ATTACHMENT F

Preferred Alternative

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Attachment F

PREFERRED ALTERNATIVE

OVERVIEW

This attachment presents details of the preferred alternative, the San Juan River Public Service of New Mexico (SJRPNM) Alternative. The description of the preferred alternative includes the system's configuration and associated considerations and features, including:

- Water supply and demand
- Physical description
- Water quality and treatment
- Land requirements, damages, and rights-of-way (ROW)
- Cultural resource issues
- Environmental mitigation
- Navajo-Gallup Water Supply Project (proposed project) construction, ownership, and operation, maintenance, and replacement (OM&R) costs
- Economic analysis
- Financial analysis

Figure F-1 is a map of the proposed project area showing project area landmarks and the SJRPNM Alternative facilities. The SJRPNM Alternative would divert water from the San Juan River downstream of Fruitland, New Mexico, just above the existing Public Service Company of New Mexico (PNM) diversion structure, treat the water, and then deliver it along Highway N36 and south to Navajo chapters along U.S. Highway 491 (shown in figure F-2). Water delivery would continue to the Navajo Nation Capital at Window Rock, Arizona, and to the city of Gallup, New Mexico. Another diversion

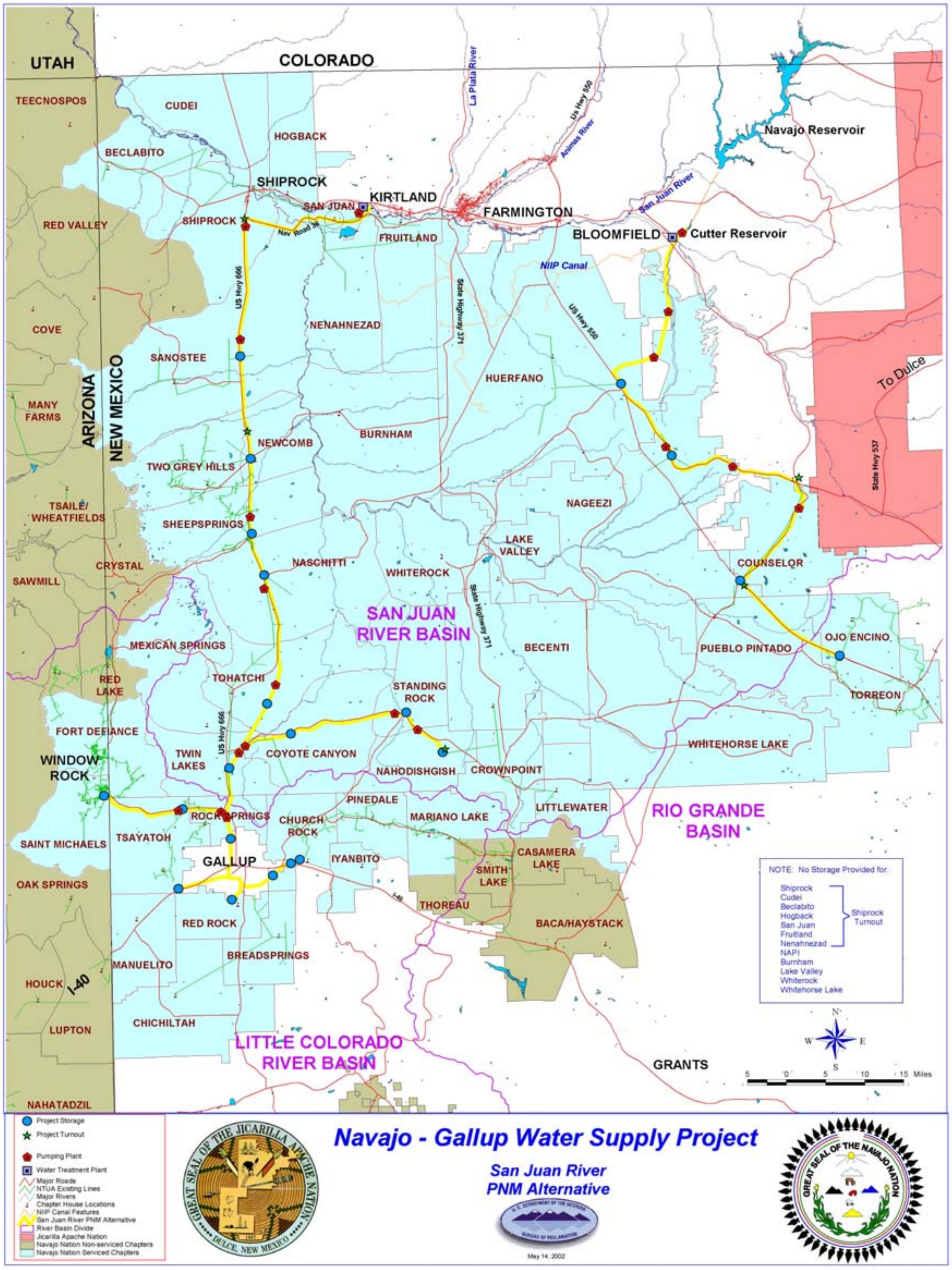

Figure F-1.—SJRPNM Alternative (preferred alternative).

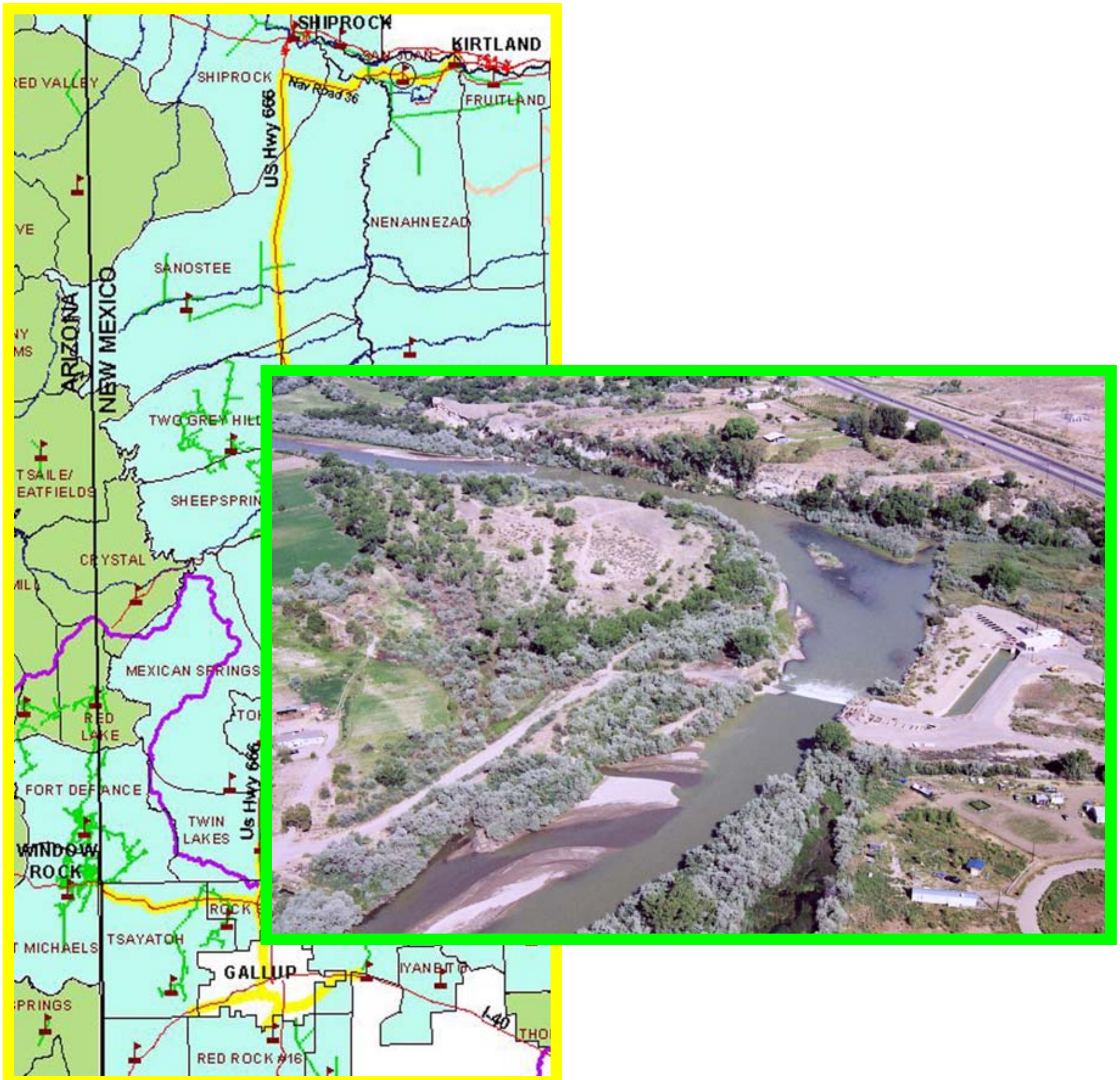

Figure F-2.—PNM diversion dam (project diversion point along the San Juan River).

would occur from Cutter Reservoir (figure F-3), an existing regulating reservoir on the Navajo Indian Irrigation Project (NIIP), conveying water to the eastern portion of the Navajo and the Jicarilla Apache Nations. The water would be provided to Window Rock, Arizona, and Crownpoint, New Mexico, through sublaterals. While basic design components were described in chapter IV, other components specific to the preferred alternative are described in this attachment.

TOTAL PROJECT WATER SUPPLY AND DEMAND

The proposed project is designed to divert a total of 37,764 acre-feet per year (AFY) from the San Juan River with a resulting depletion of 35,893 acre-feet to the San Juan River Basin, based on 2040 projected population with a demand rate of 160 gallons per capita per day (gpcd). The Cutter diversion would require 4,645 AFY with no return flow to the San Juan River. The PNM diversion would take the remaining 33,119 AFY of diversion, with an average return flow of 1,871 AFY. (The planned diversion and depletion by location is shown in table F-1).

It is assumed that the only return flow from the proposed project to the San Juan River would enter the river at the Shiprock waste water treatment plant. There may be some water delivery to users with individual septic systems in the Shiprock area, but the delivery is expected to be a small percentage of the total. All other deliveries would have similar losses, but the resulting return flow would be lost to evaporation or to recharging local groundwater aquifers. For water balance purposes, no return flow to the San Juan River from these other locations is expected or accounted for. Return flow to the Rio Grande or Little Colorado Rivers is highly unlikely, even though there would be discharge to the groundwater in these areas. Local groundwater storage space, together with local pumping, would limit the potential for surface discharge. Even if surface discharge does occur, the distance to the Rio Grande or Little Colorado Rivers is so great that it is unlikely that return flows would reach these rivers.

Deliveries typically vary depending on changes in demand, and the largest demand is in the summer months. The Shiprock water delivery pattern for March 1992 through February 1993, shown in table F-2, was used to determine average monthly deliveries, and return flows were assumed to follow the same distribution. The system would be designed to handle a 7-day peak demand for pumping plants and pipelines and is computed as 1.3 times the peak average monthly demand. Daily and diurnal demand peaking would be handled by the proposed project storage tanks.

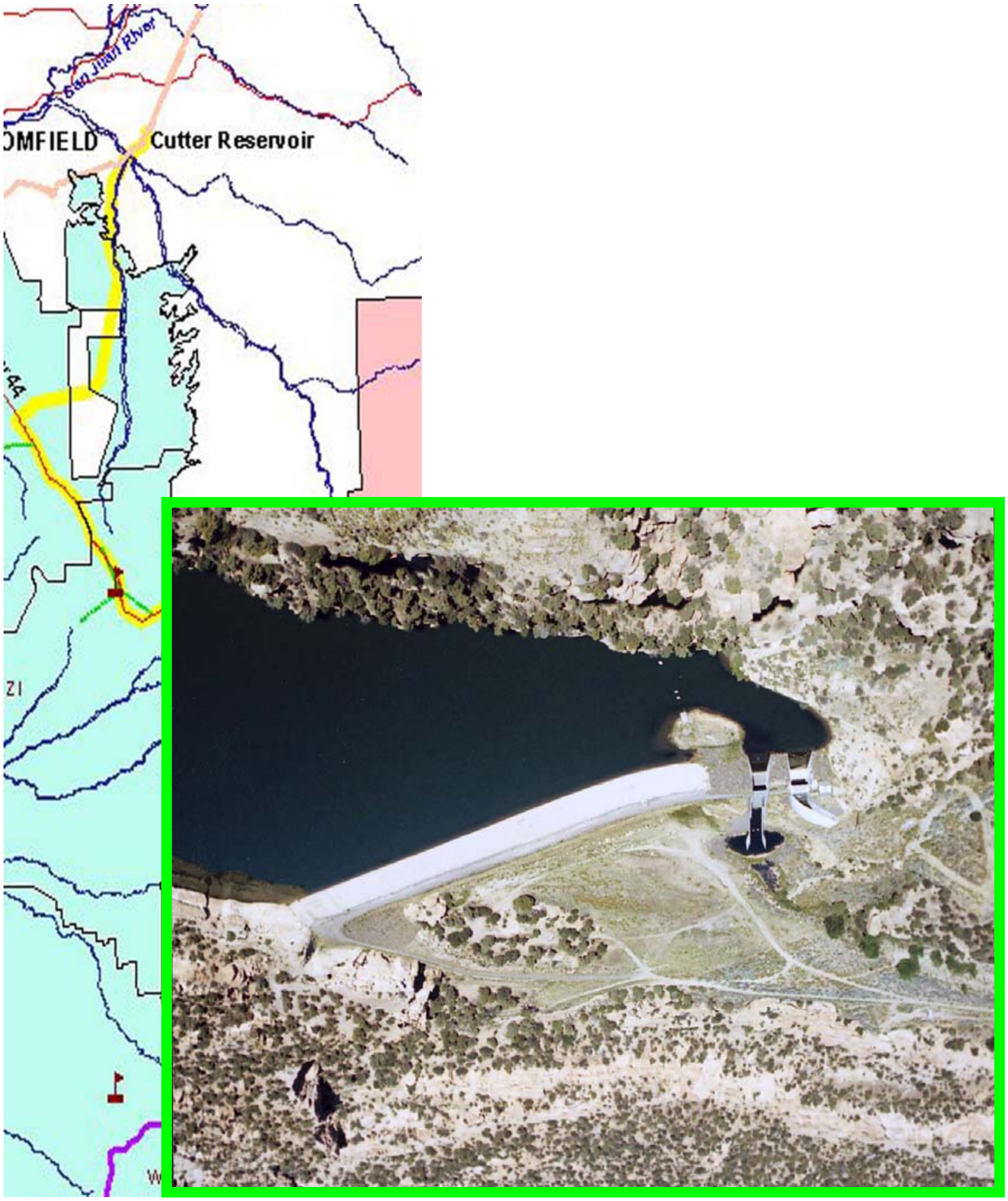

Figure F-3.—Cutter Dam and Reservoir.

Table F-1.—Project forecast 2040 demand and design capacity by service area

Location	San Juan River diversion (AFY)	San Juan River depletion (AFY)
City of Gallup, New Mexico	7,500	7,500
Jicarilla Apache Nation	1,200	1,200
Navajo Nation, New Mexico		
Central area	834	834
Crownpoint	2,473	2,473
Gallup area	4,316	4,316
Huerfano	864	864
Rock Springs	2,118	2,118
Route 491	5,366	5,366
Torreon	2,240	2,240
San Juan River	3,742	1,871
Navajo Agricultural Products Industry industrial uses	700	700
Navajo Nation, Arizona (Window Rock area)	6,411	6,411
Total Navajo Nation	29,064	27,193
Project total	37,764	35,893

Table F-2.—Monthly demand pattern for all deliveries

Month	Percent demand	Month	Percent demand
January	7	July	10
February	6	August	10
March	9	September	10
April	7	October	8
May	9	November	7
June	10	December	7

Navajo Nation

The proposed projected project water need for the Navajo Nation is a total diversion of 29,064 AFY. Of this, 6,411 AFY is for use in the Window Rock area of Arizona and 22,653 AFY is for use in the eastern portion of the reservation in New Mexico. The 22,653 AFY of water would come from Navajo Reservoir (3,445 AFY) through the Cutter diversion and from the San Juan River at the existing PNM diversion dam (19,208 AFY).

Water for the proposed project's New Mexico part of the Navajo Nation (22,653 AFY) would be supplied from New Mexico State Engineer File Nos. 2849 and 3215 held by the Secretary of the Interior (Secretary). This would be administered through a long-term water supply contract between the Bureau of Reclamation (Reclamation) and the Navajo Nation.

Consumptive uses by the Navajo Nation under the proposed project within Arizona in and near Window Rock must be supplied from the apportionments or allocations of water made to the State of Arizona by compact or decree. The *Colorado River System Consumptive Uses and Losses Report*, 1996–2000 (Reclamation, February 2004), estimates that current consumptive uses within the Upper Basin in Arizona amount to about 38,100 AFY. Thus, there appears to be adequate unused apportionment within the 50,000 AFY of Upper Basin consumptive use apportioned to the State of Arizona by article III(a) of the Upper Colorado River Basin Compact to source the Arizona portion of the proposed project. Use of Arizona's Upper Basin apportionment in the Lower Basin in Arizona for the Navajo Nation's project uses in the Window Rock area would be consistent with the provisions of section 303(d) of the Colorado River Basin Project Act and the June 2003 Resolution of the Upper Colorado River Commission consenting to New Mexico's use of its Upper Basin apportionment in the Lower Basin in New Mexico for project uses in Gallup and surrounding areas. The Arizona Water Settlements Act (S 437 – 108th Congress, January 20, 2004, §104, Allocation of the Central Arizona Project) provides that the Secretary is to retain 6,411 acre-feet of water from the Central Arizona Project for a future water rights settlement agreement. The State of Arizona and the Navajo Nation are in the process of determining which State water would be identified and accounted for to supply project demands. A diversion permit from the State of New Mexico would be required to divert water in New Mexico. Permits and/or contracts for using the Arizona water would be required and would be dependent on which source of water is used to supply the proposed project demand.

Jicarilla Apache Nation

The projected project water need for the Jicarilla Apache Nation is a total diversion of 1,200 AFY. All of this water would come from Navajo Reservoir to be supplied from

New Mexico State Engineer File No. 2849. This is part of the water obtained by the Jicarilla Apache Nation through the Jicarilla Apache Nation Apache Tribe Water Right Settlement Act, Public Law 102-441, October 23, 1992. This water would be made available through the existing Settlement Contract between the Jicarilla Apache Nation and the United States.

City of Gallup, New Mexico

The city of Gallup holds no water rights in the San Juan River and would be obtaining a long-term water supply contract for 7,500 AFY of water. The city has requested a water supply contract from Reclamation. As part of water right settlement and trust responsibilities, Reclamation asked the Jicarilla Apache Nation if it would be interested in providing this need with water it holds from its water rights settlement agreement. The Jicarilla Apache Nation was interested and is in the process of discussing terms and conditions of a long-term water contract with the city of Gallup (see attachment C). A long-term water supply subcontract between the city of Gallup and the Jicarilla Apache and/or the Navajo Nation and approved by the United States would consummate this arrangement.

Physical Description

The river intake would divert 33,118 AFY of water from the San Juan River from the water pool created by the existing PNM diversion dam. Water entering the intake would pass through a self-cleaning screen and then enter a sump where low-head pumps would lift the water into settling ponds for removal of suspended sediment. From the settling ponds, the water would enter a water treatment plant to be treated to meet safe drinking water standards. The treatment plant and pumping plant would occupy approximately 18 acres of land on the north side of the river just upstream from the existing PNM diversion dam.

The treated water would be pumped into the San Juan Lateral, a buried pipeline that crosses the San Juan River and ascends a mesa south of the river. Seven relift pumping stations would be constructed along the San Juan Lateral to keep the water flowing in the pipeline. The pipeline would extend south to Ya-ta-hey, New Mexico, and would connect to spur pipelines extending to Window Rock, Arizona; Gallup, New Mexico; and Crown Point, New Mexico. Navajo communities that have an existing water distribution system would have a storage tank and a method to increase (by means of a pumping plant) the pressure for proper distribution. In the city of Gallup, one new pumping plant would be constructed, three pumping plants upgraded, five new storage tanks constructed, and 32 miles of pipeline upgraded. The upgraded Gallup Regional System would be connected to five Navajo Nation water distribution systems on the outskirts of the city.

The Cutter Lateral would be constructed to carry water from Cutter Reservoir (an existing feature of the NIIP) to the eastern portion of the Navajo and Jicarilla Apache Nations. A water treatment plant would be constructed at the base of Cutter Reservoir to deliver treated water to the relift pumps and pipeline that make up Cutter Lateral. Existing Navajo Nation water distribution systems would be connected to the pipeline, and a tee with a blind flange would be provided for a future connection by the Jicarilla Apache Nation. Primary project features and their purposes are shown in table F-3.

Table F-3.—Primary project features and their purposes

Component	Purpose	Total project number
River intakes	Draw water from the San Juan River	1
River pump plants	Pump San Juan River water to treatment plant	1
Treatment plants	Treat water from San Juan River and the NIIP	2
Forebay tanks	Provide water for operation of relift pumping plants	19
Pumping plants	Force water through pipelines	24
Regulating tanks	Moderate fluctuations in system pressures	5
Community storage tanks	Provide for fluctuations in the water users' demands	25
Pipelines	Transmit treated water to point of distribution	266.4 miles

A typical relift pumping plant has a forebay tank, pumps and motors within an enclosed building, an air chamber, and re-chlorination equipment. The forebay tank provides an adequate supply of water to minimize the number of times the pumps cycle on and off. The air chamber provides protection of the pumping plant and pipeline when the pumps are started and stopped. Re-chlorination equipment provides the required chlorine residual in the treated water. The turnout pumping plants have the same components as the relift pumping plants except that a storage tank replaces the forebay tank. Figure F-4 shows a schematic of the proposed project's order of operation.

San Juan Lateral Water Treatment and Pumping Plant

The San Juan Lateral water treatment and pumping plant would include seven ultrafiltration units, seven ultraviolet (UV) disinfection units, a 797,000-gallon water tank, two waste water ponds, two sediment drying beds, mixing and flocculation tanks, chemical storage buildings, an operation and maintenance (O&M) building, a four-unit

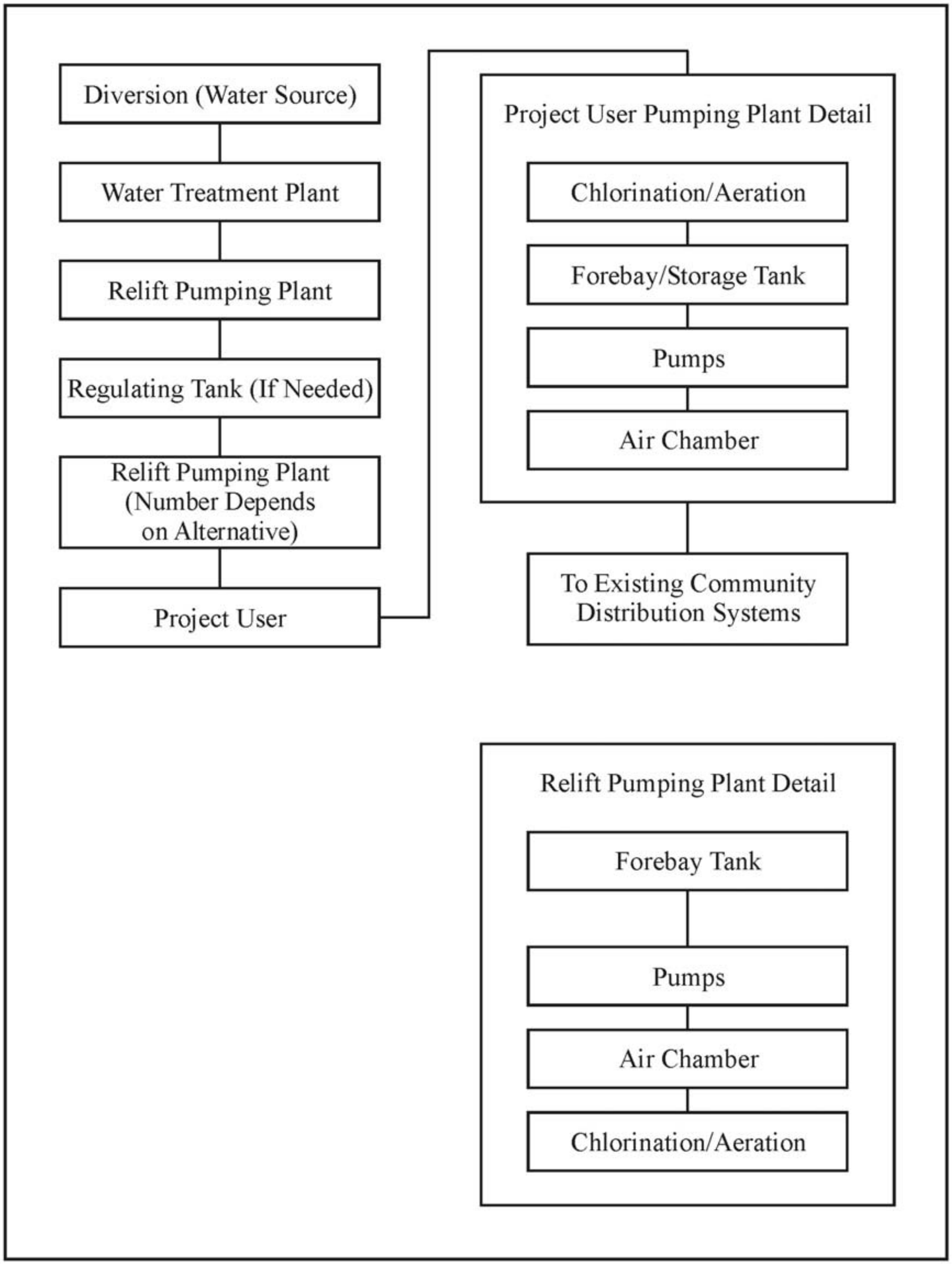

Figure F-4.—Typical schematic for the proposed project.

pumping station, and electrical control equipment. The capacity of the treatment plant would be approximately 38.25 million gallons per day (MGD) of water (59.19 cubic feet per second [cfs]).

The San Juan Lateral pumping plant would pump treated water into approximately 145 miles of buried 12- to 48-inch-diameter pipeline. From the pumping plant, the pipeline would cross the San Juan River upstream of the treatment plant and PNM diversion dam and ascend a mesa south of the river. From the mesa, the pipeline would extend west along the ROW of Navajo Highway 64 to U.S. 491. At U.S. 491, the pipeline would extend south along the highway ROW to Ya-ta-hey, New Mexico. At Ya-ta-hey, the pipeline would connect to spur waterlines extending to Window Rock and the city of Gallup. In the city of Gallup, one new pumping plant would be constructed, and three existing pumping plants, five storage tanks, and 32 miles of pipeline would be upgraded.

Seven booster pumping stations would be constructed along the San Juan Lateral. Each booster pumping station would occupy approximately 1 acre of land and would consist of a water tank, pumping plant, air chamber, chlorination building, and an electrical control structure. The San Juan Lateral would also include the construction of 17 water storage tanks, 3 water regulating tanks, junctions to the existing water supply systems, and a turnout to the NIIP and Navajo Nation chapters that do not have existing water supply systems.

The San Juan Lateral would serve the Shiprock, Burnham, Sanostee, Two Grey Hills, Newcomb, Sheep Springs, Naschitti, Tohatchi, Twin Lakes, and Mexican Springs Chapters. The Crown Point Lateral, which follows Navajo Route 9, would serve the Coyote Canyon, Standing Rock, Nahodishgish, Crown Point, Little Water, Becenti, Lake Valley, and White Rock Chapters. The Window Rock Lateral following Navajo Route 3 would serve the Rock Springs, Tsayatoh, St. Michaels, and Fort Defiance Chapters. The Gallup Junction Lateral would serve the city of Gallup and the Red Rock, Bread Springs, Chichillah, Manuelito, Church Rock, Iyanbito, Pinedale, and Mariano Lake Chapters. The proposed project would also include the construction of a new overhead electrical transmission line that parallels the San Juan Lateral pipeline and would provide power to the booster pumping stations.

The SJRPNM Alternative would also include construction of the Cutter Lateral pipeline. The Cutter Lateral would serve the Huerfano, Nageezi, Counselor, Pueblo Pintado, Ojo Encino, Toreon, and Whitehorse Chapters in the eastern portion of the proposed project area in New Mexico as well as the Jicarilla Apache Nation. The Cutter Lateral would originate at Cutter Reservoir and provide up to 4,645 AFY of water to the eastern service area. This lateral would include a water treatment and pumping plant that occupies approximately 3 to 4 acres of land. The Cutter Lateral water treatment and pumping plant would be smaller than the San Juan Lateral plant, but would contain much of the same equipment. The plant would include three ultrafiltration units, three UV disinfection units, a 112,000-gallon subsurface pumping plant forebay, two waste water ponds, mixing and flocculation tanks, chemical storage buildings, an O&M building, a four-unit pumping station, and electrical control equipment. The capacity of the Cutter Lateral treatment plant would be approximately 5.39 MGD (8.34 cfs).

The Cutter Lateral pumping plant would pump treated water into approximately 89 miles of buried 10- to 24-inch-diameter pipeline. The Cutter Lateral would include the construction of five 1-acre booster pumping stations, three community water storage tanks, and two water regulating tanks. Similar to that of the San Juan Lateral, an overhead electrical transmission line would be constructed along the Cutter Lateral to power the booster pumping stations. A substation would also be constructed to provide power from an existing PNM transmission line to the newly constructed transmission line.

Cutter Dam and Reservoir

The Cutter Lateral would serve communities in the eastern portion of the Navajo and Jicarilla Apache Nations by delivering water from Cutter Reservoir via the outlet works (see figure F-3). Water in Cutter Reservoir comes from Navajo Reservoir through an existing intake structure and a series of tunnels and siphons that would be operated throughout the year under the proposed project. The Cutter water treatment plant would deliver treated water to a pumping plant, which would then pump the water into Cutter Lateral for transmission to the various communities.

Service to Municipal Subareas

The 2040 population of the Navajo communities (1990 population with 2.48 percent annual growth rate) was used with an average daily water demand of 160 gpcd to determine the average daily demand. Surface diversion required for the proposed project was the average demand minus the available groundwater sources in each of the subareas. Supporting information can be found in volume II, appendix A. Peak daily demand was computed by multiplying the surface diversion for the proposed project by a 1.3 peaking factor. The peaking factor was derived from a 7-day average in mid-July. Navajo Nation communities that have an existing water distribution system would have a storage tank and a method to increase (by means of a turnout pumping plant) the pressure for proper distribution. Delivery locations in the transmission line that do not have an existing water distribution system would be provided with a tee and a blind flange for future use. The proposed project would connect to approximately 31 existing Navajo Nation municipal systems and would provide a pressure of 70 pounds per square inch at those locations. The storage capacity for each of the municipal systems was based on the individual service area 5-day demand for the year 2020 for those communities with existing water distribution systems.

The city of Gallup and Jicarilla Apache Nation surface diversion requirements are 7,500 and 1,200 AFY, respectively, for all years in the proposed project. An independent analysis (volume II, appendix B) conducted by the city of Gallup identifies the system requirements for the city and the surrounding Navajo communities served by the Gallup Regional System. No storage is provided for the Jicarilla Apache Nation.

WATER TREATMENT CONSIDERATIONS

Water Quality

Water from the Navajo Indian Irrigation Project

The water source for the Cutter Reservoir diversion is Navajo Reservoir. The water quality parameters, shown in table F-4, indicate that the only treatment requirements are filtration and disinfection as required under the Surface Water Treatment Rule (SWTR), which is part of the Safe Drinking Water Act (SDWA). Further sampling and analysis would be required before final design and construction to verify that the data presented in table F-4 are correct, especially during low- and high-precipitation years.

Table F-4.—Water quality (NIIP source water)

Parameter	Average[1]	Design range	Secondary maximum contaminant level (MCL)[2]
Electrical conductivity (umhos/cm)	195	205-187	
pH	7.72	7.75 – 7.71	
Temperature (degrees Fahrenheit)	46.7	49.1 – 45.3	
Turbidity (NTU)[3]	2.6	3.16 – 1.47	
Total suspended solids (mg/L)[4]	1.15	1.3 – 1	
Total dissolved solids (mg/L)	154	181 – 140	500
Sulfates, SO_4 (mg/L)	32.5	38.2 – 2.29	250
Total organic carbon (mg/L)	4.47	8 – 2.29	
Chlorides (mg/L)	1.6	1.9 – 1.2	250

[1] Data from three samples collected from the Cutter diversion April 2000 to June 2000.
[2] Secondary standards for MCLs are established by the Environmental Protection Agency for control of aesthetic qualities relating to public acceptance and include contaminants that may affect taste, color, odor, and appearance.
[3] Nestler Turbidity Units.
[4] Milligrams per liter.

San Juan River Diversion

The San Juan River, upstream of the PNM diversion, would provide water to the SJRPNM water treatment plant. Table F-5 provides water quality parameters. As shown, the water quality meets all primary standards established by the Environmental Protection Agency (EPA) for the parameters shown, resulting in the need for filtration and disinfection to meet the requirements of the SWTR. Several samples exceeded the total dissolved solids (TDS) and sulfates secondary standards. Sulfates and TDS are constituents that cannot be substantially reduced by the proposed ultrafiltration system. Further investigation is required to confirm the reduction of water quality due to the increase of TDS and sulfates associated with storm water runoff flows at the SJRPNM diversion points. Since this water cannot be treated by the proposed system, the following operation scenarios are suggested during major runoff events:

Table F-5.—Water quality (San Juan alternatives)

	PNM historic[1]		**Design**[2]	
Parameters	**Average**	**Range**	**Range**	**Secondary maximum contaminant level (MCL)**[3]
EC (umhos/cm)	538	1,102 – 276	632 – 214	
pH	8.1	8.7 – 7.7	8.7 – 7.6.	
Temperature (degrees Fahrenheit)	53	71 – 32.2	75 – 33	
Turbidity (NTU)[4]	166	1055 – 8	200 – 5.4[5]	
Total suspended solids (mg/L)[6]	876.6	1080 – 21	262 – 21	
TDS (mg/L)	362	772 – 145	1000 – 24	500[7]
SO_4 (mg/L)	140	322 – 65	200 – 38	250
TOC (mg/L)	5.7	10.5 – 2.9	4.76 – 2.89	
Chloride (mg/L)	14	23 – 6	26.6 – 2.91	250
T. hardness (mg/L)	163	232 – 84	232 – 84	

[1] Data for PNM is based on 34 samples collected at the diversion point between February 2003 through July 1, 2005.

[2] Design value for total suspended solids incorporates the reduction of turbidity and suspended solids by the pre-treatment settling pond.

[3] Secondary standards for MCLs are established by EPA for control of aesthetic qualities relating to public acceptance and include contaminants that may affect taste, color, odor, and appearance.

[4] Nestler Turbidity Units.

[5] All source water with a turbidity of over 200 NTU will need to be pre-treated by diversion through the settling ponds.

[6] Milligrams per liter.

[7] State of New Mexico secondary MCL for TDS is 1,000 mg/L.

Water hauling is necessary for a quality water supply
in parts of the Navajo Nation.

- Significant dilution may be provided in the SJRPNM settling ponds to reduce TDS and sulfate concentrations to below maximum contaminant level (MCL) limits.

- Storage capacity in the settling ponds, waste water polishing ponds, and treated water distribution system may be adequate to temporarily stop diverting water from the San Juan River to the treatment plant during large storm events. Once the concentrations of TDS at the diversion intakes are below 500 parts per million (ppm) TDS and 250 ppm sulfate, diversion of San Juan River water can resume.

Water Treatment

The water source for the SJRPNM Alternative is surface water from the NIIP and the San Juan River. The treatment systems used to provide drinking water to the consumers must comply with the SWTR.[1] The filtration and disinfection requirements under this rule protect consumers against the potential adverse effects of exposure to Giardia lamblia, Cryptosporidium, viruses, Legionella, and heterotrophic bacteria by requiring the inactivation of 99.9 percent (3 log) for Giardia cysts and 99.99 percent (4 log) for viruses.

The inactivation of potential pathogens, as required by the SWTR, is accomplished by the use of EPA-approved technologies for filtration and disinfection methods. Newly adopted regulations to address the risk of disinfection byproducts (DBPs) include the Disinfectants - Disinfection Byproducts Rule and the Interim Enhanced Surface Water Treatment Rule, which requires continual monitoring of filtered water turbidity and routine DBP levels in the distribution system.

The relatively high concentrations of total organic carbons (TOC) in samples from the NIIP and San Juan River water sources, as shown in tables F-4 and F-5, in combination with the long detention times required to convey the treated water to some of the delivery points, indicate a potential for the production of DBPs that may exceed current and future regulatory limits at the treated water service points or within the domestic water storage and distributions systems used to distribute the water to consumers. In order to determine the expected reduction in TOC concentrations by the proposed treatment system and the potential of DBPs production over time, bench-scale distribution simulation studies using chloramine and free chlorine disinfection should be done. If bench scale analysis indicates that the DBP limits are exceeded, additional treatment systems to remove the DBPs before consumption may be required in some locations.

Description of the Proposed Water Treatment System

The proposed water treatment system consists of enhanced coagulation, ultrafiltration, and ultraviolet disinfection to provide multiple treatment barriers for removal of organic molecules, Giardia, Cryptosporidium, and viruses. The use of chloramines to provide a disinfection residual during the conveyance of treated water from the treatment plant to the service areas will not only provide treated water that is not conducive to the formation of disinfection byproducts, but will also provide an additional disinfection barrier. Figure F-5 illustrates the proposal. Before final design and construction, a

[1] The SWTR was published in the *Federal Register* on June 29, 1989, and is promulgated by EPA as a National Primary Drinking Water Regulation for public water systems using surface water sources or groundwater under the direct influence of surface water.

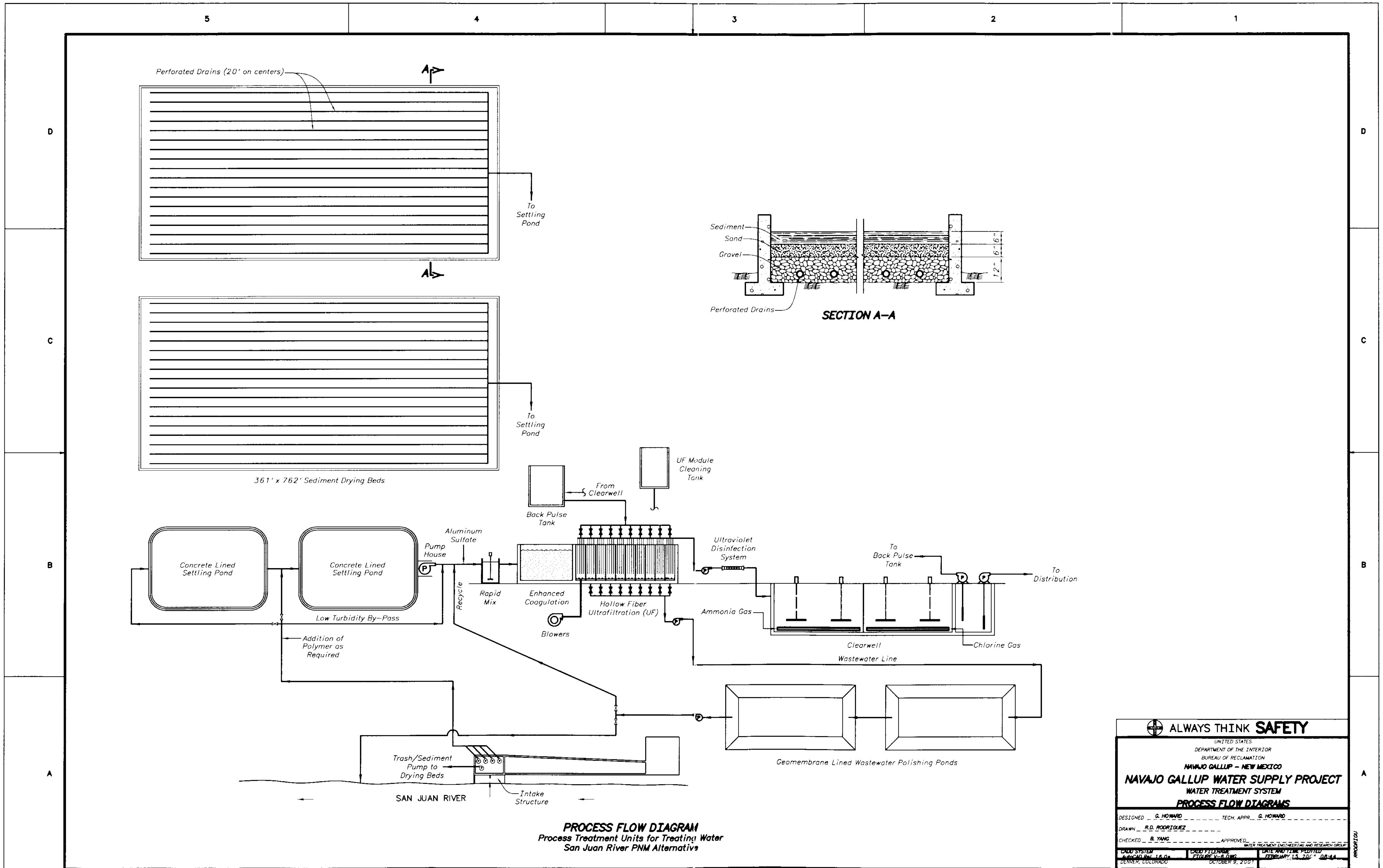
Perforated Drains (20' on centers)
To Settling Pond
To Settling Pond
361' x 762' Sediment Drying Beds
Sediment
Sand
Gravel
Perforated Drains
6"
6"
12"
SECTION A–A
UF Module Cleaning Tank
Back Pulse Tank
From Clearwell
Concrete Lined Settling Pond
Concrete Lined Settling Pond
Pump House
Aluminum Sulfate
Recycle
Rapid Mix
Enhanced Coagulation
Hollow Fiber Ultrafiltration (UF)
Blowers
Ultraviolet Disinfection System
To Back Pulse Tank
To Distribution
Ammonia Gas
Clearwell
Chlorine Gas
Wastewater Line
Low Turbidity By–Pass
Addition of Polymer as Required
Geomembrane Lined Wastewater Polishing Ponds
Trash/Sediment Pump to Drying Beds
SAN JUAN RIVER
Intake Structure
PROCESS FLOW DIAGRAM
Process Treatment Units for Treating Water
San Juan River PNM Alternative
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO
NAVAJO GALLUP WATER SUPPLY PROJECT
WATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAMS
DESIGNED G. HOWARD
TECH. APPR. G. HOWARD
DRAWN R.D. RODRIGUEZ
CHECKED B. YANG
APPROVED
WATER TREATMENT ENGINEERING AND RESEARCH GROUP
CADD SYSTEM
CADD FILENAME
DATE AND TIME PLOTTED
DENVER, COLORADO
OCTOBER 9, 2001
RRODRIGU

Figure F-5

comprehensive pilot-scale operation of each process will be required to verify the effectiveness and operation of each unit process and resultant water quality.

Water Treatment Plants.—The proposed water treatment plants primarily include buildings that would house most of the water treatment features already described. Figure F-5 displays the water treatment plant structures (all plant structures, except intakes, must be located above the 100-year flood plain).

Main Treatment Building – The main treatment building would be approximately 24,500 square feet with a second floor mezzanine that would be approximately 22 feet wide and 122 feet long. The proposed building would be a pre-engineered, pre-fabricated structure with metal siding and suitable insulation and ventilation to meet the building code requirements of the State of New Mexico and all other applicable code requirements. The building would house the 10-foot-tall flocculation basins, 10-foot-tall concrete tanks containing the ultrafiltration modules for each train, UV units, vacuum pumps, and internal piping. The second floor mezzanine would contain the control room for the filters and UV units, air blowers used for module cleaning, and the motor control center. The chlorine storage room and ammonia storage room would be included in the main building, but would have outside entrances and separate heating, ventilation, and air conditioning (HVAC) systems to eliminate the risk to the operators if leakage occurred in any of the cylinders. The building is designed to house the treatment system required to meet 2040 demands.

The chlorine and ammonia storage room would house the 1-ton containers of each gas along with the chlorinators and ammoniators, which would meter the gases into the clear well for mixing. Trunnions are provided in the storage room to provide for the storage of full containers to meet a 2-month demand along with spare trunnions for storage of an equal amount of empty or full containers.

NIIP Cutter Diversion Treatment Plant – The Cutter diversion water treatment plant is a scaled-down version of the main treatment plant, with a building area of approximately 4,600 square feet. Like the larger plant, the flocculation basins would be located inside the building to protect the water from windblown sand and freezing temperatures. Due to its reduced size, all treatment components for the Cutter treatment plant would be located on a single floor.

Regional O&M Buildings – The preferred alternative (SJRPNM) includes a 2,500-square-foot regional O&M building located within the treatment plant compound. Buildings would be on a slab on grade with 15-foot eave heights. The facility would be used for spare equipment/parts storage and for maintenance areas relating to the treatment, conveyance, and pumping of water for the proposed project.

Clear Well – The below-grade clear well would provide a detention time of 30 minutes and would include injection manifolds, baffles, and mixers to properly mix ammonia and chlorine with treated water. After chloramination, the treated water would be pumped by the service pumping station into the distribution system.

Waste Water Storage/Treatment Ponds – Water generated during the routine cleaning of the filters would flow into one of two passive treatment ponds. In these ponds, fine suspended solids filtered by the hollow fiber system would be settled out and removed from the site. After passive treatment, the water could be conveyed back into the treatment plant, discharged back into the source, or discharged to surface waters. The useful life of a pond is estimated to be between 10 to 15 years before settled sediment would need to be removed and conveyed to the sediment drying beds. Each pond would be lined with a 45-mil-thick geomembrane system to reduce the impact on regional groundwater.

Sediment Drying Beds – With the construction of a new diversion upstream from the existing PNM diversion dam, all sediment removed by the intake structure and settling ponds would have to be retained and ultimately disposed of off-site. The determination of the frequency of pond cleaning, volume of sediment, volume of dried sediment, size of required sediment drying beds, and resulting O&M costs in this report was based on one water quality sample taken during one storm event. This event occurred on August 23, 2000, and analyses indicated a turbidity reading over 23,000 Nestler Turbidity Units (NTU) units and a suspended solids loading of over 15,000 milligrams per liter (mg/L). The drying bed size and costs should be taken as preliminary because additional sampling and analyses would be required prior to design and construction. Using this data point, the lead pond would need to be dredged of sediment after every 10 days of storm runoff, and two sediment drying beds with a surface area of approximately 6 acres each would be required. When the sediment in the 10-foot-deep lead pond became 2 feet deep, approximately 130,000 cubic feet of sediment would need to be removed and placed on one of the drying beds. The excavated sediment would be applied at an approximate depth of 6 inches on the surface of each bed.[2] The system would remove water from the sediment by drainage and evaporation, reducing the water content by approximately 50 percent with a dried sediment depth of 2.5 to 3 inches. Once dried, the sludge would be removed from the top of each bed and transported to a nearby abandoned open pit coal mine for final disposal. O&M costs associated with excavation and transport of sediment collected from the settling ponds are based on two cleaning cycles per year.

Sediment Removal Ponds – The settling basins considered in this alternative are required to reduce turbidity of the San Juan River water before treatment. Most of the

[2] Beds consist of perforated polyvinyl chloride pipes located in a gravel under-drain system. Sand would lie on top of the gravel.

sediment contained in the source water would be removed by the intake and the proposed settling ponds. Each pond is designed with a 3-hour detention time, providing optimum conditions for the reduction of turbidity to acceptable limits before treatment by the enhanced coagulation and ultrafiltration systems. Settling tests using San Juan River water (collected during a high turbidity of 4,266 NTU) have verified that a two-pond system with each pond to provide a detention time of 3 hours would be sufficient to reduce turbidity to acceptable limits before treatment. The settling basins would have minimal effects on the quality of the water, with the exception of some dilution of high TDS and sulfate concentrations occurring during high runoff conditions. To reduce the impact of the ponds on regional groundwater through infiltration, and to avoid the need to replace the liner after each sediment removal event, each pond would be lined with 6 inches of reinforced concrete. The settling pond(s), sized to meet the hydraulic requirements for the demand year 2040, are based on a 6-hour detention time and have the following specifications:

- Influent flow rate of 38.25 MGD
- A required volume of 9,653,000 gallons in settling pond(s)
- A surface area of 1.72 acres with a 10-foot depth and 1:1 side slopes

Source water from the NIIP would not require settling basins because the water would have already passed through a large surface impoundment that acts like a settling basin.

Enhanced Coagulation – In waters that have variable annual turbidity or moderate-to-high TOC concentrations, ultrafiltration systems typically include an enhanced coagulation step prior to filtration to coagulate small suspended materials in the water and to increase the filtration efficiency. This process increases the removal of organic matter before disinfection to meet the requirements of the Stage 1 and Stage 2 DPB Rule. This pre-treatment process uses aluminum sulfate or other coagulants in such a manner that the type and dosage can only be determined by laboratory and field tests (assuming aluminum sulfate would be the coagulant of choice and the required concentration would be 30 mg/L).

Hollow Fiber Ultrafiltration Treatment System – Previous studies have evaluated the potential for using conventional, diatomaceous earth and microfiltration/ultrafiltration for the treatment of surface waters associated with this project. A discussion of these studies is included in volume II, appendix A, section 8.5. Based on this analysis, ultrafiltration using hollow fiber membranes along with enhanced coagulation is the proposed method for filtration because the system is (1) able to treat water with varying turbidity, (2) able to meet current and future regulatory standards, and (3) easy to operate and maintain.

The hollow fiber ultrafiltration treatment system physically removes suspended particles greater than 0.1 micron in diameter by having a nominal and absolute pore size of 0.035 and 0.1 micron, respectively. Particles found in surface water that exceed this size range are easily filtered. These particles include Giardia (5–15 microns in size), Cryptosporidium (4–6 microns in size), large viruses, and large organic molecules. The continuous hollow fiber ultrafiltration system manufactured by US Filter (CMF-S) or Zenon (ZeeWeed) are bundles or cassettes of tubular membranes that filter water through microscopic holes. Designed for large-scale systems, the pre-engineered cassettes are submerged into open-top concrete or steel tanks.

Ultraviolet Disinfection Units – Disinfection after ultrafiltration would be accomplished by state-of-the-art flow-through UV disinfection units that are located on the filtered water discharge line from each ultrafiltration treatment train. Each unit would consist of a stainless steel chamber containing eight UV lamps, an automatic cleaning system, a UV monitoring system, and a control cabinet. Each unit would provide a minimum UV dose of 40 microjewels per square centimeter to the filtered water before being routed to the clear well.

The proposed UV units would add an additional 3 log (99.9 percent) reduction of Giardia and Cryptosporidium and an additional 4 log (99.99 percent) reduction in viruses to the water following the ultrafiltration process. Based on this information, the unit processes of ultrafiltration and UV disinfection would provide a reduction of 9 log for Giardia and Cryptosporidium and 6 log for viruses. This reduction would far exceed the SDWA requirements.

Chloramination – The mixing of filtered and disinfected water with ammonia gas followed by chlorine gas in the clear well would provide a chloramine residual prior to being pumped by the service water pumping plant into the treated water mains leading to the service areas. This form of residual is being used to reduce the development of DBPs that would be generated by extended contact times in the conveyance and storage facilities if a free chlorine residual were used. Other benefits of a chloramine residual include prevention of taste and odor problems and the fact that the chloramine residual would last longer in the treated water transmission line and storage system, thus eliminating the number of re-chloramination stations (Reclamation, 2002).

Other Treatment Components.—

Chloramine Booster Stations – Each pumping plant would contain a chloramine booster station that would monitor the chloramine residual of the incoming water and automatically add, as required, additional chlorine to maintain the 0.5 ppm residual to the water being pumped by the plant. The capital and O&M costs of these re-chloramination systems are included as part of the unlisted items in the water treatment cost estimate.

Water Blending – Blending of good water quality produced by the proposed surface water treatment plants with low quality groundwater presently used by the city of Gallup and many of the Navajo Nation communities may increase turbidity in the mixed water.

Increased turbidity, a secondary MCL, in the blended water would decrease the aesthetic quality of the water. In order to predict and compensate for any reactions, a detailed water quality analysis for each well system is required. These data would then be used in the "Rothberg, Tamburnini & Windsor Model for Corrosion Control and Process Chemistry" or a similar model to predict turbidity formation. If the modeling determines chemical addition(s) are required to eliminate the formation of turbidity, followup laboratory verification is required. In order to provide funding for modeling and potential chemical injection systems, a 10-percent unlisted additive is included in the capital cost for each treatment system and each demand. To account for potential O&M costs of these systems, a 10-percent miscellaneous additive is provided.

Disinfection Byproduct Treatment – Included in the unlisted percentage in the capital cost for each alternative is funding for the installation of aeration systems and re-chlorination systems at each service point to remove DBPs that may be created during conveyance.

Pilot Plant Operation – Prior to final design of the selected alternative, a pilot study using the proposed treatment system would be required to optimize each treatment process and collect design data. The pilot plant should operate 24 hours a day over a minimum of 12 consecutive months to determine treatment requirements with changing water conditions. A line item providing a sum of $200,000 to fund the pilot study is included in the capital cost. The study would provide or determine:

- The most efficient chemical to use for coagulation
- Chemical injection rates based on changing water quality
- Backwash requirements and membrane cleaning requirements
- Waste water quality and production rates
- The potential for DBP formation during conveyance
- Operation requirements
- The ability of the treatment system to meet current and future regulatory standards
- Data to update capital and O&M costs
- Training for future operators on the full-scale treatment system

Operation.—The overall operational system would monitor the demands in the treated water distribution system and activate/deactivate the treatment system to maintain required water levels or pressures in the treated water storage tanks. When in operation, the water treatment system master control panel would control the local control panels (LCP) for each treatment process. During automatic operation, the water treatment master control system monitors all LCPs and provides inputs for adjustments for optimal treatment efficiency. Operators would be required to monitor operations 24 hours a day, along with routine duties such as calibrations of turbidity meters, chemical injection equipment, residual monitors, inventory control, and monthly reports. This control system would be integrated into the overall project control system.

Plant Operators.—Plant operation for all treatment plants and all demands would require a total staff of six personnel (four operators, one maintenance person, and one supervisor). The staff would ensure that at least one operator was at the plant during operation with suitable maintenance and supervisory support.

Chemicals.—Chemicals required include those for routine cleaning of the hollow fiber membranes, aluminum sulfate to flocculate the small suspended particles in the source water, and chlorine and ammonia gas to form a chloramine residual to keep the water disinfected during its transport from the treatment plants to service.

Power.—The annual cost for power to operate each plant would include power to operate vacuum pumps, air compressors, UV disinfection units, low-head lift pumps, lights, and HVAC units and a percentage increase for other loads required for operation of a large water treatment facility. For the Cutter diversion, a low lift pump would divert water from the waste water polishing ponds to the plant influent for recycling. Three low-head lift stations would be required for the SJRPNM component—one to transfer water from the river diversion to the settling ponds, one to transfer water from the settling ponds to the water treatment plant, and one to recycle water from the waste water ponds to the water treatment plant. To provide uninterrupted treated water, the New Mexico Environmental Department requires backup generators to be provided for all potable water treatment plants. These generators need to be rated to meet the power requirements during the average daily flow or 70 percent of the design flow.

Replacement of Equipment.—Annualized equipment replacement costs include annual replacement of UV light bulbs, the replacement of all hollow fiber cassettes every 10 years, and the replacement of mechanical equipment every 15 years. Details on the annualized cost of each are provided in volume II, appendix B.

Dredging and Disposing of Sediment.—When the settling and waste water polishing ponds contain a maximum of 2 to 3 feet of sediment, a dragline would be used to remove the sediment in the SJRPNM settling pond and each of the waste water polishing ponds. The sediment would be dried on the sand drying beds and, when dry, would be transported off-site for disposal. The estimated frequency for dredging and disposing of sediment is every 10 days of storm runoff for the SJRPNM lead settling pond and every 15 years for the waste water polishing pond.

PROJECT LAND, RIGHTS-OF-WAY, RELOCATIONS, AND DAMAGES

The proposed pipeline corridor needs a 60-foot-wide permanent ROW and a 150-foot temporary ROW (the total length of the pipeline is approximately 262 miles). Of this corridor, 8 percent is allotted Navajo Land, and 57 percent is Navajo Reservation Fee and Trust Land. The remainder is divided among a number of State, Federal, and private ownerships. The distribution of the land status is shown in table F-6. Existing utility ROW will be used where possible.

Table F-6.—Land status of the Navajo-Gallup water supply pipeline

Land status	San Juan River Alternative (miles)
Main Navajo Reservation	126
Checkerboard area	
Bureau of Land Management	39
Indian allotment	22
Navajo Fee land	11
Navajo Trust land	12
Private	36
State	13
Other	4
Total	262

The Navajo Nation Department of Natural Resources recommended that project parameters assume that the ROW within the Navajo Nation would be donated with no direct cost. Damages and necessary relocations associated with facility construction would be a project cost. It is also assumed that there would be no direct project costs for ROW on Federal and State land. The Navajo Nation requires that an appraisal of the proposed ROW be conducted. This evaluation is based on the beneficial use of the land and the value of the product in the pipeline. The fair market value of the corridor through the allotted land is between $240,000 and $480,000, and the fair market value of the corridor through Tribal Trust Land is between $14.1 and $23.5 million.

Pipeline construction.

As described in the Code of Federal Regulations 25 Part 169 – Rights-Of-Way Over Indian Lands, the Bureau of Indian Affairs (BIA) has a multi-step process for establishing ROWs across Trust Land (information on the specific procedures is available from BIA). Depending on the number of Indian land allotments crossed by the proposed project corridor, the ROW procedures may be complicated. The land affected must be appraised, the individual allotment owners must be contacted and informed, and consents for the proposed project must be obtained. This process could take 18 months or longer. The cost of this process is included in the non-contract costs associated with the proposed project.

Depending on the specific pipeline location, approximately 36 miles of the alignment could be on private land. It is assumed that there would be no direct project cost for obtaining this ROW.

The water treatment plant at the San Juan River diversion is to be located on private land. A 20-acre piece of land would be required. Six families will be re-located and their houses and land purchased at fair market value.

Cultural Resources

Although the SJRPNM Alternative is decidedly less impacting to cultural resources than the NIIP alternatives, significant impacts would result from the proposed project. An analysis predicts that approximately104 historic properties would exist in the Area of Potential Effects of the preferred alternative. Of the 104 properties, it is anticipated that approximately 83 of them would require some level of mitigative treatment—either archeological testing or full data recovery. The contract costs for performing such work (as estimated in December 2002) are estimated at $5.7 million. Other cultural resource costs include ethnographic investigations; identification and evaluation of in-use areas; non-contract (administrative) costs; consultation with Navajo Nation chapters and State, Tribal, and Federal entities; Native American Graves and Repatriation Act repatriation; unanticipated contingencies; and museum curation of cultural materials. Therefore, the total cost of a cultural resources program is estimated to be a maximum of 4% of the total project cost, $34.5 million (based on January 2007 prices). Other projects in the region, the Dolores and Animas LaPlata Projects, have needed this level of cultural resource program funding.

Environmental Mitigation

The construction of the proposed project diversion, treatment plant, pumping plant, and pipeline within the San Juan River Valley would impact approximately 25 acres of riparian and wetland area. Assuming a 3:1 mitigation ratio, 75 acres of similar adjacent land would be purchased or a permanent ROW obtained. This land's riparian and wetland characteristics would be enhanced through land management (i.e., fencing, grading, weed control, and planting vegetation).

Construction of the proposed project pumping plants and storage tanks along the pipeline would impact approximately 50 acres. It is anticipated that an equal number of adjacent lands would be improved through range enhancement (i.e., fencing, seeding, and constructing wildlife watering stations). Construction of the Cutter Lateral treatment plant and pumping plant would impact approximately 10 acres. It is anticipated that an equal number of adjacent lands would be improved through seeding, fertilizing, and mulching. Pipeline construction would impact an area up to 300 feet wide along the pipeline alignment. It is anticipated that this area would be re-seeded, fertilized, and mulched to restore the vegetation. This re-seeding would occur as sections of the pipeline are constructed.

CAPITAL AND OM&R

Project Construction, Ownership, and OM&R

Project facilities would be constructed through Reclamation. Ownership of all of the proposed project facilities would remain with Reclamation until a point in the future when the Navajo Nation and the city of Gallup would be capable, by mutual agreement, of taking over ownership. Until facilities are transferred from Reclamation, project OM&R would be the responsibility of Reclamation through contract to the Navajo Tribal Utility Authority (NTUA) and the city of Gallup. The costs of OM&R would be paid by the NTUA and the city. This arrangement would be detailed in an agreement among the entities. It is anticipated that the entire project's ownership and OM&R responsibility would be transferred to the Navajo Nation and the city of Gallup. The Jicarilla Apache Nation would pay its share of the project's OM&R costs and be party to all agreements pertaining to this proposed project's ownership and OM&R.

The appraisal design and construction cost estimate was provided by Reclamation's Denver Technical Service Center (TSC). This information was documented in the *Appraisal Level Designs and Cost Estimates Report*, April 2002 (volume II, appendix B). A peer review of the designs and cost estimates was performed by Boyle Engineering Corporation in February 2004. Based on results from this review and using current unit costs of materials, the TSC revised the proposed project construction cost estimate in April 2007. A summary of this April 2007 cost estimate is shown in table F-7 (based on January 2007 dollars).

Reclamation historically supports projects for construction after a feasibility report is completed, which includes a feasibility-level cost estimate. This appraisal-level cost estimate does not meet that requirement. Additional analysis, detail, and updates of the appraisal-level cost estimates presented in this draft report are needed before project construction authorization can be supported. Failure to complete this additional effort may result in reliance on a cost estimate for the proposed project that is not sufficient to characterize the expected cost. The appraisal-level design must be upgraded to feasibility level before Reclamation would begin construction. The cost of, and time for, completing this additional work would be substantial.

OM&R costs include electrical power, chemicals for water treatment, repair and replacement of components of the facilities, and personnel required to operate the system. Power costs were calculated using the January 2007 costs from the local power provider, NTUA, and the Colorado River Storage Project (CRSP). This analysis also included estimating the cost using power from the CRSP, and the economic analysis used NTUA and CRSP power rates for comparison purposes. Table F-8 details the OM&R costs.

Table F-7.—Preferred alternative cost estimate

Feature	Reclamation April 2007 cost estimate ($)
Pipelines	202,546,620
Pumping plants	28,355,000
Water treatment plants	53,673,055
Tanks and air chambers	85,575,000
Transmission lines	26,677,200
Turnout structure	1,707,380
Gallup Regional System	25,754,500
Subtotal	424,288,755
Mobilization (5%)	21,000,000
Unlisted items (10%)	44,711,245
Subtotal	490,000,000
Contingencies (22.5%)	110,000,000
Subtotal (field costs)	600,000,000
Noncontract costs (27%)	162,000,000
Subtotal	762,000,000
New Mexico taxes on field costs (estimated at 6%)	36,000,000
Navajo Nation taxes on field costs, excluding Gallup Regional System field cost of $30 million (estimated at 3%)	16,900,000
Subtotal	814,900,000
Land, relocation, and damage[1]	9,000,000
Cultural resource mitigation	34,500,000
Environmental mitigation	6,000,000
Total project cost	864,400,000

[1] The estimate includes ROW costs for the San Juan treatment plant only. Should it be determined that ROW for the rest of the features needs to be included in the project costs, an additional $30–60 million should be added.

Table F-8.—Yearly OM&R costs ($) (SJRPNM Alternative)

Item	San Juan Lateral	Cutter Lateral	Gallup Regional System
NTUA power costs (relift pumping plant)	4,962,000	597,000	82,000
CRSP power costs (relift pumping plant)	1,841,000	221,000	31,000
NTUA power costs (booster pumping plant)	215,000	35,000	
CRSP power costs (booster pumping plant)	80,000	13,000	—
Relift pumping plant OM&R	3,170,000	1,245,000	723,000
Booster pumping plant OM&R	78,000	12,000	
Canal OM&R	—	35,000	—
NTUA power cost water treatment plant	511,000	63,000	—
CRSP power cost water treatment plant	187,000	22,000	—
Water treatment OM&R	2,605,000	1,064,000	—
NTUA water treatment, miscellaneous 10%	312,000	113,000	
CRSP water treatment, miscellaneous 10%	279,000	109,000	
Power transmission OM&R	350,000	Included in San Juan Lateral	
Pipeline OM&R	801,000	187,000	57,000
Total NTUA	13,004,000	3,351,000	862,000
Total CRSP	9,391,000	2,908,000	811,000
Relift pumping plant power consumption (kilowatts [kW])	16,219	2,026	305
Booster pumping plant power consumption (kilowatts)	784	128	
Water Treatment Plant power consumption (kilowatts)	1,588	224	
Total kW	18,592	2,379	305

Notes: (1) CRSP rate is10.43 mils/kilowatthour and demand charge of $4.43 per kW/month.
(2) CRSP total project power cost is $2,395,000.
(3) NTUA rate is 20 mils/kilowatthour and demand charge of $16.50 per kW/month.
(4) NTUA total project power cost is $6,465,000.
(5) Cost reflects April 2007 project cost estimate with January 2007 price level.

Construction and Associated Costs

Interest During Construction

A project construction schedule was developed to support the economic analysis and help the proposed project beneficiaries plan future water supplies. The first objective of the schedule was to provide water to people in the shortest time period to get the earliest possible benefit from the proposed project. Consideration was given to constructing Cutter Lateral first to give the operators some years of experience operating a smaller scale facility before operating the very similar but larger facilities of the San Juan Lateral.

The Cutter Lateral would be constructed first. The San Juan Lateral from Twin Lakes to Window Rock and the Gallup Regional System would be next. This section of lateral would draw groundwater from the Twin Lakes area until surface water would be available from the San Juan River. The San Juan Lateral from the San Juan River to Twin Lakes and to Crownpoint would be the last segment constructed.

A construction schedule was developed based on the assumed limitation of $60 million in appropriations annually until project completion. The schedule shown in table F-9 shows the assumed yearly expenditures by feature from project construction start to finish. The schedule was used to estimate interest accrued on potentially borrowed money during construction and to estimate when people would receive water—the start of project benefits.

Cost Allocation

The purpose of cost allocation is to assign shares of the overall project costs to the various participants. The proposed project would provide municipal water supplies to three participating groups—the Navajo Nation, the city of Gallup, and the Jicarilla Apache Nation. The overriding philosophy in allocating project costs is that the three participants are equal partners in the proposed project.

Costs are separated into capital, fixed OM&R, and variable OM&R costs. Each of these cost categories is further divided into specific project reaches and then allocated to the participating parties. The analysis assumes that construction would begin in 2011, with a construction budget of approximately $60 million per year, and full project completion by January 1, 2027. The details of the cost allocation are documented in volume II, appendix D.

In allocating costs, specific project components were separated out by those that would be dedicated for the exclusive use by any single participant; the cost of those ***dedicated components*** was assigned to the beneficiary participant. These dedicated components typically include water storage tanks and pressurization pumps at most of the major delivery points. The bulk of the proposed project cost, however, is for components that would benefit more than one participant. These joint costs were allocated among the project participants to derive each participant's share of the total costs.

Joint costs were allocated according to the following principles:

- ***Capital costs were allocated according to each participant's share of design capacity***. The idea is that the size and cost of the facilities depend on each participant's desired capacity and not on average use or use in any particular period.

- ***Fixed OM&R costs were also allocated according to each participant's share of design capacity***. Here again, the fixed OM&R costs (staff size, dredging, equipment replacement, and pump maintenance) are primarily a function of the design capacity, not of flows in any particular period.

- ***Variable OM&R costs were allocated according to each participant's share of annual water deliveries***. The variable OM&R costs consist mainly of energy and water treatment chemical costs. These costs vary according to the water flows in any period, so the method used to allocate these costs assigns cost shares in each year according to the projected use in that year.

The proposed project envisions water deliveries at many locations along two main laterals. Every delivery changes the relative shares of the water flow that continues along the pipeline beyond the delivery point. Because, as described above, the relative share of design capacity and projected flow serve as the basis for the cost allocation, the cost allocations change after every delivery point. Therefore, each pipeline branch has been separated into specific ***reaches*** that are defined as the intervals between each two succeeding delivery points. The diversion structure and water treatment plant on each branch is also treated as a separate segment or reach. Each participant's share of design capacity on each reach was computed in order to serve as the basis for allocating capital and fixed OM&R costs.

Gallup Regional System Costs

The design work and cost estimates for the Gallup Regional System were first prepared by DePauli Engineering (DePauli Engineering and Surveying Company, 2002). Reclamation used the DePauli design but re-estimated much of the cost. Some of the Gallup Regional System components were included in Reclamation's cost estimates for the overall system (e.g., Navajo Nation chapter water storage tanks), but most components were listed separately as Gallup-specific. The components included with the other Reclamation elements were treated as part of the overall system cost allocation. The remaining items (all joint facilities) were allocated by their cost to participants based on their respective shares of design capacity. The OM&R costs were estimated as

Table F-9.—Construction schedule (cost in $ millions)
($60 million/year schedule)

	Year																
Construction phase	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total**
Navajo-Gallup Water Supply Project	2.35	4.29	22.32	11.91													40.86
Cutter Lateral	5.99	7.53	4.27	16.20	16.14	21.72	21.70	17.19	7.41								118.14
Twin Lakes/ Window Rock	0.78	0.21				19.94	30.76	2.23									53.92
Cutter Power	0.72	0.73	0.73		3.00	3.27	6.60	9.59									24.63
San Juan Power		0.78	1.57					6.00	18.26	0.00							26.61
Gallup Regional System	0.40	4.37	20.33	26.66	28.09												79.85
San Juan Lateral		8.47	3.63		7.78	15.07	0.94			33.18	32.74	53.00	60.00	54.31	57.03	34.91	361.04
San Juan Pumping Plant		3.51	1.16					8.16	16.00		8.48	7.00		5.69	2.97		52.97
San Juan Water Treatment Plant	5.33	2.48						16.85	18.33	26.83	18.78						88.59
Cutter Water Treatment Plant	1.11	0.46	6.00	5.23	4.99												17.79
Total allocated spending	16.67	32.82	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	34.91	864.40
Percent distribution	1.93%	3.80%	6.94%	6.94%	6.94%	6.94%	6.94%	6.94%	6.94%	6.94%	6.94%	6.94%	6.94%	6.94%	6.94%	4.04%	100.00%
Overall spending	16.68	32.84	60.04	60.04	60.04	60.04	60.04	60.04	60.04	60.04	60.04	60.04	60.04	60.04	60.04	34.94	865.00
Interest during construction to January 1 of year 14	18.20	32.65	54.12	48.81	43.75	38.93	34.33	29.94	25.76	21.77	17.97	14.34	10.88	7.59	4.44	0.84	404.34

Note: The construction schedule assumes that annual appropriations will be indexed to keep in step with construction cost trends.

a lump sum (one each for the CRSP and NTUA energy rates). This overall annual OM&R cost was allocated to the participants based on their respective shares of design capacity.

The city of Gallup's cost of purchasing 7,500 AFY of water that would be conveyed by the proposed project is included. At this point, the city of Gallup has not reached an agreement with any water supplier, so the cost estimates may change. For purposes of this analysis, the price per acre-foot of water was estimated at $110, beginning when the city takes water in 2027. No financial cost for the water to be delivered to the Navajo and Jicarilla Apache Nation communities was included, although there may be some non-financial consideration between those two participants.

Cost of Water

In the absence of a water right settlement that establishes different terms, it is assumed that the Navajo Nation would pay for municipal and industrial water from Navajo Reservoir. These payments were estimated by Reclamation to have a present value of $108.45 per acre-foot. The Jicarilla Apache Nation presently has rights to water they intend to use in the proposed project. It is assumed that there would be no cost for their water, as described in their Navajo Reservoir water supply contract.

The city of Gallup, however, will have to pay for obtaining water from a water right holder. The present value of a tentative purchase arrangement is $20 million. Table F-10 shows how this cost translates to the levelized rate needed to cover the projected payments for water.

Table F-10.—Levelized water cost per thousand gallons
(2007$)

	Navajo Nation	City of Gallup	Jicarilla Apache Nation	Project total
Present value of water costs	3,300,617	32,605,398	0	35,906,016
Annual amortization of water costs	177,317	1,751,636	0	1,928,953
Annual equivalent water deliveries (1,000 gallons)	9,889,759	2,443,890	560,120	12,893,770
Levelized cost per thousand gallons	0.02	0.72	0.00	0.15

Cost Allocation

Table F-11 summarizes the above analysis. The table addresses the capital, annual OM&R, and present value of OM&R costs for a scenario that assumes a construction budget of $60 million per year. The table combines total construction costs, including taxes for the Reclamation-designed system and for the Gallup Regional System. Allocated costs were added for environmental mitigation, cultural resources, and land acquisition, then interest during construction was added. The present value of the annual fixed plus variable OM&R costs (discounted at 4.875 percent) was calculated and estimated under both the CRSP and NTUA energy rates. All financial costs are expressed as of the beginning of the year 2027, the year in which the proposed project would be completed. Interest during construction and interest on pre-project completion water purchase fees are compiled up to January 1, 2027, and post-completion OM&R and post-completion water purchase fees are discounted to January 1, 2027. Next, the total present value of all costs, including capital, fixed OM&R, and variable OM&R costs, is shown. Table F-11 allocates these costs to each of the participants. All costs are based on January 2007 price levels.

Figures F-6 and F-7 illustrate the components of overall cost. Figure F-6 shows how total project costs are split among capital cost, interest during construction, the present value of future OM&R costs, and the present value of water cost. Figure F-7 shows how total project costs are allocated to the three project participants. Figures F-8, F-9, and F-10 show how the cost allocated to each project participant is composed of capital, interest during construction, OM&R, and water costs. Figure F-11 shows what the levelized cost per thousand gallons would be to each project participant, assuming full self-funding.

ECONOMIC BENEFIT/COST ANALYSIS

This economic analysis section is distinct from a financial analysis because an economic analysis is concerned with the generation and use of societal resources instead of the financial analyses' focus on tracing cash receipts and expenditures. Because Reclamation is overseeing the planning of the proposed project and its participants are seeking monetary support from the Federal Government, the resources of concern are those of the United States as a whole. The principal differences between this economic analysis and a financial analysis are:

- Inclusion of non-cash project costs that would affect third parties (diminished power generation and increased salinity effects)

Table F-11.—Present value of total costs (2007)

Total capital costs by user				
	Navajo	**City of Gallup**	**Jicarilla Apache Nation**	**Total**
Allocated construction costs – main system	$620,700,000	$115,800,000	$30,400,000	$766,900,000
Allocated capital costs – Gallup Regional	18,600,000	29,900,000	0	48,500,000
Allocated environmental mitigation cost	4,700,000	1,100,000	200,000	6,000,000
Allocated cultural resources cost	27,100,000	6,200,000	1,300,000	34,600,000
Allocated ROW cost	7,100,000	1,600,000	300,000	9,000,000
Total project capital cost before interest	678,200,000	154,600,000	32,200,000	865,000,000
Allocated interest during construction	317,000,000	72,300,000	15,100,000	404,300,000
Total project capital cost	995,200,000	226,900,000	47,300,000	1,269,400,000
Rounded values	995,000,000	227,000,000	47,000,000	1,269,000,000

Annual OM&R costs by user (at design capacity)				
CRSP rates	**Navajo**	**City of Gallup**	**Jicarilla Apache Nation**	**Total**
Allocated OM&R costs – main system	$9,542,654	$2,075,238	$743,636	$12,361,528
Allocated OM&R costs – Gallup Regional	311,000	500,000	0	811,000
Annual cost of water	177,317	1,751,636	0	1,928,953
Total allocated OM&R costs	10,030,971	4,326,874	743,636	15,101,481
Rounded values	10,000,000	4,300,000	700,000	15,100,000
NTUA rates				
Allocated OM&R costs – main system	12,594,137	2,977,044	846,194	16,417,375
Allocated OM&R costs – Gallup Regional	330,000	532,000	0	862,000
Annual cost of water	171,317	1,751,636	0	1,928,953
Total allocated OM&R costs	13,101,454	5,260,681	846,194	19,208,328
Rounded values	13,100,000	5,300,000	800,000	19,200,000

Table F-11.—Present value of total costs (2007) (continued)

Present value of total OM&R costs by user				
CRSP rates	**Navajo**	**City of Gallup**	**Jicarilla Apache Nation**	**Total**
Allocated OM&R costs–- main system	$210,482,000	$40,512,000	$20,843,000	$271,837,000
Allocated OM&R costs – Gallup Regional	5,781,000	9,315,000	0	15,096,000
Cost of water	3,300,617	32,605,398	0	35,906,016
Total allocated OM&R costs	219,563,617	82,432,398	20,843,000	322,839,016
Rounded values	220,000,000	82,000,000	21,000,000	323,000,000
NTUA rates				
Allocated OM&R costs – main system	267,447,000	58,117,000	23,717,000	349,281,000
Allocated OM&R costs – Gallup Regional	6,145,000	9,901,000	0	16,046,000
Cost of water	3,300,617	32,605,398	0	35,906,016
Total allocated OM&R costs	276,892,617	100,623,398	23,717,000	401,233,016
Rounded values	277,000,000	101,000,000	24,000,000	401,000,000
Present value of total capital and OM&R costs by user				
CRSP Rates	**Navajo**	**City of Gallup**	**Jicarilla Apache Nation**	**Total**
Capital	$995,000,000	$227,000,000	$47,000,000	$1,269,000,000
OM&R (including cost of water)	220,000,000	82,000,000	21,000,000	323,000,000
Total all costs	1,215,000,000	309,000,000	68,000,000	1,592,000,000
NTUA rates				
Capital	995,000,000	227,000,000	47,000,000	1,269,000,000
OM&R	277,000,000	101,000,000	24,000,000	401,000,000
Total all costs	1,272,000,000	328,000,000	71,000,000	1,670,000,000

Note: Present value of OM&R costs include fixed and variable OM&R costs incurred for partial water delivery before project completion.

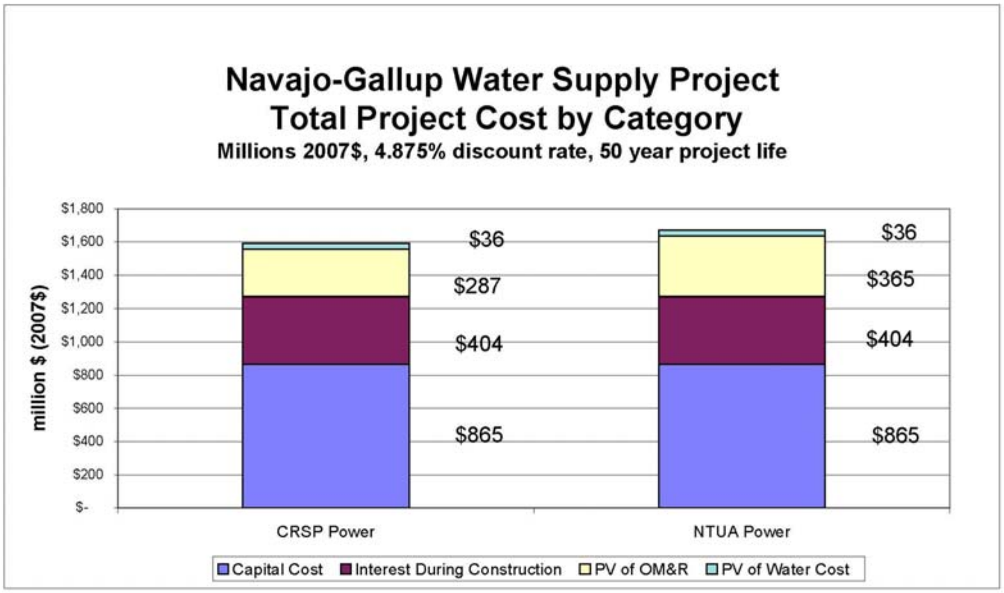

Figure F-6.—Total project cost by category.

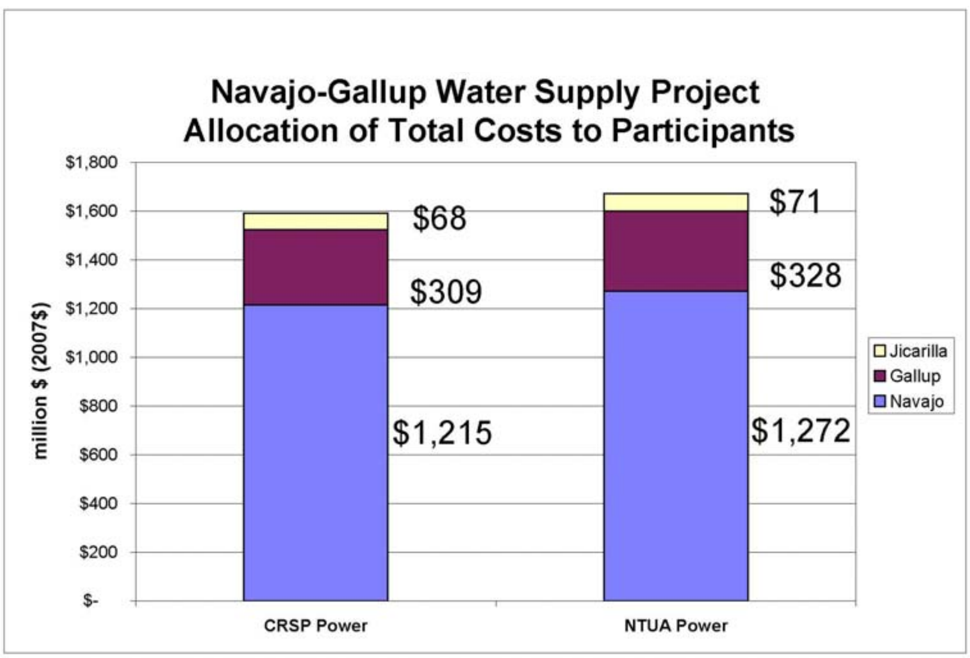

Figure F-7.—Allocation of total costs to participants.

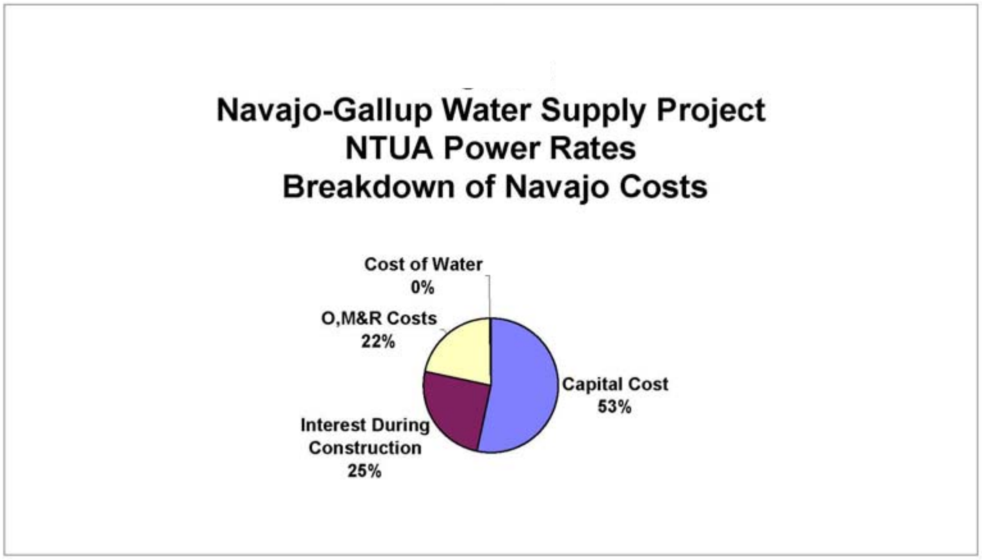

Figure F-8.—NTUA power rates (breakdown of Navajo costs).

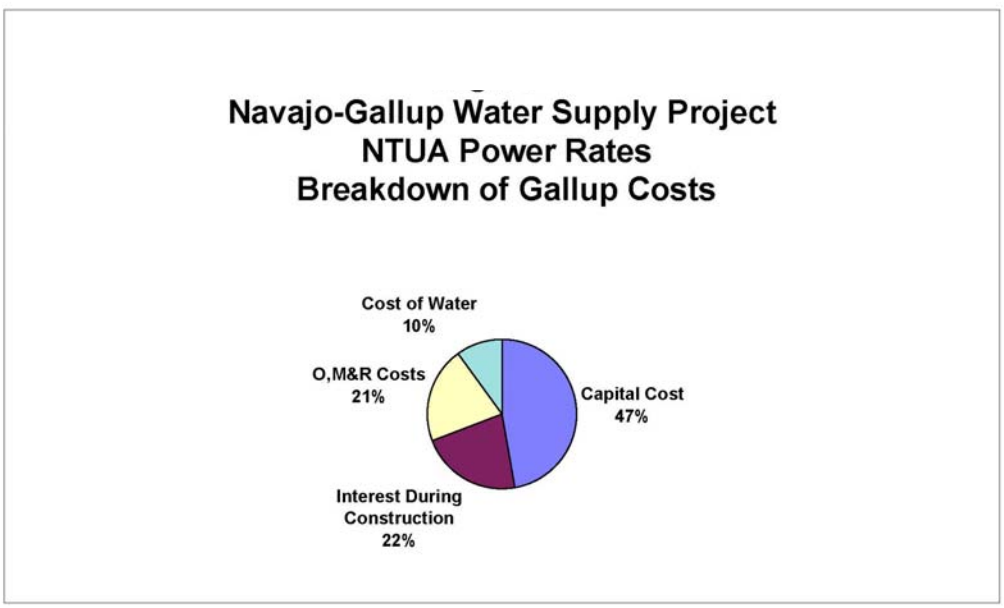

Figure F-9.—NTUA power rates (breakdown of Gallup costs).

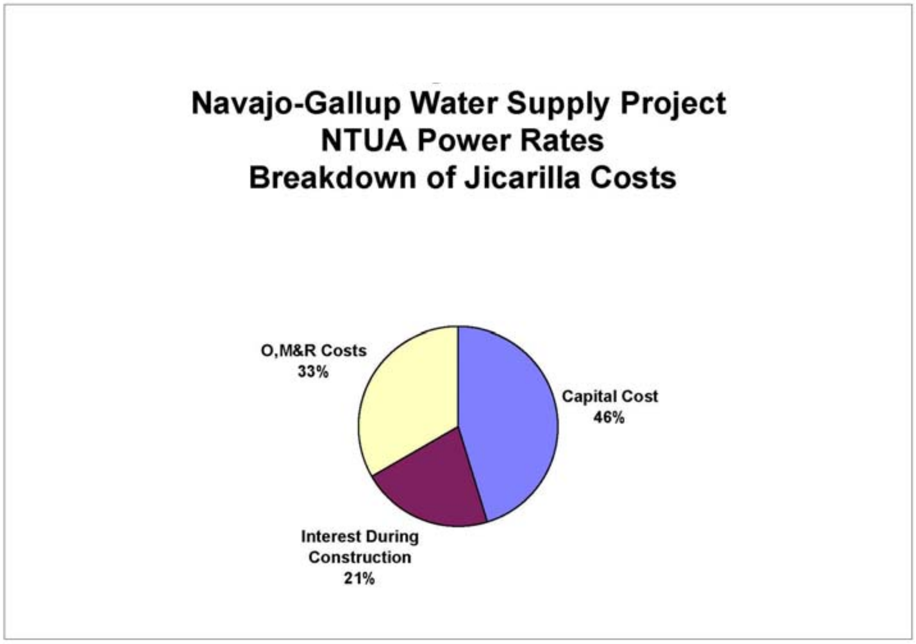

Figure F-10.—NTUA power rates (breakdown of Jicarilla costs).

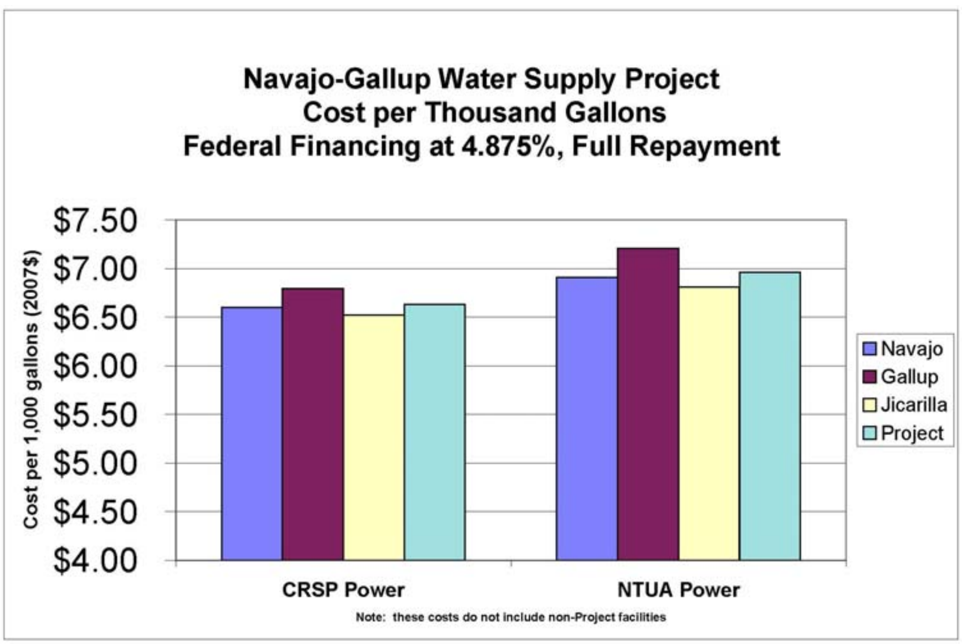

Figure F-11.—Cost per thousand gallons
(Federal financing at 4.875%, full repayment).

- Exclusion of project cash costs that do not represent use of scarce national resources (use of otherwise unemployed people for construction workforce)

- Exclusion of project transfer payments that do not represent use of scarce national resources (taxes paid on construction spending)

The proposed project would principally benefit people in the northwest corner of New Mexico by providing water to which they otherwise would not have access or could only have access at a relatively higher cost. The measure of the benefits to the city of Gallup and to the Navajo Nation members who would be supplied by the proposed project is the willingness of these beneficiaries to pay for project water. The city of Gallup's willingness to pay was estimated from data on the current use of water by people in communities throughout the Mountain States. The Navajo people's willingness to pay was estimated from data on their spending for piped water service when available and on spending to haul water when no service is available.

Benefits to the Jicarilla Apache Nation were estimated from the cost of the next least expensive alternative source of water for the area of the reservation to be served by the proposed project. The Indian Health Service identifies the availability of a community water supply as critical for maintaining the health of Indian people. This report roughly estimates the indirect health benefits to Navajo people that would accrue from the provision of a clean water supply.

The completion of the water supply project would also provide infrastructure that is a necessary prerequisite to economic development and poverty relief on the reservations. While it is uncertain how much economic development would be encouraged by the proposed project, it is clear that the lack of a reliable water supply presently poses a significant constraint to most types of economic development. Table F-12 summarizes the economic costs and benefits associated with the proposed project. The details of this analysis are presented in volume II, appendix D.

Ability to Pay

Ability to pay in a water supply context refers to the affordability of a water system. A common measure of ability to pay for water services is utility payments as a percent of median household income (EPA Prioritizing Drinking Water Needs, 1999). The EPA, for example, uses 2.5 percent of median household income (MHI) to determine whether water treatment options to comply with clean water standards are affordable and should be required.

Table F-12.—Summary of project economic benefits and costs (million 2007$, 4.875% discount rate)

	Direct	Direct plus other
Benefits		
Gallup willingness to pay	361	361
Navajo willingness to pay	1,448	1,448
Jicarilla avoided cost	57	57
Construction employment	231	231
Indirect and induced employment	0	111
Health benefits	0	435
Reverse outmigration	0	+
Economic development	0	+
Total benefits	2,137	2,683
Costs		
Project construction	1,192	1,192
Distribution system construction	48	48
OM&R	368	368
Gallup water cost	33	33
Navajo water cost	24	24
Power generating cost	19	19
Salinity increase cost	20	20
Total costs	1,704	1,704
Benefit/cost ratio	1.25	1.57

Note: The benefit/cost ratio greater than 1.0 indicates that the anticipated project benefits are greater than cost and, thus, that the proposed project represents a beneficial use of national resources.

Legislation proposed in the 109th Congress allows the Secretary to determine the Federal share of construction costs based on an analysis of per capita income, MHI, poverty rate, ability to raise revenues, the strength of the balance sheet, and the existing cost of water, all relative to regional averages (109S 897, Section 106(f) (2)); however, the bill does not specify any threshold for these measures.

Given this lack of a basis for determining affordability, it may be useful to show the average percentage of MHI that the project participants would pay for water under various assumptions about the respective participant's share of capital cost. These percentages are determined by dividing the estimated annual household cost of project water to the MHI shown in table F-13.

Table F-13.—Median household income

	Navajo Nation	City of Gallup	Jicarilla Apache Nation
1999 median household income (1999$)	20,005	34,868	26,750
2005 median household income (2005$)	23,807	41,247	30,620

Source: 1999 MHI from U.S. Census Bureau, "2000 Census of Population and Housing" indexed to 2005$ with U.S. Bureau of Labor Statistics, "Consumer Price Index," annual growth rates from U.S. Census Bureau, "1990 Census of Housing" and "2000 Census of Population and Housing," Dornbusch and Associates.

The affordability percentages for different levels of participant capital cost repayment are shown by adjusting the capital portion of the levelized cost. Figure F-12 shows these affordability percentages for capital repayment ratio scenarios ranging from 0 percent repayment to 100 percent. Finally, figure F-12 also compares these affordability percentages to the benchmark 2.5 percent of MHI. These benchmarks are based on EPA judgments of the affordable portion of household income used to pay for a water supply.

Figure F-12 shows that all three project participants could pay project OM&R and a portion of the capital costs without exceeding the EPA threshold of 2.5 percent.

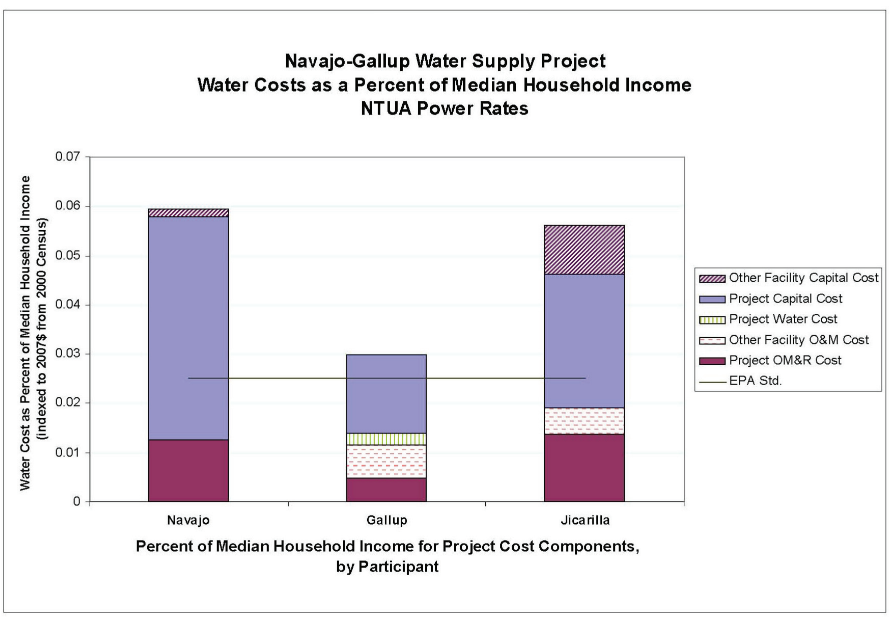

Figure F-12.—Water costs as a percent of median household income (NTUA power rates).