Long-Range Water Supply Plan

Los Alamos County

Prepared for **Los Alamos County**
Department of Public Utilities

October 2017

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1. Introduction

The Los Alamos County Department of Public Utilities (DPU) supplies water for Los Alamos, White Rock, Los Alamos National Laboratory (LANL), and Bandelier National Monument. To prepare for the future water supply needs of these communities, the DPU developed a long-range water supply plan that was published in 2006 (DBS&A, 2006). This document updates that plan to incorporate more recent data and developments relevant to water resources management. The objective of this plan is to evaluate projected demands in relation to available supply, while considering water quality and water rights risks to the supply, to ultimately ensure that both a viable physical supply and associated water rights are in place as needed to meet future demands.

In addition to providing a plan for a sustainable future water supply, a long-range water plan that covers at least 40 years addresses several regulatory requirements regarding water rights and water conservation. In particular, a water plan allows certain organizations, including Counties, to set aside water for use in the future. Section 72-1-9(B) of the New Mexico Water Code allows covered entities such as Los Alamos County to legally appropriate and preserve water that they cannot currently use but will need in the future to meet projected water requirements for the service area based on projected growth and other factors. Counties are specifically exempt from forfeiture of unused water rights if those rights have been appropriated for the implementation of a water development plan or for preservation of water supplies (NMSA 72-12-8 (F)). These provisions are the same for both surface water and groundwater (NMSA 72-5-28(C)).

The New Mexico Office of the State Engineer (OSE) requirements set out in statute NMSA 1978 Section 72-14-3.2 call for conservation planning by any public supply system with diversions of at least 500 acre-feet annually for domestic, commercial, industrial, or government customers for other than agricultural purposes. Covered entities must develop, adopt, and submit to the OSE a comprehensive water conservation plan, including a drought management plan, as a prerequisite for applying for funding from key state funding agencies. The Water Trust Board requires funding applicants to provide verification from the OSE that all of its statutory and regulatory requirements have been met, and the OSE is requiring that Water Trust Board funding applicants have a conservation plan that was prepared in accordance with New Mexico's *Water Conservation Planning Guide for Public Water Suppliers* (NMOSE, 2013). The U.S. Bureau of Reclamation (USBR) also requires a conservation plan for diversion of San Juan-Chama Project water.

The DPU published an *Energy and Water Conservation Plan* in 2013 (LADPU, 2013a) and updated it in 2015 (LADPU, 2015), and prepares reports annually discussing the County's progress toward the goals established in that plan. This long-range water supply plan summarizes the water conservation goals established by the *Energy and Water Conservation Plan* and provides an update on its implementation and recommendations.

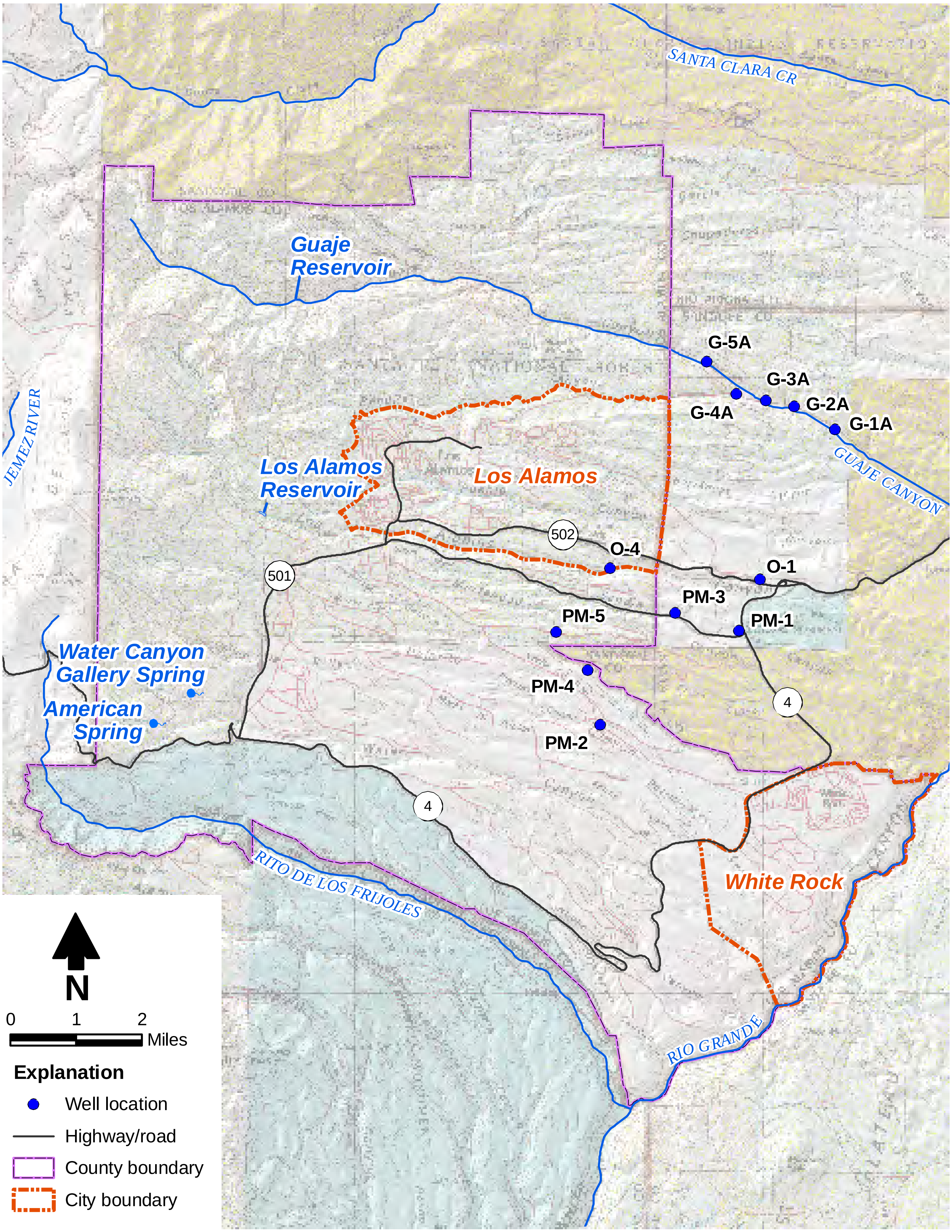
For this long-range water supply plan, the DPU retained Daniel B. Stephens & Associates, Inc. (DBS&A) to update the 2006 plan with current data and analyses. The remainder of this water plan presents the results of the summarized and updated information including an overview of the water system (Section 2), water supply and water rights (Sections 3 and 4), current and projected demand and supply-demand gaps (Sections 5 and 6), risks due to climate change (Section 7), water conservation (Section 8), and actions the Incorporated County of Los Alamos (County) may undertake to plan for a sustainable future water supply (Section 9).

2. Overview of Los Alamos County Water System

The Los Alamos Boys Ranch, a school for teenage boys started in 1918, was the original settlement in the area that is now Los Alamos County. The sole source of water for the school was surface water from Los Alamos Reservoir in Los Alamos Canyon (Figure 2-1). The water was piped from the reservoir and stored in a redwood water tank near the school. During World War II, Los Alamos was selected as the site for the secret Project Y, because the steep canyons and mesa tops provided a secure location for the project. The Los Alamos Laboratory (as it was then called) came into existence in early 1943 for the single purpose of Project Y: to design and build an atomic bomb (LANL, 2006). Los Alamos Boys Ranch closed in early 1943 and the Laboratory became the only establishment. In 1949, Los Alamos County was created from parts of Sandoval and Santa Fe Counties.

When the Laboratory took over the water system in 1943, they continued to use Los Alamos Reservoir, but also piped in water from a spring gallery in Guaje Canyon. In 1947, a dam was built in Guaje Canyon and water from the resulting Guaje Reservoir was used for water supply (Figure 2-1). In addition, American Spring and several springs in Water Canyon were tapped and piped into the water system. The Los Alamos well field was drilled in 1946 on San Ildefonso Pueblo property, thereby increasing the supply to meet the growing demands of the Laboratory and its residents. By 1989, groundwater from the Los Alamos, Guaje, Pajarito, and Otowi well fields supplied all of the potable demands for Los Alamos.

The Los Alamos well field was plugged and abandoned in 1992 because the wells had reached the end of their useful life. Also in the 1990s, six of the seven wells in the Guaje well field were retired, and four replacement wells were drilled and tapped into the existing piping and booster stations. Los Alamos Reservoir continued to be used to water parks, but the Cerro Grande fire in 2000, Las Conchas fire in 2011, and subsequent flooding in 2012, 2013, and 2014 damaged the reservoir and the diversion system. The DPU has been working on a water line replacement project in order to bring the reservoir back online. The reservoir has been dredged and the DPU will be installing a new pipeline from the reservoir into town in order to connect to the existing non-potable infrastructure (Meyers, 2016). The DPU recently completed a few other non-potable projects, including installing booster pumps and pipelines to push non-potable water to the Group 12 tank, which has been renovated. This allows gravity feed of the non-potable water to all current users, including the golf course and ball fields (Alarid, 2017).



LOS ALAMOS COUNTY WATER PLAN

Water Supply

Figure 2-1

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04/27/2006

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The DPU began operating the water system in September 1998; however, ownership of the water system and water rights was not transferred from the U.S. Department of Energy (DOE) to the County until September 2001 (ownership of 70 percent of the water rights was transferred to Los Alamos County and DOE retained the other 30 percent). The DPU provides water service to the residents of Los Alamos and White Rock, LANL, and Bandelier National Monument. The County has a contract to supply DOE with the water required by LANL with no limitations. This contract will expire in 2019 (LANL demands have been projected beyond 2019 under the assumption that a new contract will be negotiated).

The County has a contract with the USBR for water from the San Juan-Chama Project, which brings water from the San Juan Basin (Colorado River Basin) to Heron Reservoir on the Rio Chama (the Rio Grande Basin). Releases from Heron Reservoir flow down the Rio Chama to the Rio Grande. In the *San Juan-Chama Water Supply Project Final Preliminary Engineering Report,* the recommended alternative for the County to obtain and treat San Juan-Chama Project water for distribution was to construct up to three groundwater wells in the White Rock area and install pumps and a pipeline to connect the new wells to the Pajarito Booster Station (CDM Smith, 2012); however, the alternatives will be revisited after the long-range water supply plan update is complete. The diversion rights of San Juan-Chama Project water could alternatively be used to offset impacts of pumping (as the City of Santa Fe has done since 1972), as further discussed in Sections 4.3.2 and 6.

With the abandonment of the Los Alamos well field and six wells in the Guaje well field, the water system is currently supplied by the 12 wells shown in Figure 2-1 and listed in Table 2-1. These wells, with depths up to 3,000 feet below ground surface (ft bgs) and water levels ranging from approximately 250 to 1,200 ft bgs, all draw on the regional aquifer beneath the Pajarito Plateau.

Two new applications have been filed recently:

- The County filed an application for an additional point of diversion on April 28, 2016. The new well will be called Otowi Well 2 and will be drilled to supplement the system's existing production wells in anticipation of declining production rates from existing wells that are nearing the end of their service life (Alarid, 2016). The new well will be drilled during the fall and winter of 2017-2018 under an exploratory permit (Alarid, 2017).

Table 2-1. Active Wells in the Los Alamos Water Supply System

Well Field	Well Name	Date Completed	Completion Depth (feet)	Coordinates (feet)		Initial Depth to Water
				x	Y	
Guaje	G-1A	Oct-54	1,519	1,655,241	1,784,353	250
	G-2A	Mar-98	1,980	1,651,974	1,786,166	318
	G-3A	May-98	1,980	1,649,662	1,786,585	408
	G-4A	Apr-98	1,980	1,647,318	1,787,113	452
	G-5A	Jun-98	1,980	1,644,877	1,789,636	551
Otowi	O-1 [a]	Aug-90	2,497	1,649,396	1,772,232	673
	O-4	Mar-90	2,595	1,637,337	1,772,995	780
Pajarito	PM-1	Feb-65	2,499	1,647,734	1,768,112	722
	PM-2	Jul-65	2,300	1,636,698	1,760,406	823
	PM-3	Nov-66	2,552	1,642,590	1,769,530	740
	PM-4	Aug-81	2,874	1,635,623	1,764,740	1,060
	PM-5	Sep-82	3,092	1,632,110	1,767,790	1,208

Source: Koch and Rogers, 2003

[a] Well is currently not being used to supply drinking water.

- In May 2016, an application for permit to change an existing water right was filed jointly by DOE and the County in support of the chromium plume control interim measure and chromium plume center characterization project (U.S. DOE and LADPU, 2016), and emergency authorization was received on September 10, 2016 (NMOSE, 2016).

The addition of new points of diversion under these applications will not increase the appropriation of water above the existing permitted water rights.

Wastewater is treated at two facilities: the White Rock wastewater treatment plant (WWTP) and the Los Alamos WWTP. Both of these WWTPs have treated effluent reuse lines that are used for irrigation of turf. Two former WWTPs—the East Road, abandoned and demolished in the mid-1960s, and the Pueblo, abandoned in 1993—also had effluent reuse systems, both of which supplied the golf course.

The DPU operates a non-potable water system, using treated wastewater effluent to irrigate several areas in Los Alamos and White Rock and using stormwater runoff for fire protection and snow making at the Pajarito Mountain Ski Area (Forsgren & Associates, 2013). The system has three separate components:

- *Los Alamos Townsite:* Reuse is used to irrigate four sites in Los Alamos (Los Alamos County Golf Course, Los Alamos Middle School, North Mesa Ball Fields, and North Mesa Soccer Fields) and to feed the wetlands located downgradient of the Los Alamos wastewater treatment facility. A volume of 180,000 gallons per day is needed to keep the wetlands healthy. LANL is currently receiving reuse water for the wetlands from the DPU at no charge because surplus reuse water is available.

- *White Rock:* Reuse is used to irrigate Overlook Park.

- *Pajarito Mountain Ski Area:* Captured stormwater is used for fire protection and snow making.

A Los Alamos County non-potable water system master plan was completed in 2013, to evaluate the efficiency of the existing non-potable water system, make recommendations for how to improve the system's efficiency, determine if additional development of non-potable water use is economically feasible, and identify and evaluate sites that could potentially be served (Forsgren & Associates, 2013), most of which currently use potable water for irrigation. The plan identified a total of 25 sites (5 existing and 20 new) suitable for service by the Los Alamos Townsite non-potable water system and 6 sites (1 existing and 5 new) for the White Rock non-potable water system. Bringing the additional sites online would increase the annual average system demands from 152.8 to 206.5 million gallons per year for the Los Alamos Townsite system and from 18.9 to 41.2 million gallons per year for the White Rock system (Forsgren & Associates, 2013).

3. Hydrologic Overview and Risks to Water Supply

The County's public drinking water supply is supplied by groundwater, with surface water supplying a small amount of non-potable use. This section describes the hydrogeologic conditions pertinent to the Los Alamos groundwater supply (Section 3.1) and includes an assessment of potential risks to the groundwater supply due to depletion or contamination of the aquifer (Section 3.2). The County water rights (groundwater and surface water) are discussed in Section 4.

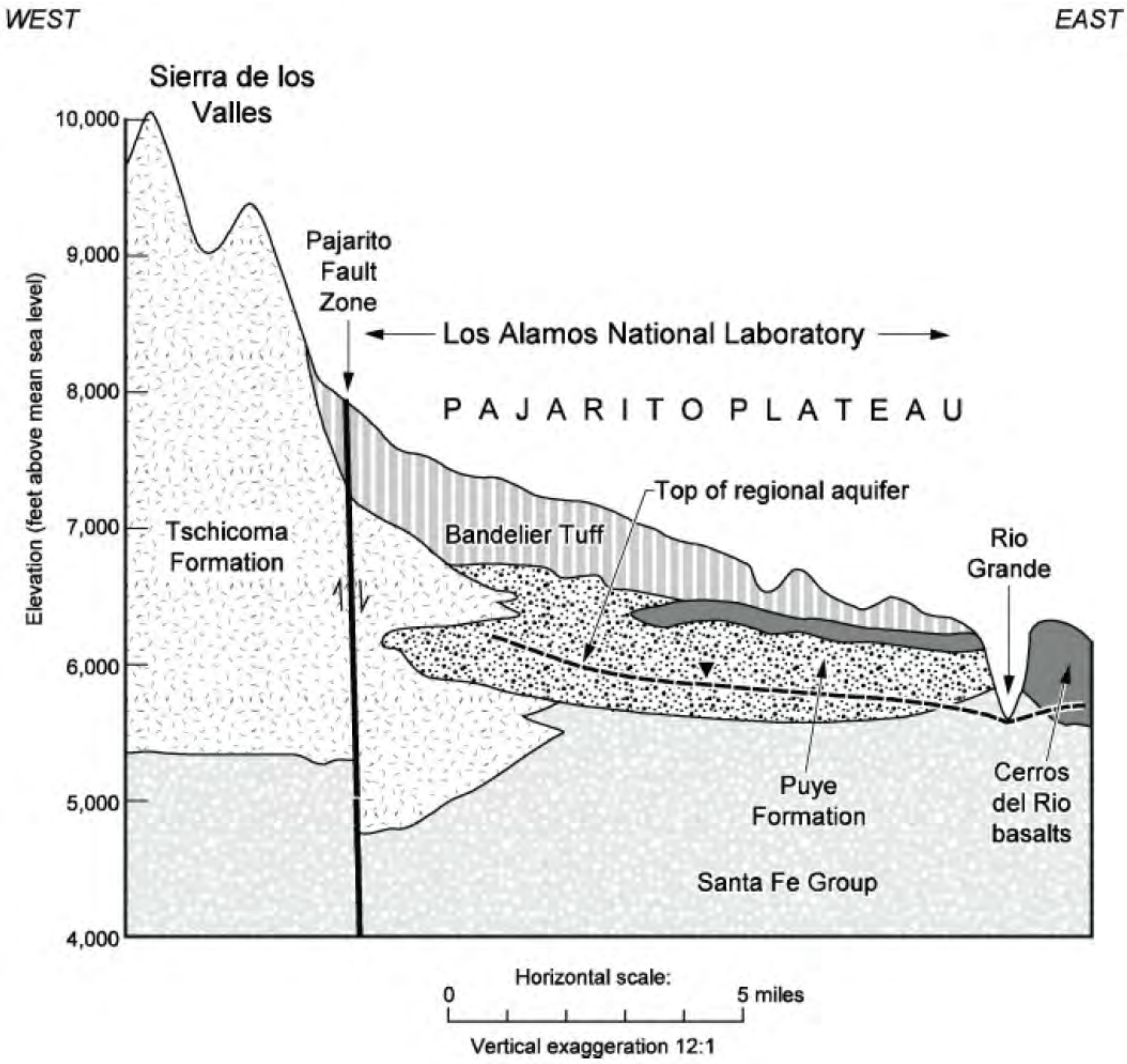
3.1 Hydrogeology

Los Alamos County is situated on the Pajarito Plateau within the western side of the Española Basin. The Pajarito Plateau extends eastward from the Sierra de los Valles, the eastern range of the Jemez Mountains. On the western part of the Pajarito Plateau, the Bandelier Tuff overlaps the Tschicoma Formation, which consists of older volcanics that form the Jemez Mountains. In the central Pajarito Plateau and near the Rio Grande, the Bandelier Tuff is underlain by the Puye Formation. The Cerros del Rio basalts interfinger with the Puye Formation conglomerate along the river and extend beneath the Bandelier Tuff to the west. These formations overlie the sediments of the Santa Fe Group, which extend across the basin between LANL and the Sangre de Cristo Mountains and are more than 3,300 ft thick (LANL, 2014a). A cross section of the area is shown on Figure 3-1.

The hydrogeologic framework within Los Alamos County consists of three distinct aquifer systems (LANL, 2014a):

- Shallow perched groundwater in alluvial deposits along canyon bottoms
- Intermediate-depth perched groundwater
- Deeper regional aquifer, which extends through the neighboring Española Basin

A block diagram depicting a conceptual model of the hydrogeology of the Los Alamos area that illustrates the general configuration of these aquifer systems is shown in Figure 3-2.



Source: LANL, 2014b

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LOS ALAMOS COUNTY WATER PLAN

Cross Section

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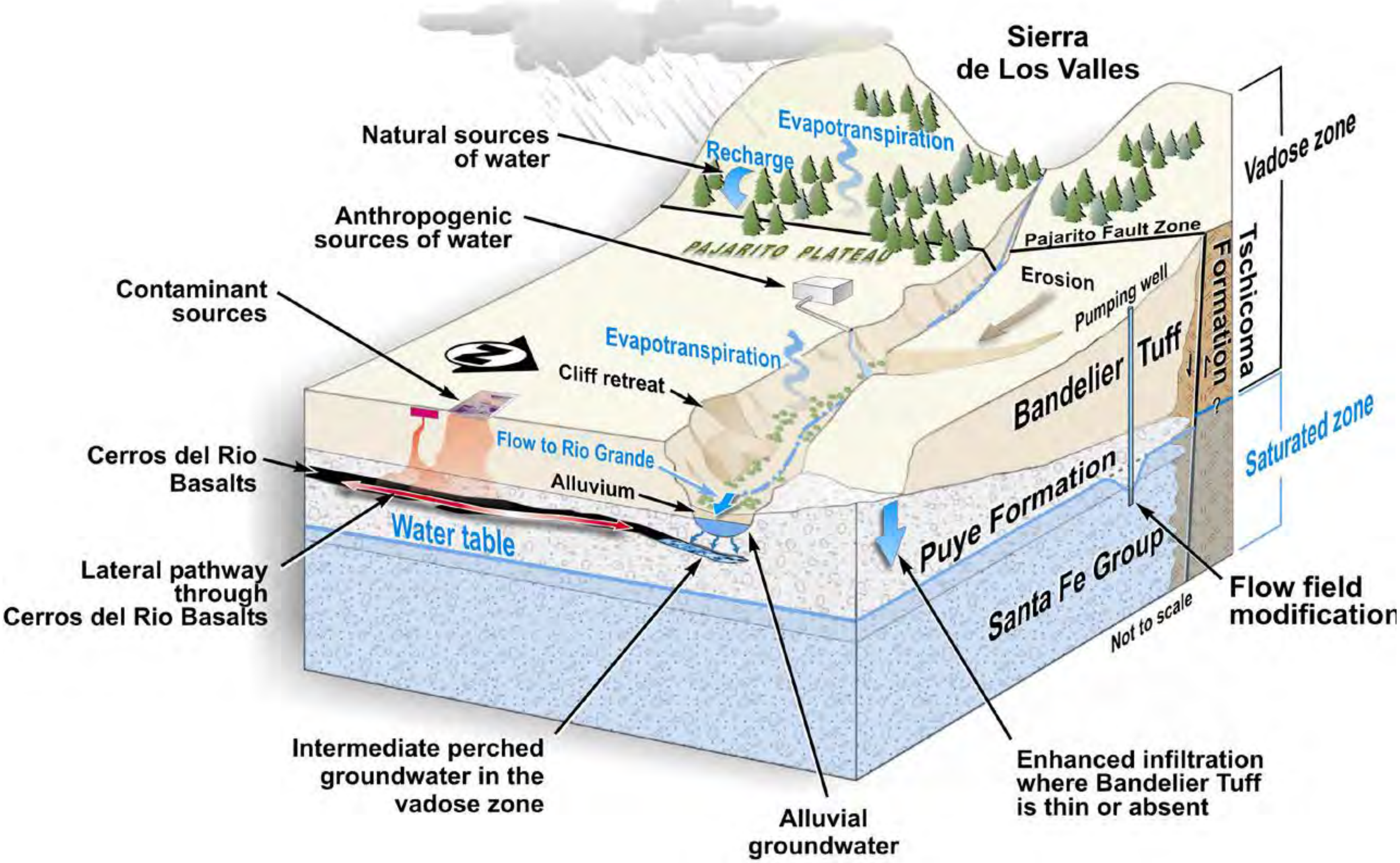
Figure 3-1



Source: LANL, 2005

LOS ALAMOS COUNTY WATER PLAN

Conceptual Hydrogeologic Model of the Los Alamos County Area

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Figure 3-2

Alluvial aquifers occur within axial fluvial deposits located along canyon bottoms and have a limited saturated thickness and variable lateral extent, depending on the presence of intermittent surface flow or anthropogenic discharges from wastewater treatment outfalls. Hydrologic investigations of alluvial aquifers have been conducted in Los Alamos Canyon, Pueblo Canyon, Mortandad Canyon, Pajarito Canyon, Sandia Canyon, Cañon de Valle, and Water Canyon. Though their limited extent precludes any utility for beneficial use, these aquifers provide an important pathway for contaminant migration.

Intermediate-depth perched aquifers are widely distributed across the northern, western, and central parts of the Pajarito Plateau beneath Los Alamos Canyon, Pueblo Canyon, Sandia Canyon, Mortandad Canyon, and Cañon de Valle. These perched zones usually occur in the Puye Formation fanglomerates, the Cerros del Rio Basalt, and units of the Bandelier Tuff, and are typically associated with low-permeability layers such as unfractured basalt flows and fine-grained zones. Saturated thicknesses range from about 3 to 420 feet, but lateral extents are sometimes poorly defined (LANL, 2005). Depths to the intermediate perched groundwater vary. For example, the depth to intermediate-perched groundwater is approximately 120 feet in Pueblo Canyon, 450 feet in Sandia Canyon, and 500 to 750 feet in Mortandad Canyon (LANL, 2014a). Though the exact extent of these aquifers is not well defined, it is clear that they are generally small enough that their potential for beneficial use is limited. However, they provide an important pathway for contaminant migration through the vadose zone.

The regional aquifer occurs primarily within the poorly to semi-consolidated basin-fill sediments of the Santa Fe Group. The total thickness of the Santa Fe Group beneath the Pajarito Plateau is poorly defined. The deepest well on the plateau (PM-5), with a depth of 3,110 feet, does not fully penetrate the base of the basin-fill sediments. Estimates of the total thickness of these sediments range from 6,650 feet in the central basin to as much as 9,000 to 10,000 feet in the central and western parts of the basin (Broxton and Vaniman, 2005).

The regional aquifer extends into the overlying Puye Formation fanglomerate beneath parts of the Pajarito Plateau. Other geologic units encompassed by the regional aquifer beneath parts of the county include fractured volcanic rocks of the Tschicoma Formation (western part) and the Cerros del Rio Basalt (eastern part), as well as localized occurrences of older basalts.

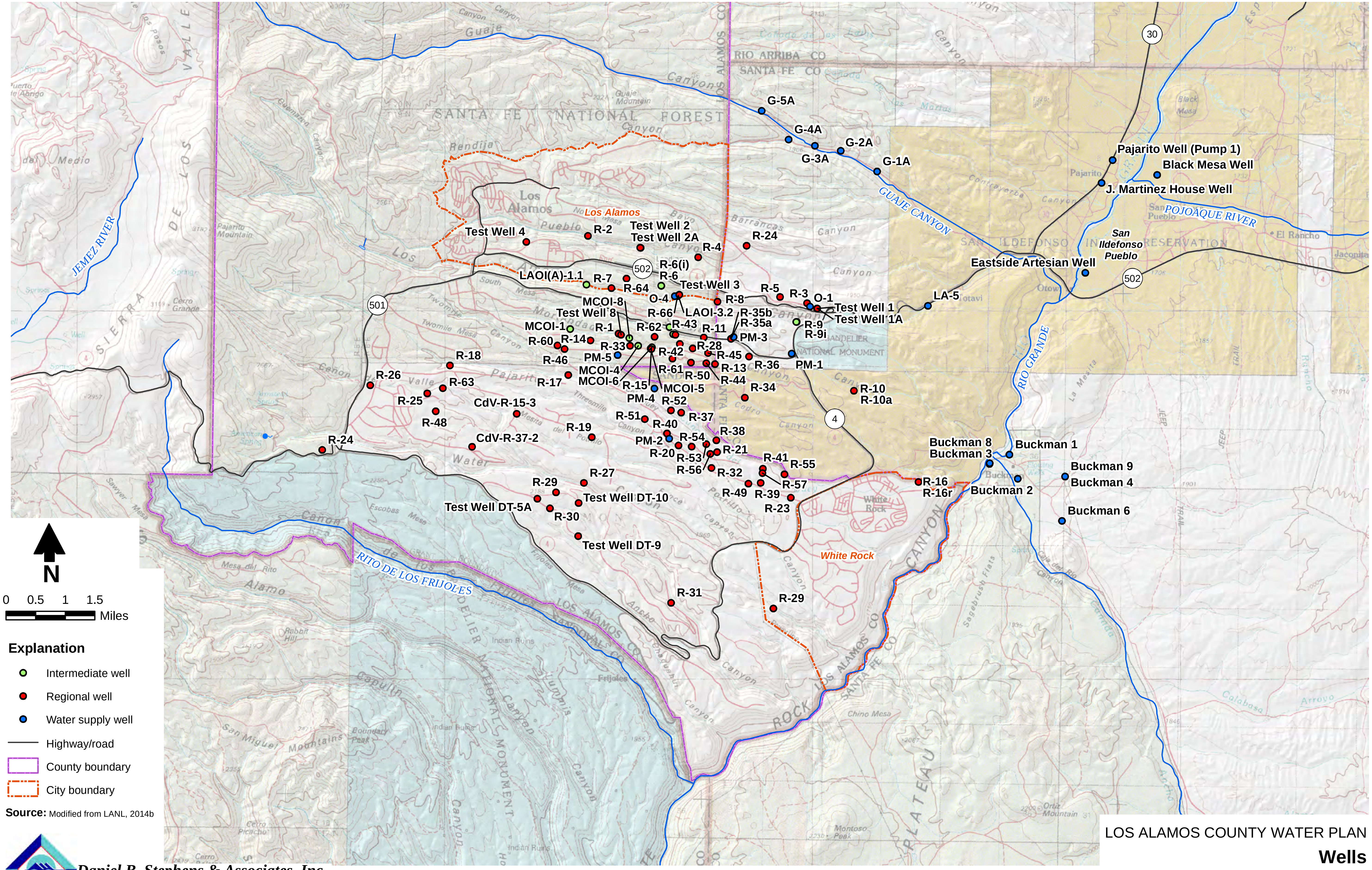
The regional aquifer water table occurs at a depth of 1,200 feet along the western edge of the plateau and 600 feet along the eastern edge. In the central part of the plateau, the regional aquifer lies about 1,000 feet beneath the mesa tops. The regional aquifer is the only aquifer in the area capable of serving as a municipal water supply (LANL, 2014a).

Well locations and types are shown in Figure 3-3, and the potentiometric surface contours and extrapolated flow directions in the regional aquifer are shown in Figure 3-4. Water in the regional aquifer generally flows east or southeast (LANL, 2015c). As discussed in Section 2, the County's production wells have water levels that range between approximately 250 and 1,200 feet below ground surface (ft bgs). Water in the regional aquifer is under artesian conditions beneath the eastern part of the Pajarito Plateau near the Rio Grande and under phreatic conditions beneath most of the Pajarito Plateau (Purtymun and Johansen, 1974). The upper portion of the regional aquifer beneath the Laboratory discharges into the Rio Grande through springs in White Rock Canyon (LANL, 2014a).

Groundwater modeling studies indicate that underflow of groundwater from the Sierra de los Valles west of Los Alamos is the main source of regional aquifer recharge (LANL, 2014a). Alluvial groundwater is also a source of recharge to the regional aquifer, as well as to the intermediate perched saturated zones (thereby providing potential downward pathways for contaminants released at the surface to eventually reach the regional aquifer).

A number of studies have estimated recharge to the regional aquifer for the Española Basin and for the Pajarito Plateau (Table 3-1). Recharge varies in relation to precipitation, which in Los Alamos County is elevation-dependent and ranges between about 13 and 20 inches annually (Newman and Robinson, 2005). Keating et al. (2005) determined that significant recharge occurs primarily above the 2,195-meter (7,200-foot) elevation. At lower elevations, recharge occurs primarily in canyons and arroyos; recharge on mesas is minimal to non-existent (Anderholm, 1994; Birdsell et al., 2005). Kwicklis et al. (2005) estimated that 23 percent of total recharge to the regional aquifer beneath the plateau is from streamflow loss.

In addition to the recharge estimates, Table 3-1 includes an estimate of discharge to the Rio Grande (determined from inverse modeling using streamflow data and transient head data), which approximates aquifer recharge before significant pumping began.



Source: Modified from LANL, 2014b

LOS ALAMOS COUNTY WATER PLAN

Wells

Figure 3-3

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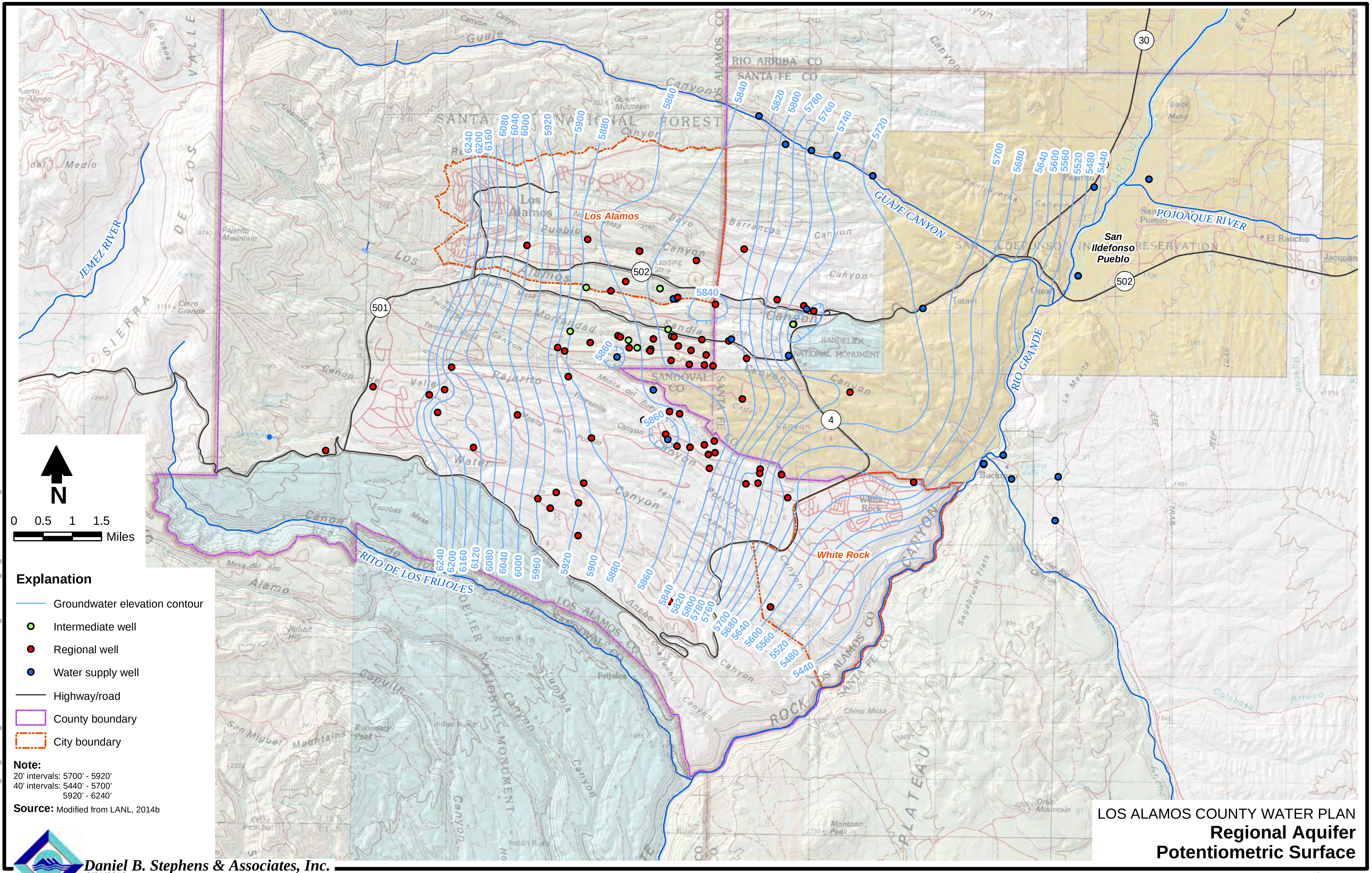

Note:
20' intervals: 5700' - 5920'
40' intervals: 5440' - 5700'
5920' - 6240'

Source: Modified from LANL, 2014b

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LOS ALAMOS COUNTY WATER PLAN
Regional Aquifer
Potentiometric Surface

Figure 3-4

Table 3-1. Regional Aquifer Recharge Estimates

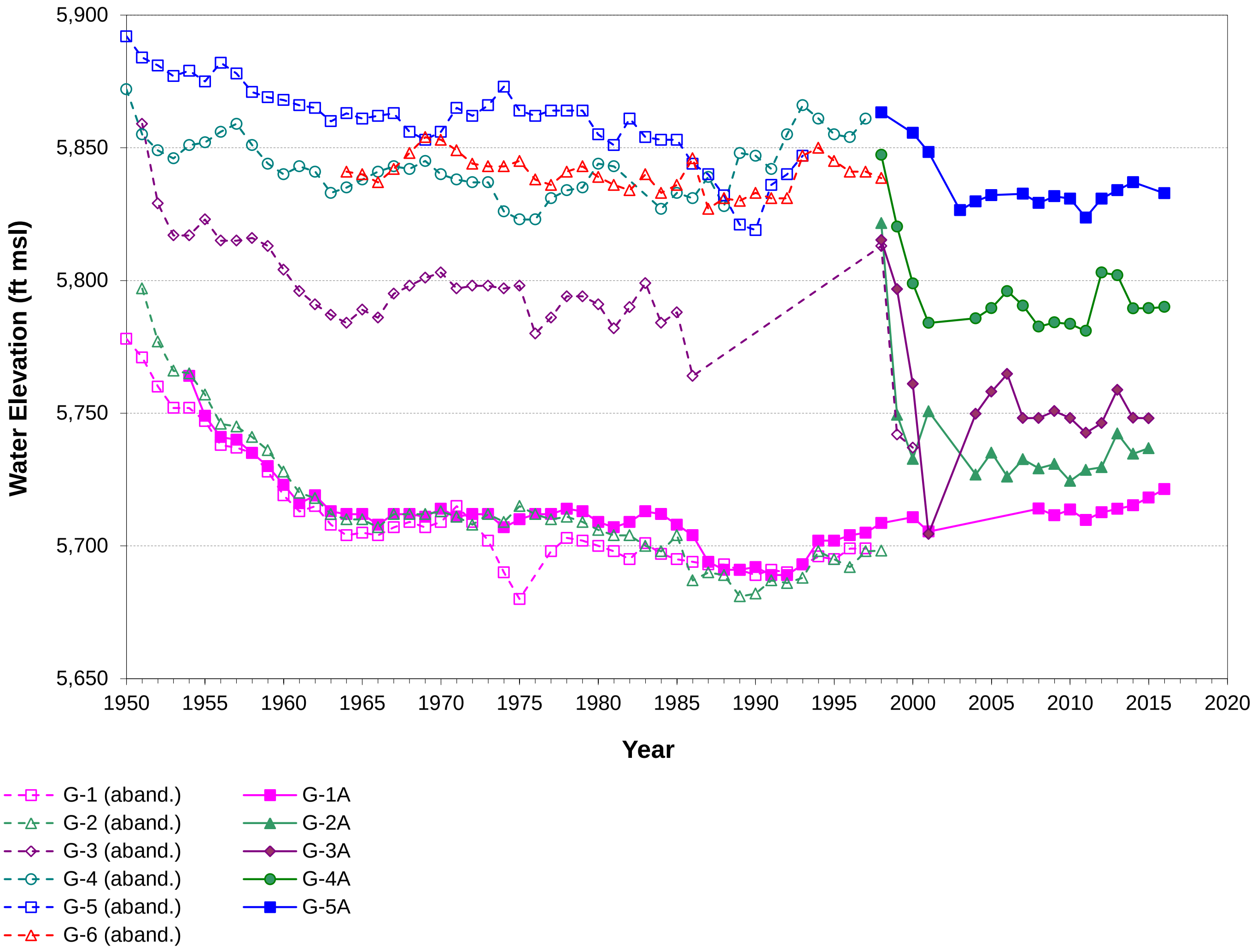
Category	Rate (ac-ft/yr)	Source
Pajarito Plateau recharge	8,596	Kwicklis et al., 2005
	4,912	McLin et al., 1996
	4,298 to 5,526	Griggs and Hem, 1964
	8,084	Hearne, 1985
Lateral inflow from Jemez Mountains	7,445	McAda and Wasiolek, 1988
Discharge to Rio Grande from Pajarito Plateau and Sierra de los Valles	6,473	Keating et al., 2003

3.2 Aquifer Depletion Risk

To evaluate risks of water supply depletion, available water level data from numerous wells screened in the regional aquifer were used to plot hydrographs illustrating historical water level behavior in the regional aquifer. Locations of these wells are shown in Figure 3-3. Long-term supply well data, consisting of annual average non-pumping water levels for the Guaje well field (since 1950) and the Pajarito well field (since 1965), are shown in Figures 3-5 and 3-6 respectively. More recent (since 1990) but sporadic data are available for the Otowi well field (Figure 3-7).

Table 3-2 summarizes the net changes and average water level declines indicated by these data. Long-term data from the Pajarito and Guaje well fields indicate an average water level decline of about 1.1 and 3.5 feet per year (ft/yr), respectively; the average decline in the Otowi well field is about 0.8 ft/yr. Substantial declines have occurred in the abandoned Guaje wells, ranging from about 0.2 to 2.5 feet, and averaging about 1.3 ft/yr. Declining water levels indicate that groundwater withdrawals exceed recharge.

LANL also monitors water levels in regional wells. Previous analysis of those data indicated that responses were mixed but that water levels in most regional wells were also steadily declining (DBS&A, 2006). Though the average rate of decline appears modest on an annual basis, one supply well has experienced a total water level decline of approximately 85 feet since 1998, and water levels in four of the active production wells have declined by more than 50 feet (Table 3-2).



LOS ALAMOS COUNTY WATER PLAN

Average Annual Non-Pumping Water Levels
Guaje Well Field

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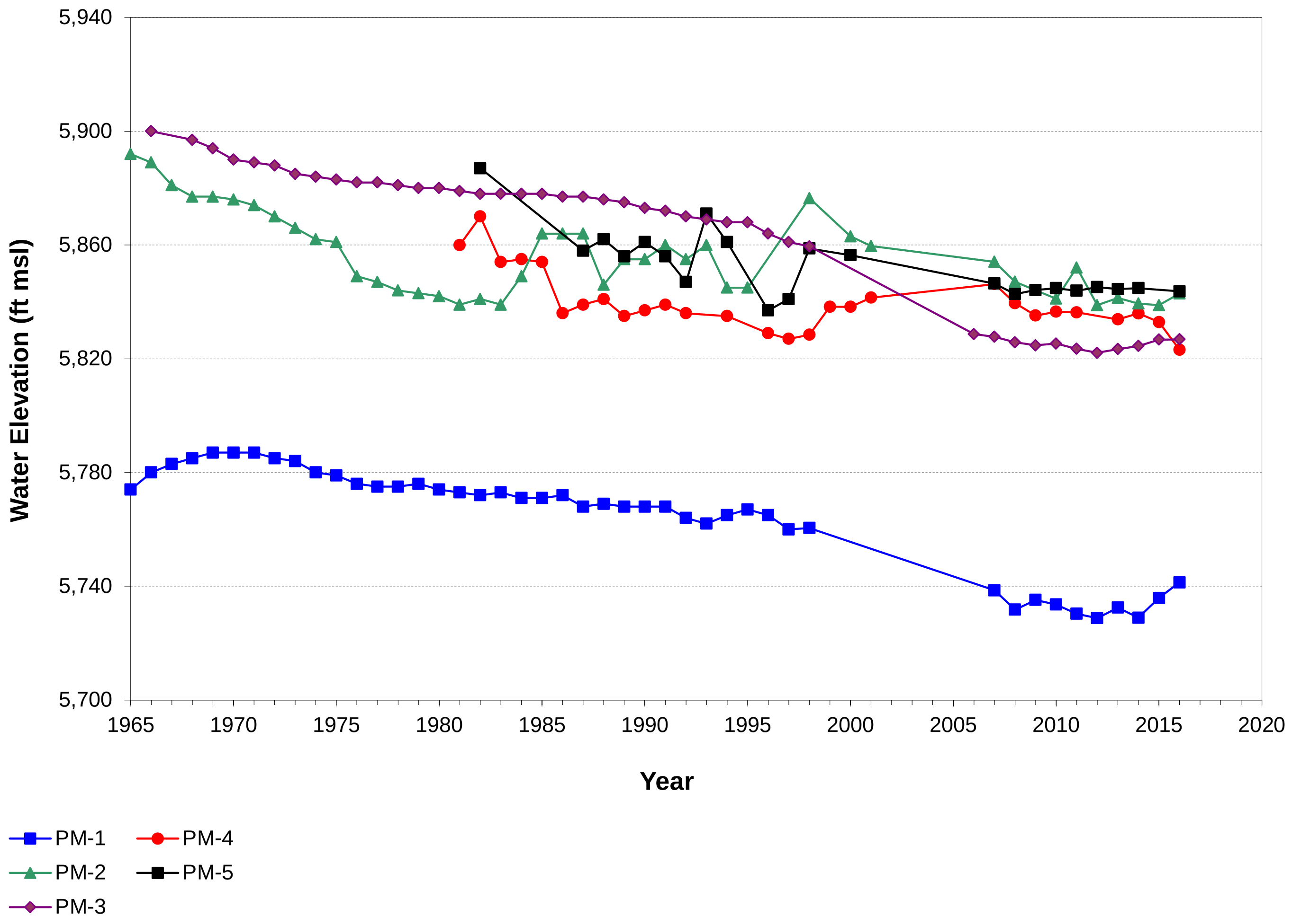
Figure 3-5



LOS ALAMOS COUNTY WATER PLAN

Average Annual Non-Pumping Water Levels
Pajarito Well Field

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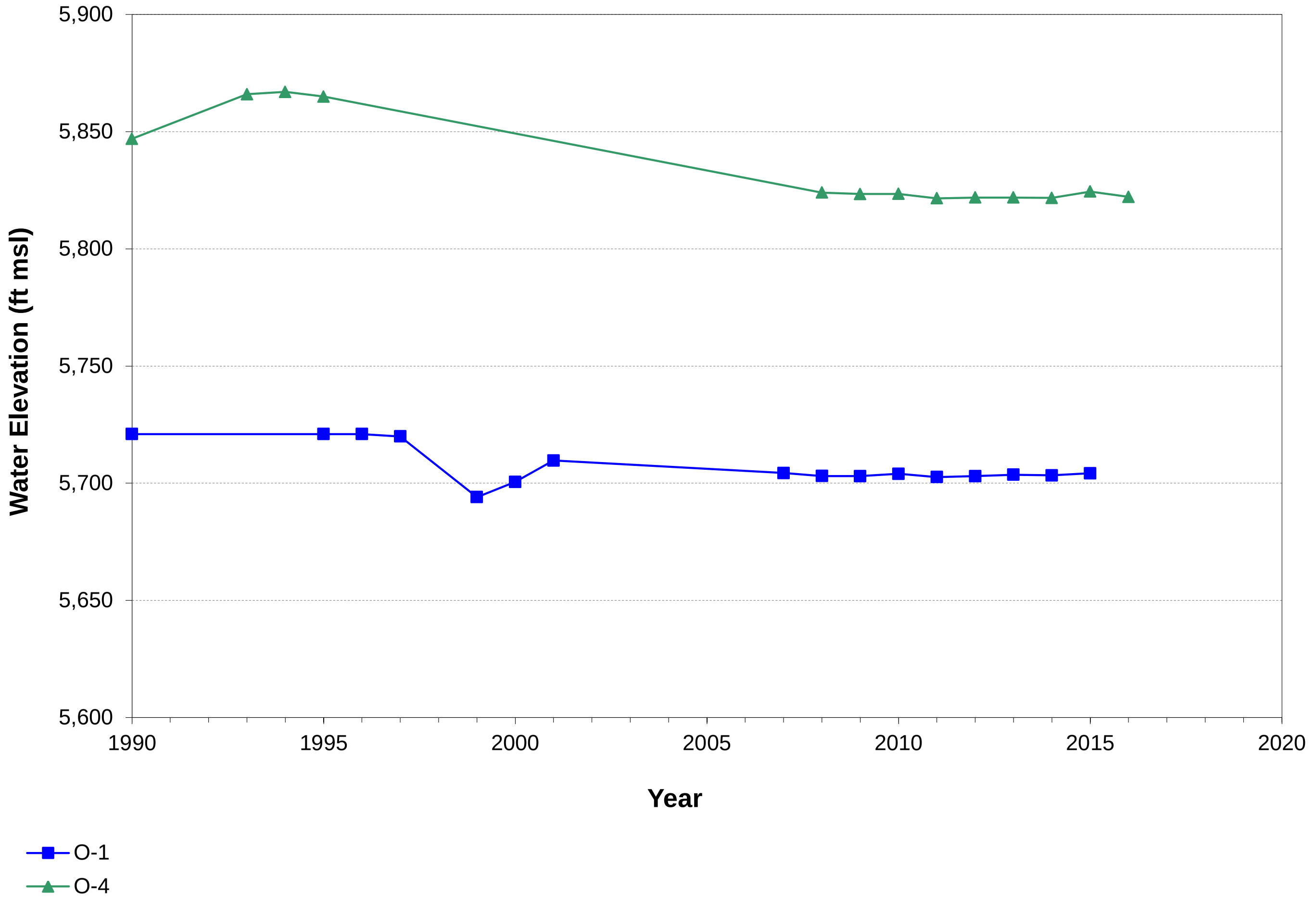
Figure 3-6



LOS ALAMOS COUNTY WATER PLAN

Average Annual Non-Pumping Water Levels
Otowi Well Field

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Figure 3-7

Table 3-2. Average Supply Well Water Level Declines

Well	Well Depth (ft)	Year	Average Water Level (ft msl)	Water Level Change (ft)	Years of Record	Average Decline (ft/yr)
PM-1	2,499	1965	5,774.0	–32.6	51	–0.64
		2016	5,741.4			
PM-2	2,300	1965	5,892.0	–49.1	51	–0.96
		2016	5,842.9			
PM-3	2,552	1966	5,900.0	–73.2	50	–1.46
		2016	5,826.8			
PM-4	2,874	1981	5,860.0	–36.8	35	–1.05
		2016	5,823.2			
PM-5	3,092	1982	5,887.0	–43.3	34	–1.27
		2016	5,843.7			
Pajarito Well Field Average (1965-2016)						**–1.08**
O-1	2,497	1990	5,721.0	–16.7	25	–0.67
		2015	5,704.3			
O-4	2,595	1990	5,847.0	–24.8	26	–0.95
		2016	5,822.2			
Otowi Well Field Average (1990-2016)						**–0.81**
G-1A	1,519	1954	5,764.0	–42.6	62	–0.69
		2016	5,721.4			
G-2A	1,980	1998	5,821.6	–84.8	17	–4.99
		2015	5,736.8			
G-3A	1,980	1998	5,815.2	–67.1	17	–3.95
		2015	5,748.1			
G-4A	1,980	1998	5,847.3	–57.3	18	–3.18
		2016	5,790.0			
G-5A	1,980	1998	5,863.3	–30.4	18	–1.69
		2016	5,832.8			
Guaje Well Field Average (1954-2016)						**–3.45**
G-1 (aband.)	2,000	1950	5,778.0	–79.0	47	–1.68
		1997	5,699.0			
G-2 (aband.)	1,980	1951	5,797.0	–98.8	47	–2.10
		1998	5,698.2			
G-3 (aband.)	1,800	1951	5,859.0	–122.0	49	–2.49
		2000	5,737.0			
G-4 (aband.)	1,940	1951	5,872.0	–11.0	47	–0.23
		1998	5,861.0			
G-5 (aband.)	1,850	1951	5,892.0	–45.0	43	–1.05
		1994	5,847.0			
G-6 (aband.)	1,530	1964	5,850.0	–11.4	34	–0.34
		1998	5,838.6			
Guaje Well Field Abandoned Wells Average (1950-1998)						**–1.32**

ft = feet   ft msl = feet above mean sea level   ft/yr = feet per year   aband. = abandoned

Using water level data, Rogers et al. (1996) estimated the volume of groundwater depletion from supply well production between 1949 and 1993 to be between 4.0 x 10^{10} and 6.0 x 10^{10} gallons (123,000 and 184,000 acre-feet), compared to total pumping withdrawals of 5.7 x 10^{10} gallons (175,000 acre-feet) during the same period. This analysis implies that recharge to the regional aquifer during this period was negligible and that production well pumping was essentially mining the aquifer. However, the recovery of water levels in wells that were not pumped for extended periods was cited by McLin et al. (1996) as evidence that recharge has occurred. Water levels can recover without recharge as the cone of depression that develops during pumping re-equilibrates, however, and it should be noted that the recharge estimates presented in Table 3-1 are on the same order as pumping withdrawals.

Even if net recharge is negligible, considering a demonstrated saturated thickness of at least 1,900 feet penetrated in supply well PM-5 and potentially as much as 10,000 feet of Santa Fe Group sediments underlying the plateau (Section 3.1), a continuation of the observed rates of decline does not represent a substantial imminent or foreseeable risk to the water supply. Barring potential water quality issues, continued pumping of the regional aquifer at current rates is likely to be sustainable for hundreds of years. LANL's Española Basin and Pajarito Plateau Regional Flow Model predicts that water levels will continue to decline at the same rate (with the same production rates) and that this rate can be sustained for hundreds of years (Keating, 2006). However, the water is expected to be of poorer quality as wells begin to draw from greater depths, and pumping costs will increase.

3.3 Contamination Risk

To evaluate the potential for the County water system to produce water quality that meets all drinking water standards, this section (1) identifies sources of contaminants in the Los Alamos area, (2) summarizes existing knowledge of contaminant transport pathways and velocities, and (3) summarizes the concentrations and extent of chromium, perchlorate, and other contaminants in groundwater.

3.3.1 Sources of Contamination

Since the early 1940s, a wide array of chemicals have been released into the canyons of the Pajarito Plateau from various LANL operations. These releases have occurred through effluent discharges from wastewater treatment facilities and other miscellaneous sources, such as sanitary septic systems, cooling towers, and runoff from firing sites and other LANL facilities. Figure 3-8 shows the locations of industrial outfall sites at LANL.

The presence of contaminants in groundwater in Los Alamos County is primarily associated with areas where effluent discharges have led to enhanced infiltration. Since the 1940s, liquid effluent discharge by LANL has affected the shallow perched alluvial groundwater that lies beneath the floor of a few canyons, and has also affected intermediate-perched zones and the regional aquifer (LANL, 2014a). The major effluent discharges include:

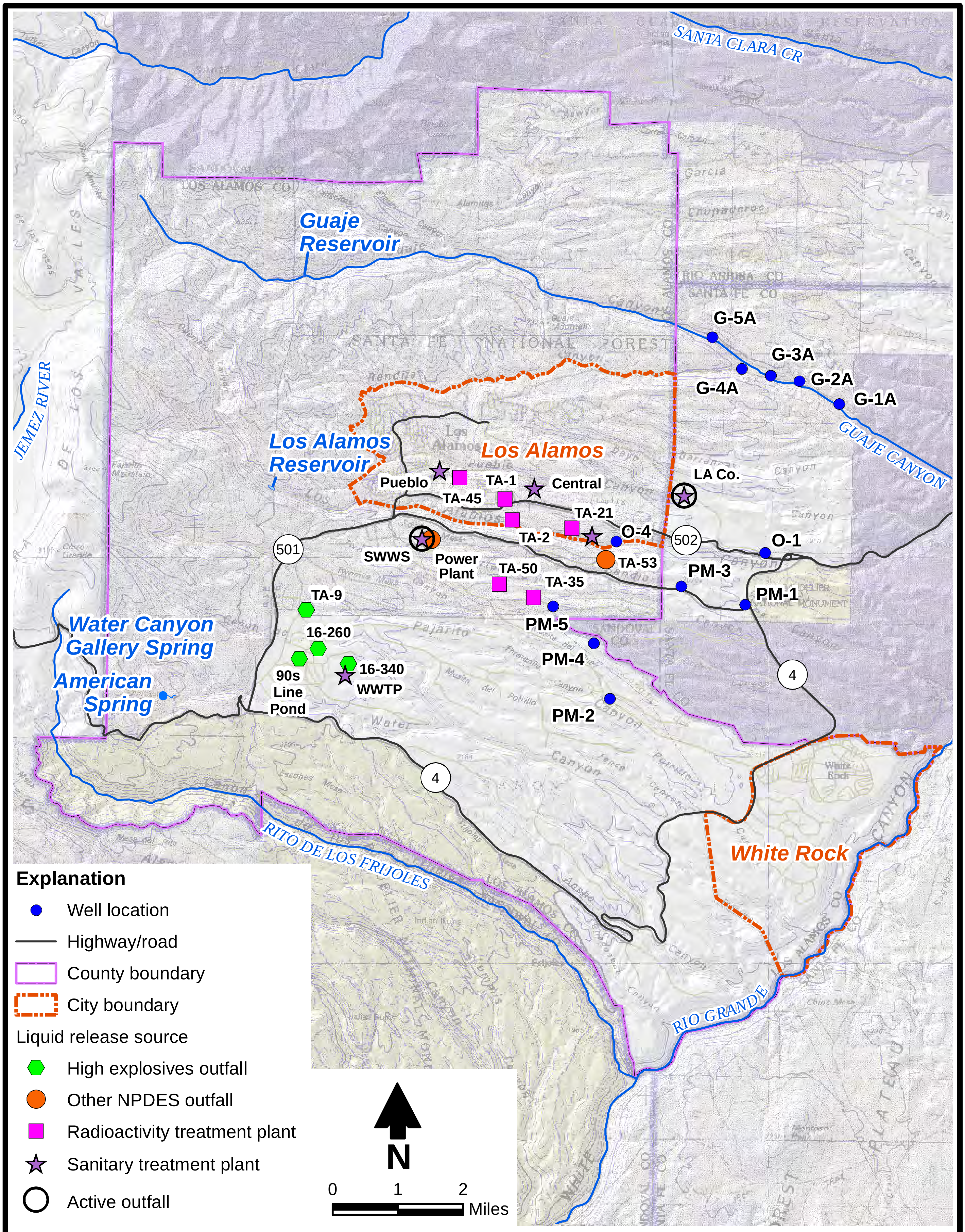
- Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon from its tributary DP Canyon received liquid radioactive effluents during past decades (LANL, 2015c).

- Sandia Canyon has received discharges of power plant cooling water and water from LANL’s Sanitary Wastewater Systems Consolidation (SWSC) Plant.

- Water Canyon and its tributary Cañon de Valle have received effluents produced by high explosives processing and experimentation (LANL, 1993a, 1993b).

- Over the years, Los Alamos County has operated several sanitary wastewater treatment plants (WWTPs) in Pueblo Canyon (LANL, 1981). The Los Alamos and White Rock WWTPs are currently operating. LANL has also operated numerous sanitary treatment plants.

- From 1956 through 1976, up to 160,000 pounds of hexavalent chromium were released from cooling towers at a LANL power plant. The chromium was commonly used in industry at the time as a corrosion inhibitor (LANL, 2014b).



Source: LANL, 2014b, Figure 5-4

LOS ALAMOS COUNTY WATER PLAN

Major Industrial Outfall Sites

Figure 3-8

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S:\PROJECTS\WR14.0178_LOS_ALAMOS_COUNTY\GIS\MXDS\FIGURES_2016-08\FIG_3-8_OUTFALLS.MXD

Since the early 1990s, LANL has significantly reduced both the number of industrial outfalls and the volume of water discharged. The quality of the remaining discharges has been improved through treatment process improvements so that they meet applicable standards (LANL, 2014a).

Los Alamos groundwater monitoring has defined two areas of notable contamination: RDX contamination beneath Technical Area 16 and chromium contamination beneath Sandia and Mortandad Canyons (LANL, 2015c).

3.3.2 Contaminant Transport Pathways and Velocities

Numerous pathways for potential contaminant transport are present throughout the Pajarito Plateau. Transport modes for contaminants from the surface to the regional aquifer vary according to the hydrogeologic setting and include:

- Matrix flow through nonwelded and poorly welded tuffs (mesa tops and dry canyons)
- Fracture flow through welded tuffs (mountain front and Pajarito Fault zone)
- Fracture and matrix flow through dense and brecciated basalts (Cerros del Rio basalt outcrop at low-head weir and perched intermediate aquifers)
- Infiltration from wet canyons (portions of Los Alamos Canyon, Pueblo Canyon, Mortandad Canyon, Sandia Canyon, and Cañon de Valle)

Transport velocities are highly variable throughout the plateau. Infiltration beneath dry canyons and mesa tops is estimated to be very low, resulting in travel times to the regional aquifer of several hundred to thousands of years (Birdsell et al., 2005). On the other hand, fracture flow through fractured tuffs or basalts is likely to be comparatively rapid in many locations. Although they vary spatially, groundwater velocities are typically on the order of 30 feet per year (LANL, 2016).

Another possible contaminant transport pathway is potential cross contamination between perched aquifers and the regional aquifer during well drilling, primarily when open borehole conditions are maintained over an extended period of time. Well drilling by LANL has incorporated procedures to minimize this risk, such as sealing off zones of saturation above the regional aquifer prior to advancing the borehole to the regional aquifer. Data do not indicate any cases of cross contamination in the monitoring network; however, future drilling should include the procedures that are in place to minimize the risk of cross contamination.

The chemical properties of each contaminant control the degree to which they move into the subsurface. Reactive chemicals have a tendency for adsorption (adhesion of dissolved molecules to the surfaces of solids), limiting their movement in groundwater, while conservative or non-reactive chemicals tend to move readily in groundwater. Examples of these two types of contaminants that have been released from LANL facilities are:

- Non-reactive contaminants include chromium, tritium, nitrate, perchlorate, and RDX (a component of explosives, also known as cyclotrimethylenetrinitramine, cyclonite, hexogen, and T4). These chemicals are highly mobile and are observed in groundwater within perched intermediate zones and the regional aquifer beneath several canyons, including Cañon de Valle, Los Alamos Canyon, Mortandad Canyon, Pueblo Canyon, and Sandia Canyon (LANL, 2005).

- Reactive contaminants include strontium-90, americium-241, cesium-137, plutonium-238, -239, and -240 (LANL, 2005). These contaminants have been detected in the alluvial system but are not observed in the intermediate and regional aquifers.

3.4 Extent of Contamination and Risk to Water Supply

To evaluate the risk of contamination to the County's water supply, this section summarizes existing contaminant levels in the regional aquifer (Section 3.4.1) and provides additional detail on perchlorate, hexavalent chromium, and other contaminants (Sections 3.4.2 through 3.4.4).

3.4.1 Summary of Contamination in Groundwater

Monitoring of production wells is conducted by the DPU as part of routine monitoring and compliance with the U.S. Safe Drinking Water Act, and monitoring is also conducted by LANL. Recent monitoring and reporting indicates that all drinking water produced by the County's water system meets federal and state drinking water standards. Drinking water wells in the Los Alamos area have not been impacted by LANL discharges with one exception: well Otowi-1

(O-1) in Pueblo Canyon, where perchlorate has been detected below the 2012 LANL Compliance Order on Consent screening level of 4-micrograms per liter (µg/L) (the 2016 LANL Compliance Order on Consent does not include a screening level for perchlorate and the perchlorate standard that will apply going forward is a New Mexico Environment Department (NMED) tap water screening level of 13.8 µg/L). Concentrations of perchlorate in this well are continuing to decline (LANL, 2016). Tritium has also been detected at low levels in well O-1. This well is not being used to supply drinking water due to water leaks in the transmission line, but the DPU plans to put it back online in the future after this pipeline has been replaced.

Table 3-3 summarizes groundwater contaminants that were detected in the regional aquifer in 2015. These data were downloaded from the LANL and NMED Intellus New Mexico web site (LANL and NMED, 2016). Data for well O-1 has been included on Table 3-3, although there were no standard exceedances for samples collected from this well.

The alluvial and intermediate-perched groundwater bodies are separated from the regional aquifer by hundreds of feet of unsaturated rock and sediments, so recharge from the shallow groundwater occurs slowly. As a result, less contamination reaches the regional aquifer than is found in the shallow perched groundwater (LANL, 2014a). Where contaminants are found at depth, the setting is either a canyon where alluvial groundwater is usually present or a location beneath canyons where large amounts of liquid effluent have been discharged. This section focuses mainly on contamination that has been detected in the regional aquifer, since it is the source of the County water supply.

Discussion of the extent and concentrations of specific contaminants follows.

3.4.2 Perchlorate Contamination

Perchlorate is used as an energetics booster or oxidant in solid propellant for rockets and missiles. An official standard for this chemical has not been established. A screening level for perchlorate of 4 µg/L was set in the LANL Compliance Order on Consent issued by NMED on March 1, 2005 and revised on April 20, 2012 (NMED, 2012); however, a new LANL Compliance Order on Consent was issued in 2016 and it does not include a screening level for perchlorate (NMED, 2016). The perchlorate standard that will apply going forward is an NMED tap water screening level of 13.8 µg/L (NMED, 2014).

Table 3-3. Groundwater Contaminants in the Regional Aquifer in 2015

Chemical	Location	Concentration [a] (µg/L [b])		Trends
		Result	Screening Level	
Regional Aquifer (LANL and NMED, 2016)				
Perchlorate	Mortandad Canyon	**≤ 99.4**	4 [c] 13.8 [d]	
Hexavalent chromium	Sandia Canyon	**≤ 386** (2014)	50 [e]	Flat trend in the center of the plume (monitoring wells R-42 and R-28) and gradually increasing trend along the edge of the plume (monitoring wells R-45 screen 1, R-43 screen 1, and R-50 screen 1).
	Mortandad Canyon	**≤ 915**	50 [e]	
Los Alamos County Water Supply Wells (LANL and NMED, 2016)				
Tritium	Well O-1	2.373 pCi/L	20,000 pCi/L [f]	Results have declined since 2004, when there was a detection of 58 pCi/L.
Perchlorate	Well O-1	0.515	4 [c] 13.8 [d]	Results variable, but declining since 2008; concentrations ≤ 3 µg/L since 2001.

[a] **Bold** text indicates standard exceedances.

[b] Unless otherwise noted

[c] 2012 LANL Compliance Order on Consent screening level (NMED, 2012)

[d] NMED tap water screening level (NMED, 2014)

[e] NMWQCC Groundwater Standards for Human Health (20.6.2.3103)

[f] The EPA has established an MCL of 4 millirem per year for beta particle and photon radioactivity from man-made radionuclides in drinking water. The average concentration of tritium that is assumed to yield 4 millirem per year is 20,000 pCi/L. If other radionuclides that emit beta particles and photon radioactivity are present in addition to tritium, the sum of the annual dose from all the radionuclides shall not exceed 4 millirem per year (U.S. EPA, 2002).

µg/L = Micrograms per liter
≤ = Less than or equal to
pCi/L = PicoCuries per liter

Perchlorate contamination is present in groundwater beneath Mortandad Canyon (LANL, 2016). In 2015, perchlorate concentrations exceeded 4 µg/L in samples collected from 8 monitoring wells, one of which (R-15) is completed in the regional aquifer (LANL, 2016). The concentrations detected in 2015 in the regional aquifer well R-15 ranged between 7.22 and 9.05 µg/L (LANL and NMED, 2016). The 4-µg/L screening level was the standard in effect in 2015, but with the higher standard being applied in the future, the number of standard exceedances is expected to decrease (any similar concentrations detected in the future will not exceed the 13.8-µg/L screening level). The two monitoring wells with the highest detected concentrations of perchlorate in 2015 were MCOI-5 and MCOI-6 (LANL and NMED, 2016), and these wells are completed in the perched-intermediate aquifer (LANL, 2016). The concentrations detected in these wells in 2015 ranged between 61.1 and 99.4 µg/L (LANL and NMED, 2016).

3.4.3 Hexavalent Chromium

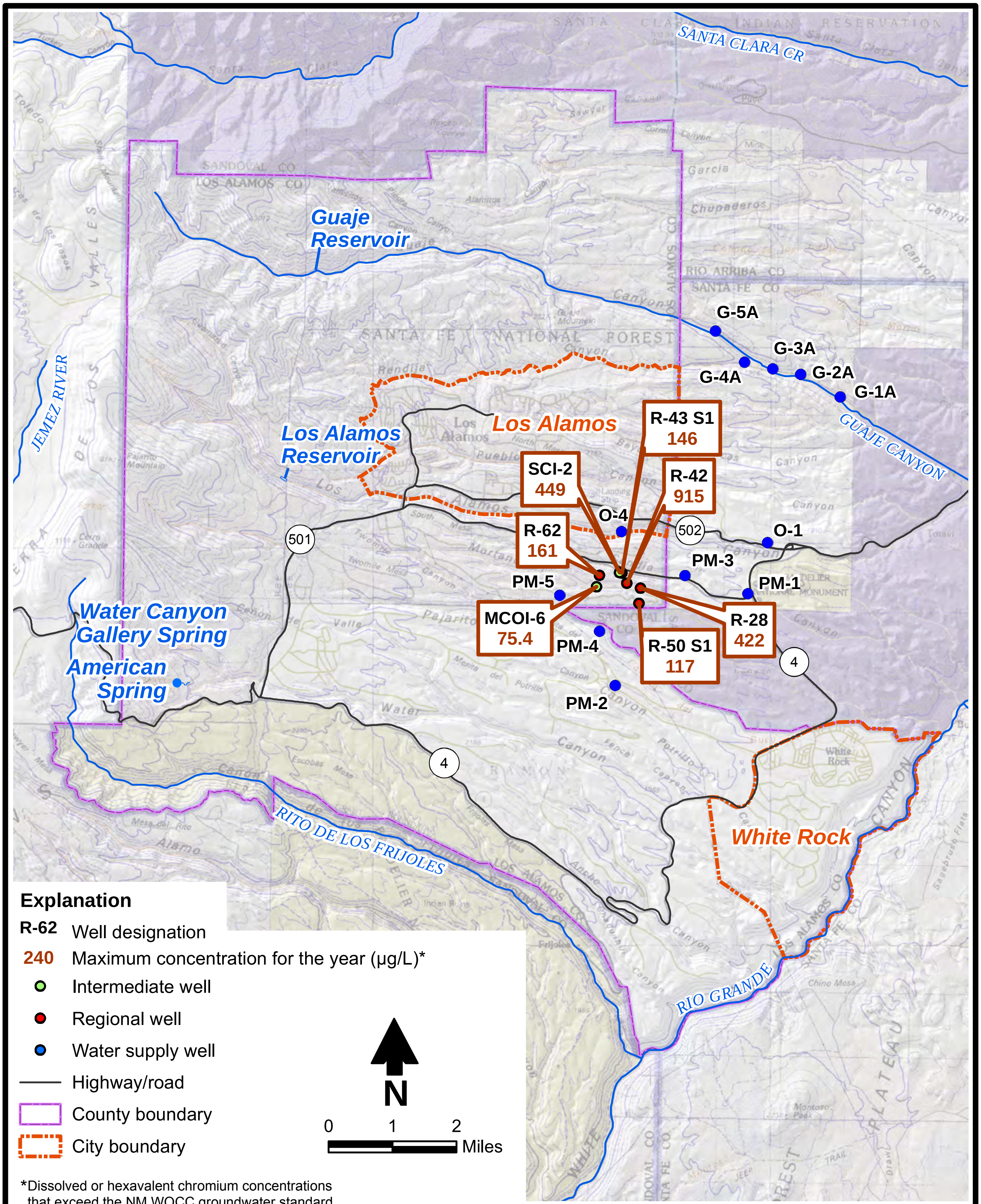
Most contaminants that have been detected in groundwater beneath LANL have concentrations that are largely below regulatory standards; however, a hexavalent chromium plume is present in the regional aquifer. Chromium can be present in either the Cr^{+3} (trivalent chromium) or Cr^{+6} (hexavalent chromium) species. Cr^{+3} is an essential nutrient for humans and occurs naturally in many foods; Cr^{+6} causes various health effects. The U.S. Environmental Protection Agency (U.S. EPA) is currently reviewing data from a 2008 long-term animal study by the Department of Health and Human Service's National Toxicology Program, which concluded that hexavalent chromium may be a human carcinogen if ingested (U.S. EPA, 2015a).

The primary source of chromium in groundwater beneath LANL is blowdown of potassium dichromate from the TA-03 power plant cooling tower that occurred from 1956 to 1972. LANL’s conceptual model hypothesizes that chromium originated from releases into Sandia Canyon and may have migrated along lateral pathways to locations beneath Mortandad Canyon. For this reason, perched-intermediate and regional wells beneath Mortandad Canyon are monitored. Other contamination beneath Sandia and Mortandad Canyons may be associated with Mortandad Canyon sources. These sources and the migration pathways are described in the *Investigation Report for Sandia Canyon* (LANL, 2009) and *Phase II Investigation Report for Sandia Canyon* (LANL, 2012).

As discussed in the original long-range water supply plan (DBS&A, 2006), several exceedances of the New Mexico Water Quality Control Commission (NMWQCC) groundwater standard for human health of 50 µg/L for chromium were observed in samples collected in 2005 from monitoring well R-28. Since the 2006 water plan was completed, the areal extent and concentrations within the plume have been better defined. The chromium plume is located in an area of approximately 1 mile by 0.5 mile and within the top 50 feet of the regional aquifer (LANL, 2016). Data for monitoring wells where there were chromium concentration exceedances of the NMWQCC groundwater quality standard for human health in 2015 are shown on Figure 3-9.

In 2015, hexavalent chromium concentrations exceeded the NMWQCC groundwater quality standard in five regional aquifer monitoring wells—R-28, R-42, R-62, R-50 Screen 1, and R-43 Screen 1 (Figure 3-9)—and the highest concentrations of hexavalent chromium detected in the plume are near monitoring wells R-42 and R-28. Two intermediate wells (SCI-2 and MCOI-6) also had hexavalent chromium concentrations above the standard (LANL, 2016). The monitoring wells located in the center of the plume (R-42 and R-28) show a relatively flat trend in the hexavalent chromium concentrations, while monitoring wells along the edge of the plume (R-45 Screen 1, R-43 Screen 1, and R-50 Screen 1) show gradually increasing hexavalent chromium concentrations (LANL, 2016). The production well that is located closest to the hexavalent chromium plume is PM-3, which is located about ½ mile from R-28 (Figure 3-9). Hexavalent chromium detections in monitoring wells R-35a and R-35b (located adjacent to PM-3 and screened deep in the upper louvered section of PM-3 and at the water table, respectively) are at background levels (Katzman, 2016). Well PM-3 could become contaminated in the future, depending on the direction of groundwater flow and on the interim measures being implemented by LANL (discussed below) to control plume migration (LANL, 2015b).

The screened interval in monitoring well R-28 is from 934 to 958 feet deep, extending only 69 feet into the top of the regional aquifer, while PM-3 is screened at much greater depths (from 956 to 2,532 feet), therefore producing water from a much larger section of the aquifer. If the chromium plume were to reach PM-3 yet be confined to a shallow segment near the top of the aquifer, the concentration is likely to be highly diluted as a result of pumping from an interval of more than 1,500 feet. Nevertheless, the presence of hexavalent chromium near the well represents a risk that should be carefully monitored. During 2015, the NMED DOE Oversight



*Dissolved or hexavalent chromium concentrations that exceed the NM WQCC groundwater standard of 50 µg/L for human health.

Source: LANL, 2016

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LOS ALAMOS COUNTY WATER PLAN

Monitoring Wells with 2015 Chromium Concentration Exceedances

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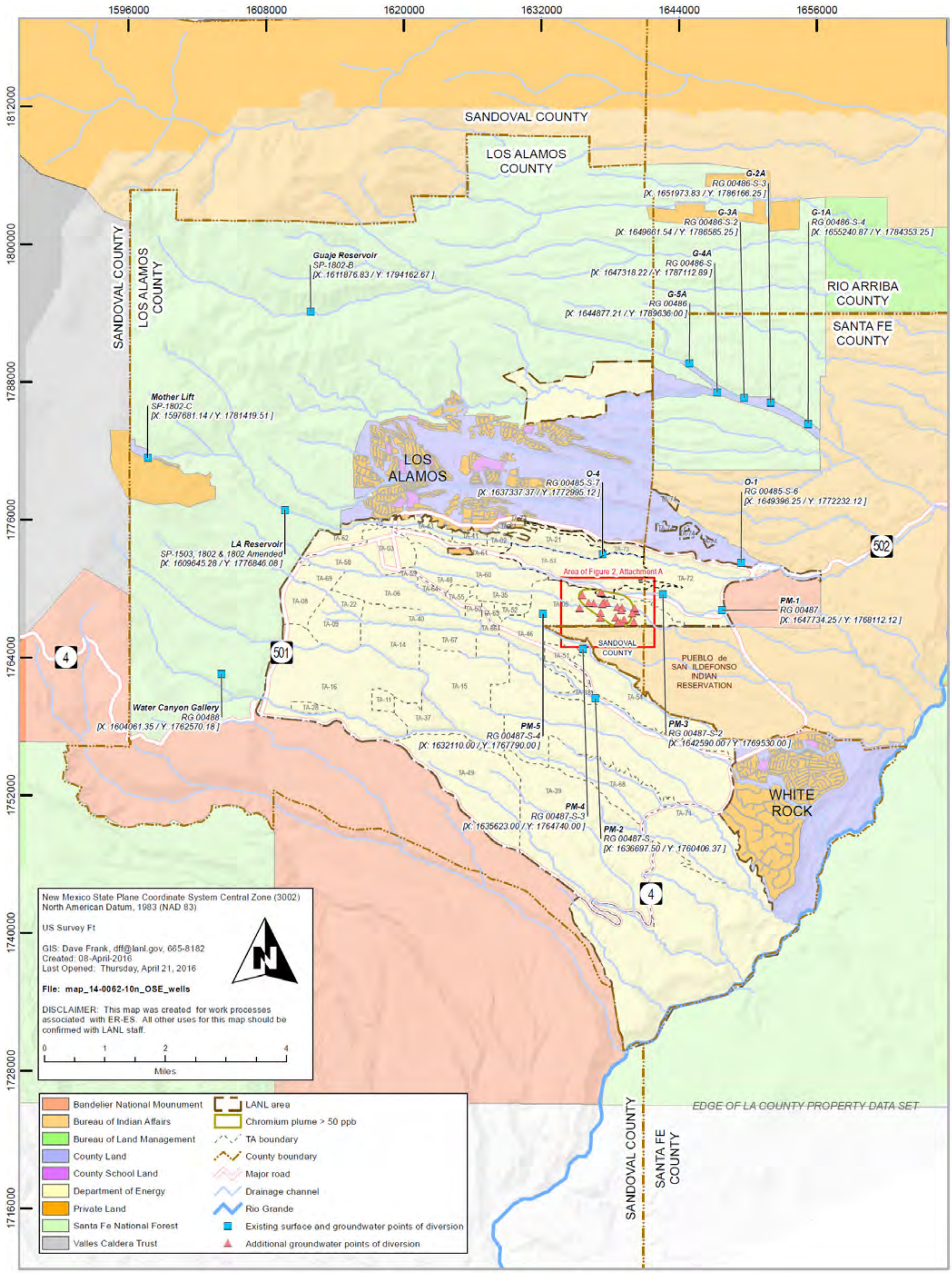
Figure 3-9

Bureau coordinated with the NMED Drinking Water Bureau on a scope of work for a potential project to assess the vulnerability of the water supply wells to contamination; however, due to grant timing and State contracting limitations, the project has been put on hold (Yanicak, 2016). In the event that any of the production wells are impacted by hexavalent chromium, the DPU maintains an insurance policy to fund and implement corrective actions, as needed.

The May 2015 Interim Measures Work Plan (LANL, 2015a) presents LANL's approach for controlling movement of chromium-contaminated groundwater along the downgradient portions of the plume. LANL plans to extract contaminated groundwater, treat it at the surface using ion exchange, and reinject it into the aquifer, with project implementation beginning in 2016 (LANL, 2016). In an October 2015 letter, NMED approved the LANL work plan and set due dates for the interim measure task work plans (NMED, 2015b). Figure 3-10a shows the chromium interim measure project area in relation to the rest of the County, and Figure 3-10b shows the existing and planned extraction, injection, and monitoring wells, and provides an approximate areal extent of the hexavalent chromium-contaminated groundwater that exceeds the 50-µg/L NMWQCC groundwater standard for human health (U.S. DOE and LADPU, 2016). The work plan also provides a general description of the planned treatment system, including two ion exchange vessels for treatment and redundancy (LANL, 2015b).

In addition, LANL is conducting work under the July 2015 *Work Plan for Chromium Plume Center Characterization* to further investigate the aquifer in the center of the chromium plume and to further characterize the nature and extent of the contamination in order to identify remedial alternatives for the chromium plume (LANL, 2015b). Objectives include investigating the feasibility of chromium source removal, further characterizing the aquifer—including heterogeneity and dual porosity—in order to evaluate the potential for in situ remedial strategies, studying the hydrologic and geochemical conditions that occur near the proposed injection wells, and characterizing the infiltration beneath the shallow alluvial groundwater in Sandia Canyon (LANL, 2015b). The LANL chromium plume center characterization work plan details planned LANL activities, including extraction well installation, pumping, and sampling, aquifer tracer tests and a field cross-hole trace study, an injection well study, and characterization of infiltration in Sandia Canyon (LANL, 2015b).



New Mexico State Plane Coordinate System Central Zone (3002)
North American Datum, 1983 (NAD 83)

US Survey Ft

GIS: Dave Frank, dff@lanl.gov, 665-8182
Created: 08-April-2016
Last Opened: Thursday, April 21, 2016

File: map_14-0062-10n_OSE_wells

DISCLAIMER: This map was created for work processes associated with ER-ES. All other uses for this map should be confirmed with LANL staff.

- ▨ Bandelier National Mounument
- ▨ Bureau of Indian Affairs
- ▨ Bureau of Land Management
- ▨ County Land
- ▨ County School Land
- ▨ Department of Energy
- ▨ Private Land
- ▨ Santa Fe National Forest
- ▨ Valles Caldera Trust
- LANL area
- Chromium plume > 50 ppb
- TA boundary
- County boundary
- Major road
- Drainage channel
- Rio Grande
- ■ Existing surface and groundwater points of diversion
- ▲ Additional groundwater points of diversion

Source: U.S. DOE and LACWU, 2016

LOS ALAMOS COUNTY WATER PLAN

Points of Diversion

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Figure 3-10a

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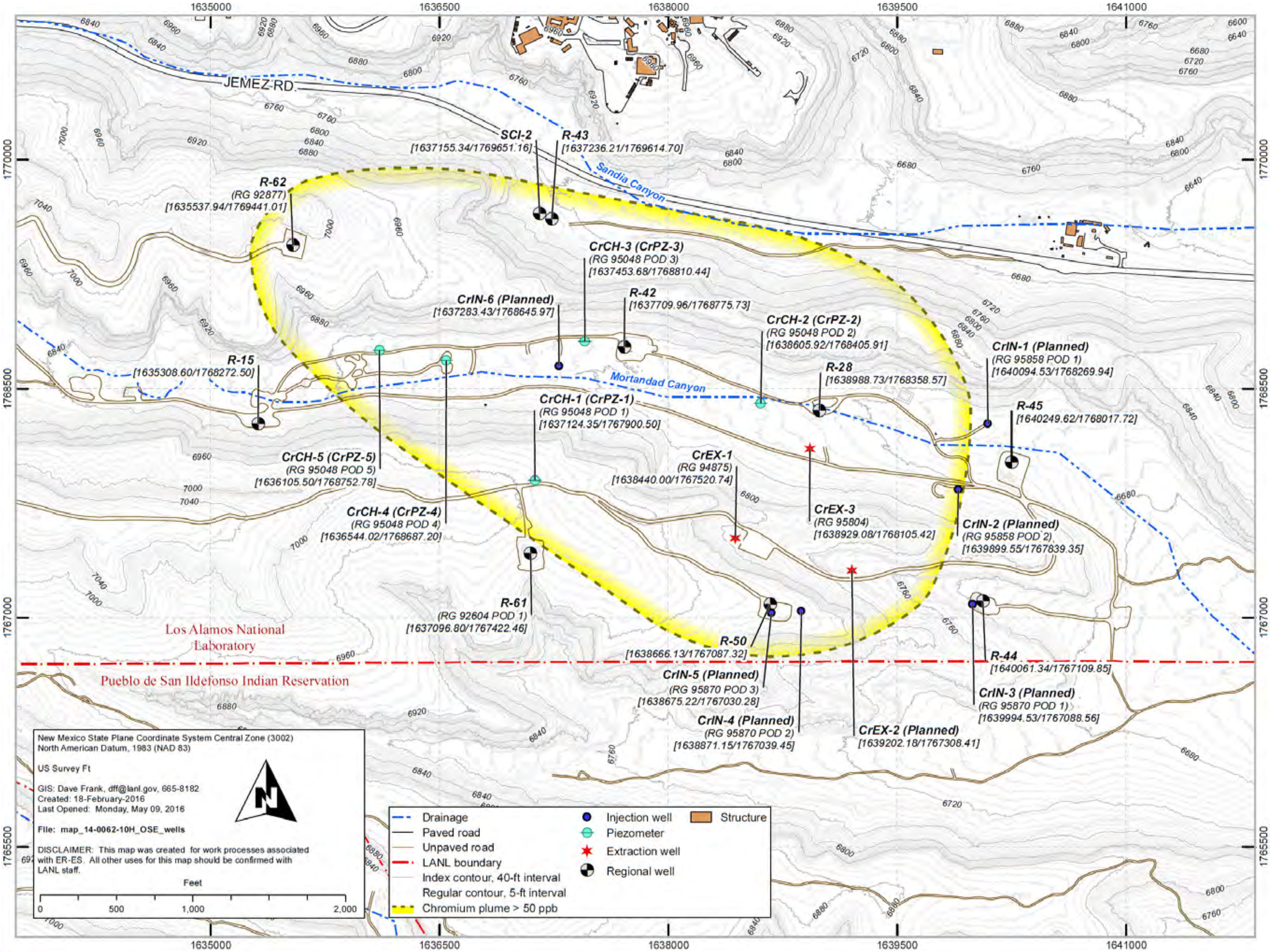

Source: U.S. DOE and LACWU, 2016

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LOS ALAMOS COUNTY WATER PLAN
Points of Diversion

Figure 3-10b

LANL plans to work with the DPU to ensure that the interim measure pumping does not interfere with the water supply pumping and to continue to monitor water quality in the monitoring and water supply wells (LANL, 2014c). In addition, LANL will prepare a corrective measures evaluation report that proposes the final remedy for the chromium plume (LANL, 2015b).

3.4.4 Other Contaminants in Groundwater

A number of additional contaminants have been detected in groundwater, including nitrate, RDX, tritium, trichloroethene, and radioactive contaminants. These contaminants are discussed briefly in the sections that follow.

3.4.4.1 Nitrate

Nitrate (NO_3 as nitrogen) has been detected in the regional aquifer at concentrations of up to 6.1 milligrams per liter (mg/L) in monitoring wells R-43 S1 and R-11 in Sandia Canyon and R-42 in Mortandad Canyon (the U.S. EPA national primary drinking water standard and NMWQCC groundwater standard for human health are both 10 mg/L). Nitrate (as N) concentrations are also elevated (> 2 mg/L) in samples from regional aquifer monitoring wells R-36 in Sandia Canyon and R-15, R-28, and R-45 in Mortandad Canyon (LANL, 2014a).

3.4.4.2 RDX

RDX, a component of explosives, has been detected in groundwater. An official standard for this chemical has not been established; however, the EPA's tap water screening level for RDX is 0.70 µg/L (U.S. EPA, 2016). LANL indicated that EPA is using a target risk of E–6 for RDX (0.70 x 10^{-6} µg/L), and that NMED requires LANL to use a target risk of E–5 (Katzman, 2015). The RDX standard used by LANL is 7.0 µg/L (NMED, 2015a).

RDX is monitored by LANL, and RDX concentrations exceed LANL's 7.0-µg/L standard at two springs (Burning Ground Spring and Martin Spring), one alluvial well (CdV-16-02659), and three intermediate-perched zone wells (CdV-16-4ip S1, CdV-16-2(i)r, and CdV-16-1(i)) near TA-16 in the Water Canyon watershed (LANL, 2015c). RDX is also persistently detected in regional aquifer monitoring wells R-18 and R-63 at concentrations that are below the standard. In 2015, the maximum concentrations detected were 1.66 µg/L in R-63 and 2.86 µg/L in R-18. The concentrations in R-63 have been relatively steady since this well was installed in 2011, with the exception of the first few samples following well construction. Detected concentrations in R-18 show an increasing trend since the well was completed in 2006 (LANL, 2016).

3.4.4.3 Trichloroethene and Tetrachloroethene

Chlorinated solvents are present in the groundwater near TA-16 (LANL, 2015c). Trichloroethene (TCE) was detected in Pajarito Canyon regional aquifer monitoring well R-20 S2 beginning in late 2008 and continued to be detected in every sampling event through 2011. In 2015, TCE was not detected in R-20 S2 (LANL and NMED, 2016). In 2014, tetrachloroethene (PCE) and TCE were detected in alluvial well FLC-16-25280 at concentrations above the U.S. EPA national primary drinking water standards of 5 µg/L (LANL and NMED, 2016).

3.4.4.4 Radioactive Contaminants

Radioactive effluent was discharged into Los Alamos Canyon during the earliest Manhattan Project operations at TA-01 (1942 through 1945) and from nuclear reactors at TA-02 (until 1993). Liquid and solid radioactive wastes were also discharged in Los Alamos Canyon from TA-21, and radionuclides and metals were discharged from the sanitary sewage lagoons and cooling towers at the Los Alamos Neutron Science Center at TA-53. Compared with past decades, little radioactivity is now found in groundwater samples. In 2013, strontium-90 was detected in shallow alluvial wells in DP and Los Alamos Canyons, at concentrations of up to 17 picoCuries per liter (pCi/L) (LANL, 2014a). The U.S. EPA has established a national primary drinking water standard of 4 millirem per year (mrem/yr) for beta particle and photon radioactivity from man-made radionuclides in drinking water (including strontium-90, which emits beta particles during radioactive decay). Based on conversions provided by the U.S. Department of Commerce Bureau of Standards, the derived concentration of 8 pCi/L is equivalent to a dose of 4 mrem/yr for strontium-90 (U.S. Department of Commerce, 1959; U.S. EPA, 2015b). Samples collected from alluvial well LAO-3a continue to exceed the standard. In 2015, the strontium-90 concentration in this well was 12.4 pCi/L (LANL and NMED, 2016).

Tritium activities in groundwater peaked in the early 1980s and have since declined. Tritium was detected in water supply well O-1 at an activity of 2.373 pCi/L in 2015 (LANL and NMED, 2016). In the intermediate zone monitor wells MCOI-5 and MCOI-6, tritium was detected in

2015 at activities of 3,140 and 2,940 pCi/L, respectively. The U.S. EPA's dose-based drinking water standard for tritium is 4 mrem/yr, based on a maximum contaminant level of 20,000 pCi/L (U.S. EPA, 2002).

3.5 Surface Water Supply

Though most of the County’s water supply is from groundwater, there are two sources of surface water supply:

- The Los Alamos Canyon reservoir has provided non-potable water supplies to schools, parks, and a golf course. The reservoir filled with debris following the 2000 Cerro Grande Fire, and the area was further impacted by the 2011 Los Conchas fire and subsequent flooding. The debris was cleared and reservoir repair and reconstruction was completed in the spring of 2013, but a flood in September 2013 filled the reservoir with silt again. The reservoir has been dredged and the DPU plans to install a new pipeline from the reservoir into town in order to connect to the existing non-potable infrastructure (Meyers, 2016).

- The County has the potential to use Rio Grande surface water from the San Juan-Chama Project in the future, though a diversion structure has not yet been constructed. Bringing the San Juan-Chama Project water online would diversify the water supply geographically and also in terms of water rights (using surface water rights from the Colorado River Basin in addition to native groundwater from the Rio Grande Basin), helping the County to mitigate any future effects due to contamination of existing wells and/or climate change. Details of a potential San Juan-Chama Project diversion and County water rights are discussed in Section 4.

Since surface water currently supplies only non-potable supplies, surface water contamination is not a primary issue for drinking water quality. However, careful management of stormwater runoff, particularly in areas impacted by fire, is an important water resource management issue for Los Alamos County, as discussed in Section 7. Surface water quality will become more of an issue if and when a project to use San Juan-Chama Project water comes online.

4. Water Rights

In addition to having sufficient physical supply, the County needs to have the legal rights to use the water. New Mexico water law is founded on the principle that all water in New Mexico belongs to the State of New Mexico, which thus has the sole authority to grant or recognize rights to use that water. Two further tenets, both based on New Mexico Constitution Article XVI, Section 2, are that (1) water rights “are subject to appropriation for beneficial use, in accordance with the laws of the state” and (2) ”priority of appropriation shall give the better right.”

- The concept underlying the principle of prior appropriation is that the first person to use water for a beneficial purpose has a prior right to use that water against subsequent appropriators. Water rights acquired through this system of prior appropriation are a type of property right and may be sold or leased.

- The essential basis of water right ownership is beneficial use. The principle of beneficial use is that a water right arises out of a use that is productive or beneficial, such as agricultural, municipal, industrial, and domestic uses, among others.

The State Engineer, through the OSE, administers water rights for the State of New Mexico:

- To actively manage groundwater resources in New Mexico, the State Engineer has the authority, as set forth in the Water Code, to delineate groundwater basins that require a permit for groundwater withdrawals. Such a permit specifies (1) how much water a user can withdraw in any given year, (2) the location and type of well that will be used to withdraw the water, and (3) the use to which the water will be put. Many water right permits have special conditions that further define the use and quantity of water allowed under the permit.

- Like groundwater, the diversion of water from New Mexico’s surface waters requires either a declaration, permit, license, or court decree to divert the water. Surface water appropriations follow the same standards as groundwater rights in that a transfer or lease cannot impair existing water rights and must not be contrary to public welfare or conservation (NMSA 72-5-23, 72-12-3(D)).

Many of New Mexico's surface waters are governed by interstate compacts that require set amounts of water to be delivered to specified delivery points. The Interstate Stream Commission (ISC), an adjunct commission to the OSE, has responsibility for ensuring that specific rivers in New Mexico meet their obligations under their respective interstate compacts.

4.1 Water Rights

The County has existing water rights from a variety of sources, including water rights from the Rio Grande surface water and underground water basins and rights to use 1,200 acre-feet of water from the San Juan-Chama Project. The U.S. DOE also owns Rio Grande underground water basin rights. These rights are discussed in Sections 4.1.1 and 4.1.2, respectively.

4.1.1 Rio Grande Surface Water and Groundwater Rights

As discussed in Section 2, the County's Rio Grande water rights were originally owned by the U.S. DOE. In 2001, 70 percent ownership was transferred to the County, and DOE retained 30 percent ownership. Table 4-1 summarizes these permitted, licensed, and declared water rights.

Table 4-1. Summary of Water Rights

Permit Number	Water Source	Priority Date	Quantity of Water Originally Appropriated (ac-ft/yr)
RG-485 through RG-496-Comb-S-4 [a]	Groundwater	1948-1951	5,329
RG-485 through RG-496-Comb-S-5 [b]	Groundwater	1948-1951	50
1503,1802, and 1802-amended [c]	Surface water	March 14, 1922	168.1
Evaporation loss	Surface water	NA	(5.8)
		Total water rights	5,541.3 [d]

Source: Southwest Water Consultants, Inc., 1999

[a] Permitted August 31, 1965 from numerous underground water right declarations filed on March 5, 1957 and amended in 1965. These declarations identified actual use of 3,966 acre-feet in 1964, a capacity of 6,579 ac-ft/yr, and an OSE feasible diversion of 5,329 ac-ft/yr. Dates that water was put to beneficial use vary.

[b] Subsequent declarations added an additional 50 acre-feet and new points of diversion.

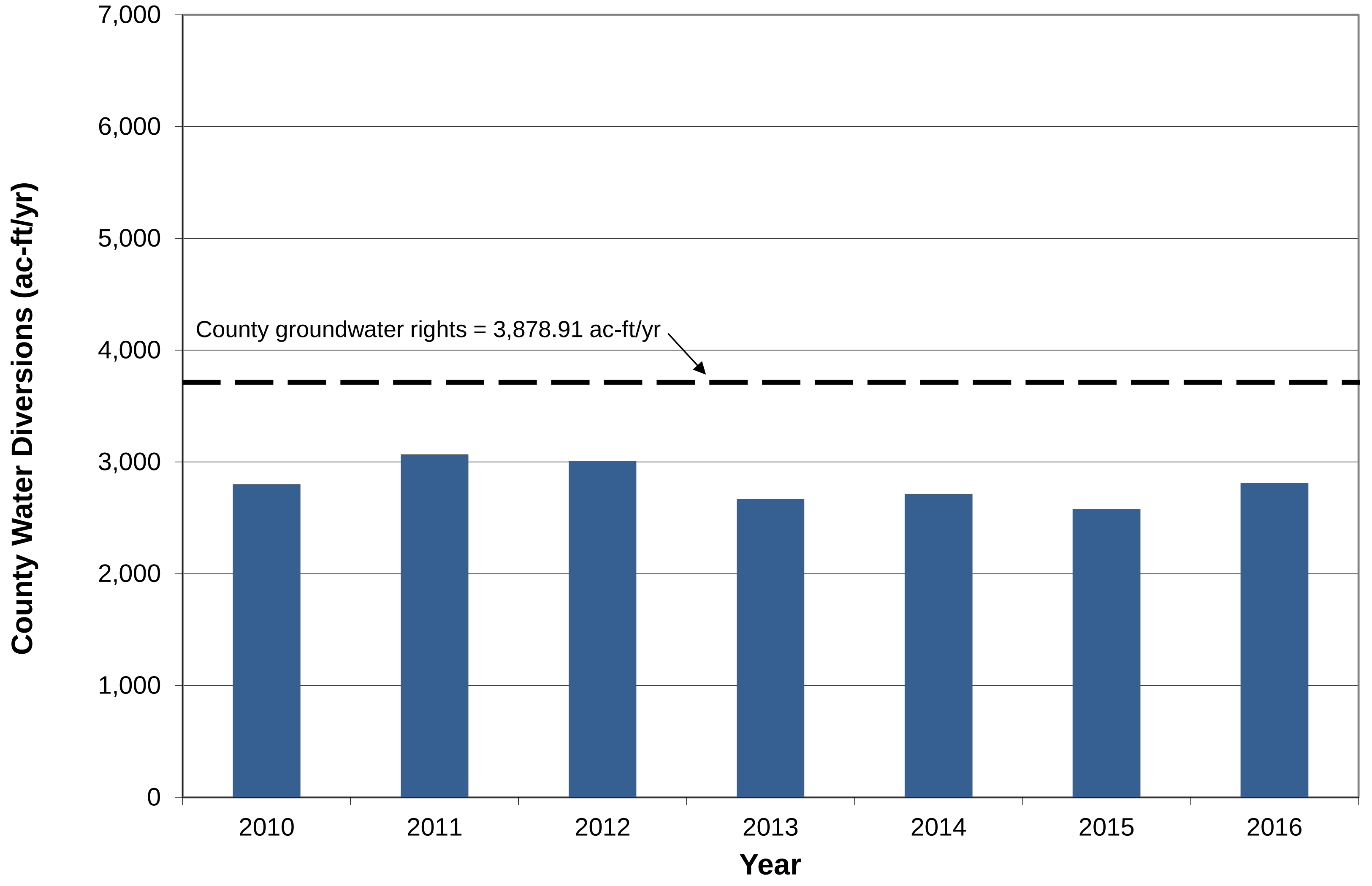
[c] The amendment to Permit 1802 raised the storage capacity from 6.66 acre-feet to 28.33 acre-feet.

[d] Of the total 5,541.3 ac-ft/yr under the 1975 combined permit, the County owns 70 percent (3,878.91 ac-ft/yr) and DOE owns 30 percent (1,662.39 ac-ft/yr).

The rights outlined in Table 4-1 are based on a permit application filed by U.S. Energy Research on May 29, 1975 to combine a series of previously licensed and declared water rights. That application requested a total right of 5,547.1 ac-ft/yr for municipal, industrial, and related purposes that could be diverted from any combination of permitted points of diversion. The OSE approved the application on October 30, 1975 with the exception of subtracting 5.8 ac-ft/yr for evaporation losses at Los Alamos Reservoir. Figure 4-1 shows the DPU water diversions for 2010 to 2015 (these volumes were calculated by subtracting LANL demands from total diversions), and Figure 4-2 shows the LANL water use volumes for the same period, in comparison to their respective groundwater rights. Figure 4-3 shows the DPU water diversions and LANL water use volume, along with the water rights for both entities. The County has an extension of time for putting their rights to beneficial use that will expire on September 30, 2017. A request for a three-year extension of time was submitted on August 25, 2017 (Alarid, 2017).

The County (which is the sole water provider for LANL) leased the DOE-owned water rights from 2001 to 2011, when the lease expired. In May 2016, an application for permit to change an existing water right was filed jointly by DOE and the County in support of the chromium plume control interim measure and chromium plume center characterization project (U.S. DOE and LADPU, 2016). In addition, a Request for Emergency Authorization associated with the joint application was submitted, and emergency authorization was received on September 10, 2016 (NMOSE, 2016). The application and emergency authorization request were filed jointly because of the nature of the existing permitted rights between the DOE and the County (U.S. DOE and LADPU, 2016).

The application requests a change in purpose of use for groundwater to add groundwater remediation and additional groundwater points of diversion (PODs) to be used for control and future characterization of hexavalent chromium-contaminated groundwater at LANL (U.S. DOE and LADPU, 2016). The application calls for 24 additional PODs (3 extraction wells, 6 injection wells, and 15 monitoring wells). The volume of water for this application is 679 ac-ft/yr (U.S. DOE and LADPU, 2016), and LANL also plans to file for return credits from the OSE. Operation of the additional PODs will not impair or increase the appropriation of water above the existing permitted water rights between DOE and the County (5,541.3 ac-ft/yr total) (U.S. DOE and LADPU, 2016). On September 10, 2016, the OSE approved the request for Emergency Authorization and issued Emergency Authorization, RG-00485 et al. (NMOSE, 2016). The County continues to negotiate a new lease with DOE for the full 1,662.39 ac-ft/yr, for use by all customers, including LANL and the chromium interim measure (Meyers, 2016).



Note: These values were obtained by subtracting the LANL water demands from the total diversions.

LOS ALAMOS COUNTY WATER PLAN

Annual Water Use by Los Alamos County 2010 Through 2016

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Figure 4-1

Notes:
1. The groundwater supply being used for the LANL chromium interim measure project has not been subtracted from DOE's total water rights.
2. See Section 4.1.1 for a discussion of water rights ownership and leasing.

LOS ALAMOS COUNTY WATER PLAN

Annual Water Use by Los Alamos National Laboratory
2010 Through 2016

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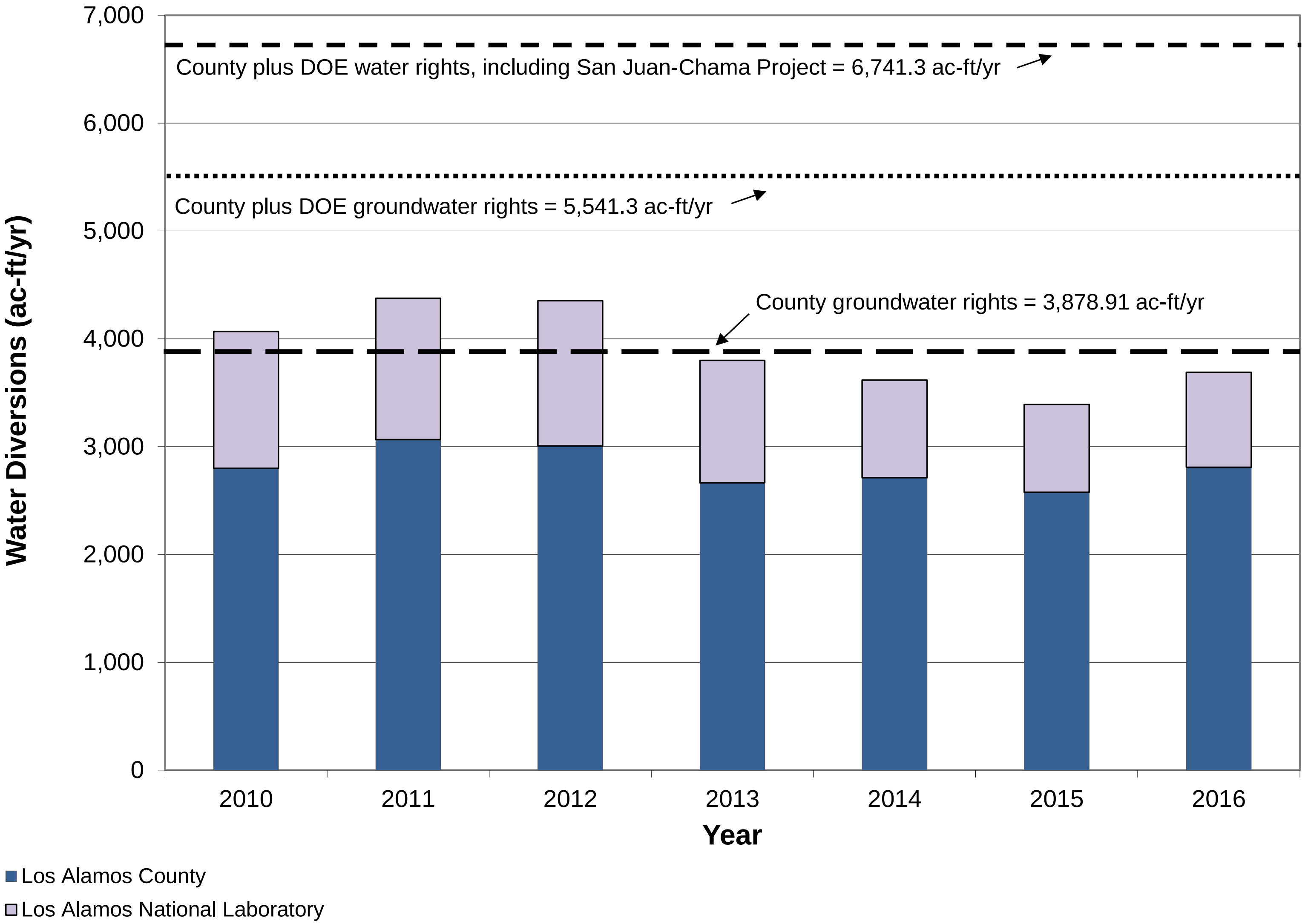
Figure 4-2



Notes:
1. The groundwater supply being used for the LANL chromium interim measure project has not been subtracted from DOE's total water rights.
2. See Section 4.1.1 for a discussion of water rights ownership and leasing.

LOS ALAMOS COUNTY WATER PLAN

Annual Water Use by Los Alamos County and Los Alamos National Laboratory, 2010 Through 2016

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In 2006, the OSE approved a 30-ac-ft/yr surface water diversion from Los Alamos Canyon for snowmaking, which is included in the existing total water rights volume of 5,541.3 ac-ft/yr. The purpose of use was changed from municipal and industrial to municipal, industrial, recreational, and snowmaking.

4.1.2 San Juan-Chama Surface Water Rights

Implementation of a project to use San Juan-Chama Project water would help to diversify the Los Alamos County water supply, both geographically and from a water rights perspective. The San Juan-Chama Project surface water originates in the Colorado River Basin and provides a source of supply that is geographically separate from the regional aquifer near Los Alamos. This geographic separation would be a benefit should there be expanded water quality contamination issues in the local groundwater in the future. Additionally, as a federal project, San Juan-Chama Project water contracts are not subject to OSE priority issues, although they may be subject to water rights administration (discussed in Section 4.3.1 and 4.3.2). The San Juan-Chama Project water rights may also be subject to shortage sharing on a pro rata basis among all contractors in drought years, as discussed in Section 4.3.3. Even with some drought vulnerability, having a separate source of supply could help to provide back-up supply if contamination or water rights issues affect the use of the regional aquifer.

Los Alamos County has contracted water rights with the U.S. Department of the Interior Bureau of Reclamation for 1,200 acre-feet of San Juan-Chama Project surface water, which flows into the Rio Grande through a series of tunnels, conveyance channels, and reservoirs. Los Alamos County's San Juan-Chama contract was converted from a service contract to a repayment contract in October 2006, and the County completed repayment of the contract (Los Alamos County's share of the San Juan-Chama Water Project construction costs) in December 2015. Under the current contract, remaining payments are for operation, maintenance, and replacement costs only (San Juan-Chama Project Contract No. 05-WC-40-560).

A final preliminary engineering report (PER) was completed for the County's San Juan-Chama Project water supply project in September 2012. The PER evaluated five alternatives for diverting, treating, and conveying the San Juan-Chama Project water and recommended the alternative that called for the installation of three wells in White Rock (CDM Smith, 2012).

Under this alternative, groundwater that would have naturally discharged to the river would be pumped, and the San Juan-Chama Project water would replace the pumped groundwater in the river (CDM Smith, 2012). This alternative would not require treatment above disinfection, and the proposed well locations would allow for connection to the water system at an existing booster station (CDM Smith, 2012). The Los Alamos County Council advised that further study of alternatives and an environmental assessment be completed before the project moves forward (LADPU, 2014).

An environmental assessment would provide an opportunity to re-evaluate specifics of the project design in light of environmental and public concerns. In July 2014, the Utilities Manager recommended delaying further action on a potential San Juan-Chama Project diversion until the 40-year water plan update has been completed (LADPU, 2014). Through the environmental assessment and further planning processes, the County will need to consider the benefits of the separate San Juan-Chama Project water supply in relation to costs and other concerns, and to determine when and if to construct a project that would bring this water online.

4.2 Water Rights Administration

As part of the planning process, it is important to view the County’s water rights in the larger context of the administrative and other legal considerations that could affect the County’s ability to use and divert its water rights in any given year. This section discusses the administrative policies currently or potentially affecting the County’s water rights; Section 4.3 assesses the potential risks to those water rights.

4.2.1 Rio Grande Compact

Water in the Rio Grande is governed by the Rio Grande Compact, an agreement entered into by New Mexico, Texas, and Colorado in 1939 and approved by the United States Congress and the State of New Mexico (NMSA 72-15-23). The Compact applies to the use of surface water of the Rio Grande, from its headwaters in Colorado to Fort Quitman, Texas, by each of the three states. Each upstream state is required to make a surface water delivery to its downstream neighbor. The volumes of water required to be delivered to New Mexico and Texas are calculated based on upstream flows, and an annual accounting is conducted to determine each state's actual deliveries in relation to that delivery obligation and the resulting credits or debits (over- or under-deliveries), which are carried over from year to year.

New Mexico's Compact delivery requirements are based on an inflow-outflow schedule where inflow is measured at the Rio Grande at Otowi Bridge near San Ildefonso, NM gage (Otowi gage) east of Los Alamos. Because of the Otowi gage's role in determining delivery amounts, the State Engineer has a long-standing administrative practice of not permitting a change in point of diversion from one side of the gage to the other, whether by sale or by lease (Cartron et al., 2002). This requirement places a significant restriction on the water rights market, and coupled with the fact that few pre-1907 water rights are available for purchase, means that purchasing water rights, whether for municipal use or offsets (Section 4.2.4), will be a significant challenge. Additionally, even if a willing seller can be identified, water rights transfers on the Rio Grande are routinely protested and can require expenditure of significant technical and legal fees.

4.2.2 Protection of Senior Water Rights

As discussed above, the State of New Mexico adheres to the prior appropriation system for water rights administration. This approach is based on a "first in time, first in right" concept, whereby the water right holder with a priority date senior to other rights can exercise that right to the detriment of a right with a junior priority date. When senior water right holders are unable to fully exercise their right due to diversions by junior water right holders, they can make a priority call on a river (including stream-connected groundwater rights). This call, which would be administered by the OSE, would require junior users to cease pumping or diverting so that the senior rights could be fulfilled.

To date, priority call-based administration has rarely happened; however, most rivers and connected groundwater basins are over-appropriated. Even though the Rio Grande Basin has not been adjudicated (a legal process that establishes the amounts and priority dates of all surface water and groundwater rights in a stream system), the County's water rights are junior to a significant number of downstream senior water rights, such as the Middle Rio Grande Conservancy District, that could be impacted by additional depletions upstream. With additional growth and other pressures, such as endangered species requirements, active administrative protection of senior water rights in groundwater basins and rivers is likely to become more frequent over the 40-year planning horizon.

4.2.3 Active Water Resource Management

In an effort to develop more flexible tools for administering water rights in New Mexico, the OSE adopted Active Water Resource Management (AWRM) regulations (NMAC 19.25.13.1 to 13.49) in December 2004. The AWRM legislation creates an administrative framework within which the OSE will establish water master districts, appoint water masters for those districts, and develop district-specific water rights administration regulations.

The OSE has established seven priority basins for AWRM (NMOSE, 2004a), including the Lower Rio Grande. Over time, the OSE may extend the AWRM program to the Upper Rio Grande and develop regulations that will address administration of water rights, although the regulations will not become final until the Rio Grande Basin has been adjudicated (NMOSE, 2004b). In the Pecos River and connected groundwater basins, the OSE has developed AWRM regulations that clearly lay out several approaches to priority administration, all of which allow for curtailment of junior water rights to protect senior water rights.

4.2.4 Rio Grande Offset Requirements

In accordance with statutory authority and case law, the OSE manages the Rio Grande surface water and groundwater basins conjunctively and considers Rio Grande surface water to have been fully appropriated as of the year 1939 (the year the Rio Grande Compact was signed) (NMOSE, 2000). This means that the OSE recognizes the groundwater-surface water connection and conditions permits so that new groundwater appropriations will not increase surface water depletions and thereby affect senior water right holders. Specifically, the OSE requires applicants for groundwater rights to purchase and retire valid water rights in an amount equivalent to the effect the groundwater withdrawals will have on the river.

Previously, the OSE did not require applicants to immediately begin purchasing and retiring water rights. However, current policy, which was upheld in a case involving the City of Rio Rancho, specifies that offsets must be in place to counteract the effect of pumping on the river.

A phased acquisition of the offsets is possible, especially if the applicant is not planning to immediately pump up to the full permitted amount; however, offsets for impacts must be in place by the time those impacts affect the river (i.e., increase depletion).

The OSE has further clarified this policy, stating that offset rights may be valid only for pre-1907 rights, a pre-1907 surface water right previously transferred into a well, or an existing groundwater right with a priority date older than May 31, 1939, the date of the Rio Grande Compact (NMOSE, 2006). This policy limits the number of water rights that could be considered for offset requirements.

4.2.5 Rio Grande Declared Underground Water Basin

The Rio Grande Underground Water Basin covers 26,209 square miles along the Rio Grande in the center of the state. Although specific administrative criteria exist for the area near the river in the Middle Rio Grande (the reach from Cochiti to Socorro) (NMOSE, 2000), the OSE has no unique administrative criteria for the portion of the Rio Grande Basin near Los Alamos County. The OSE evaluates applications for water rights in this reach, including a change in point of diversion or place and purpose of use of water rights, to determine whether the granting of the application will impair existing water rights or be detrimental to the public welfare or contrary to the conservation of water.

4.3 Risks to Los Alamos County Water Rights

Although the County owns a specific volume of water rights, the legal right to divert and use those rights in any given year can be affected by the rights of other water rights holders and even as a result of interstate compacts or other agreements governing interstate waters. These risks are discussed in the following subsections.

4.3.1 Protection of Senior Water Rights

As discussed in Section 4.2.2, the County could potentially be subject to limitation of its water rights in order to protect senior water rights. A significant yet unquantified number of the water rights on the Rio Grande are senior to those of the County. In the event that the OSE begins administering priorities based on a call or based on AWRM regulations, the County could be required to limit its use or to use some of its San Juan-Chama Project water to mitigate the effects of its diversions on senior water right holders. Until the OSE conducts a hydrographic survey and adjudicates the Rio Grande Basin, however, it is impossible to quantitatively evaluate the County's susceptibility to curtailment of its water rights under priority administration.

4.3.2 Rio Grande Offset Requirements

Even without a priority call, the OSE could potentially require the County to offset its current pumping to avoid impairment of pre-1939 senior water rights holders. For example, should the County submit an application to change the POD or purpose and place of use of a water right, the OSE would evaluate that application with respect to impairment, public welfare, and conservation. Because the County's use of its water rights increases depletions on the Rio Grande, thereby impacting senior water rights holders, the OSE could require offsets due to impairment even though the existing permits have no offset requirement. As discussed in Sections 4.2.4 and 6, the County could satisfy those offset requirements by using San Juan-Chama Project water as offset rights or by purchasing water rights. However, willing sellers of pre-1907 water rights are difficult to find, and many municipalities have encountered difficulties in identifying water rights to purchase.

The County might also be able to reduce the number of offset water rights the OSE would require by applying to the OSE for return flow credit for the treated wastewater effluent it returns to the Rio Grande. Credit for return flow to the aquifer is also possible. Both types must be demonstrated in a return flow plan subject to OSE approval (NMOSE, 2000, Section 3).

4.3.3 Navajo Water Rights Settlement Provisions

The original legislation authorizing the San Juan-Chama Project includes provisions for sharing shortages among beneficiaries of the project (76 Stat. 96, PL 87-483). The Northwestern New Mexico Rural Water Projects Act (123 Stat. 1372, PL 111-11) was enacted on March 30, 2009, and Section 10402 amends Public Law 87-483, providing additional detail about shortage sharing. The Navajo Water Rights Settlement, which was approved in August 2013, defines flows and other requirements in a manner that could result in shortages to the San Juan-Chama Project. These shortages would likely be shared on a pro rata basis among all contractors. Although conditions giving rise to shortage sharing may be rare, implementation of the act could nonetheless reduce the quantity of San Juan-Chama Project water available to contractors in some years. Predicted changes in San Juan-Chama Project water allocations resulting from climate change are discussed in Section 7.

4.4 Acquisition of New Water Rights to Meet Future Demand

As discussed in Section 6, the County could be required to obtain additional water rights to meet future water demand, or to move points of diversion for existing rights if contamination affects supply wells (Section 3). As the Rio Grande basin is considered to be fully appropriated, the County would have to purchase water rights to meet future needs, which may not be feasible given water market limitations. The County should consider maximizing use of its existing water rights through conservation or reuse and through maximizing return flow credits.

4.5 Los Alamos National Laboratory

In September 2009, the County signed an agreement with DOE to provide water service to LANL for the period October 1, 2009 through September 30, 2019, and the County will be the sole water provider for LANL at least through the term of this agreement. The contract indicates that DOE will provide support to the County for implementing use of San Juan-Chama Project water. The contract also identifies other terms of service such as meter testing, access to wells for hydrologic monitoring, water storage for firefighting, and water rates. Estimated quantities of water to be provided to LANL range from 412,000,000 gallons (1,264 acre-feet) in 2010 to 572,000,000 gallons (1,743 acre-feet) in 2019. The contract recognized that predicting future water needs for LANL is difficult and included provisions for notification if the future water needs were expected to increase by more than 50,000,000 gallons (153 acre-feet) per year. The agreement also includes a curtailment plan with provisions to reduce water use during times of shortage. LANL provided a 10-year water demand forecast (fiscal year 2017 through fiscal year 2027) in support of this plan update, with values ranging between 254,600,000 gallons (781 acre-feet) and 490,500,000 gallons (1,505 acre-feet) (Begay, 2017) (Section 5).

5. Water Demand

In order to assess the County's projected future demand for water, this section discusses current and historical water uses (Sections 5.1 and 5.2) and demographic and economic trends (Section 5.3). Based on this information, projected future water demands for the region are presented in Section 5.4.

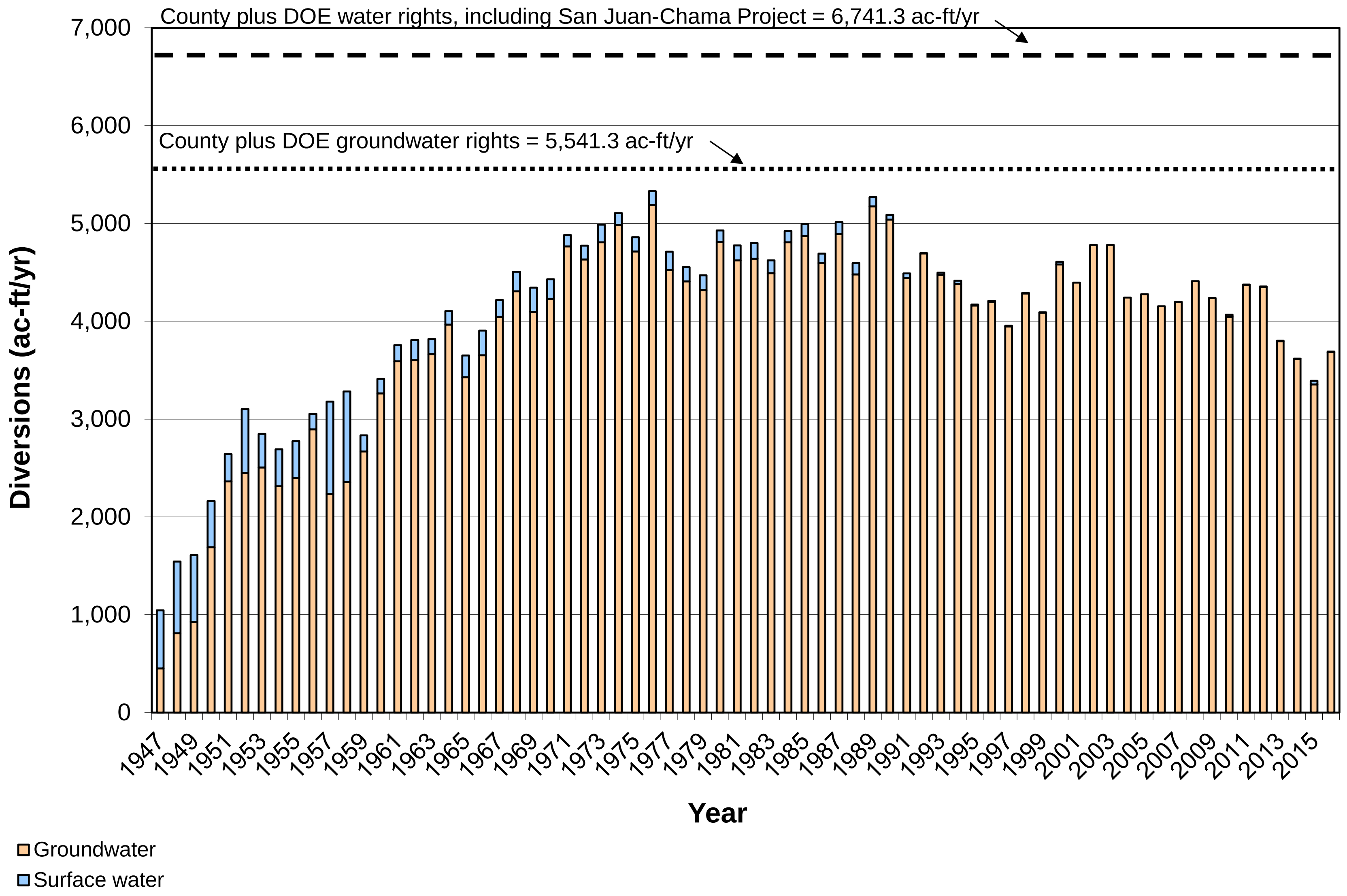
5.1 Historical Use

Groundwater and surface water have supplied the community of Los Alamos for 60 years. Figure 5-1 and Table 5-1 show the metered diversion amounts from wells and surface water from 1947 through 2016. Table 5-2 shows water diversions and population by decade from 1950 through 2010.

Between 1950 and 2000, population increased in Los Alamos County, and since 2000, the population has decreased by approximately 2 percent (Table 5-2). Diversions also increased between 1950 and 1990, due to increased population, and decreased between 1990 and 2010, partially due to water conservation efforts.

Diversions fluctuate significantly from year to year due in part to fluctuating levels of precipitation (Figure 5-2). For instance, in 2012 precipitation was 8.76 inches, and total system demand was 156 gallons per capita per day (gpcd). In 2016, precipitation was 16.4 inches, and total system demand was 144 gpcd.

Demand from the LANL's operations also impacts the magnitude of diversions. Figure 5-3 shows the monthly variation in water use in 2016, with an annual diversion for LANL of 27 percent and 73 percent for the County. While demand in summer months triples for the County due to outdoor watering, the monthly range in water use by LANL varies less. In 2016, LANL used the greatest volume of water in November.



LOS ALAMOS COUNTY WATER PLAN

Historical Los Alamos County Water Diversions

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Figure 5-1

Table 5-1. Annual Diversions from Groundwater and Surface Water Los Alamos County, 1947-2016

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	Annual Diversions (million gallons per year[a])										
	Groundwater					Surface Water					
Year	Los Alamos Well Field	Guaje Well Field	Pajarito Well Field	Otowi Well Field	Total	Water Canyon Gallery Spring	Los Alamos Reservoir	Guaje Reservoir	Camp May	Total	Total
1947	147	—	—	—	147	84	21.7	87.8	—	193.5	341
1948	264	—	—	—	264	97	21.9	119.8	—	238.7	503
1949	302	—	—	—	302	92	14.7	116.1	—	222.8	525
1950	547	3	—	—	550	54	20.6	79.9	—	154.5	705
1951	702	68	—	—	770	39	10.5	41	—	90.5	861
1952	448	350	—	—	798	48	33.6	131	—	212.6	1,011
1953	444	372	—	—	816	39	14.8	58	—	111.8	928
1954	380	374	—	—	754	40	16.9	66	—	122.9	877
1955	407	375	—	—	782	33	18.1	71	—	122.1	904
1956	437	506	—	—	943	23	4.8	24	—	51.8	995
1957	350	378	—	—	728	40	54.8	213	—	307.8	1,036
1958	372	395	—	—	767	60	49.4	193	—	302.4	1,069
1959	391	478	—	—	869	54	—	0	—	54	923
1960	530	533	—	—	1,063	48	—	—	—	48	1,111
1961	546	624	—	—	1,170	54	—	—	—	54	1,224
1962	577	597	—	—	1,174	67	—	—	—	67	1,241
1963	539	654	—	—	1,193	51	—	—	—	51	1,244
1964	627	665	—	—	1,292	45	—	—	—	45	1,337
1965	447	571	99	—	1,117	72	—	—	—	72	1,189
1966	450	613	127	—	1,190	82	—	—	—	82	1,272
1967	373	464	481	—	1,318	56	—	—	—	56	1,374
1968	345	474	584	—	1,403	65	—	—	—	65	1,468

Sources: Koch & Rogers, 2003 (1947-1998)
LADPU (1999-2015)

[a] 1 million gallons = 3.07 acre-feet

— = Not applicable (not yet installed or no longer used)

Table 5-1. Annual Diversions from Groundwater and Surface Water
Los Alamos County, 1947-2016
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Year	Annual Diversions (million gallons per year[a])										
	Groundwater					Surface Water					Total
	Los Alamos Well Field	Guaje Well Field	Pajarito Well Field	Otowi Well Field	Total	Water Canyon Gallery Spring	Los Alamos Reservoir	Guaje Reservoir	Camp May	Total	
1969	331	435	569	—	1,335	80	—	—	—	80	1,415
1970	360	423	595	—	1,378	65	—	—	—	65	1,443
1971	412	484	657	—	1,553	37	—	—	—	37	1,590
1972	380	467	662	—	1,509	40	—	5.8	—	45.8	1,555
1973	406	475	685	—	1,566	49	—	9.7	—	58.7	1,625
1974	369	453	802	—	1,624	35	—	4.9	—	39.9	1,664
1975	356	431	749	—	1,536	42	—	5.3	—	47.3	1,583
1976	343	531	817	—	1,691	41	—	4.4	—	45.4	1,736
1977	345	515	614	—	1,474	57	—	4.1	—	61.1	1,535
1978	302	444	690	—	1,436	45	—	2.8	—	47.8	1,484
1979	289	456	662	—	1,407	44	1.3	3.7	—	49	1,456
1980	339	485	743	—	1,567	32	2.3	4.7	—	39	1,606
1981	336	469	701	—	1,506	45	2.1	2.7	—	49.8	1,556
1982	317	422	773	—	1,512	46	2.8	3.4	—	52.2	1,564
1983	221	338	904	—	1,463	38	1.4	3.4	—	42.8	1,506
1984	326	460	780	—	1,566	34	1.3	3	—	38.3	1,604
1985	290	456	841	—	1,587	37	0.9	2.8	—	40.7	1,628
1986	179	460	858	—	1,497	28	1.5	2.4	—	31.9	1,529
1987	217	485	892	—	1,594	34	3.2	2.8	—	40	1,634
1988	158	477	824	—	1,459	34.5	1.4	2.4	—	38.3	1,497
1989	219	506	961	—	1,686	23	3.3	4.6	—	30.9	1,717
1990	187	532	923	—	1,642	9.3	4.6	2.2	—	16.1	1,658

Sources: Koch & Rogers, 2003 (1947-1998)
LADPU (1999-2015)

[a] 1 million gallons = 3.07 acre-feet

— = Not applicable (not yet installed or no longer used)

Table 5-1. Annual Diversions from Groundwater and Surface Water
Los Alamos County, 1947-2016
Page 3 of 4

Year	Annual Diversions (million gallons per year[a])										
	Groundwater					Surface Water					Total
	Los Alamos Well Field	Guaje Well Field	Pajarito Well Field	Otowi Well Field	Total	Water Canyon Gallery Spring	Los Alamos Reservoir	Guaje Reservoir	Camp May	Total	
1991	125	502	820	—	1,447	12	2.4	1.5	—	15.9	1,463
1992	13	472	1,044	—	1,529	0.1	0	0	—	0.1	1,529
1993	—	298	876	284	1,458	6.4	0.5	0	—	6.9	1,465
1994	—	179	1,042	206	1,427	11.6	0	0	—	11.6	1,439
1995	—	230	1,126	0	1,356	1.6	1.6	0	—	3.2	1,359
1996	—	269	889	210	1,368	0	2.6	0	—	2.6	1,371
1997	—	272	798	216	1,286	0	2.4	0	—	2.4	1,288
1998	—	148	941	307	1,396	0	1.6	0	—	1.6	1,398
1999	—	323	800	209	1,331	0	2	0	—	2	1,333
2000	—	417	902	174	1,492	0	9.3	0	—	9.3	1,501
2001	—	269	785	389	1,443	0	0	0	—	0	1,443
2002	—	405	855	297	1,557	0	0	0	—	0	1,557
2003	—	430	855	273	1,558	0	0	0	—	0	1,558
2004	—	370	800	212	1,382	0	0	0	—	0	1,382
2005	—	303	814	276	1,393	0	0	0	—	0	1,393
2006	—	358	690	305	1,353	0	0	0	—	0	1,353
2007	—	373	750	245	1,368	0	0	0	—	0	1,368
2008	—	382	806	249	1,437	0	0	0	—	0	1,437
2009	—	389	680	312	1,381	0	0	0	—	0	1,381
2010	—	399	695	224	1,318	0	0	0	7.2	7.2	1,325
2011	—	364	767	294	1,425	0	0	0	0.6	0.6	1,426
2012	—	380	741	296	1,417	0	0	0	1.9	1.9	1,419

Sources: Koch & Rogers, 2003 (1947-1998)
LADPU (1999-2015)

[a] 1 million gallons = 3.07 acre-feet

— = Not applicable (not yet installed or no longer used)

Table 5-1. Annual Diversions from Groundwater and Surface Water
Los Alamos County, 1947-2016
Page 4 of 4

Year	Annual Diversions (million gallons per year[a])										
	Groundwater					Surface Water					
	Los Alamos Well Field	Guaje Well Field	Pajarito Well Field	Otowi Well Field	Total	Water Canyon Gallery Spring	Los Alamos Reservoir	Guaje Reservoir	Camp May	Total	Total
2013	—	290	689	258	1,237	0	0	0	1.3	1.3	1,238
2014	—	351	650	177	1,178	0	0	0	0.4	0.4	1,178
2015	—	298	647	148	1,093	0	0	0	12.3	12.3	1,105
2016	—	294	685	221	1,200	0	0	0	2.1	2.1	1,202

Sources: Koch & Rogers, 2003 (1947-1998)
LADPU (1999-2016)

[a] 1 million gallons = 3.07 acre-feet

— = Not applicable (not yet installed or no longer used)

Table 5-2. Historical Diversions and Population for Los Alamos County 1950-2010

Year	Diversions (ac-ft/yr)			Population [a]	10-Year Growth Rate [b]
	Groundwater	Surface Water	Total		
1950	1,688	474	2,162	10,476	—
1960	3,262	147	3,410	13,037	24.4
1970	4,229	199	4,429	15,198	16.6
1980	4,809	120	4,929	17,599	15.8
1990	5,039	49	5,089	18,115	3.2
2000	4,580	29	4,608	18,343	1.0
2010	4,045	22	4,067	17,950	–2.1

[a] Source: U.S. Census Bureau, 1995, 2006, 2010
[b] Population growth over preceding decade

ac-ft/yr = Acre-feet per year
— = Not applicable

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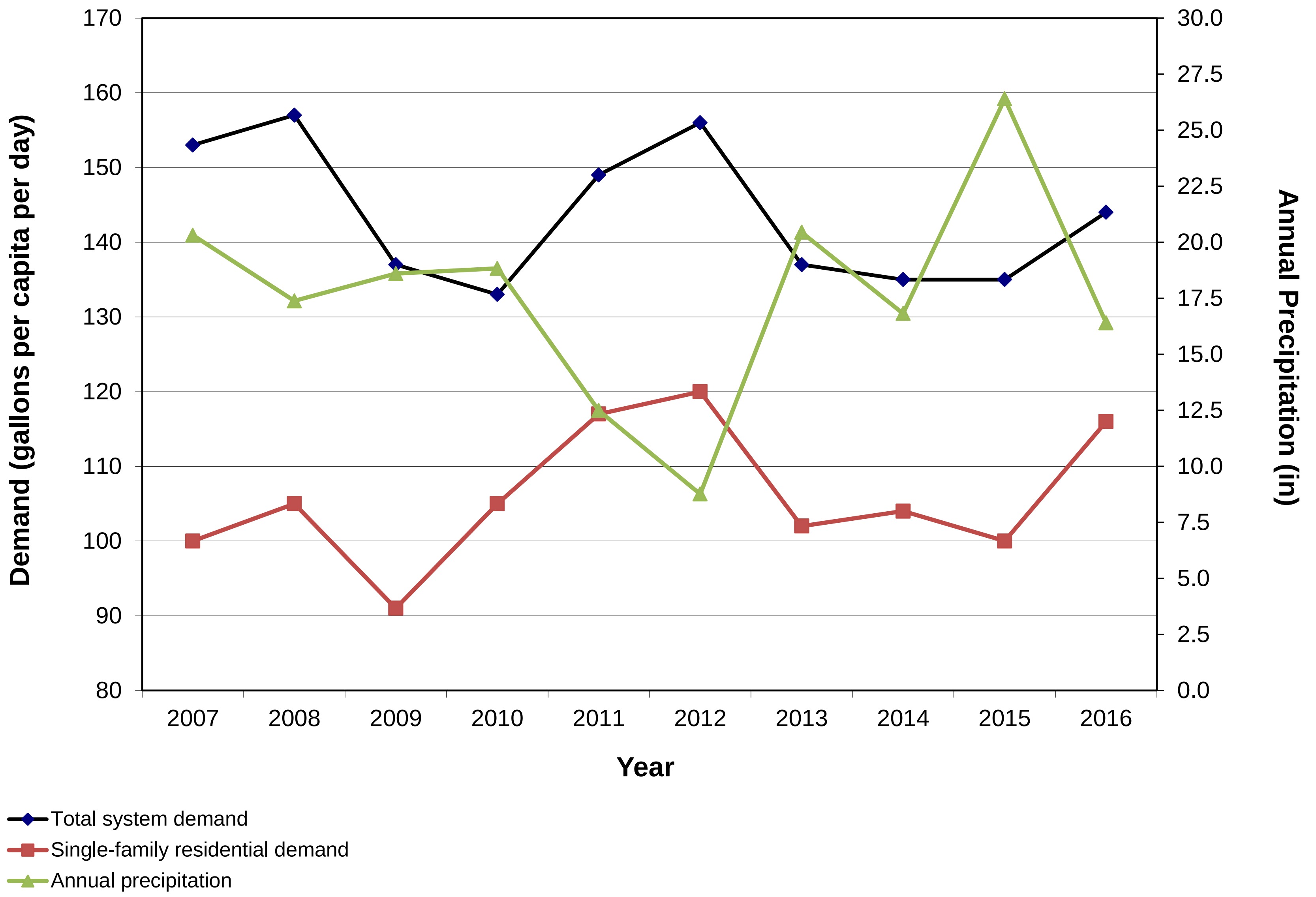

LOS ALAMOS COUNTY WATER PLAN

Per Capita Demand and Precipitation in Los Alamos County, 2007-2016

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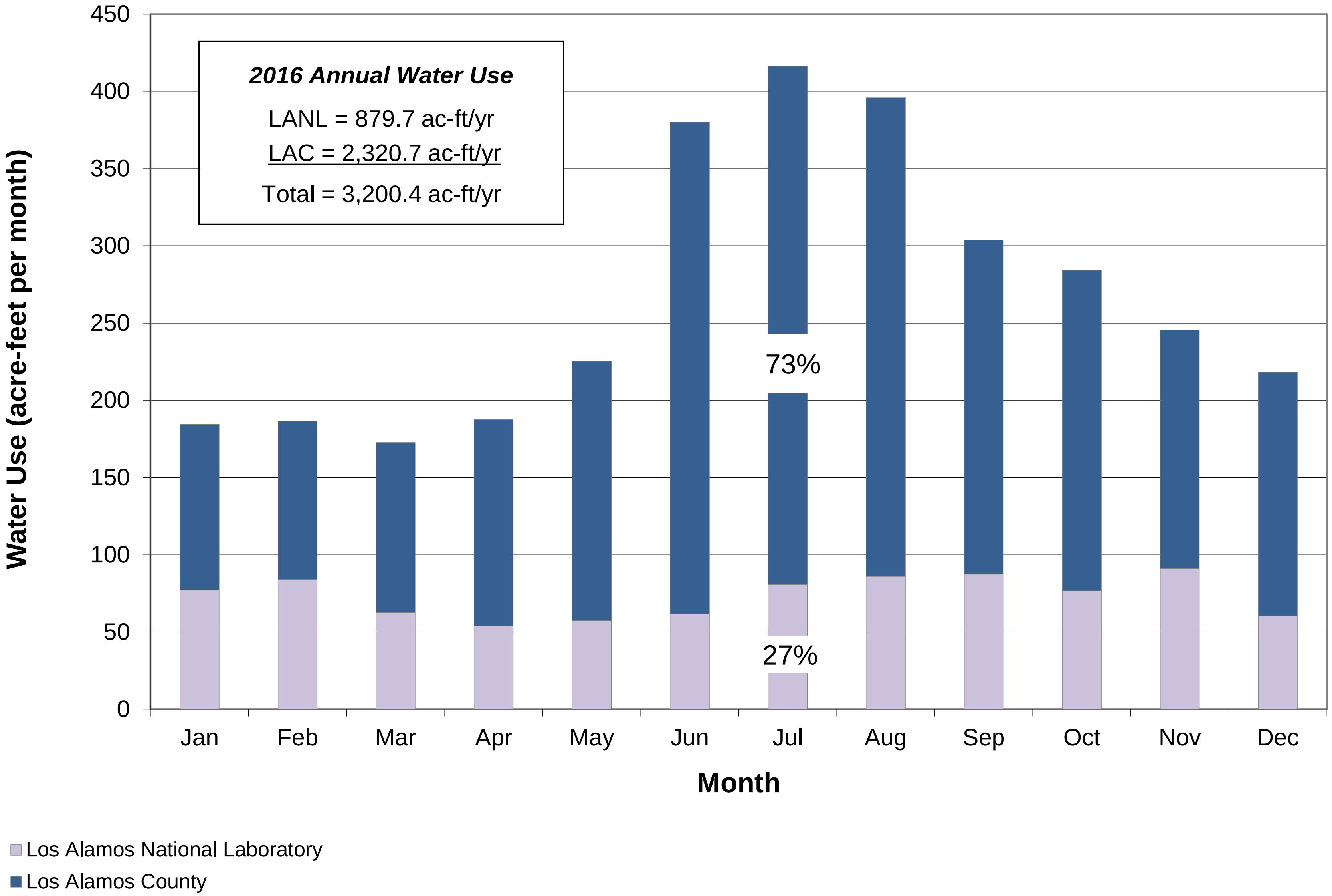
Figure 5-2



LOS ALAMOS COUNTY WATER PLAN

Monthly Water Use by Los Alamos County and Los Alamos National Laboratory in 2016

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Figure 5-3

The DPU has been using the GPCD (gallons per capita per day) calculator developed by the OSE to calculate per capita use since 2007. This allows the County to evaluate water use apart from the bulk water sales to LANL. The per capita values calculated for the total water system demand and by sector for 2007 through 2016 are presented on Table 5-3. Since 2007, total system water demand has ranged between 133 and 157 gallons per day. For the single-family residential sector, per capita demand has ranged between 91 and 120 gallons per day.

Table 5-3. Los Alamos County Daily Per Capita Demand, 2007-2016

	Per Capita Demand (gpcd)			
	Sector			
Year	Single-Family Residential [a]	Multi-Family Residential [a]	Industrial, Commercial, and Institutional	Annual System Total
2007	100	55	32	153
2008	105	55	29	157
2009	91	51	26	137
2010	105	53	29	133
2011	117	59	31	149
2012	120	60	31	156
2013	102	56	22	137
2014	104	54	23	135
2015	100	48	24	135
2016	116	53	25	144

Sources:: Los Alamos County (2007-2013 data)
LADPU, 2015 (2014 data)
Alarid, 2017 (2015-2016 data)

[a] = Based on sector (not total) population

gpcd = Gallons per capita per day

5.2 Current Water Use

The total population served by the DPU includes the 17,950 residents estimated to live within Los Alamos County in 2010, primarily in the communities of White Rock and Los Alamos.

Table 5-4 shows the monthly and annual billing data by sector for 2010 through 2016. The total system water demand supplied by DPU (excluding LANL sales) was 144 gallons per day in 2016. In 2016, the per capita demand for the single-family residential sector was 116 gallons per day (Table 5-3). As shown in Figure 5-3, water use increases in the summer months for landscape watering.

Table 5-4. Billing Records by Sector, 2010-2016
Page 1 of 3

	Billing Data (gallons)				
Month	Single-Family Residential	Multi-Family Residential	Industrial, Commercial, and Institutional	Los Alamos National Laboratory	Total
2010					
January	18,752,000	8,024,000	9,104,000	27,669,780	63,549,780
February	15,770,000	7,433,000	7,799,000	31,723,200	62,725,200
March	21,188,000	8,360,000	10,450,000	47,397,810	87,395,810
April	13,929,000	9,019,000	6,432,000	19,740,800	49,120,800
May	42,197,000	9,868,000	18,551,000	50,069,470	120,685,470
June	77,716,000	15,101,000	27,480,000	27,979,260	148,276,260
July	69,237,000	15,132,000	25,641,000	41,127,820	151,137,820
August	55,788,000	11,015,000	25,345,000	39,362,040	131,510,040
September	47,968,000	13,423,000	21,939,000	32,726,930	116,056,930
October	51,155,000	10,220,000	22,262,000	30,883,230	114,520,230
November	26,682,000	7,499,000	9,698,000	30,988,209	74,867,209
December	24,830,000	8,641,000	9,943,000	33,087,840	76,501,840
Total	465,212,000	123,735,000	194,644,000	412,756,389	1,196,347,389
2011					
January	19,011,000	8,290,000	7,881,000	30,941,680	66,123,680
February	16,908,000	7,558,000	7,201,000	32,069,010	63,736,010
March	23,571,000	9,499,000	6,768,000	31,559,390	71,397,390
April	27,385,000	9,634,000	7,613,000	32,417,950	77,049,950
May	50,605,000	12,940,000	18,041,000	41,797,130	123,383,130
June	64,440,000	16,456,000	30,624,000	47,764,100	159,284,100
July	101,524,000	19,854,000	29,846,000	41,386,960	192,610,960
August	77,689,000	14,812,000	40,891,000	39,369,280	172,761,280
September	48,319,000	11,611,000	23,745,000	34,507,460	118,182,460
October	37,970,000	10,142,000	18,087,000	31,195,970	97,394,970
November	25,065,000	8,216,000	9,923,000	32,784,870	75,988,870
December	19,800,000	8,600,000	9,024,000	30,914,740	68,338,740
Total	512,287,000	137,612,000	209,644,000	426,708,540	1,286,251,540
2012					
January	18,147,000	8,299,000	10,593,833	33,976,790	71,016,623
February	14,030,000	8,073,000	7,076,400	31,111,040	60,290,440
March	23,042,000	8,067,000	9,187,400	30,945,380	71,241,780
April	22,091,000	8,719,000	8,954,700	30,361,480	70,126,180
May	57,004,000	12,862,000	18,249,900	35,650,090	123,765,990
June	78,009,000	18,041,000	30,796,500	39,560,560	166,407,060
July	82,714,000	16,927,000	29,577,700	41,969,120	171,187,820

Table 5-4. Billing Records by Sector, 2010-2016
Page 2 of 3

Month	Billing Data (gallons)				
	Single-Family Residential	Multi-Family Residential	Industrial, Commercial, and Institutional	Los Alamos National Laboratory	Total
2012 (cont.)					
August	68,750,000	15,062,000	27,941,000	44,359,720	156,112,720
September	55,520,000	12,787,000	22,721,700	41,365,310	132,394,010
October	53,003,000	10,517,000	19,666,183	43,986,330	127,172,513
November	29,417,800	9,102,000	11,291,717	31,005,310	80,816,827
December	22,877,590	8,181,000	8,067,200	34,763,240	73,889,030
Total	524,605,390	136,637,000	204,124,233	439,054,370	1,304,420,993
2013					
January	20,496,000	7,974,000	11,195,000	34,157,620	73,822,620
February	16,225,000	7,681,000	6,861,000	29,673,620	60,440,620
March	16,579,000	8,887,000	5,947,000	30,484,280	61,897,280
April	28,921,000	8,942,000	6,842,000	25,629,270	70,334,270
May	51,390,000	13,204,000	13,745,000	26,420,100	104,759,100
June	76,121,000	16,515,000	20,696,000	28,455,360	141,787,360
July	71,977,000	13,641,000	22,750,000	36,036,030	144,404,030
August	52,219,000	12,688,000	17,920,000	35,773,540	118,600,540
September	48,435,000	12,201,000	19,144,000	31,803,760	111,583,760
October	35,013,000	8,710,000	12,683,000	30,889,410	87,295,410
November	20,597,000	7,141,000	7,706,000	30,907,190	66,351,190
December	15,939,000	8,099,000	5,703,000	29,549,140	59,290,140
Total	453,912,000	125,683,000	151,192,000	369,779,320	1,100,566,320
2014					
January	18,284,000	7,392,000	7,070,000	27,111,050	59,857,050
February	15,516,000	7,159,000	5,201,000	21,960,230	49,836,230
March	18,537,000	7,145,000	5,323,000	23,225,500	54,230,500
April	21,927,000	9,044,000	7,550,000	25,888,920	64,409,920
May	40,100,000	11,090,000	15,510,000	25,202,260	91,902,260
June	58,293,000	13,459,000	19,464,000	27,072,730	118,288,730
July	64,336,000	14,653,000	23,832,000	22,706,380	125,527,380
August	50,511,000	9,968,000	15,201,000	21,943,590	97,623,590
September	55,548,000	12,674,000	19,231,000	21,759,250	109,212,250
October	67,465,000	10,317,000	16,561,000	26,957,850	121,300,850
November	22,535,000	7,762,000	8,767,000	27,556,690	66,620,690
December	24,325,000	7,653,000	7,978,000	23,331,140	63,287,140
Total	457,377,000	118,316,000	151,688,000	294,715,590	1,022,096,590

Table 5-4. Billing Records by Sector, 2010-2016
Page 3 of 3

	Billing Data (gallons)				
Month	Single-Family Residential	Multi-Family Residential	Industrial, Commercial, and Institutional	Los Alamos National Laboratory	Total
2015					
January	18,403,570	8,220,800	6,757,990	26,171,490	59,553,850
February	14,877,600	6,179,000	5,407,479	17,246,620	43,710,699
March	16,133,700	7,133,300	6,401,700	18,442,090	48,110,790
April	22,074,600	7,786,100	9,556,600	17,205,510	56,622,810
May	30,609,300	8,806,100	14,576,391	17,378,210	71,370,001
June	55,658,420	10,263,300	18,194,264	17,004,930	101,120,914
July	51,318,980	11,423,700	19,425,160	31,891,120	114,058,960
August	40,413,330	9,562,400	13,966,707	14,443,150	78,385,587
September	48,407,030	11,413,369	20,191,581	26,247,120	106,259,100
October	50,709,951	10,188,972	18,210,788	28,905,780	108,015,491
November	23,676,649	6,913,362	9,130,233	25,658,300	65,378,544
December	27,276,540	8,039,800	6,992,101	24,953,020	67,261,461
Total	399,559,670	105,930,203	148,810,994	265,547,340	919,848,207
2016					
January	21,331,841	7,411,140	6,200,586	25,133,820	60,077,387
February	20,026,030	7,149,504	6,246,610	27,368,200	60,790,344
March	21,942,347	7,348,068	6,539,019	20,431,210	56,260,644
April	28,104,987	8,211,570	7,168,181	17,601,790	61,086,528
May	34,213,237	9,441,190	11,087,000	18,697,580	73,439,007
June	64,951,680	14,537,700	24,164,880	20,181,160	123,835,420
July	67,322,000	16,383,000	25,662,000	26,313,000	135,680,000
August	68,344,000	11,475,000	21,137,000	28,035,000	128,991,000
September	43,345,000	11,225,000	15,923,000	28,500,000	98,993,000
October	41,870,000	8,891,000	16,848,000	24,974,000	92,583,000
November	30,902,000	8,431,000	10,968,000	29,727,000	80,028,000
December	34,704,000	8,278,000	8,419,000	19,693,000	71,094,000
Total	477,057,122	118,782,172	160,363,276	286,655,760	1,042,858,330

In 2016, single-family residential water use accounted for 45.7 percent of DPU water use (excluding LANL), and multi-family residential water use accounted for 11.4 percent of DPU water use. Industrial, commercial, and institutional water use accounted for 15.4 percent of the DPU's water use, with LANL sales accounting for 27.5 percent of the billed totals (Figure 5-4).

Indoor watering is estimated as the average water demand for December, January, and February. Comparing the average summer (June, July, and August) and winter demands for the single-family residential sector in 2016, approximately 62 percent of the average summer demand was used outdoors, with the remaining 38 percent used indoors. Comparing the average summer and winter demands for the multi-family residential sector in 2016, approximately 46 percent of the average summer demand was used outdoors and 54 percent was used indoors.

For more than 70 years, Los Alamos County has used treated wastewater to irrigate turf for a golf course and parks during summer months. The golf course built in Los Alamos in the 1940s has never been irrigated with anything but effluent. As discussed in Section 2, the DPU has a non-potable water system that uses treated wastewater effluent for irrigation of several areas in Los Alamos and White Rock, for fire protection, and for snow making at the Pajarito Mountain Ski Area. Table 5-5 shows the monthly volume of treated effluent that was reused in 2010 through 2016; approximately 112 million gallons was reused in 2016.

5.3 AWWA Water Audit

The American Water Works Association (AWWA) is the industry source for guidance on audits and has published *Water Audits and Loss Control Programs: Manual of Water Supply Practices M36* (AWWA, 2016). The AWWA water audit methodology was established in 2000 with the goal of accounting for all water that is produced and minimizing both physical and paper losses (AWWA, 2003). A water audit of the Los Alamos County system was completed for calendar year 2016 to estimate revenue versus non-revenue water and to distinguish real and apparent losses using the water accounting technique based on the AWWA Water Balance Model, shown on Figure 5-5.

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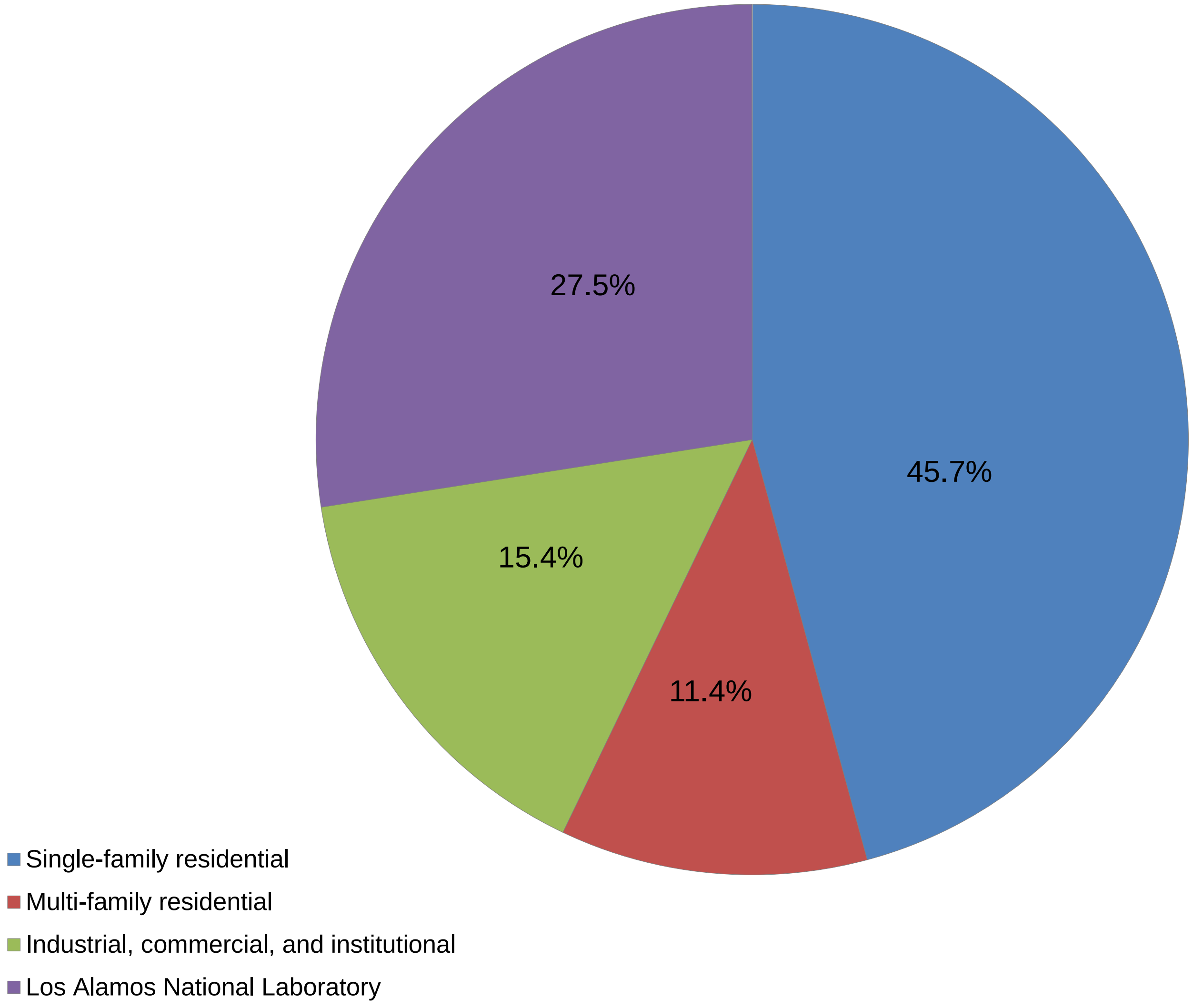

LOS ALAMOS COUNTY WATER PLAN

Water Demand by Customer Class in 2016

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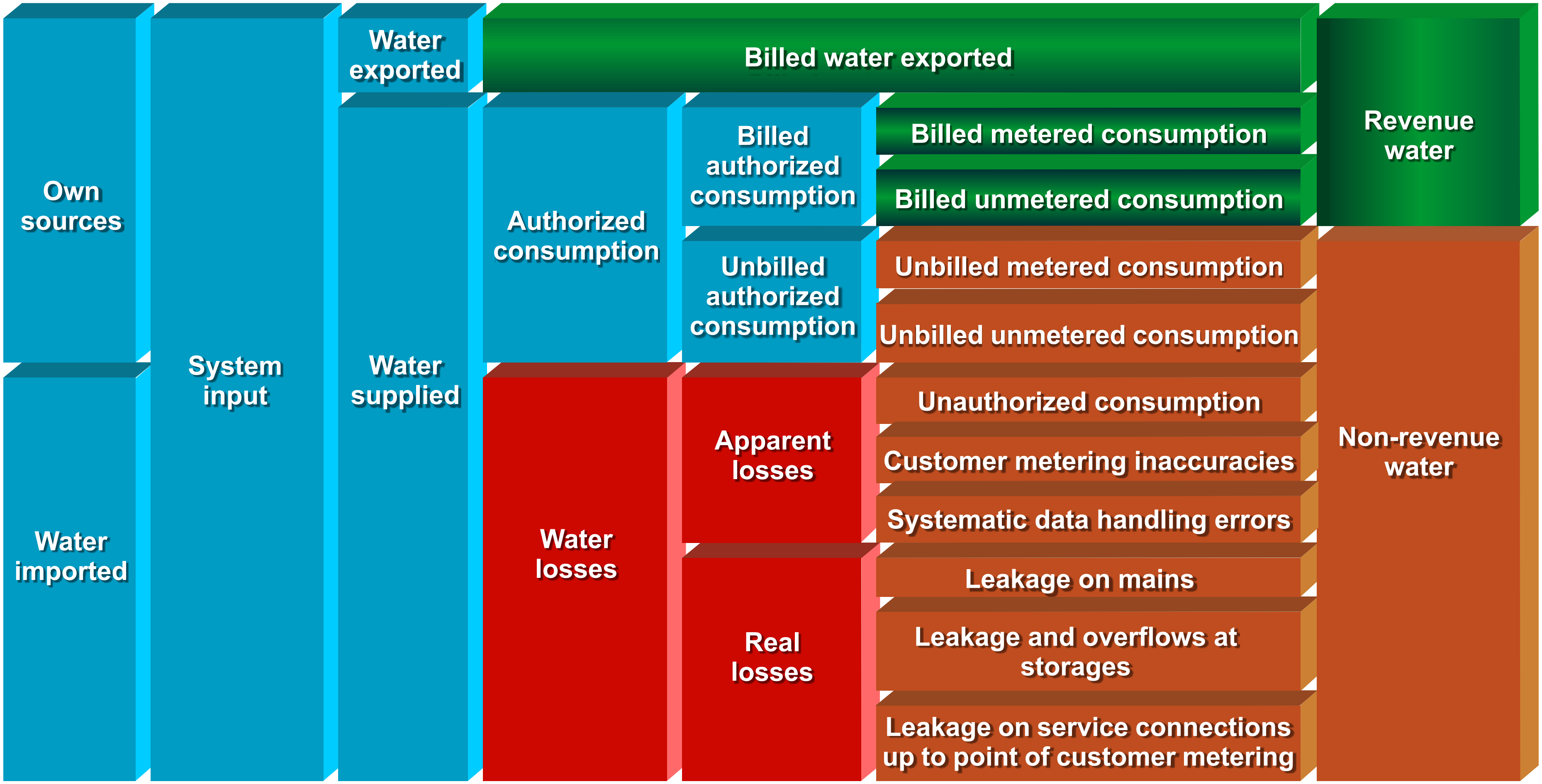
Figure 5-4

Table 5-5. Water Reuse, 2010-2016

Month	Reuse (gallons)						
	2010	2011	2012	2013	2014	2015	2016
January	81,600	104,800	0	0	0	0	8,354
February	107,100	96,900	0	0	1,012,477	0	5,562,428
March	145,200	7,369,900	5,638,165	3,867,063	4,544,270	2,311,815	7,555,448
April	11,178,612	14,612,700	9,032,844	11,552,192	7,256,932	10,895,334	12,846,001
May	11,427,200	19,023,600	17,904,886	20,165,106	14,125,782	5,531,325	28,466,181
June	23,262,400	22,388,800	24,743,657	21,739,135	18,148,354	14,975,357	22,270,328
July	12,140,000	21,091,000	16,050,773	9,850,279	8,197,735	2,916,420	3,533,764
August	5,531,600	7,950,983	18,097,000	10,504,260	12,815,537	12,186,453	7,008,934
September	18,847,100	4,660,344	13,174,880	7,470,298	16,036,338	16,723,354	18,282,006
October	8,367,300	6,392,581	11,028,777	6,106,035	7,517,914	6,133,506	6,501,094
November	249,300	1,293,627	4,256,322	876,738	1,651,125	321,250	79
December	126,800	0	0	0	0	77	0
Total	91,464,212	104,985,235	119,927,304	92,131,106	91,306,464	71,994,891	112,034,617
Total (acre-feet)	281	322	368	283	280	221	344



LOS ALAMOS COUNTY WATER PLAN
AWWA Water Audit Format

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9-7-17
JN WR14.0178

Figure 5-5

The AWWA Water Loss Control Committee makes the AWWA water audit software available for free. The AWWA software provides a nationally recognized, systematic method for documenting and evaluating annual water losses in order to provide information that can be used to reduce loss. The audit provides information on the cost of the losses and provides a measure of benchmarking against other utilities nationwide through the performance indicators. In the updated water conservation planning guidelines the OSE recommends that systems conduct water audits using the AWWA software (NMOSE, 2013).

System and financial information was obtained from the DPU and input into the most up-to-date AWWA water audit software (Version 5.0) (AWWA, 2014) to evaluate performance indicators for the County. The comprehensive water audit balance for Los Alamos County in 2016 is provided as Appendix A. Table 5-6 compares the results of the County's 2016 water audit to the 2011 North American dataset (validated water audit data for 10 utilities with fewer than 50,000 connections; 2011 is the most recent year that AWWA has calculated statistics for).

Table 5-6. Los Alamos County AWWA Water Audit Results for 2016

Item	North American Dataset (2011 average)	Los Alamos County (2016)
Non-revenue water (% by volume)	24.1	17.0
Non-revenue water (% by cost)	9.3	11.8
Apparent losses (gallons per connection per day)	10.38	6.28
Real losses (gallons per connection per day)	58.71	39.54 [a]
Customer retail unit cost ($/1,000 gallons)	5.09	7.78
Variable production cost ($/1,000 gallons)	0.98	0.59
Infrastructure leakage index	3.51	2.41
Water audit data validity score	70.44	72

[a] = Valued at the customer retail unit cost.

For the 2016 County water audit, lower values were calculated for non-revenue water (percent by volume), apparent losses, real water losses, variable production cost, and infrastructure leakage index than the average. Higher values were calculated for the non-revenue water (percent by cost), customer retail unit cost, and data validity score. Based on these data, the County is performing better than average. We recommend that the County compare the values for each of these items when new water audits are performed each year.

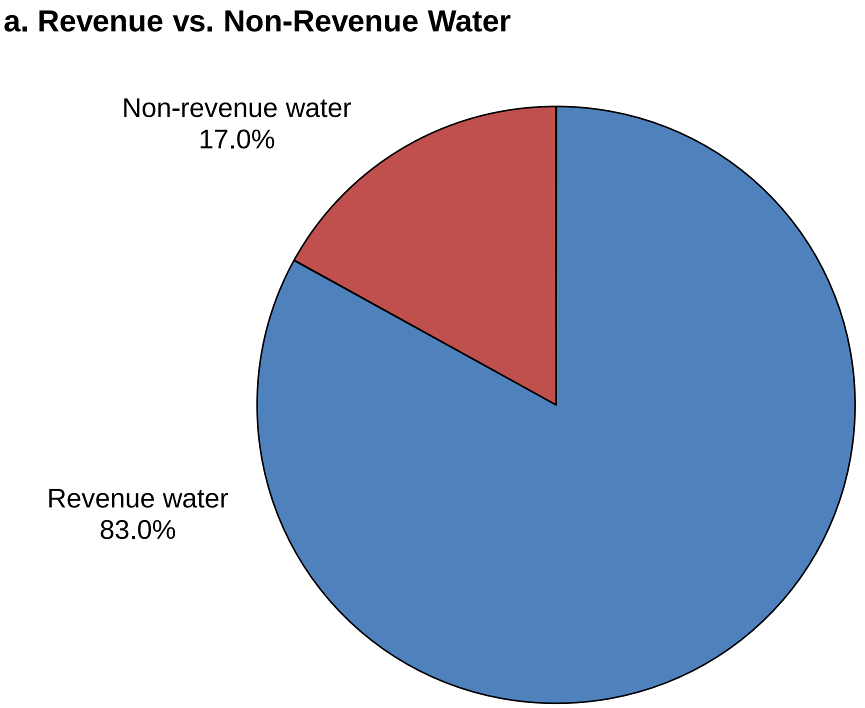
Figure 5-6a shows the breakdown between revenue and non-revenue water for Los Alamos County in 2016. Revenue water consists of billed water by sector; non-revenue categories include total authorized unbilled unmetered use (e.g., fire department), total apparent losses (estimated customer meter error, total low-flow inaccuracies, illegal connections and theft, and database errors), and total potential real water loss (calculated by subtracting authorized consumption and apparent losses from adjusted production). Revenue water accounted for 83 percent of total adjusted production in 2016, and non-revenue water accounted for 17 percent of total adjusted production.

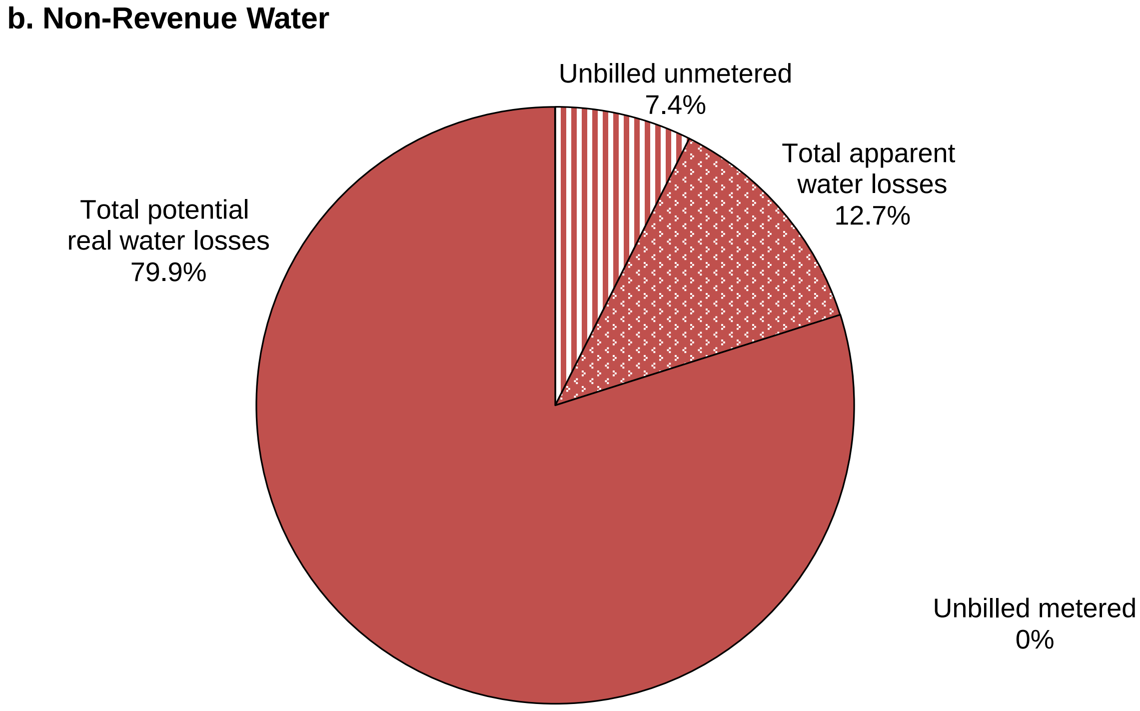
Figure 5-6b further breaks down the 17 percent of total non-revenue water between total potential real water loss (79.9 percent), total apparent losses (12.7 percent), and unbilled unmetered water use (7.4 percent; the volume of unbilled unmetered water use was calculated by the water audit software using the default percentage of 1.25 percent of the adjusted production). There were no unbilled metered water uses in 2016. The 2016 data suggest that the best target for further minimizing the County's non-revenue water is minimizing total potential real water loss, as this is estimated to be the largest component of non-revenue water. Real water loss reflects the volume of water not accounted for by authorized consumption or apparent losses (e.g., leaks). The County should also review the components of apparent loss (e.g., unauthorized consumption and meter error), because if the apparent losses have been under-estimated, the volume shown for total potential real losses may be too high.

The water audit analysis is summarized below:

- A total of 1,202.098 million gallons was supplied in 2016, including 286.656 million gallons provided to LANL.

- Total water production was adjusted by subtracting 0.4 percent of the total diversions to account for production meter error. Three production meters were tested in 2016; two were calibrated (Otowi Well 4 and Pajarito Well 2) and one was replaced (Otowi Well 1). The average production meter error of 0.4 percent over-reporting is the average of the results from Otowi Well 4 and Pajarito Well 2.





Total non-revenue water
154,451,000 gallons

LOS ALAMOS COUNTY WATER PLAN

Los Alamos County
Non-Revenue Water in 2016

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9/7/17

Figure 5-6

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- Total revenue water in 2016 (756.202 million gallons) was 83 percent of the total water supplied (the LANL sales were treated as exported water in the water audit and are not included in this total).

- The overall water audit data validity score was 72 out of 100.

- The operating budget for water was approximately $10.2 million in 2016.

- Total annual water system variable cost (the sum of all treatment and power costs) was $616,496 in 2016.

- The cost to produce and supply the next million gallons of water (total annual water system variable cost divided by the County's volume from its own sources for 2016), termed the variable production cost by AWWA, was calculated to be $591.16. The LANL revenues were included in the total annual water system variable cost, and so the volume supplied to LANL was included in the County's volume from its own sources for this calculation.

- The customer retail unit cost for 2016 was calculated to be $7.78 per thousand gallons (this value includes the cost for water; wastewater fees are billed as a flat fee rather than being based on potable water use, so wastewater costs were not included). The customer retail unit cost is calculated by dividing the total revenue ($8,109,095 in 2016, including the revenue from LANL) by the total volume sold (1,042.858 million gallons in 2016). For 2016, the volume sold was the sum of the billed metered water use (756.202 million gallons) and water exported to LANL (286.656 million gallons).

The AWWA water audit software reports performance as financial and operational efficiency indicators (Sections 5.3.1 and 5.3.2).

5.3.1 Financial Indicators

The financial indicators provide information about the relative amounts of non-revenue water and the cost of water losses. The AWWA water audit software estimates that:

- Non-revenue water amounted to 17 percent by the volume of water supplied and cost the County approximately $1.1 million (annual costs of real and apparent losses), or 11.8 percent of the cost of operating the system (with the losses being valued at the customer retail unit cost).
- Total apparent losses were calculated to cost $152,487 in 2016.
- Total potential real losses were calculated to cost $960,579 in 2016.

5.3.2 Operational Efficiency Indicators

Operational efficiency indicators address water losses and are provided by the audit in several forms.

- Apparent loss comes from customers being undercharged or getting water in an unauthorized manner. The annual cost of apparent loss is calculated by multiplying the apparent loss volume by the customer retail unit cost of $7.78 per 1,000 gallons ($7,780 per million gallons). The total apparent losses of 19.600 million gallons were 2.2 percent of the adjusted production.

- Real losses are physical losses from the system. The water audit software gives utilities the option of valuing real water loss based on either customer retail unit cost or variable production cost (the cost to treat and deliver the water). Real losses have been valued using the customer retail unit cost. The total potential real losses of 123.468 million gallons were 13.6 percent of the adjusted production.

- The unavoidable annual real losses (UARL) were 51.23 million gallons (5.6 percent of the adjusted production) in 2016, which was less than the current annual real losses (CARL) of 123.47 million gallons per year (13.6 percent of the adjusted production). The UARL represents the theoretical lower limit of leakage that could be achieved if today's best technology were successfully applied.

The goal set by the international water audit methodology is to reduce losses to the level of UARLs (AWWA, 2003). With the calculated current annual real loss volume being higher than the unavoidable annual real loss volume, the County has the potential to reduce real water loss in future years.

5.3.3 Recommendations

AWWA provides recommendations to utilities based on the range in which the overall data validity score falls. There are five levels of data validity scores, with Level V including the highest scores. The 2016 water audit analysis indicates that Los Alamos County falls in Level IV, which applies to data validity scores between 71 and 90. The recommendations for improving the data validity score for Level IV utilities (AWWA, 2014) include:

- Refine data collection practices and establish routine business processes.
- Refine, enhance, or expand ongoing programs based upon economic justification.
- Conduct detailed planning, budgeting, and launch of comprehensive improvements for metering, billing, and infrastructure management.
- Establish mid-range (5-year horizon) apparent and real loss reduction goals.

The infrastructure leakage index (ILI) is an AWWA performance indicator used to compare utility performance in operational management of real losses. Target ILI ranges and the circumstances they apply to include 1.0 to 3.0 for utilities with high water resources development costs and a restricted ability to increase revenues, 3.1 to 5.0 for utilities where water resources development costs are reasonable and water rate increases can be feasibly imposed, and 5.1 to 8.0 for utilities with low costs to obtain and treat additional water resources. The lower the amount of leakage and real losses in a system (and the closer the utility’s leakage volume is to the UARL volume), the lower the ILI will be. The ILI calculated for the County in 2016 was 2.41, indicating that the system leakage is within the target range of 1.0 to 3.0 for a utility where water resources are costly to develop (AWWA, 2014), as is the case in Los Alamos County. The County should set an ILI goal for the target range of 1.0 to 3.0 for future years, aiming to either maintain or decrease the volume of real water loss.

5.4 County Comprehensive Planning

In 2015, the Los Alamos County Council commissioned an update of the *Los Alamos County Comprehensive Plan,* which was last updated in full in 1987. The new comprehensive plan compiles, updates, and adds to the goals, intentions and strategies that were previously adopted by the Council through the *Los Alamos County Vision Statement and Policy Plan* of 2005, Historic Preservation Plan Element of 2008, Los Alamos Downtown Element of 2009, and White Rock Center Element of 2012 (LAC, 2016). The plan considers the themes of land use, economic vitality, and infrastructure, and emphasizes community development, particularly in the downtown areas of Los Alamos Townsite and White Rock. The community development focus will likely impact population growth and subsequent water usage (LAC, 2016).

The geography of Los Alamos County partially bounds growth within the area. Los Alamos Townsite and White Rock sit on mesas with deep canyons surrounding and throughout both communities. The two towns are also bounded by federally owned lands, which to some extent limit the growth of the communities (LAC, 2016). The County is implementing plans to begin growing their tourism economy by optimizing connectivity between visitor activities and parks, and improving visitor lodging and transportation within the Townsite and White Rock (LAC, 2016). Another addition to Los Alamos County's tourist economy is the new Manhattan Project National Historical Park, which is underway and will showcase much of the history of Los Alamos as it relates to the engineering of the first atomic bomb (LAC, 2016).

The County is also working to create opportunities for community and business development within the two towns, in order to create growth and sustainability. In April 2016, LANL announced its plan to hire 2,400 new employees by 2021. The 2016 Comprehensive Plan indicates that the County is preparing for an increase in population to 20,000 over approximately the next decade (LAC, 2016). Along with the County's desire for growth and development, there is a concurrent desire to preserve the character and feel of existing neighborhoods and avoid sprawl, and the primary focus for new development lies within existing areas of development (LAC, 2016).

As described in the Comprehensive Plan, the County intends to revitalize the downtown areas of both the Townsite and White Rock. Revitalization efforts will include re-zoning and attending to blighted and abandoned properties, and encouraging new business and population density in these areas (LAC, 2016). The County is in ongoing negotiation to acquire some parcels of land owned by the U.S. Forest Service, and these parcels of land are being considered for future utility use (LAC, 2016). Usable land area is not expected to increase significantly, and the County is planning to make better use of the already available land within its boundaries (LAC, 2016). The Comprehensive Plan document includes information about the capacity for new housing development. Planned, proposed, and potential future dwelling units for Los Alamos and White Rock total 1,108 dwelling units, or 891 and 217 units respectively (LAC, 2016).

Water infrastructure is believed to be sufficient for delivering water to existing users, and routine capital improvement on aged infrastructure is ongoing (LAC, 2016). The County is waiting to determine the need for development of new water resources, such as San Juan-Chama Project water, pending completion of the *Long-Range Water Supply Plan* update.

5.5 Population Projections

The Bureau of Business and Economic Research (BBER) at the University of New Mexico has prepared multiple population projections for Los Alamos County, by examining the growth rate in the previous decades, the age of the population, current rates of in-migration, and death and birth rates (BBER, 1996, 2000). Because Los Alamos County's growth rate slowed significantly in the 1980s and 1990s, the 1996 and 2000 projections for growth were very small, showing an increase of only about 3,000 people (Table 5-7). The previous long-range water supply plan (DBS&A, 2006) presented the BBER projections, but did not use them to project demand, because they did not take recent land transfers and plans for growth into account. Instead, the 2006 projections were based on the growth scenario identified in the August 2004 New Mexico First Town Hall (Fruth, 2004), which showed that a full build-out could occur rapidly, increasing the population to 25,000 people in 2020 (Table 5-7). Contrary to these projections, the population in Los Alamos County actually declined between 2000 and 2010 (Table 5-2), largely due to a reduction in the work force at LANL.

Table 5-7. Population Projections for Los Alamos County 2000 through 2060

Year	Population Census	BBER (1996)	BBER (2000) [a]	Fruth (2004)	BBER (2012)	2014 Population Projections [b]	
						Low	High
2000	18,343	19,317	19,234	18,359	—	—	—
2004	18,796	19,647	19,505	18,796	—	—	—
2005	18,407	19,729	19,573	19,189	—	—	—
2010	17,950	20,123	19,913	21,155	—	—	—
2015	NA	20,601	20,318	23,120	—	—	—
2020	NA	21,079	20,722	25,086	18,063	17,988	20,000
2030	NA	21,758	21,289	—	17,880	17,789	20,812
2040	NA	22,141	21,627	—	17,210	17,123	21,447
2050	NA	22,291	21,761	—	—	16,480	21,874
2060	NA	22,404	21,854	—	—	15,863	22,092

[a] Based on BBER's (2000) "most likely" scenario
[b] Poster Enterprises, 2014

— = Population not estimated for this decade
NA = Not yet available

The State of New Mexico prepared updates of the 16 regional water plans that were published in 2016, and population projections were prepared by a market research consultant as a part of this effort (Poster Enterprises, 2014). BBER released new population projections in November 2012 that project population by decade through 2040, and these projections were extended by the ISC market research consultant in 10-year increments through 2060 using the BBER growth rate trends as a basis for the extensions. Interviews were conducted to obtain input on growth trends and potential water conservation measures, with the feedback being used to refine the projections. Two population projections were developed for Los Alamos County, with the high forecast assuming that the County's goal of a population of 20,000 is achieved in 2020, with a very low rate of growth thereafter, and the low forecast closely tracking the BBER projections (Table 5-7).

The high and low population projections that were developed for Los Alamos County as part of the regional water planning effort have been used as the basis for projecting demand as part of the updated long-range water supply plan. In addition, a separate water demand forecast was obtained from LANL (Table 5-8). There is considerable uncertainty in developing forecasts for LANL over a 40-year horizon, because its mission and size is dependent on political and national security decisions that could result in a wide range of possible activity.

Table 5-8. Los Alamos National Laboratory 10-Year Water Forecast

Fiscal Year	Estimated Annual Consumption [a] (gallons)	Water Demand [b] (acre-feet)
2017	254,600,000	781
2018	262,200,000	805
2019	269,000,000	826
2020	299,100,000	918
2021	363,200,000	1,115
2022	380,800,000	1,169
2023	387,700,000	1,190
2024	389,700,000	1,196
2025	411,700,000	1,263
2026	483,000,000	1,482
2027	490,500,000	1,505

Source: Begay, 2017

[a] After savings from the Sanitary Effluent Reclamation Facility (maximum savings of 72 million gallons per year).

[b] The DPU provides the LANL water supply, so these demands have been included on Table 5-9.

A conceptual master plan has been developed for a new development that is planned in White Rock (Baer, 2016). The A-19 tract development will have a maximum residential density of 8.7 dwelling units per acre (Baer, 2016). This will be a private development with a proposed 159 dwelling units and a small commercial development (Alarid, 2017). The proposed A-19 tract development was not called out specifically in the ISC population projections; however, the high population projection will account for this growth. The 2010 Census reported a County population of 17,950 people and an average household size of 2.33 people (U.S. Census Bureau, 2010). Adding 159 dwelling units would add approximately 370 people, which is within the 20,000-person high projection for 2020. A preliminary plat had been developed by the time this plan was finalized (Alarid, 2017).

5.6 Future Water Demand

DBS&A developed two projections of future water demand for the County for 2020 through 2060. The projections are based on (1) the population projections developed as a part of the State of New Mexico’s regional water plan update project (Poster Enterprises, 2014), (2) the total water system per capita demand for 2016, and (3) a separate water demand forecast that was provided by LANL (Begay, 2017). The demand projections are shown on Table 5-9 and Figures 5-7 and 5-8. Total projected demand ranges between 3,814 and 5,062 ac-ft/yr (the low-water-use projection in 2020 and high-water-use projection in 2060, respectively), with the low projection showing an increase in demand between 2020 and 2030 and decreasing demand between 2030 and 2060, and the high projection showing increasing demands throughout the 40-year time frame.

The previous long-range water supply plan recommended an initial minimum goal of a 12 percent reduction in water demand (DBS&A, 2006). This was one of the long-term goals developed for the County's fiscal year 2013 planning, and it was approved by the Utility Board on September 18, 2013 (Alarid, 2015). Comparing the 2006 water diversions to the more current data, this goal was met by 2014 (Table 5-1), when total diversions were 13 percent less than in 2006. Los Alamos County has a robust water conservation program (Section 8) and published an update to the *Energy and Water Conservation Plan* in 2015 (LADPU, 2015). Further reductions in per capita demand are expected.

LANL provided a 10-year water demand forecast, spanning the period of fiscal year 2017 to 2027 (Table 5-8). For the projections beyond 2027, to 2060, LANL demand was assumed to remain at the fiscal year 2027 volume. LANL also provided projections for the volume of water to be pumped as part of the chromium interim measure project. As discussed in Section 4.1.1, an application for permit to change an existing water right was filed jointly by DOE and the County in May 2016, in support of the chromium interim measure project that will run through December 2023 (Rodriguez, 2016), and emergency authorization was received on September 10, 2016 (NMOSE, 2016). The volume of water for this application is 679 ac-ft/yr (U.S. DOE and LADPU, 2016). In the absence of any estimates for the volume of water that will be needed to support the future chromium remediation project, the chromium interim measure volume is assumed to be needed through 2060. This volume has not been included in the water demand projections (Table 5-9), as the water will be pumped separately and will not be supplied by the DPU. Figures 5-7 and 5-8 present the low and high water demand projections and illustrate the County- and DOE-owned water rights volumes, including and excluding the volume needed for the chromium interim measure project. The projections assume that the water supply remains available in terms of water rights and contamination, and do not take into account the possibility of treating and using contaminated groundwater, which would be possible (with public support).

Table 5-9. Projected County-Supplied Water Demand, 2020-2060

Year	Population Projection[a]		Projected Per Capita Demand[b] (ac-ft/yr)	2016 Total Diversions (ac-ft/yr)	2016 Water Sales (ac-ft/yr)		Projected Demand[c] (ac-ft/yr)		LANL Water Demand Forecast[d] (ac-ft/yr)	Total Projected Demand[e] (ac-ft/yr)	
	Low	High			County[c]	LANL	Low Projection	High Projection		Low Projection	High Projection
2010	17,950[f]		0.161	3,689	2,321	880	—	—	—	—	—
2020	17,988	20,000	0.161	—	—	—	2,896	3,220	918	3,814	4,138
2030	17,789	20,812	0.161	—	—	—	2,864	3,351	1,505	4,369	4,856
2040	17,123	21,447	0.161	—	—	—	2,757	3,453	1,505	4,262	4,958
2050	16,480	21,874	0.161	—	—	—	2,653	3,522	1,505	4,158	5,027
2060	15,863	22,092	0.161	—	—	—	2,554	3,557	1,505	4,059	5,062

[a] Poster Enterprises, 2014

[b] Equivalent to 144 gpcd (the 2016 total water system per capita demand)

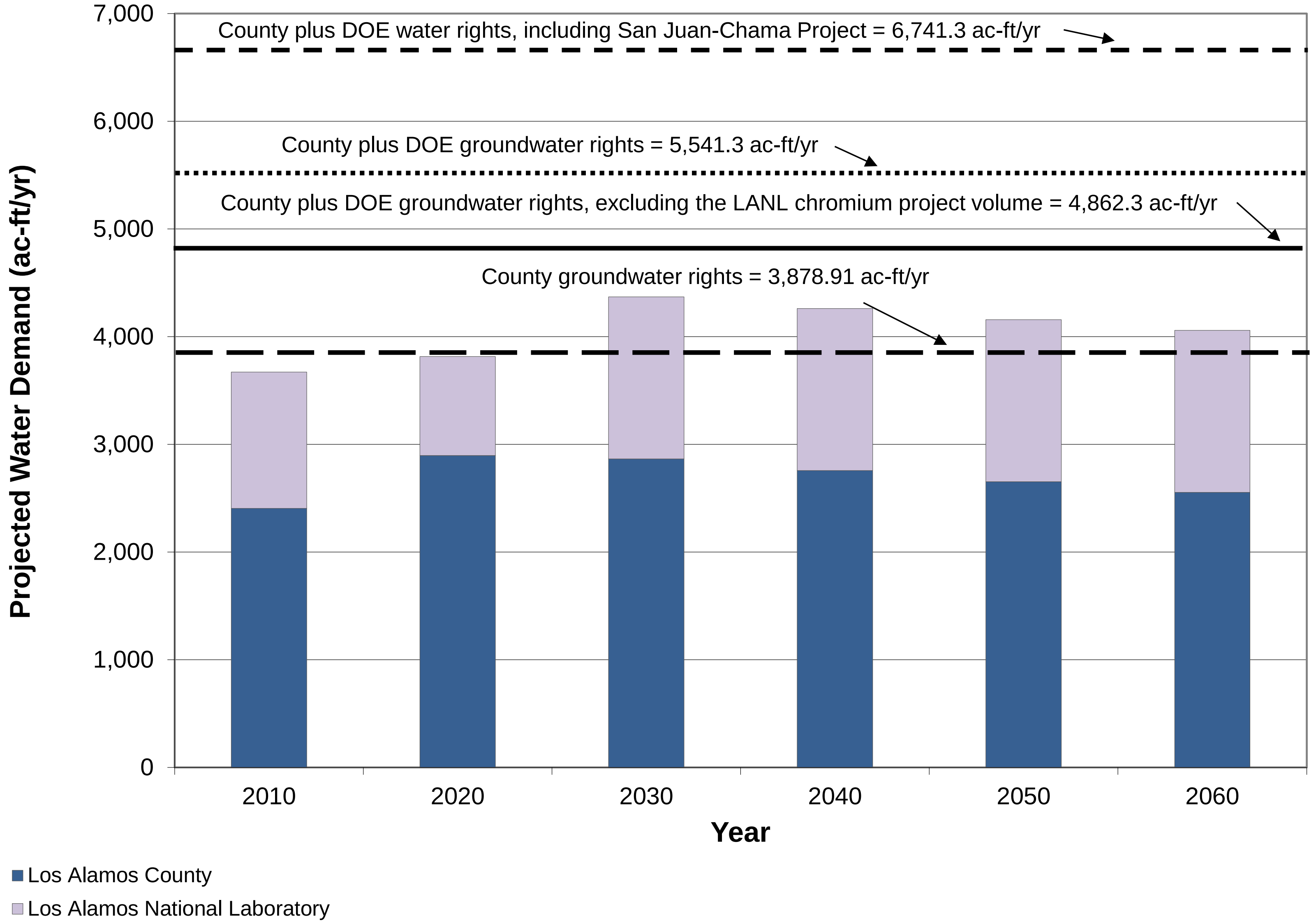
[c] Excluding LANL demands

[d] Begay, 2017 (through fiscal year 2027; projections held constant beyond 2030)

[e] Including LANL demands, but not including the demand for the LANL chromium plume control and characterization project (679 ac-ft/yr; U.S. DOE and DPU, 2016)

[f] Actual U.S. Census population

ac-ft/yr = Acre-feet per year
LANL = Los Alamos National Laboratory
— = Not applicable



Note: See Section 4.1.1 for a discussion of water rights ownership and leasing.

LOS ALAMOS COUNTY WATER PLAN

Projected Water Demand Under the Low Water Use Projection

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Figure 5-7

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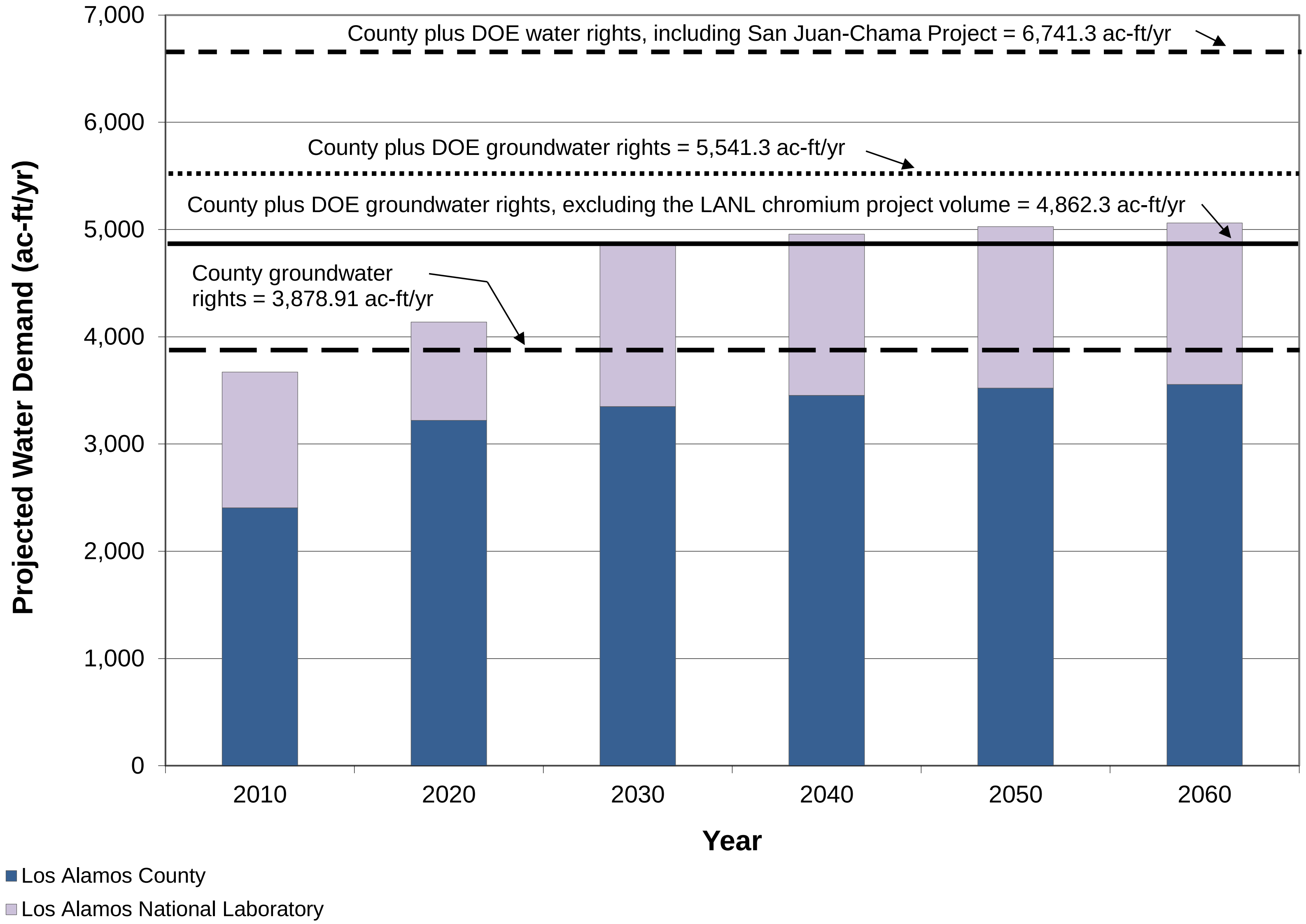

Note: See Section 4.1.1 for a discussion of water rights ownership and leasing.

LOS ALAMOS COUNTY WATER PLAN

Projected Water Demand Under the High Water Use Projection

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Figure 5-8

Table 5-10 presents a range in conservation savings that could be achieved with further reductions in the DPU's 2016 per capita demand of 144 gpcd, ranging from a 14-gpcd savings to a 54-gpcd savings (the reduction necessary to match the City of Santa Fe's 2015 per capita value of 90 gpcd). Achieving the City of Santa Fe's 2015 per capita value would be equivalent to a water conservation savings of between 960 and 1,336 acre-feet per year, based on the population projections for 2060.

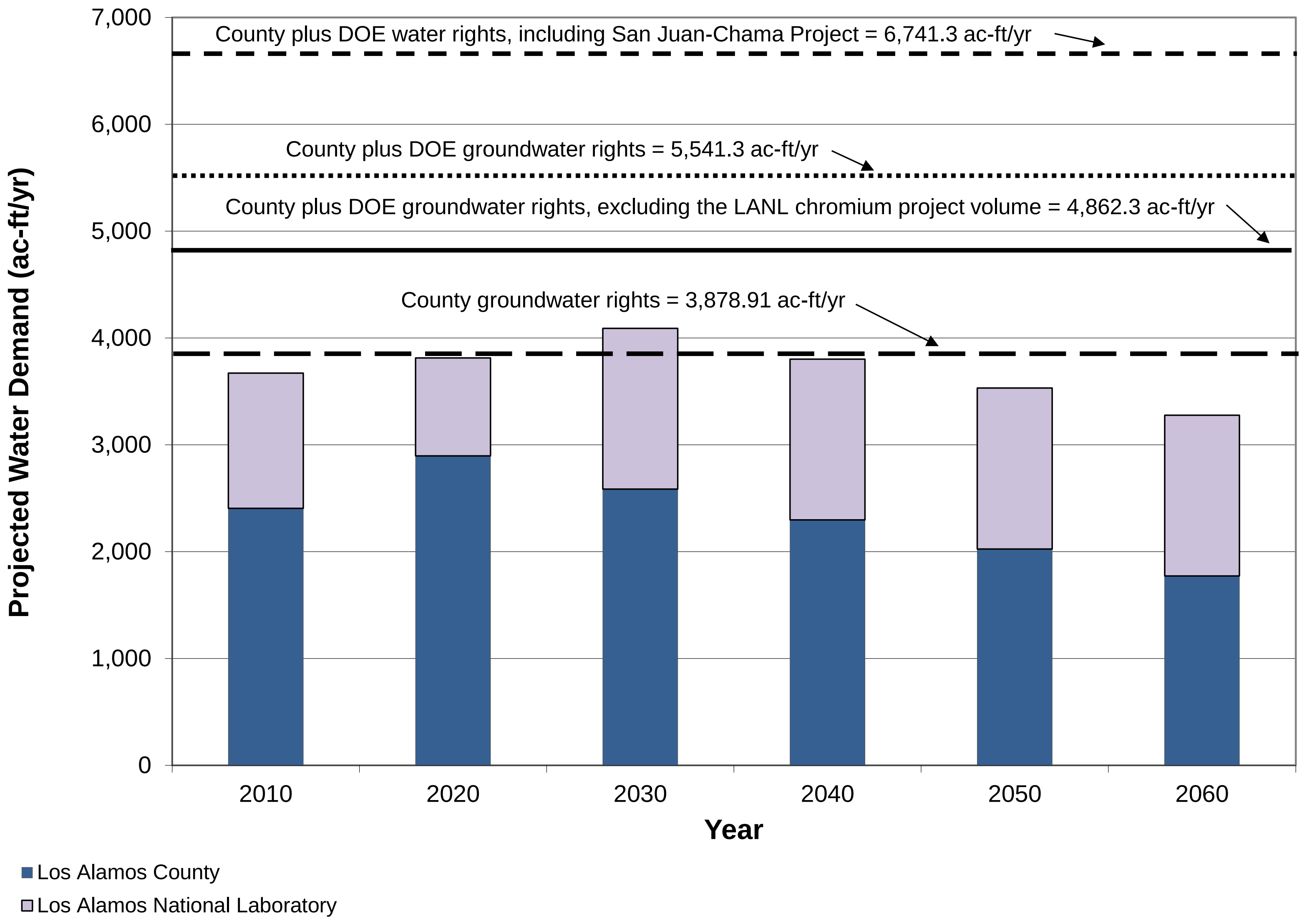
Table 5-10. Potential Water Conservation Savings

Per Capita Water Use (gpcd)	Reduction from 2016 Per Capita Use (%)	Annual Conservation Savings	
		Low Population Projection (acre-feet) [a]	High Population Projection (acre-feet) [a]
130	10	249	346
120	17	426	594
110	24	604	841
100	31	782	1,089
90 [b]	38	960	1,336

[a] Annual water conservation savings that would be achieved based on reductions from the 2016 per capita value of 144 gallons per day in 2060.

[b] This value is equivalent to the City of Santa Fe's per capita demand in 2015.

Figures 5-9 and 5-10 show low and high water demand projections, assuming that the County water demands are reduced in the future due to conservation (the LANL water demands remain unchanged). Table 5-11 shows the data that are plotted on Figures 5-9 and 5-10. The same low and high population projections that are used for Figures 5-7 and 5-8 have been used for both scenarios, but the per capita demand is assumed to be reduced from 144 gpcd (the 2016 value) to 130 gpcd by 2030, 120 gpcd by 2040, 110 gpcd by 2050, and 100 gpcd by 2060.



Notes: 1. Per capita demand assumed to be reduced over time due to water conservation.

2. See Section 4.1.1 for a discussion of water rights ownership and leasing.

LOS ALAMOS COUNTY WATER PLAN

Projected Water Demand Under the Low Water Use Projection with Reduced Per Capita Demand

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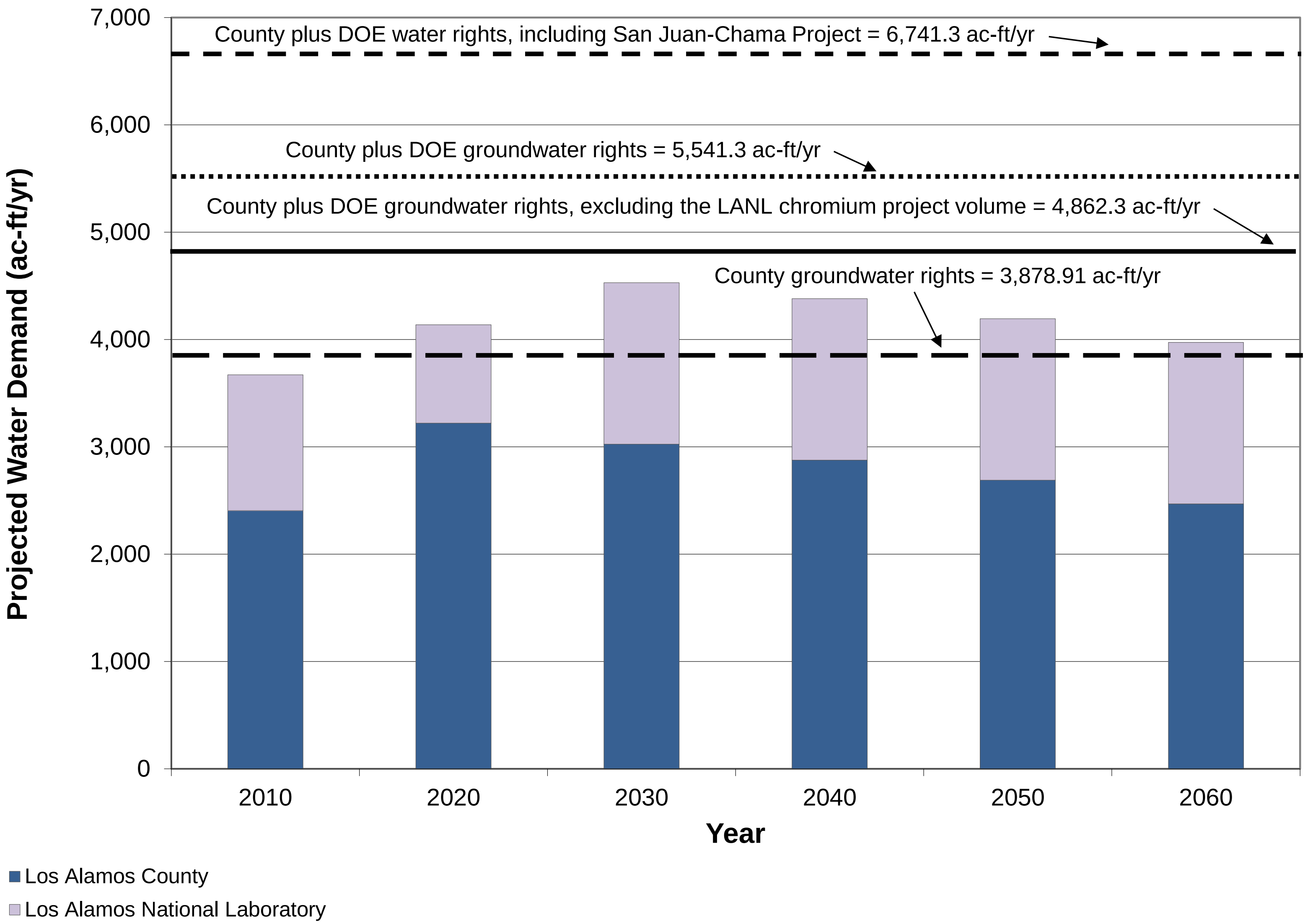
Figure 5-9



Notes:
1. Per capita demand assumed to be reduced over time due to water conservation.
2. See Section 4.1.1 for a discussion of water rights ownership and leasing.

LOS ALAMOS COUNTY WATER PLAN

Projected Water Demand Under the High Water Use Projection with Reduced Per Capita Demand

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Figure 5-10

Table 5-11. Projected County-Supplied Water Demand Assuming Decreased Demand Due to Water Conservation, 2020-2060

Year	Per Capita Water Demand Used to Calculate County Demand (gpcd)	Low Demand Scenario (ac-ft/yr)			High Demand Scenario (ac-ft/yr)			LANL Projected Demand (ac-ft/yr)
		County Projected Demand	Potential Conservation Savings	County Projected Demand with Conservation	County Projected Demand	Potential Conservation Savings	County Projected Demand with Conservation	
2010	144 [a]	2,712	—	2,712	2,712	—	2,712	904
2020	144	2,896	0	2,896	3,220	0	3,220	918
2030	130	2,864	279	2,585	3,351	326	3,025	1,505
2040	120	2,757	460	2,297	3,453	577	2,876	1,505
2050	110	2,653	628	2,025	3,522	833	2,689	1,505
2060	100	2,554	782	1,772	3,557	1,089	2,468	1,505

[a] Actual 2016 value

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year
LANL = Los Alamos National Laboratory
— = Not applicable

6. Reconciliation of Supply with Demand

To ensure that adequate water resources are available to meet future demands, the County must take into consideration the quantity of supply available, limitations to the supply due to water quality concerns, and the legal ability to use the available supply (water rights).

The physical water supply is discussed in detail in Section 3. Given the amount of water in storage and the large saturated thickness in relation to observed rates of water level decline, and assuming that the County remains the primary diverter in the area, the County is expected to have an adequate quantity of supply to meet the projected demands over a 40-year time frame. Wells may need to be replaced or moved to new locations, but it is expected that the available supply somewhere in the vicinity of Los Alamos will be adequate to fulfill the County's existing water rights. Ongoing monitoring of water levels and aquifer testing is recommended to confirm that threats to water supply do not develop.

As discussed in Section 3.2.2, there is some risk to the supply due to contamination, and if the County's supply wells were to be impacted, they could become unusable over the 40-year plan horizon (without treatment). The hexavalent chromium plume near several supply wells will continue to be monitored as the interim measure is implemented, and the presence of this contamination highlights why contingency planning for potential impacts to water supply wells is important.

If contaminant levels exceed applicable standards in any supply well, the DPU could potentially re-drill the well in an alternate location and continue to pump the same volume, provided that the transfer of the diversion point is approved by the OSE. Potential locations for replacement wells have not been identified, but the best locations would be upgradient from contaminant sources, accessible to existing water supply infrastructure, in productive zones, and separate from the influence of other pumping wells. The County filed an application for an additional point of diversion (Otowi Well No. 2) on April 28, 2016, and the new well will be drilled under an exploratory well permit during the fall and winter of 2017-2018. This well will be drilled to supplement the system's existing production wells in anticipation of declining production rates from existing wells that are nearing the end of their service life (Alarid, 2016), rather than as a replacement well for any future contamination of well(s) that could occur.

As discussed in Section 4.1.1, DOE owns 30 percent (1,662.39 ac-ft/yr) of the total groundwater rights (5,541.3 ac-ft/yr), and the long-term lease that was in place for County to use these water rights expired in 2011. A portion of the volume of the DOE-owned water rights (679 ac-ft/yr) will be used for the chromium interim measure project; however, the County is pursuing a lease for the full DOE-owned water rights volume (1,662.39 ac-ft/yr). The lease is not yet in place. If DOE declines to lease their water rights to the County, the groundwater rights volume that the County has access to will be reduced to 3,878.91 ac-ft/yr. As discussed in Section 5.4, both low- and high-water-use projections were developed based on County and LANL growth projections made for the current New Mexico regional water plan updates. To evaluate the gap between the projected demands and the available supply, the two scenarios (low-water-use and high-water-use) were considered.

The County-owned groundwater rights volume (3,878.91 ac-ft/yr) is adequate to meet the DPU-only low-water-use projections for all decades, and the DPU-plus-LANL low-water-use projections for 2020. The County-owned groundwater rights volume is not adequate to meet the DPU-plus-LANL low-water-use projections for 2030, 2040, 2050, or 2060 (Figure 5-7). The County-owned groundwater rights volume is also adequate to meet the DPU-only high-water-use projections for all decades, but is not adequate to meet the DPU-plus-LANL high-water-use projections for any decade (Figure 5-8).

With increased conservation in the amounts shown on Table 5-11, the County-owned groundwater rights volume is not adequate to meet the DPU-plus-LANL low-water-use projections for 2030, but the 2020, 2040, 2050, and 2060 low-water-use projections can be met with this volume (Figure 5-9). Even with increased conservation, the County-owned groundwater rights volume is not adequate to meet any of the DPU-plus-LANL high-water-use projections (Figure 5-10). If the remaining DOE water rights are not leased to the County, the DPU continues to be the sole water provider for LANL, and the high population projections are realized, even with significant additional conservation the County will need to implement a project to bring their San Juan-Chama Project water online.

Additional discussion of contaminant and water rights risks is presented in Sections 3.2.3 and 4.3, and recommendations for responding to these risks are discussed in Section 9.

7. Climate Change

One of the goals of the DPU water resource planning effort is anticipating and preparing for potential climate change impacts. For water resources planning, it is important to understand both natural variations in climate and variations that may result from anthropogenic climate change. This section includes information on natural climate variability (Section 7.1), anticipated changes in temperature and precipitation due to climate change (Section 7.2), potential impacts of climate change in the Los Alamos area (Section 7.3), and recommendations for mitigating climate change impacts (Section 7.4).

7.1 Natural Climate Variability

The climate of Los Alamos County naturally exhibits variability in precipitation and temperature, including both seasonal and annual variations. Weather patterns in the southwestern United States, including the Los Alamos area, are affected by several natural cycles:

- *El Niño/La Niña:* El Niño and La Niña are characterized by unusually warm and unusually cool temperatures, respectively, in the equatorial Pacific. Years in which El Niño is present are more likely to be wetter than average in New Mexico, and years with La Niña conditions are more likely to be drier than average.

- *The Pacific Decadal Oscillation (PDO):* The PDO is a long-lived pattern of climate variability caused by shifting sea surface temperatures between the eastern and western Pacific Ocean that cycle approximately every 20 to 30 years. Warm phases of the PDO (shown as positive numbers on the PDO index) correspond to El Niño-like temperature and precipitation anomalies (i.e., wetter than average), while cool phases of the PDO (shown as negative numbers on the PDO index) correspond to La Niña-like climate patterns (drier than average). It is believed that since 1999, Los Alamos County has been in the cool phase of the PDO.

- *The Atlantic Multidecadal Oscillation (AMO):* The AMO refers to variations in surface temperatures of the Atlantic Ocean which, similarly to the PDO, cycle on a multi-decade frequency. The pairing of a cool phase of the PDO with the warm phase of the AMO is typical of drought in the southwestern United States (McCabe et al., 2004; Stewart, 2009). The AMO has been in a warm phase since 1995 and it is possible that the AMO may be shifting to a cool phase, but the data are not yet conclusive. LANL has been doing statistical analyses to evaluate the correlation between the AMO and warming temperatures and has concluded that anthropogenic effects account for two-thirds of the post-1975 global warming, while the AMO accounts for one-third of the effect (Chylek et al., 2014).

These natural cycles and other short-term meteorological conditions lead to considerable annual and monthly variability in temperature and precipitation.

7.2 Changes in Temperature and Precipitation

In addition to the natural variability in temperature and precipitation, there is significant research indicating that long-term trends, particularly in temperature, are changing. The Intergovernmental Panel on Climate Change (IPCC) is an international body that was created to assess the science related to climate change world-wide. The IPCC's most recent research efforts are summarized in the Fifth Assessment Report, which was released in September 2013.

IPCC assessments are prepared and reviewed by hundreds of scientists and provide a scientific basis for governments at all levels to develop policies related to climate change. The Fifth Assessment report indicates that globally the atmosphere and oceans have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased (IPCC, 2013). Atmospheric concentrations of greenhouse gases are rising so quickly that all current climate models project significant warming trends over continental areas in the 21st century. The IPCC report also suggests that it is extremely likely that more than half of the increase in annual surface temperature from 1951 to 2010 is explained by anthropogenic increases in greenhouse gases and other anthropogenic forcings (IPCC, 2014). Likely impacts of climate change include increased numbers of dry days and extreme events (IPCC, 2012).

In the United States, regional assessments conducted by the U.S. Global Change Research Program (USGCRP, 2015) have found that temperatures in the southwestern United States have increased and are predicted to continue to increase. Reduced snowpack and streamflow and increased drought and wildfires are anticipated impacts of climate change in the southwest (USGCRP, 2015). Recent flows in the Upper Colorado and Rio Grande were 3 to 5 percent lower during 2001 through 2010 than 20th Century average flows, and snowmelt occurred earlier (Overpeck et al., 2013).

To assess climate trends in New Mexico, the NMOSE and NMISC (2006) conducted a study of observed climate conditions over the century and found that observed wintertime average temperatures had increased statewide by about 1.5 degrees Fahrenheit (°F) since the 1950s. A number of other studies predict temperature increases in New Mexico from 5° to 10°F by the end of the century (Forest Guild, 2008; Hurd and Coonrod, 2008; USBR, 2011).

More recently, the USBR, with technical assistance from Sandia National Laboratories and the U.S. Army Corps of Engineers, conducted a climate risk impact assessment for the Upper Rio Grande that evaluated climate impacts in northern New Mexico (USBR, 2013). The study, entitled the Upper Rio Grande Impact Assessment (URGIA), found that average temperatures from 1971 through 2011 rose at a rate of approximately 0.7°F per decade, approximately twice the global average, for a total warming of approximately 2.5°F since 1971. Temperatures are predicted to rise an additional 4° to 6°F by the end of the century. The study additionally projected a decrease in native Rio Grande water by about a third and a decrease in tributary flow by about a quarter, increasing frequency, intensity, and duration of droughts and floods, earlier snowmelt runoff, and increased variability in the magnitude, timing, and spatial distribution of streamflow and other hydrologic variables.

Although there is consensus among climate scientists that global temperatures are warming, there is considerable uncertainty regarding the specific local and temporal impacts that can be expected. Predictions of annual precipitation are also subject to uncertainty, particularly regarding precipitation during the summer monsoon season in the southwestern U.S.

While attribution of individual events remains a challenge, droughts and heavy short-term precipitation in the Southwest are predicted to be more severe as human-induced climate change progresses (USGCRP, 2014). An example of extreme precipitation events occurred in September 2013 in Boulder, Colorado, where a 3-day rainfall exceeded the monthly total for any month on record and was classified as a 1,000-year event (chance of 1 in 1,000 of occurring) (NOAA Climate.gov, 2013). During the same September 2013 time period, the Los Alamos area also experienced extreme precipitation. Initial research indicates that the extreme events that occurred in Colorado in 2013 were not due to anthropogenic climate change (NOAA Climate.gov, 2014). Since extreme events occur infrequently, however, it is difficult to observe trends and conclusively attribute causes.

7.3 Impacts of Climate Change on Los Alamos County

Climate change impacts that are likely to occur in Los Alamos County based on studies of the Southwest and New Mexico in particular (Christensen et al., 2004; Hurd and Coonrod, 2008; NMOSE/NMISC, 2006; Overpeck et al., 2013; USBR, 2011, 2013, 2015; USGCRP, 2015; Williams et al., 2010) include:

- Though model predictions vary, increasing temperatures are expected to occur. Warming will continue with longer and hotter heat waves during summer months.

- Higher temperatures will result in a longer and warmer growing season, resulting in increased water demand for outdoor watering during the spring and summer months and potentially lower rates of recharge.

- Reservoir and other open water evaporation is expected to increase. This could affect the non-potable water in storage in Los Alamos Reservoir and could potentially lead to shortages of San Juan-Chama Project water.

- Although predictions of annual precipitation are subject to greater uncertainty “given poor representation of the North American monsoon processes in most climate models” (NMOSE/NMISC, 2006), precipitation is expected to be more concentrated and intense, so increases in the frequency and severity of flooding are projected. Due to the presence of various contaminated areas around Los Alamos due to historical LANL operations, stormwater management is a key issue for the County and LANL.

- Streamflow in major rivers across the Southwest is projected to decrease during this century, due to a combination of diminished cold season snowpack in the headwaters regions and higher evapotranspiration during the warm season. The USBR developed projections of the hydrologic impacts of modeled climate changes for the Upper Rio Grande Basin over the rest of this century and published their results in the climate risk impact assessment for the Upper Rio Grande (USBR, 2013). Their analysis included the reliability of the San Juan-Chama Project water under potential climate change scenarios. The projections suggest an increase in the month-to-month and inter-annual variability, and a somewhat more reliable supply from the San Juan-Chama Project than for the native Rio Grande supply (USBR, 2013). The results for the average total San Juan-Chama allocations were 94 percent of contracted water rights in the 2020s, 88 percent in the 2050s, and 81 percent in the 2090s (USBR, 2013), indicating that the average total San Juan-Chama Project allocation would be reduced by about 20 percent by the 2090s (USBR, 2013).

- The USBR collaborated with the City of Santa Fe and Santa Fe County on a basin study focused on the Santa Fe River Basin in northern New Mexico. This study evaluated surface water sources in New Mexico and southern Colorado that provide water supply to the City of Santa Fe and Santa Fe County, including the San Juan-Chama Project, and local groundwater supplies (USBR, 2015). Projected changes to the water supply and San Juan-Chama Project operations include an overall decrease in flows by 25 percent (the total Project diversion decreases from around 90,000 acre-feet per year during the historical simulation period [1950 through 1999] to between 70,000 and 80,000 acre-feet per year during the 2050 through 2099 period), decreased summer flows, increased spring flows, reduced storage in Heron Reservoir, and less frequent full water allocations to contractors (USBR, 2015). Contractors are projected to receive a full allocation in 99 percent of simulated years from 1950 through 1999, 94 percent during the 2020s, 72 percent during the 2050s, and 61 percent in the 2090s (USBR, 2015). The USBR plans to complete a Rio Grande Basin study and is looking for partners (Llewellyn, 2017).

- As cited in USBR (2015), Roach (2009) performed an analysis using 604 years of tree-ring records developed by Gangopadhyay and Harding (2008) to assess what Heron Reservoir storage would have been over the full hydrologic sequence. The analysis found that there was approximately a 10 percent chance that Heron Reservoir would start a year with less than 95,200 acre-feet in storage, meaning that the San Juan-Chama Project allocation would be less than the contracted amount less than 10 percent of the time (USBR, 2015).

- The seasonal distribution of streamflow is projected to change as well: flows could be somewhat higher than at present in late winter as warmer conditions lead to more winter precipitation falling as rain and less as snow, but peak runoff will be weaker due to reduced snowpack. Late spring/early summer flows are projected to be much lower than at present, given the combined effects of less snow, earlier melting, and higher evaporation rates after snowmelt. Since the County relies primarily on groundwater, this is not anticipated to present a major concern for County water resources, but these pressures may lead to overall added stress on the Rio Grande systems, which may increase vulnerability to administrative changes in junior water rights management, as discussed in Section 4 and by Kenney et al. (2008).

During the period of observed record, the Southwest has experienced two significant dry periods, the 1950s and the early 2000s, with the second drought period being warmer and producing greater water loss. The 1980s and 1990s were wetter and promoted a lot of vegetation growth, creating conditions of higher vulnerability to forest fire (NOAA, 2013). The extreme drought conditions prevalent throughout New Mexico and Los Alamos in the past 10 years have resulted in the mortality of many trees. Between 2002 and 2005, more than 90 percent of the mature piñon trees in the Los Alamos area died from a combination of drought stress and bark beetle infestation (Breshears et al., 2005, as cited in LANL, 2014a). Lower-elevation ponderosa pine and mixed conifer stands were also affected. More recently, large numbers of mature ponderosa pine are dying, apparently due to prolonged drought stress. These conditions lead to vulnerability to wildfire and post-fire flooding.

Los Alamos County has already experienced extreme wildfires and post-fire flooding since 2000:

- The Cerro Grande fire burned 47,000 acres in May 2000. The fire started as a result of controlled burning in Bandelier National Monument and directly impacted structures and vegetation in the Los Alamos area.

- The Las Conchas wildfire started on June 26, 2011 in the Jemez Mountains, approximately 10 miles west of Los Alamos, and ultimately burned approximately 156,600 acres, making it the largest wildfire in New Mexico history at the time. Fire damage in the upper portions of watersheds above Los Alamos greatly increased the risk of flash floods and flood damage in the downstream canyons (LANL, 2014a).

- On September 13, 2013, anywhere from 2.49 to 3.52 inches of rain fell at different locations around Los Alamos within a 24-hour period. All of the local canyons flooded, and some experienced substantial channel and bank erosion and widespread sediment deposition. Infrastructure, including roads, gaging stations, and other sampling equipment, was also significantly damaged (LANL, 2014a). With saturated antecedent soil conditions caused by a previous storm on September 10, the flooding that occurred during the September 12 to 13 storm damaged LANL's environmental monitoring and control infrastructure, including access roads, groundwater monitoring wells, gaging stations, and watershed controls. The damage to or impairment of flood- and sediment-control structures included a large amount of erosion in the Pueblo Canyon Wetlands, and overflow from sediment traps and retention basins in other canyons. LANL has since installed various sediment-control structures to minimize the erosive nature of stormwater runoff and to enhance deposition of sediment.

As discussed previously, while it may be difficult to determine if a specific event is caused by climate change, these are the types of impacts that the County needs to continue to plan for.

7.4 Recommendations for Mitigating Impacts of Climate Change

Though it is difficult to determine whether individual events are a result of natural climate variability or climate change, it is important for the County to be prepared to address variability, including drought and extreme precipitation events, and to be aware that these conditions may be both more frequent and more severe as a result of climate change. Higher temperatures and drought may contribute to increased demands for water, diminished supplies, impacts to vegetation, and wildfire risk. Extreme precipitation may damage infrastructure due to stormwater runoff and flooding, mobilize surface or shallow contaminants due to erosion, and create extreme sedimentation that can affect reservoir storage, as has occurred at Los Alamos Reservoir following the Cerro Grande and Las Conchas fires.

The following are recommendations that the DPU could implement to prepare for long-term and severe drought, as well as for extreme precipitation events:

- As a part of the long-range water supply plan, adaptive management should be implemented, where decisions are made sequentially over time, allowing adjustments to be made as more information is known. This approach may be useful in dealing with the additional uncertainty introduced by potential climate change.

- Research and monitoring should be conducted to fill knowledge gaps and enhance planning capabilities. Although neither will eliminate all uncertainty, they will provide significant improvements in understanding the effects of climate change on water resources and in evaluating associated uncertainties and risks required for more informed decision making (Brekke et al., 2009).

- The County should continue to implement and update the Los Alamos Energy and Water Conservation Plan to help reduce outdoor demands during periods of drought and to use water resources efficiently during all times.

- To account for the potential for reduced streamflow to result in shortages of San Juan-Chama Project water in some years, the San Juan-Chama Project water, if developed, should be conjunctively managed with more reliable groundwater resources.

- It will be important to bring surface water from Los Alamos Reservoir online, allowing for conservation of groundwater resources during times when surface water is available, while having provisions for meeting demand with groundwater during extreme drought periods when surface water is not available. DPU awarded a contract in September 2017 to reestablish the Los Alamos Reservoir supply by summer 2018 (Alarid, 2017).

- The County should prepare for the increasing risk of large and severe wildfires, working together with U.S. Forest Service and New Mexico State Forestry Division personnel to identify particular fire risks and vulnerabilities. Ponderosa pine and Douglas fir are particularly susceptible to drought and rising temperatures (Williams et al., 2010). An important component of wildfire planning is to work with emergency personnel on a plan to protect critical drinking water infrastructure during potential fires. The DPU should also coordinate with LANL on its efforts to mitigate the effects of potential wildfires:

  – LANL operates a program to reduce wildfire fuels and manage forest health throughout forested areas on Laboratory and DOE property. Defensible space is created and maintained around facilities and other high-priority areas, and areas not designated as defensible space are managed for a combination of wildfire fuel reduction and forest health. The major roads within the facility continue to be thinned along the road easements to the fencelines, to provide firebreaks and improve vehicle visibility to wildlife crossing the roads (LANL, 2014a).

  – Following the Los Conchas fire in 2011, high-priority areas in the canyons were armored to protect against potential flood damage (LANL, 2014a).

The U.S. EPA published the 2013 Draft National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Industrial Activities, also referred to as the Multi-Sector General Permit (MSGP), by Federal Register (FR) notice on September 27, 2013 (78 FR 59672). The MSGP requires the implementation of control measures, development of stormwater pollution prevention plans (SWPPPs), and monitoring of stormwater discharges from permitted sites. LANL conducts stormwater sampling and has implemented some flood mitigation measures. DPU should continue to work with LANL to mitigate the risk of extreme precipitation events and flooding mobilizing contamination, which could affect the drinking water system.

Climate change modeling for the Southwest is based on varying carbon emissions scenarios, with higher rates of warming predicted with higher emissions. While Los Alamos County alone cannot significantly change regional emissions, the DPU can contribute to reduced emissions through its energy policies, as discussed in the *Energy and Water Conservation Plan* (LADPU, 2015).

8. Water Conservation

The existing long-range water supply plan (DBS&A, 2006) included a water conservation plan, and additional documents that address water conservation have been published since that time. The DPU published an *Energy and Water Conservation Plan* in 2013 (LADPU, 2013a), and this document was revised and reissued in 2015. The updated *Energy and Water Conservation Plan* focuses on conservation goals for the planning period of 2015 through 2019 (LADPU, 2015), and it meets the requirements of the New Mexico *Water Conservation Planning Guide for Public Water Suppliers* (NMOSE, 2013). The 2015 *Energy and Water Conservation Plan* includes a water audit covering fiscal year 2014 (July 1, 2013 through June 30, 2014), as well as the completed GPCD calculator worksheets covering 2007 through 2014 (LADPU, 2015). A new water audit covering calendar year 2016 and GPCD analyses for 2015 and 2016 were completed as a part of this project (Sections 5.3 and 5.1).

The conservation program is implemented by customers primarily on a voluntary basis and the goals are not directed toward LANL, which falls outside of the County's jurisdiction (LADPU, 2015). Existing water conservation program activities that are discussed in detail in the 2015-2019 Energy and Water Conservation Plan (LADPU, 2015) include:

- *Customer meter testing and replacement.* The DPU routinely tests large customer meters and replaces those that are not working properly. A replacement program for all customer water meters is underway, and will be completed by fiscal year 2022 (over 2,000 White Rock customer meters have already been replaced) (Alarid, 2017). Existing 1-inch customer meters are being replaced with ¾-inch by ⅝-inch meters that will better measure low flows (Alarid, 2017). The County plans to install advanced metering infrastructure (AMI) on all existing water meters in 2018, and the new meters are compatible with AMI (Alarid, 2017).

- *Large water customer usage and account review.* The DPU completed a large water meter review project in 2011 that addressed discrepancies in the billing or metering of large customers.

- *System leak detection surveys.* The DPU surveys 20 percent of the water system annually in an effort to identify and fix water leaks.

- *Regulatory measures.* The Los Alamos Board of Public Utilities adopted Water Rule W-8 in 2005 to prohibit water waste and implement the even/odd address watering schedule, daytime watering restrictions, and leak repair requirements.

- *Water rates.* The Los Alamos County Council approved a tiered water rate structure in July 2014 for the DPU's single-family and multi-family residential customers.

- *County park irrigation water audits.* The DPU has worked with the County parks to conduct irrigation audits, recommend irrigation scheduling and maintenance, and identify any leaks or problems. The Los Alamos County Sustainability Plan includes a goal of reducing water demand for County parks by 25 percent of 2012 demand by 2020 (LADPU, 2013b).

- *Residential water leak training and audits*. The DPU participates in the nationally advertised "Fix a Leak" week, offering fix a leak demonstrations and providing water audits for high water using customers.

- *Commercial water audits.* The DPU conservation coordinator implemented a commercial water audit program in 2012, initially conducting seven audits on facilities including a hotel, grocery store, and school campus. The program is ongoing, and each participating facility is provided with a detailed report of the audit findings and recommendations.

- *Residential water conservation outreach.* Educational materials are distributed to DPU customers through bill inserts, feature articles, workshops, and booklets on subjects including graywater use, rainwater harvesting, xeriscape and permaculture, and energy efficiency.

- *Public school outreach.* Since 2008, the DPU has had a contract with the Pajarito Environmental and Education Center (PEEC) to perform energy and water conservation outreach in the public schools.

- *Conservation partnerships.* The DPU participates in numerous regional and national conservation partnerships in order to share ideas, resources, and lessons learned. Existing partnerships include EPA WaterSense (promotional partner), Alliance for Water Efficiency (charter member), New Mexico Water Conservation Alliance (member), U.S. EPA Energy Star (promotional partner), Alliance to Save Energy (member), and Los Alamos Sustainability Program (participant).

- *Residential bill revisions.* The DPU implemented changes to the residential customer bills in 2012, and customer bills now show usage for the past 13 months, allowing for comparison of usage between the current month and the previous year. Additional revisions are being planned.

A Conservation Advisory Group was formed in 2011 and has eight members, representing the Los Alamos Public Schools, County Parks Division, County Environmental Services Division, small commercial customers, and residential customers (LADPU, 2015). The long-term goal of the water conservation program is to achieve a 12 percent reduction in per capita water demand by 2050, as approved by the Utility Board on September 18, 2013 (Alarid, 2015). Specific actions that have been identified to assist in meeting this goal include:

- Increase water conservation education in the public schools.
- Increase adult education efforts, including outreach lectures and demonstration workshops.
- Implement residential irrigation water audits, focusing on customers with high summer water use.
- Improve Water Rule W-8 by researching its effectiveness, revising as necessary, and potentially adding enforcement capabilities.

- Implement incentives for replacement of lawns, including rebates for plant purchases and technical assistance.
- Implement the county's non-potable water master plan (Forsgren & Associates, 2013), which presents water use criteria for evaluating the efficiency of the existing non-potable water systems and for additional sites that could be potentially served by one of the non-potable water systems in the future.

The DPU monitors the success and implementation of the Energy and Water Conservation Program annually, using activities such as evaluating data from the Cayenta billing system, completing the OSE GPCD calculator, and using the Alliance for Water Efficiency tracking tool (LADPU, 2015).

9. Recommendations

The DPU is planning for potential future growth and increased water demands. While the groundwater supply will likely continue to produce at current rates for well beyond the 40-year planning period, issues regarding water rights and potential water quality concerns indicate that the DPU needs to proactively plan for the future. A summary of recommendations for addressing the future water supply needs of the County follows.

Water Supply (Quantity) and Demand

- Monitor water levels in the vicinity of the water supply wells and evaluate declines on a regular basis, with particular emphasis on monitoring the Guaje well field. Static water levels should also be measured in each of the active production wells on at least an annual basis.

- Expand the existing annual production meter calibration and large customer meter testing programs. Continue to calibrate the LANL master meter annually.

- Update the water demand analysis in a few years to re-evaluate whether and/or when a San Juan-Chama Project water supply project will be needed. Current unknowns that will better inform the water need projections once defined include (1) execution of a new lease with DOE for the full volume of water rights that they own (1,662.39 ac-ft/yr), (2) entering into a new water supply contract between the County and DOE (the current contract expires in 2019), and (3) definition of the water demands for the chromium remediation project, following completion of the chromium interim measure project.

Water Quality/Contaminant Risk Recommendations

- Work closely with LANL and NMED regarding the ongoing monitoring of contaminants and assessment of anticipated transport velocities and flow paths, especially relating to the chromium interim measure and future remediation projects.

- Evaluate contaminant data on a quarterly basis to identify any trends or changes.

- Begin contingency planning for alternate production well locations. In a worst case scenario, wells could be affected by contaminants over the planning period. To prepare for this contingency, identify possible locations for new wells that are upgradient from or off-gradient of key source areas, and begin to resolve infrastructure, land access, and water rights transfer issues so that alternative wells could be developed in a timely manner.

- To mitigate potential climate change impacts, work with emergency personnel to develop a plan to protect drinking water infrastructure in the event of a wildfire, and work with LANL to prepare for extreme precipitation events, to ensure that stormwater runoff does not mobilize contaminants to the detriment of the drinking water system.

Water Rights

- Pursue a new lease with DOE for their water rights (1,662.39 ac-ft/yr).

- Renegotiate the contract that County has with DOE for supplying water to LANL before it expires in 2019.

- Secure services of a water rights attorney to advise and plan for water rights acquisition (availability of pre-1907 water rights, return flow credits, costs, time to secure, potential litigation).

- Pursue return flow credits as identified in the 1999 return flow study (SWC, 1999).

- Evaluate and quantify pumping effects on the Rio Grande from the current water production regime and explore potential changes in pumping amounts and locations in order to be prepared to address OSE concerns during a potential water rights transfer application process.

- Meet with the OSE to discuss priority administration and the number and amount of water rights that are senior to the County's water rights.

Water Conservation

- Continue and expand the existing water conservation program, as discussed in Section 8, monitoring the effectiveness of the existing and new conservation measures and refining the conservation program as needed.

- Work to minimize system water loss. Conduct annual water audits to assess the change in system water loss over time, and update the recommendations for further improvements.

- Monitor the effectiveness of voluntary compliance with Rule W-8 in reducing water waste, and if necessary, pass an enforceable ordinance so that penalties can be assessed.

- Update the subdivision regulations to include requirements for graywater reuse, water harvesting, xeriscaping, and low-water-use indoor plumbing for all new commercial and residential development.

- Establish rebate programs for xeriscaping and appliance replacement.

- Distribute indoor plumbing leak detection and retrofit kits.

Implementation of these recommendations will help the DPU be prepared to meet the County's future water supply needs.

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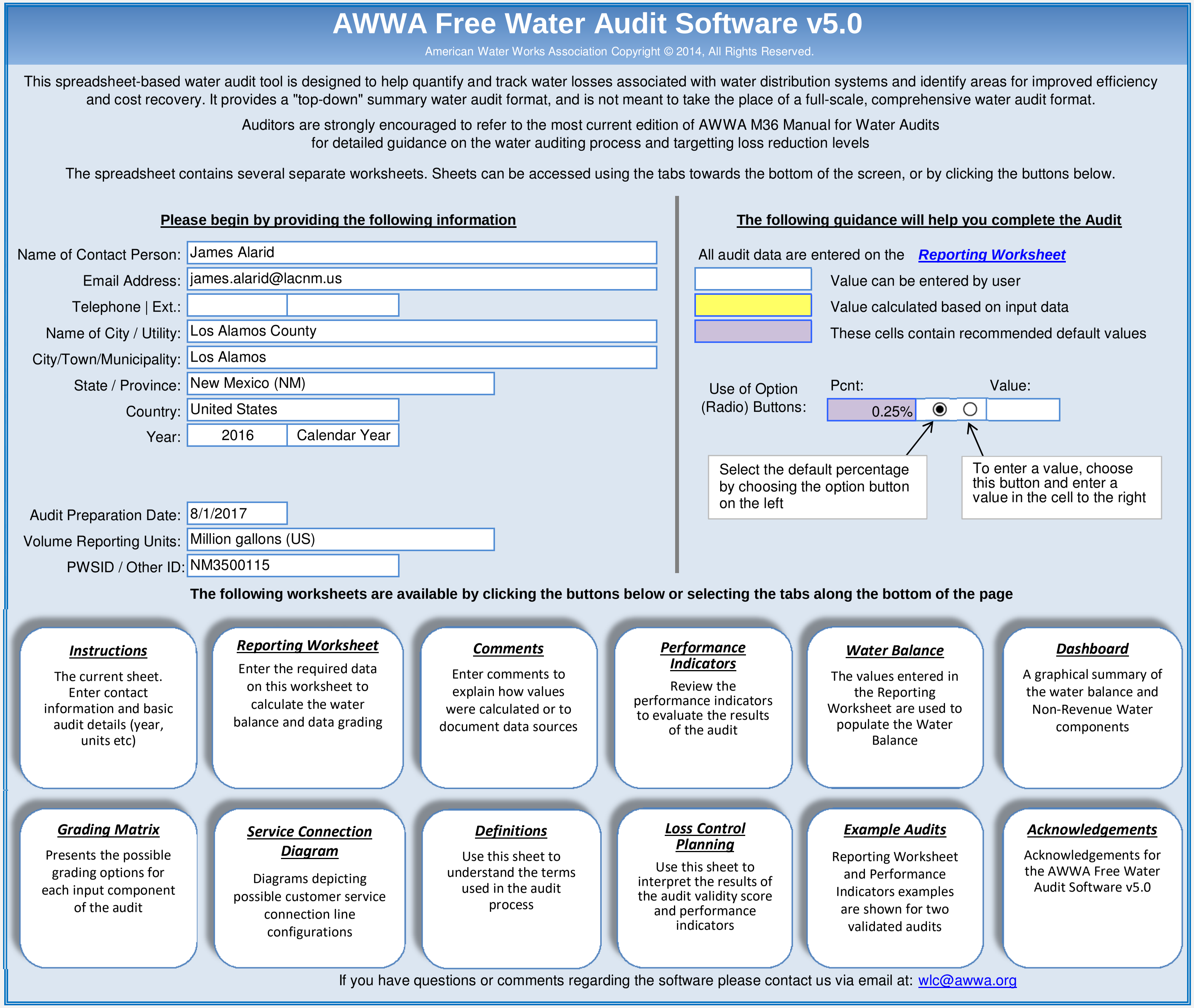
Appendix A

Los Alamos County Water Audit



AWWA Free Water Audit Software v5.0

This spreadsheet-based water audit tool is designed to help quantify and track water losses associated with water distribution systems and identify areas for improved efficiency and cost recovery. It provides a "top-down" summary water audit format, and is not meant to take the place of a full-scale, comprehensive water audit format.

Auditors are strongly encouraged to refer to the most current edition of AWWA M36 Manual for Water Audits
for detailed guidance on the water auditing process and targetting loss reduction levels

The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons below.

Please begin by providing the following information

Name of Contact Person: James Alarid
Email Address: james.alarid@lacnm.us
Telephone | Ext.:
Name of City / Utility: Los Alamos County
City/Town/Municipality: Los Alamos
State / Province: New Mexico (NM)
Country: United States
Year: 2016 Calendar Year

Audit Preparation Date: 8/1/2017
Volume Reporting Units: Million gallons (US)
PWSID / Other ID: NM3500115

The following guidance will help you complete the Audit

All audit data are entered on the ***Reporting Worksheet***

□	Value can be entered by user
🟨	Value calculated based on input data
🟪	These cells contain recommended default values

Use of Option (Radio) Buttons: Pcnt: 0.25% ● ○ Value:

Select the default percentage by choosing the option button on the left

To enter a value, choose this button and enter a value in the cell to the right

The following worksheets are available by clicking the buttons below or selecting the tabs along the bottom of the page

Instructions
The current sheet. Enter contact information and basic audit details (year, units etc)

Reporting Worksheet
Enter the required data on this worksheet to calculate the water balance and data grading

Comments
Enter comments to explain how values were calculated or to document data sources

Performance Indicators
Review the performance indicators to evaluate the results of the audit

Water Balance
The values entered in the Reporting Worksheet are used to populate the Water Balance

Dashboard
A graphical summary of the water balance and Non-Revenue Water components

Grading Matrix
Presents the possible grading options for each input component of the audit

Service Connection Diagram
Diagrams depicting possible customer service connection line configurations

Definitions
Use this sheet to understand the terms used in the audit process

Loss Control Planning
Use this sheet to interpret the results of the audit validity score and performance indicators

Example Audits
Reporting Worksheet and Performance Indicators examples are shown for two validated audits

Acknowledgements
Acknowledgements for the AWWA Free Water Audit Software v5.0

If you have questions or comments regarding the software please contact us via email at: wlc@awwa.org

AWWA Free Water Audit Software:
Reporting Worksheet

WAS v5.0

? Click to access definition
+ Click to add a comment

Water Audit Report for: Los Alamos County (NM3500115)
Reporting Year: 2016 1/2016 - 12/2016

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

<----------- Enter grading in column 'E' and 'J' ---------->

WATER SUPPLIED

Master Meter and Supply Error Adjustments

			Grade	Value	Unit			Grade	Pcnt:		Value:	
Volume from own sources:	+	?	7	1,202.098	MG/Yr	+	?	2	0.40%	● ○		MG/Yr
Water imported:	+	?	n/a	0.000	MG/Yr	+	?			● ○		MG/Yr
Water exported:	+	?	8	286.656	MG/Yr	+	?			● ○		MG/Yr

Enter negative % or value for under-registration
Enter positive % or value for over-registration

WATER SUPPLIED: 910.653 MG/Yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

			Grade	Value	Unit	Pcnt:		Value:	
Billed metered:	+	?	8	756.202	MG/Yr				
Billed unmetered:	+	?	n/a	0.000	MG/Yr				
Unbilled metered:	+	?	n/a	0.000	MG/Yr				
Unbilled unmetered:	+	?		11.383	MG/Yr	1.25%	● ○		MG/Yr

Default option selected for Unbilled unmetered - a grading of 5 is applied but not displayed

AUTHORIZED CONSUMPTION: ? 767.585 MG/Yr

Use buttons to select percentage of water supplied
OR
value

WATER LOSSES (Water Supplied - Authorized Consumption)

143.068 MG/Yr

Apparent Losses

			Grade	Value	Unit	Pcnt:		Value:	
Unauthorized consumption:	+	?		2.277	MG/Yr	0.25%	● ○		MG/Yr

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

			Grade	Value	Unit	Pcnt		Value	
Customer metering inaccuracies:	+	?	7	15.433	MG/Yr	2.00%	● ○		MG/Yr
Systematic data handling errors:	+	?		1.891	MG/Yr	0.25%	● ○		MG/Yr

Default option selected for Systematic data handling errors - a grading of 5 is applied but not displayed

Apparent Losses: ? 19.600 MG/Yr

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: ? 123.468 MG/Yr

WATER LOSSES: 143.068 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: ? 154.451 MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

			Grade	Value	Unit
Length of mains:	+	?	8	162.0	miles
Number of active AND inactive service connections:	+	?	7	8,554	
Service connection density:		?		53	conn./mile main

Are customer meters typically located at the curbstop or property line? Yes

Average length of customer service line: + ? (length of service line, beyond the property boundary, that is the responsibility of the utility)

Average length of customer service line has been set to zero and a data grading score of 10 has been applied

Average operating pressure: + ? 6 65.0 psi

COST DATA

			Grade	Value	Unit
Total annual cost of operating water system:	+	?	10	$10,201,663	$/Year
Customer retail unit cost (applied to Apparent Losses):	+	?	9	$7.78	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	+	?	5	$591.16	$/Million gallons

☑ Use Customer Retail Unit Cost to value real losses

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 72 out of 100 *****

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources

2: Variable production cost (applied to Real Losses)

3: Unauthorized consumption

AWWA Free Water Audit Software:
System Attributes and Performance Indicators

WAS v5.0

Water Audit Report for: Los Alamos County (NM3500115)
Reporting Year: 2016 | 1/2016 - 12/2016

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 72 out of 100 ***

System Attributes:

	Apparent Losses:	19.600	MG/Yr
+	Real Losses:	123.468	MG/Yr
=	**Water Losses:**	**143.068**	MG/Yr
?	Unavoidable Annual Real Losses (UARL):	51.23	MG/Yr
	Annual cost of Apparent Losses:	$152,487	
	Annual cost of Real Losses:	$960,579	Valued at **Customer Retail Unit Cost** Return to Reporting Worksheet to change this assumption

Performance Indicators:

Financial:	Non-revenue water as percent by volume of Water Supplied:	17.0%	
	Non-revenue water as percent by cost of operating system:	11.8%	Real Losses valued at Customer Retail Unit Cost
Operational Efficiency:	Apparent Losses per service connection per day:	6.28	gallons/connection/day
	Real Losses per service connection per day:	39.54	gallons/connection/day
	Real Losses per length of main per day*:	N/A	
	Real Losses per service connection per day per psi pressure:	0.61	gallons/connection/day/psi
	From Above, Real Losses = Current Annual Real Losses (CARL):	123.47	million gallons/year
?	Infrastructure Leakage Index (ILI) [CARL/UARL]:	2.41	

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

AWWA Free Water Audit Software: Water Balance

WAS v5.0

Water Audit Report for: Los Alamos County (NM3500115)
Reporting Year: 2016 1/2016 - 12/2016
Data Validity Score: 72

		Water Exported *286.656*	Billed Water Exported			Revenue Water 286.656
Own Sources (Adjusted for known errors) *1,197.309*	System Input *1,197.309*	Water Supplied *910.653*	Authorized Consumption *767.585*	Billed Authorized Consumption *756.202*	Billed Metered Consumption (water exported is removed) *756.202*	Revenue Water 756.202
					Billed Unmetered Consumption *0.000*	
				Unbilled Authorized Consumption *11.383*	Unbilled Metered Consumption *0.000*	Non-Revenue Water (NRW) 154.451
					Unbilled Unmetered Consumption *11.383*	
			Water Losses *143.068*	Apparent Losses *19.600*	Unauthorized Consumption *2.277*	
					Customer Metering Inaccuracies *15.433*	
					Systematic Data Handling Errors *1.891*	
Water Imported *0.000*				Real Losses *123.468*	Leakage on Transmission and/or Distribution Mains *Not broken down*	
					Leakage and Overflows at Utility's Storage Tanks *Not broken down*	
					Leakage on Service Connections *Not broken down*	

AWWA Free Water Audit Software:
Determining Water Loss Standing

WAS v5.0

Water Audit Report for: Los Alamos County (NM3500115)
Reporting Year: 2016 1/2016 - 12/2016
Data Validity Score: 72

Water Loss Control Planning Guide

	Water Audit Data Validity Level / Score				
Functional Focus Area	**Level I** (0-25)	**Level II** (26-50)	**Level III** (51-70)	**Level IV** (71-90)	**Level V** (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or Automatic Meter Reading (AMR) system.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.

Once data have been entered into the Reporting Worksheet, the performance indicators are automatically calculated. How does a water utility operator know how well his or her system is performing? The AWWA Water Loss Control Committee provided the following table to assist water utilities is gauging an approximate Infrastructure Leakage Index (ILI) that is appropriate for their water system and local conditions. The lower the amount of leakage and real losses that exist in the system, then the lower the ILI value will be.

Note: this table offers an approximate guideline for leakage reduction target-setting. The best means of setting such targets include performing an economic assessment of various loss control methods. However, this table is useful if such an assessment is not possible.

General Guidelines for Setting a Target ILI
(without doing a full economic analysis of leakage control options)

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 -5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		