon.
City of Albuquerque - Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque 2000	0	0	0		The small amount of riparian vegetation disturbed by this project will be restored, so there is no cumulative impact upon riparian areas.
City of Albuquerque - Actions to address water quality in the Rio Grande below Central Avenue Bridge (ongoing)	0	0	0		Improvements to water quality are generally considered beneficial to the riparian areas of streams. There are no direct impacts upon riparian resources, and the indirect positive effects of water quality improvements will not affect the overall amounts or functions of the riparian system.
U.S. Bureau of Reclamation - River maintenance activities (ongoing)	+	+	+		Several projects to remove and enhance the riparian zone are an aspect of this Reclamation program. Such activity, by increasing the amount of native riparian plants is a positive cumulative effect.
U.S. Bureau of Reclamation - Acquisition of supplemental water (ongoing)	0	+	+		Additional water supplies, if made available for environmental purposes, for example, overbank flooding, would improve the overall health of the riparian areas, and is a positive cumulative effect towards restoring the amount and natural functions of the riparian ecology.
U.S. Bureau of Reclamation –Middle Rio Grande Project 1934	–	–	–		Overall, the project has altered the bosque significantly. The reduction in amounts of riparian vegetation and changes in natural functions continue to result in overall negative cumulative effects upon riparian ecology.
U.S. Army Corps of Engineers - Jemez Dam and Reservoir 1953	–	–	–		This project removed amounts of riparian vegetation and has altered the natural sediment and flow regimes of the riparian areas through continuing operations. Cumulatively, these areas have not been restored and remain a negative effect upon riparian ecology.
U.S. Bureau of Reclamation-Low-Flow Conveyance Channel and Rio Grande Floodway FEIS 1960	0	0	–		This project removed amounts of riparian vegetation and has altered the natural sediment and flow regimes of the riparian areas, specifically in the Lower Project Subarea. Cumulatively, these areas have not been restored and remain a negative effect upon riparian ecology.

TABLE 3.30-7 (Continued)
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON RIPARIAN ECOLOGY

Project Name	**Subarea**			**Cumulative Effect with DWP**	**Analysis**
	Upper	**Middle**	**Lower**		
U.S. Army Corps of Engineers - Abiquiu Dam and Reservoir 1963	–	–-	–		This project removed amounts of riparian vegetation and has altered the natural sediment and flow regimes of the riparian areas through continuing operations.
U.S. Army Corps of Engineers - Cochiti Dan and Reservoir 1970	–	–	–		This project removed amounts of riparian vegetation and has altered the natural sediment and flow regimes of the riparian areas through continuing operations. Cumulatively, these areas have not been restored and remain a negative effect upon riparian ecology.
U.S. Army Corps of Engineers - Belen Levee Project 1999	0	0	0		This project, of rehabilitating and repairing levees does not have direct or indirect impacts upon riparian ecology, so there is no cumulative effect.
Santa Ana Pueblo Bosque Restoration Project 1999	0	+	0		The establishment of native vegetation and the removal of non-native vegetation resultant from this project is a positive effect within the Middle Project Subarea. By contributing to overall amounts and functions of riparian areas in that subarea, the overall cumulative effect is positive.
Sandia Pueblo Bosque Restoration (on-going)	0	+	0		The establishment of native vegetation and the removal of non-native vegetation resultant from this project is a positive effect within the Middle Project Subarea. By contributing to overall amounts and functions of riparian areas in that subarea, the overall cumulative effect is positive.
U.S. Army Corps of Engineers - San Acacia Levee Project (ongoing)	0	0	0		This project, of rehabilitating and repairing levees does not have direct or indirect impacts upon riparian ecology, so there is no cumulative effect.
U.S. Bureau of Reclamation and U.S. Army Corps of Engineers - Upper Rio Grande Basin Water Operations Review FEIS (ongoing)	+	+	+		Improving the reliability and operations of the water system on the Rio Grande will have a positive effect upon the environment within the entire basin. The riparian ecology will benefit from these measures cumulatively throughout the basin.
City of Santa Fe - Water Management and Restoration Strategy FEIS (planned)	–	0	0		This project may have a small direct impact upon riparian ecology within the upper subarea. Depending upon selected mitigation and alternatives there may be no impacts, therefore there is no cumulative impact overall.

TABLE 3.30-7 (Continued)
CUMULATIVE EFFECTS OF RIO GRANDE PROJECTS ON RIPARIAN ECOLOGY

Project Name	Subarea			Cumulative Effect with DWP	Analysis
	Upper	Middle	Lower		
U.S. Fish and Wildlife Bosque del Apache National Wildlife Refuge Restoration Project (on-going)	0	0	+		The removal of non-native vegetation and reestablishing native vegetation in the Lower Project Subarea will provide positive effects cumulatively to riparian ecology.
Middle Rio Grande endangered species collaborative program	+	+	+		This project will be removing non-native vegetation and restoring areas to native vegetation, throughout the project area. These activities will result in overall cumulative beneficial effects upon riparian ecology.

DWP is not detrimental when the hydrology, threatened and endangered species, and riparian areas, are considered. There are positive benefits that accrue from protecting the deep aquifer as a water supply source and potential improvements to endangered species habitats within the Albuquerque reach from mitigation steps.

Future or planned projects within the river are of maintenance or operational scenarios (Table 3.30-1). The maintenance activities would generally improve riparian habitats by repairing and replacing levees, removing non-native vegetation and making modifications to banks and channels. The operational plans (for example Upper Rio Grande Basin Water Operations Review) will likely result in improved management of river flows and water supply for all users and natural aspects of the river. Neither type of future activity is cumulatively affected by the DWP construction or operation. The City is establishing relationships with the other management entities responsible for the river, and is an active participant in work groups and restoration activities, both planned and ongoing. Future changes in the Middle Rio Grande would be related to litigation settlement agreements, collaborative programs, and future legislation. The cumulative effects of the DWP are analyzed qualitatively within Table 3.30-5, 6 and 7. Each existing, present or planned project is compared for effects to physical changes in or on the system and any effects to the resources identified.

Table 3.30-2 shows the cumulative effects upon hydrology from the AWRMS. There are no cumulative effects to the Upper Project Subarea, while within the Middle Project Subarea, there is a depletion from 11 to 33 cfs as measured at the Central gage over the life of the project. At that point, the native water is returned to the river. The SJC water is used consumptively within Albuquerque. There are no effects to the Middle Project Subarea from the non-potable project as it uses a portion of SJC water. The effects to the Lower Project Subarea are the result of the AWRMS returning 1,882 ac-ft/yr less at the treatment plant. These are the cumulative effects, expressed as additive effects from the three AWRMS projects.

Table 3.30-3 shows the cumulative effects upon the Rio Grande silvery minnow from the three AWRMS projects, after environmental commitments. In other words, the net effect of the projects. There are no cumulative effects from the AWRMS projects within the Upper Project Subarea upon the RGSM. Within the Middle Project Subarea, after planned mitigation and other enhancement efforts, there would a positive effect for the RGSM, expressed by the addition of habitat, monitoring programs and other activities for the RGSM within the Middle Project Subarea. As the basic hydrology below the SWRP would be the same after native water is returned to the river, there are no cumulative impacts from the AWRMS projects.

Table 3.30-4 shows the cumulative effects upon the riparian zone after the implementation of mitigation steps and other environmental commitments. While amounts of riparian vegetation are removed from direct construction effects and ground water drawdown, after mitigation a like amount or in some cases greater amount of riparian habitat and vegetation is restored. When combined with non-native species removal, habitat construction, re-planting and combinations of restoration projects with other entities, there are no significant cumulative effects upon riparian vegetation/habitat from the three AWRMS projects.

3.31 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are environmental consequences of an action that cannot be avoided either by changing the nature of the action or through mitigation if the action is undertaken. With implementation of the City's proposed DWP, some portions of the bosque would be lost due to construction of pump stations. There would be some fish entrainment/impingement losses associated with Angostura Diversion and Paseo del Norte Diversion. Fishways designed as components of Angostura Diversion and Paseo del Norte Diversion would help offset these potential losses.

3.32 RELATIONSHIP OF SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

This analysis investigates the relationship between short-term uses of the environment and the maintenance and possible enhancement of long-term productivity. There would be some losses of bosque in the short-term; however, the proposed mitigation measures (see Appendix O) would help offset these losses. Some portions would be affected by the diversion of surface water. There would be no disruptions of short-term uses of the river or known effects on long-term productivity within the river.

3.33 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible resource commitments are those that cannot be reversed. Irretrievable commitments of resources are expenditures/consumption of resources that cannot be recovered or restored. For the proposed action, the expenditure of materials from non-renewable sources, labor, and energy resources during DWP construction and O&M would constitute irreversible and irretrievable commitments of those resources. Under the No Action Alternative, continued withdrawal of ground water from the aquifer at rates that exceed the rate of recharge may constitute an irretrievable and/or irreversible commitment of ground water resources in the Albuquerque Basin.

SECTION 4

CONSULTATION AND COORDINATION

This section provides information about the consultation and coordination activities that have occurred to date and that will occur during the completion of this EIS and the NEPA process. Public involvement activities will continue during the DWP development and construction phase.

4.1 CONTACTS WITH AGENCY PERSONNEL

The following people were contacted regarding the environmental analyses prepared for this FEIS. These individuals are knowledgeable about specific resource areas.

Ondrea Linderoth-Hummel, Program Manager
City of Albuquerque Open Space Division
P.O. Box 1293
Albuquerque, New Mexico 87103
Subject: Open space regulations

Jean Manger, Regulatory Project Manager
U.S. Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109
Subject: Clean Water Act regulations

Corrine Brooks, District Conservationist
U.S. Department of Agriculture – Natural Resource Conservation Service
6200 Jefferson St. NE
Albuquerque, New Mexico 87109
Subject: Prime farmlands

Marcy Pincus, Environmental Engineer
City of Albuquerque Environmental Health Department
Environmental Services Division
One Civic Plaza NW
Albuquerque, New Mexico 87103
Subject: Water resources, environmental health

Dennis Coleman, Fisheries Biologist
U.S. Fish and Wildlife Service
New Mexico Ecological Services State Office
2105 Osuna Rd. NE
Albuquerque, New Mexico 87113
Subject: Rio Grande silvery minnow, river depletions

Chris Hoagstrom, Fisheries Biologist
U.S. Fish and Wildlife Service
New Mexico Ecological Services State Office
2105 Osuna Rd. NE
Albuquerque, New Mexico 87113
Subject Rio Grande silvery minnow, species distributions

Brian Hanson, Fisheries Biologist
U.S. Fish and Wildlife Service
New Mexico Ecological Services State Office
2105 Osuna Rd. NE
Albuquerque, New Mexico 87113
Subject: Rio Grande silvery minnow, river depletions

Michael Porter; Fisheries Biologist, Certified Fisheries Professional (CFP)
U.S. Bureau of Reclamation
555 Broadway NE
Albuquerque, New Mexico 87102
Subject: Rio Grande silvery minnow, fishway and fish screen design

Anna Maria Muñoz, Wildlife Biologist
U.S. Fish and Wildlife Service
New Mexico Ecological Services State Office
2105 Osuna Rd. NE
Albuquerque, New Mexico 87113
Subject: Fish and wildlife resources

Nic Medley, Fisheries Biologist
New Mexico Interstate Stream Commission
P.O. Box 25102
Santa Fe, New Mexico 87504
Subject: Rio Grande silvery minnow refugia, fishway, habitat needs

Nancy Hanks, Ph.D. Architectural Historian
State of New Mexico, Office of Cultural Affairs
Historic Preservation Division
La Villa Riveria Building
228 East Palace Avenue
Santa Fe, New Mexico 87501
Subject: Historical buildings

James Hare
State of New Mexico, Office of Cultural Affairs
Historic Preservation Division
La Villa Riveria Building
228 East Palace Avenue
Santa Fe, New Mexico 87501
Subject: Historical buildings

Mary Stuever
Bosque Ecological Monitoring Program (BEMP)
Project Coordinator
University of New Mexico
Albuquerque, New Mexico 87131
Subject: BEMP site location

Sterling Grogan
Biologist
Middle Rio Grande Conservancy District
1931 Second St.
Albuquerque, New Mexico 87102
Subject: Mitigation, MRGCD operations

Nancy Umbreit
Biologist
U.S. Bureau of Reclamation
555 Broadway NE
Albuquerque, New Mexico 87102
Subject: Mitigation

Travis Bauer
Engineer
U.S. Bureau of Reclamation
Denver Federal Center
Bldg. 67 – Room 570
POB 25007 (D-8540)
Denver, CO 80225-0007
Subject: Mitigation

Mark Harberg
Chief, Environmental Resources Branch
U.S. Army Corps of Engineers; Albuquerque District
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109
Subject: Mitigation

The following tribes and agencies were contacted regarding the environmental analyses for Indian Trust Assets, tribal cultural resources, and tribal health and safety prepared for this FEIS. As part of its trust responsibility, Reclamation requested government-to-government consultation with Tribes. Correspondence regarding consultation and tribal concerns about the DWP is provided in Appendix F.

Navajo Nation
P.O. Box 9000
Window Rock, AZ 86515

Alamo-Navajo Nation
P.O. Box 827
Magdalena, NM 87825

Ramah Navajo Chapter
Route 2, Box 13
Ramah, NM 87321

Pueblo of Acoma
P.O. Box 309
Acoma, NM 87034

Pueblo of Cochiti
PO Box 70
Cochiti, New Mexico 87072

Pueblo of Isleta
PO Box 1270
Isleta, New Mexico 87022

Pueblo of San Felipe
PO Box 4339
San Felipe Pueblo, New Mexico 97001

Pueblo of Santa Ana
2 Dove Road
Bernalillo, New Mexico 87004

Pueblo of Santo Domingo
PO Box 99
Santo Domingo Pueblo, New Mexico 87052

Pueblo of Sandia
PO Box 6008
Bernalillo, New Mexico 87004

Pueblo of Jemez
PO Box 100
Jemez Pueblo, New Mexico 87024

Pueblo of Laguna
PO Box 194
Laguna, New Mexico 87026

Pueblo of Nambe
Route 1, Box 117-BB
Santa Fe, New Mexico 87501

Pueblo of Pojoaque
Route 11, Box 71
Santa Fe, New Mexico 87501

Pueblo of Picuris
PO Box 127
Penasco, NM 87553

Pueblo of San Ildefonso
Route 5, Box 315A
Santa Fe, New Mexico 87501

Pueblo of San Juan
PO Box 1099
San Juan Pueblo, New Mexico 87566

Pueblo of Santa Clara
PO Box 580
Española, New Mexico 87532

Pueblo of Taos
PO Box 1846
Santa Fe, New Mexico 87571

Pueblo of Tesuque
Route 5, Box 360-T
Santa Fe, New Mexico 87501

Ysleta del Sur Pueblo
PO Box 17579-Ysleta Station
El Paso, Texas 79917

Pueblo of Zia
Capitol Square Drive
Zia Pueblo, New Mexico 87053

Pueblo of Zuni
PO Box 339
Zuni, New Mexico 87327

Southern Ute Tribe
PO Box 737
Ignacio, CO 81137

Ute Mountain Ute Tribe
General Delivery
Towaoc, CO 81334

Jicarilla Apache Nation
PO Box 507
Dulce, NM 87528

Mescalero Apache Tribe
PO Box 2287
Mescalero, NM 88340

Bureau of Indian Affairs, Northern Pueblos Agency
PO Box 4269
Fairview Station
Española, New Mexico 87533

Bureau of Indian Affairs, Southern Pueblos Agency
PO Box 1667
Albuquerque, New Mexico 87103

Bureau of Indian Affairs, Albuquerque Area Office
PO Box 26567
Albuquerque, New Mexico 87125

The following agency was contacted regarding the endangered species consultation for this FEIS. A copy of the letter requesting informal consultation sent to this agency is in Appendix H.

Joy Nicholopoulos, State Supervisor
U.S. Department of Interior, Fish and Wildlife Service
New Mexico Ecological Services State Office
2105 Osuna Road NE
Albuquerque, New Mexico 87113
(505) 346-2525

The following agency was contacted regarding the cultural resources consultation for this FEIS. A copy of consultation correspondence sent to this agency is in Appendix G.

Jan V. Biella, Deputy State Historic Preservation Officer
Office of Cultural Affairs
Historic Preservation Division
228 East Palace Avenue
Santa Fe, New Mexico 87501
(505) 827-4045

4.2 NOTIFICATION

A Notice of Intent to prepare a FEIS was published on September 9, 1999 in the *Federal Register* (Vol. 64). A Notice of Availability was published in the *Federal*

Register announcing the DEIS and public hearings during September 2002. A notice has been published in the *Federal Register* announcing the availability of the FEIS.

4.2.1 Newspaper and Other Notifications

Notification announcements regarding the public scoping meetings for this EIS were placed in the following local newspapers as display advertisements:

- Sunday, September 12, 1999, *Albuquerque Journal*
- Sunday, September 19, 1999, *Albuquerque Journal*
- Wednesday, September 22, 1999, *Albuquerque Journal*
- Sunday, September 19, 1999, *Santa Fe New Mexican*
- Wednesday, September 22, 1999, *Santa Fe New Mexican*
- Sunday, September 26, 1999, *Santa Fe New Mexican*
- Wednesday, September 29, 1999, *Santa Fe New Mexican*
- Thursday, September 16, 1999, *Rio Grande Sun/Española*
- Thursday, September 23, 1999, *Rio Grande Sun/Española*
- Thursday, September 30, 1999, *Rio Grande Sun/Española*
- Saturday, September 11, 1999, *El Defensor Chieftain/Socorro*
- Wednesday, September 15, 1999, *El Defensor Chieftain/Socorro*
- Saturday, September 18, 1999, *El Defensor Chieftain/Socorro*
- Wednesday, September 22, 1999, *El Defensor Chieftain/Socorro*
- Saturday, September 25, 1999, *El Defensor Chieftain/Socorro*

4.3 SCOPING MEETINGS

Prior to the scoping meetings, an Interagency Workshop on the AWRMS Implementation of Proposed Projects and Approach to Environmental Documentation was held on December 3 and 4, 1998 at the Holiday Inn Mountain View in Albuquerque.

Pursuant to NEPA requirements, three public scoping meetings were held in three cities on the Rio Grande.

- The first scoping meeting was held on Thursday, September 23, 1999, from 6:00 to 8:00 p.m. at the East Complex Albuquerque Convention Center, 401 Second Street NW.

- The second public scoping meeting was held on Tuesday, September 28, 1999, from 6:00 to 8:00 p.m. at the Macey Conference Center, on the campus of New Mexico Tech, 801 Leroy Place, Socorro, New Mexico.

- The third public scoping meeting was held on Thursday September 30, 1999, from 6:00 to 8:00 p.m. at the Northern New Mexico Community College, 921 Paseo de Oñate, Española, New Mexico.

The issues identified at the scoping meetings are included in Appendices B through D.

A presentation of diversion alternatives was made at an Alternatives Workshop for Middle Rio Grande regulatory and stakeholder agencies. This meeting was held specifically to present project alternatives. A DWP Alternatives Screening Workshop also was held on Tuesday, March 21, 2000, at the Albuquerque Convention Center, 401 Second Street NW to review the alternatives considered to date, and to screen and select alternatives for consideration in the FEIS (The Hirst Company, 2000).

4.4 PUBLIC MEETINGS ON ALTERNATIVE SELECTION

Five general public meetings/workshops were held in the City of Albuquerque. The purpose of these public meetings was to gain input and comment on the DWP alternatives.

- The first meeting was held on Wednesday, January 21, 2001, at 6:30 p.m. at the West Mesa Community Center, 5500 Glenrio Road NW.

- The second meeting was held on Tuesday, January 30, 2001, at 6:30 p.m. at Mountain View Elementary, 5317 2nd Street NW.

- The third meeting was held on Thursday, February 1, 2001, at 6:30 p.m. at Alameda Community Center, 9800 4th Street.

- The fourth meeting was held on Tuesday, February 6, 2001, at 6:30 p.m. at Highland High School, 4700 Coal Avenue SE.

- The fifth meeting was held on Thursday, February 8, 2001, at 6:30 p.m. at Sandia High School, 7801 Candelaria Road NE.

A preferred alternative workshop was also held. The workshop was held on April 20, 2001 from 7:30 a.m. to 4:00 p.m. at the Albuquerque Convention Center, East Wing. The preferred alternative was presented, and work groups were used to develop mitigation strategies and continue discussion of the preferred alternative.

4.5 AGENCY COORDINATION

Monthly interagency workgroup (IAWG) meetings have been conducted since January 1999 to present and discuss the AWRMS, including the details associated with the DWP. The focus of these IAWG meetings was to provide federal, state, and local agencies with project progress updates on the AWRMS, identify project implementation regulatory and resource issues and identify solutions, and clarify the scope and approach to AWRMS environmental analyses. These IAWG meetings will continue to serve as a primary forum for presenting project concepts and designs, and to receive agency feedback regarding resource issues and concerns.

IAWG meetings are open to all interested parties. In addition, hard copies of agendas and meeting summaries are mailed to agencies upon request. IAWG information has been distributed to representatives of the following agencies:

- Forest Guardians,
- Middle Rio Grande Conservancy District,
- New Mexico Department of Game and Fish,
- New Mexico Energy, Minerals and Natural Resources,
- New Mexico Environment Department,
- New Mexico Interstate Stream Commission,
- New Mexico Office of the State Engineer,
- New Mexico Public Interest and Research Group,
- 1000 Friends of New Mexico,
- Pueblo of Cochiti,
- Pueblo of Isleta,
- Pueblo of Sandia,
- Pueblo of Santa Ana,
- Pueblo of Santo Domingo,
- Rio Grande Restoration,
- Six Middle Rio Grande Basin Pueblos Coalition,
- U.S. Army Corps of Engineers,
- U.S. Bureau of Indian Affairs,
- U.S. Bureau of Reclamation,
- U.S. Fish and Wildlife Service, and
- Consultants representing multiple agencies.

Additional information, including agendas, minutes, and supporting materials from the FEIS Administrative Record, can be obtained for the following IAWG meetings by referencing the listed date and document identification (Doc ID) number:

IAWG Meeting No. 1 – January 12, 1999, Doc ID 1570

IAWG Meeting No. 2 – February 10, 1999, Doc ID 0641

IAWG Meeting No. 3 – March 10, 1999, Doc ID 0925

IAWG Meeting No. 4 – April 12, 1999, Doc ID 1553

IAWG Meeting No. 5 – May 12, 1999, Doc ID 1398

IAWG Meeting No. 6 – June 9, 1999, Doc ID 2489

IAWG Meeting No. 7 – July 14, 1999, Doc ID 1863

IAWG Meeting No. 8 – August 11, 1999, Doc ID 1975

IAWG Meeting No. 9 – September 8, 1999, Doc ID 2087

IAWG Meeting No. 10 – October 13, 1999, Doc ID 4499

IAWG Meeting No. 11 – November 10, 1999, Doc ID 2428

IAWG Meeting No. 12 – January 19, 2000, Doc ID 2816

IAWG Meeting No. 13 – June 21, 2000, Doc ID 2935

IAWG Meeting No. 14 - July 19, 2000, Doc ID 2963

IAWG Meeting No. 15 – September 21, 2000, Doc ID 3026

IAWG Meeting No. 16 – November 15, 2000, Doc ID 3172

IAWG Meeting No. 17 – January 17, 2001, Doc ID 3102

IAWG Meeting No. 18 – March 21, 2001 3173

Two agencies were individually briefed on the City's DWP: the New Mexico State Historic Preservation Society (October 18, 2000) and USACE (October 24, 2000). Briefings included presentation of project history and development and technical aspects of the alternatives to be evaluated within the FEIS.

4.6 PUBLIC INFORMATION

The City maintains a program to keep the public informed regarding planning and implementation of capital works projects. The City uses this public-information program to provide information regarding the status of AWRMS projects and other upcoming activities via the City's website (www.cabq.gov/waterresources), videos, news releases, meetings with stakeholders, Customer Advisory Committee meetings, and City Council meetings.

4.7 CULTURAL RESOURCES CONSULTATION

Reclamation consulted with the SHPO on June 26, 2002 regarding the identification of cultural resources and the effects of the DWP on significant resources (Appendix G). Public scoping meetings have been held (Appendices B, C and D) and tribal consultation has been completed (Appendix F). This consultation has been completed in conformance with the National Historic Preservation Act of 1966. Concurrence was received from the New Mexico State Historical Preservation Officer for the Paseo del Norte Alternative and the Subsurface Alternative on July 26, 2002.

4.8 ENDANGERED SPECIES ACT CONSULTATION

Appendix H contains correspondence related to consultation with USFWS pursuant to the ESA for this project. Reclamation has submitted a Biological Assessment initiating formal consultation with USFWS and the Biological Opinion was issued by USFWS on February 13, 2004.

This Biological Opinion concurred with Reclamation's finding of "may affect, is not likely to adversely affect" for the bald eagle and the flycatcher. In addition, the Service determined that the proposed action "is not likely to jeopardize the continued existence of the silvery minnow, and will not adversely modify its critical habitat." Specific mitigation and conservation measures for the RGSM are detailed within the biological opinion.

4.9 DISTRIBUTION OF THE FEIS

The DEIS was distributed to federal, state, and local agencies; Pueblo governments; stakeholders such as interest groups; and members of the public who requested copies. The distribution of the FEIS is listed in Appendix E.

4.10 PUBLIC HEARING AND RESPONSE TO COMMENTS

Appendix M contains public comments and the response to comments. A 60-day response period was initiated after publication of the DEIS and was further extended to 90 days. Three public hearings were held in September 2002 (Albuquerque, Española, Socorro) in conjunction with the public comment period. A summary of the comments at the public hearings is included within Appendix M.

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SECTION 6

LIST OF PREPARERS

Table 6.1-1 lists the people who were involved in preparing the FEIS for the DWP.

TABLE 6.1-1
INTERDISCIPLINARY NEPA TEAM OF THE ENVIRONMENTAL IMPACT STATEMENT

Name	Highest Degree/ Certification	Project Role	Years of Experience	Background
Department of Interior, Bureau of Reclamation (Lead Federal Agency)				
Marsha Carra	B.S., Anthopology B.S., Geography	Environmental Protection Specialist	15	RCRA, environmental compliance, NEPA
Signa Larralde	Ph.D., Anthropology	Archaeologist	24	Archaeology of the Intermountain West, cultural resources compliance
Lori Robertson	M.A., Biology	Environmental Protection Specialist	17	Aquatic biology, environmental compliance
City of Albuquerque, Public Works Department (Joint Lead Agency and Project Proponent)				
John Stomp	M.S., Civil Engineering; P.E.	Manager, Water Resources Division	13	Water resources, water and wastewater systems
Parsons (NEPA Documentation Consultant)				
Rick Billings	M.S., Fisheries Science	Technical Support and Coordination	21	Remediation, biology
David Connally	M.S., Oceanography; R.E.A., C.E.P.	Technical Support	22	Water resources and water quality
Pat Ditzel		Word Processing	12	Word processing

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INTERDISCIPLINARY NEPA TEAM OF THE ENVIRONMENTAL IMPACT STATEMENT

Name	Highest Degree/ Certification	Project Role	Years of Experience	Background
Kinzie Gordon	B.A., Anthropology	Technical Writing and Editing	27	Environmental science
Lloyd Gronning	M.S., Civil Engineering, M.B.A.; P.E.	Project Manager	28	Water resources, utility management
April Fitzner	M.S., Water Resources	Technical Support	12	Water Resources
Rita Johnson	B.A., Geography	GIS Specialist	7	Environmental science
Lorraine Lucero		Database Management	10	Office administration
John Martin	M.S., Regional Planning	Technical Support	26	Transportation, urban planning
Steve Miller	B.A., Economics	Technical Support	28	Socioeconomics
Patty Phillips	M.S., Plant Ecology	Technical Support	5	Ecology, wildlife biology
Chuck Schultz	M.S., Agricultural Biology	Technical Support	9	Biology, environmental science
John Sigler	Ph.D., Fisheries C.E.P.	Technical Support and Coordination	30	Endangered species, aquatic biology
Debra Simpson	M.S., Mining Engineering	Technical Support	15	Soil, geology
Bruce Snyder	M.S., Wildlife Biology; C.W.B.	Technical Director	30	Wildlife, wetlands, endangered species, impact analysis
Janet Snyder	B.S., Zoology	Technical Writing and Editing	27	Environmental science
Tony St. Clair	B.S., Civil Engineering, P.E.	Technical Support	10	Air quality

TABLE 6.1-1 (Continued)
INTERDISCIPLINARY NEPA TEAM OF THE ENVIRONMENTAL IMPACT STATEMENT

Name	Highest Degree/ Certification	Project Role	Years of Experience	Background
Nicole White-Scott	B.S., Environmental Science	Technical Support	3	Environmental Science
R.C. Wooten	Ph.D., Biology and Ecology	Technical Director	28	NEPA compliance and impact analysis
Ecosystem Management, Inc. (Cultural Resources Consultant)				
Mike Tremble	M.S., Biology	Technical Support	12	Endangered species; wildlife
Dan Wells	B.S., Archaeology	Technical Support	3	Cultural and historical resources
Kenneth Brown	Ph.D., Anthropology	Technical Support	25	Cultural and historical resources
F. Lee Brown (Economic Consultant)				
F. Lee Brown	Ph.D., Economics	Socioeconomics	37	Resource economics, econometrics
Miller Ecological Consultants (Biological Resources Consultant)				
William Miller	Ph.D., Fisheries	Technical Support	25	Aquatic biology, endangered species
CH2M Hill (Engineering Design Consultant/Hydrologic Analysis)				
Michael Bitner	M.S., Hydrology and Water Resource Administration	AWRMS Program Manager	17	Water resources planning and management
Joseph Chwirka	M.S., Civil Engineering, P.E.	Technical Support and Coordination	18	Water and wastewater civil engineering
Gregory Gates	M.S., Environmental Engineering; P.E.	Technical Support	7	Water resources and modeling

**TABLE 6.1-1 (Continued)
INTERDISCIPLINARY NEPA TEAM ENVIRONMENTAL IMPACT STATEMENT**

Name	Highest Degree/ Certification	Project Role	Years of Experience	Background
Walter Hines	M.S., Civil Engineering; P.E.	Technical Support	30	Water and wastewater civil engineering
David Schertler	B.S., Civil Engineering; P.E.	Technical Support	23	Water and wastewater civil engineering
Modrall Sperling Law Firm				
Maria O'Brien	J.D.	NEPA Review	10	NEPA Law

[a/] Abbreviations

AWRMS	Albuquerque Water Resources Management Strategy
B.A.	Bachelor of Arts
B.S.	Bachelor of Science
C.E.P.	Certified Environmental Professional
C.W.B.	Certified Wildlife Biologist
GIS	Geographic Information System
JD	Juris Doctor
M.A.	Master of Arts
M.B.A.	Master of Business Administration
M.S.	Master of Science
NEPA	National Environmental Policy Act
P.E.	Professional Engineer
Ph.D.	Doctor of Philosophy
R.E.A.	Registered Environmental Assessor

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