
PRELIMINARY ENGINEERING REPORT
FOR THE

**WATER SYSTEM
IMPROVEMENTS**

PREPARED FOR

Alto Lakes Water &
Sanitation District 

November 21, 2008



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Executive Summary

Parkhill, Smith & Cooper, Inc. was engaged by the Alto Lakes Water and Sanitation District to prepare a Preliminary Engineering Report (PER) for their Water System Improvements Project. The goals of the project are to replace undersized and substandard water lines, provide water distribution system pressure stability, improve system fire protection capability, and develop water treatment improvements to remove iron, manganese, total dissolved solids (TDS) and hardness. The project planning period is through the year 2030.

Background

The Alto Lakes Water and Sanitation District (ALW&SD) currently operates the water supply and distribution system in Alto Lakes, NM. Alto Lakes is located in the unincorporated area of Lincoln County. The system served 1,214 connections in 2007 with a potential build-out of 1,800 services. The District operates four domestic water wells, three irrigation wells, two storage tanks, and two booster pump stations. There are in excess of 25 pressure reducing stations throughout the system to regulate the customer pressures. Some areas currently experience pressures in excess of 100 psi (compared to national standard maximum of 80 psi) which increases the risk of leaks and pipe failures. The existing distribution system contains a significant amount of thin wall pipe installed in the 1960's and 70's that is susceptible to breakage in high pressure areas. Additionally much of the system does not meet the County's minimum requirements for line size, fire flows, and hydrant spacing. Lincoln County's subdivision ordinance requires a minimum of 6" water lines, a minimum fire flow of 500 gallons per minute, and a maximum fire hydrant spacing of 1,000 feet along the route of access.

The water quality produced from the domestic wells exceeds the New Mexico Environmental Departments secondary standards for iron, manganese, and TDS. The extremely high level of TDS and hardness requires the use of household water softeners which contaminate septic systems and could potentially contaminate groundwater with large quantities of brine. The typical household water softener in Alto Lakes uses 40-60 pounds of salt per month or 50-70,000 pounds per month for all softener units operating. Lincoln County has been designated a Critical Groundwater Management Area by NMED. The following table shows the existing water quality and the proposed treatment goals.

Table ES- 1 - Water Quality and Treatment Goals

Constituent	Secondary Std.	Alto Lakes Well	
		Water Concentration	ALW&SD Goal
Iron	0.3 mg/L	0.9 mg/L	<0.3 mg/L
Manganese	0.05 mg/L	0.08 mg/L	<0.05 mg/L
TDS	500 mg/L	1320 mg/L	<500 mg/L
Hardness	N/A	850 mg/L	<100 mg/L

Distribution System Improvements

The District intends to replace all lines with substandard piping materials and all 2 and 3-inch lines with 6-inches in diameter lines, minimum. This will be done in conjunction improvements made to the relieve pressure problems and improve fire flow capability. In order to develop the water distribution system improvements a computerized hydraulic model was developed using H2OMap Water by MWH Soft. The system was calibrated using pressure readings in the

existing system coupled with flow rates from the booster station. The ultimate distribution system design criteria limited the system pressures to between 50 and 80 psi and provided a minimum fire flow of 750 gallons per minute with a residual pressure not less than 20 psi. The minimum pipe size in the ultimate system was limited to 6-inches in diameter. Three alternatives were developed which provided various levels of fire protection in order to identify stages in which the project could be built. The proposed alternative is the system which meets the Lincoln County requirements and maintains system pressures between 50 and 80 psi. The following table shows the cost opinion for each of the three alternatives.

Table ES- 2 - Cost Opinion for Distribution System Alternatives

	Capital Cost
Alternate 1 – Minimum Coverage – Coverage along major thoroughfares	\$ 1,827,197.17
Alternate 2 – Full Coverage Phase I – Provides some coverage throughout	\$ 5,029,543.52
Alternate 3 – Full Coverage Phase I & II – Meets Lincoln County Ordinance	\$ 9,725,324.83

Water Treatment Improvements

The water treatment alternatives developed in the PER evaluated different processes for removing iron and manganese from the water supply. The alternatives evaluated were ion exchange, membrane softening, oxidation/filtration and lime softening. The preferred alternative for this stage of the treatment process is oxidation/filtration, a process by which iron and manganese are reduced to an insoluble state through the use of chlorine. Once the particles are oxidized, they are removed by media filtration. This process was selected for its ease of operation and minimal waste stream production.

The reverse osmosis (desalination) process was selected to remove the TDS and hardness from the water. It is a proven technology and far more cost effective than the electro-dialysis reversal process which uses large amounts of electricity to achieve the same results as reverse osmosis.

The reverse osmosis process produces a constant brine stream as waste. Four alternatives were identified for disposing of this waste stream. The first is blend with golf course irrigation water which, if implemented could result in damage to the turf due to the high salt concentrations. The other three alternatives involve evaporation; natural evaporation, mechanically enhanced evaporation and a combination of both. An evaporation pond with out evaporation enhancement would be large and the District does not currently have a piece of land to house this operation. Enhanced evaporation using sprayers is the preferred alternative but still uses more land than currently owned by the District. The most costly alternative is flash evaporation which is a very energy intensive process. Since there is no feasible way to dispose of the brine at this time, the water treatment project will be accomplished in two phases.

Phase I will reduce Iron and Manganese to NMED secondary standards. Phase II, which will be undertaken when the required brine disposal site is acquired, will reduce TDS to NMED secondary standards and reduce hardness to a level which will allow the community to discontinue the use of household water softeners. The cost opinion for the water treatment phases is shown in the following table.

Table ES- 3 - Cost Opinion for Water Treatment Projects

Description	Total Cost
Phase I Water Treatment (Iron/Manganese Removal)	\$ 926,634.06
Phase II Water Treatment (TDS/Hardness Removal)	\$ 1,099,545.08
Total Capital Cost	\$ 2,026,179.14



Conclusions and Recommendations

In conclusion, the Alto Lakes Water & Sanitation District has a sufficient supply of water to last for the planning period of this PER. The water quality suffers from high iron, manganese, TDS and hardness which affects the customers by staining fixtures and clothing and at times emits an odor. The need for, and use of, household water softeners results in contamination of septic systems and could potential contaminate the underlying ground water. The distribution system is also impacted by the high iron and manganese concentrations due to the possibility of precipitation of oxidized iron and manganese which attaches to the inside of the pipes and building up over time which reduces the capacity of the pipes. Substandard piping materials, small line, and high and variable pressures compromise system integrity and performance. Fire protection coverage in most of the District is inadequate or non-existent.

It is recommended that the priority project be the implementation of iron and manganese removal (Phase I Water Treatment) as it will benefit customers with noticeable water quality improvement. It will also prevent degradation of the pipes in the distribution system due to sediment build-up. The second project recommended will upgrade undersized and substandard lines, provide more stable system pressures, and upgrade the distribution system to provide better fire protection capability to all areas (Alternative 3). The third project recommended is the reduction of TDS and hardness (Phase II Water Treatment). This treatment process will be undertaken when the required brine disposal site is acquired. This phase will permit the elimination of household water softeners and result in significant reductions in septic and groundwater contamination. Table ES-4 shows the cost breakdown for the recommended projects.

Table ES- 4 - Total Project Opinion of Cost

Project	Total Cost
Water Treatment Plant (Phase I)	\$ 926,634
Water Distribution (Alternative 3)	\$ 9,725,325
Water Treatment Plant (Phase II)	\$ 1,099,545
TOTAL	\$ 11,751,504

I. GENERAL

The Alto Lakes Water and Sanitation District (ALWS&D) currently operates the water supply and distribution system in Alto Lakes, NM. A master plan for Alto Lakes was developed in 2004 by Livingston and Associates from Alamogordo, NM. The master plan covers water supply, distribution, and treatment. This Preliminary Engineering Report (PER) further develops many of the concepts presented in the 2004 master plan. The existing distribution system contains 2, 3, 6 and 10-inch piping and several pressure reducing stations to minimize instances of high pressures. A significant portion of the system is made up of thin wall 2 and 3-inch pipe installed in the 1960's and 70's. The thin wall pipe is susceptible to breakage, particularly in higher pressure areas. Due to the small pipe diameters, the water pressure and volume throughout the system can be highly variable. The smaller lines also cannot support higher flow volumes required to respond to fires. The water supply has concentrations of iron, manganese and total dissolved solids (TDS) that exceeds the state of New Mexico's secondary standards for drinking water. The iron and manganese are indicated by black and red water and can cause staining of fixtures and clothing, reduced flow in pipes due to deposition and taste and odor problems. The high TDS and extreme hardness require the use of household water softeners. Softeners not only increase the salt content of household water but release a brine stream which could potentially contaminate ground water in the area.

The purpose of this project is to identify water distribution and treatment system improvements necessary to adequately serve the ALWS&D service area and to make recommendations on steps needed to mitigate the problems identified above. The plan addresses water quality and quantity, distribution and treatment. It also addresses financial and operational issues. The plan evaluates the water supply of the ALWS&D used for both domestic and golf course irrigation, for the current need as well as future (to year 2030) conditions. Alternatives for new or additional water supplies are presented, as well as a discussion of water rights.

The current ALWS&D domestic water demands are approximately 51 MG per year, and are expected to grow to just under 70 MG per year over the next twenty years. The District also supplies just over 58 MG per year for irrigation use for which no demand increase is projected.

The domestic demand currently serves 1,214 meters (2007 totals). The number of connections is expected to increase to 1,800 between 2015 and 2020.

II. PROJECT PLANNING AREA

A. Location Map

The unincorporated community of Alto Lakes, NM is located in the Sacramento Mountains of Lincoln County, approximately five miles north of Ruidoso. The Alto Lakes Water and Sanitation District serves an area of approximately 3.8 square miles (1,689 acres). The service area spans 3.3 miles east to west and 2.3 miles north-south (see Figure 1). The service area ranges in elevation from 7,550 to 6,915 feet above sea level. According to Daniel B. Stephens & Associates, Inc. (DBS&A) who prepared a hydrogeologic study of the area for this project, the characteristic geology of the area consists of a sequence of sedimentary rocks which have been fault folded to form the terrain in the area. Many of the formations have also experienced igneous rock intrusions which alter the sedimentary rock by exposing them to high heat and pressure. The hydrogeologic study is contained in Appendix E.

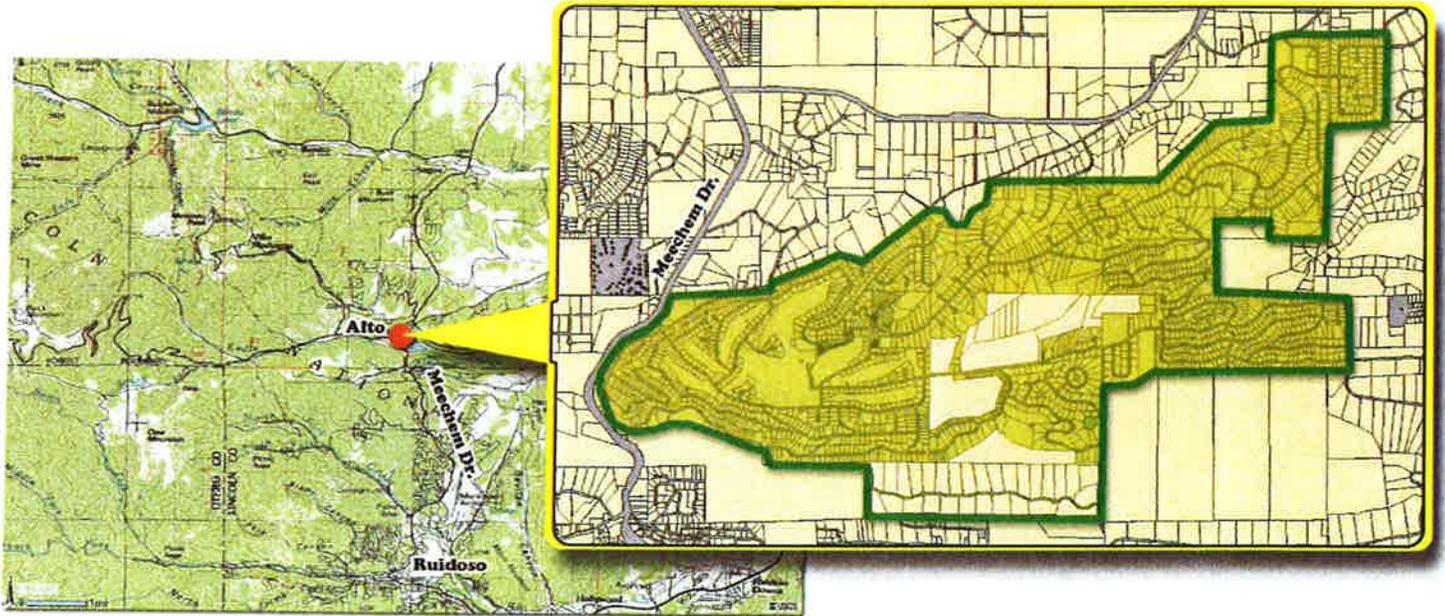


Figure 1 – Location – Study Area Map

B. Environmental Resources Present

The study area consists of forested area that is interspersed with grassy meadows. The community includes both high and low density subdivisions, although low density predominates. There are not any wetlands or streams located within the study area and the area does not contain any flood plains. The majority of the project components will be contained in previously disturbed areas such as roadways and shoulders. The water treatment plant site is partially forested and may require clearing of some trees. The forested area surrounding the proposed plant site will provide adequate habitat for any small animals and avian species that may be displaced by the clearing of the trees. It is not anticipated that any endangered species or critical habitats will be affected by the clearing of the water treatment plant site. An Environmental Report has been prepared detailing more of the environmental aspects of the project.

The archeological investigation is complete; no cultural resources were identified in the project area. The archeological report is included as an appendix to the Environmental Report.

C. Growth Areas and Population Trends

Approximately 40% of the homes in the District’s service area are occupied by full-time residents with the remainder used as seasonal homes. Since the community is made up of both part time and full time residents, the number of people per household is not easy to determine. It is for this reason that the population is expressed in terms of water connections for this report. Approximately 1,214 of the 2,050 lots in the Alto Lakes community are occupied by homes. The remaining vacant lots are scattered throughout the community. The ALW&SD also serves domestic water to two areas outside of the District: the Kokopelli subdivision which includes about 10 lots currently (120 total obligation), and the Eagle Creek II subdivision which includes about 8 lots currently (25 total obligation).

There are currently 1,214 meters in the ALWS&D service area. Two of the meters serve large commercial users and 22 serve small commercial users. The remaining meters are residential. Build-out is estimated at 1800 lots/meters due to lot consolidations and some lots being located on exceedingly steep slopes. The meter growth from 1998 through 2007 has averaged 3.8% per year. Build out of the service area is expected by 2018. Increased growth rate would allow the build out to happen sooner while a decrease would postpone the build out and the need for future facilities. While the number of connections is increasing, the water use, on a per meter basis, has been shown to be declining at a rate of approximately one percent per year. The reduction is due to a steeply rising conservation rate schedule and to strong water conservation restrictions

Flow meter and usage projections provided by the ALW&SD are shown in Appendix A and summarized in the following table through the build-out of the 1800 available lots.

Table 1 - Projected Domestic Water Usage

YEAR	DOMESTIC		
	FLOW (GAL)	METERS	USAGE (GAL/METER/DAY)
2000	58,611,470	951	168.85
2005	52,819,550	1138	127.16
2007	50,847,921	1214	114.75
2010	55,189,933	1358	111.34
2015	63,229,445	1636	105.89
2020	69,567,849	1800	105.89

III. EXISTING FACILITIES

A. Facility Map

The ALW&SD water system consists of two ground storage tanks with a total capacity of 450,000 gallons, a booster pump station capable of providing 800 gpm at 60 psi, four wells used for domestic demands and three wells available for providing irrigation water to the golf course. The domestic wells provide up to 520 gpm capacity according to operator reports. The District also operates a small wastewater treatment plant that serves one large commercial customer and 80 town homes. Figure 2 shows the existing distribution system, water storage tank and booster station site as well as the water well sites.

B. History

The water supply and distribution infrastructure of Alto Lakes was constructed by a developer beginning in the late 1960's. The distribution system was developed in small increments as indicated by the minimal backbone system and the various pipe sizes and piping materials extended to the outlying areas. In 1990, the system was acquired out of bankruptcy by the Alto Lakes Water Corporation, a private company which was regulated by the New Mexico Public Regulatory Commission. In April of 2008, the Alto Lakes Water & Sanitation District purchased the water and wastewater assets from the Water Corporation and now operates the system as a public entity with the intention of improving the water quality and the distribution system operation while taking

Legend

— Existing Water Lines

● Water Well

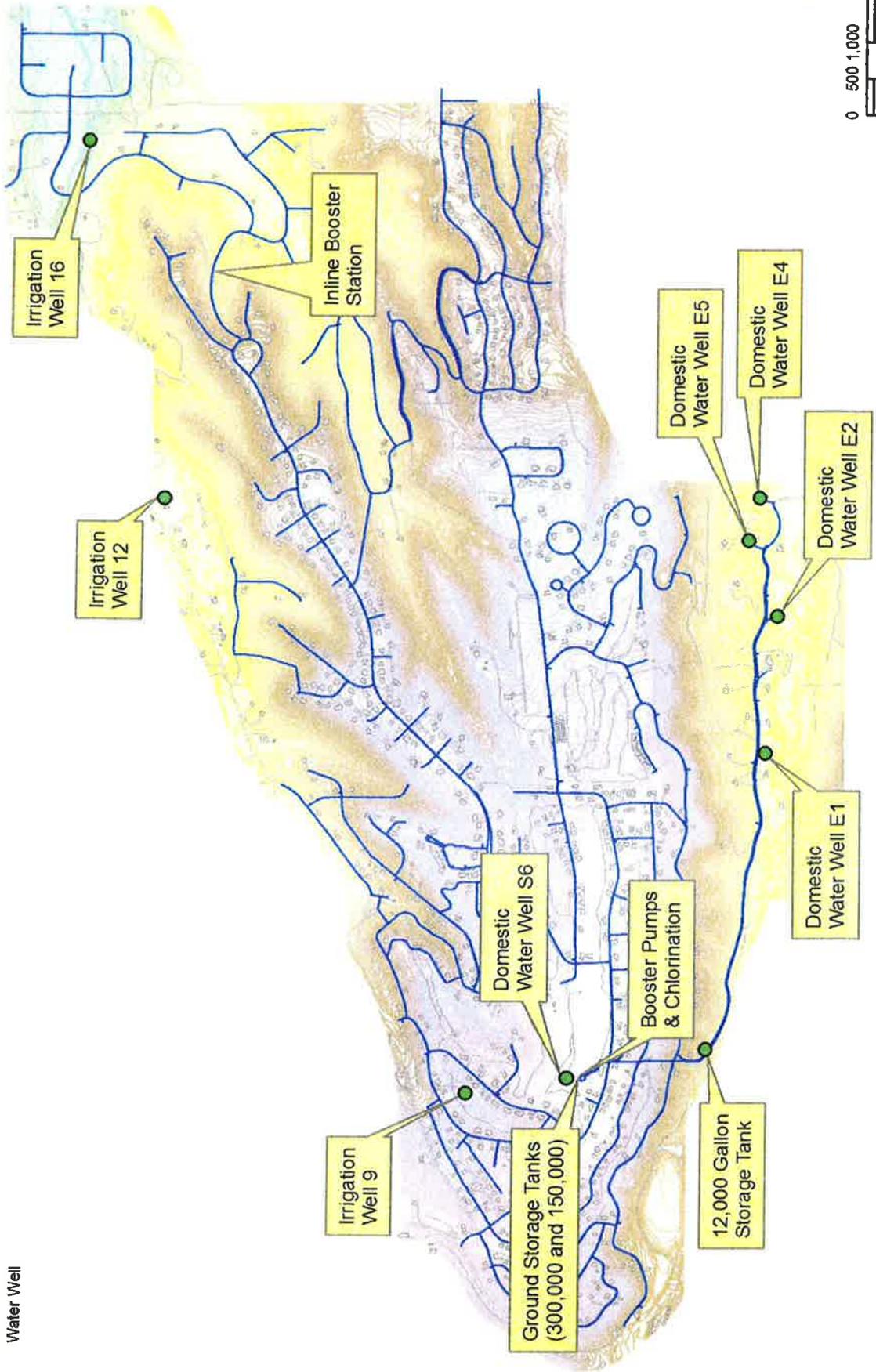


FIGURE 2
Existing Facilities



advantage of public programs developed to help public water utilities meet State and Federal standards for drinking water supplies.

C. Condition of Facilities

The water quality of the ALW&SD wells was assessed through the use of existing data. The ground water contains high levels of total-dissolved-solids (TDS) and hardness which exceed the State's secondary standards. Additionally, the ground water contains high levels of iron and manganese, which causes "red" and "black" water problems in the distribution system. Both iron and manganese levels exceed the State's secondary standards.

The water distribution system was evaluated through the use of a computerized hydraulic model. The majority of the piping is 2 and 3-inch diameter pipe with some segments of 6-inch and 10-inch pipe. Much of the 2 and 3-inch pipe was installed in the 1960's and 70's and is thin wall pipe, possibly irrigation piping. This substandard piping leads to line breakages, particularly in high pressure areas. Lincoln County's current subdivision regulations provide for 6-inch distribution piping, minimum. The system has over 25 pressure reducing stations to regulate the pressures in the system. Many of the stations need maintenance or replacement in order to provide protection against pipe failures due to over pressurization. Re-zoning the water system into pressure zones that supply between 50 and 80 psi will help to minimize areas of high and low pressure and provide a more consistent pressure to the customers. As noted in the modeling section, there are areas which require 8-inch piping to provide improved capability to fight fires.

1. High and low pressure areas

Pressure issues are the direct result of the 635' variation in elevation with the District's service area. High pressure areas (>80 psi) are apparent in lower lying areas of the system where the existing pressure reducing stations are located too high above the service location. Low pressure (<50 psi) areas are found near the existing pressure reducing stations. While pressures above 35 psi are not considered low by the State, most of the customers in Alto Lakes have water softeners and other water treatment systems in their home which further reduce their pressure en route to the faucet. In addition, the low pressures are very apparent in the model when fire demands are imposed on areas where there are small pipes.

2. Small Pipes

Small, thin wall pipe makes up the majority of the existing distribution system. Given the iron and manganese concentrations of the well water, the pipe in the system is subject to attached growth of iron bacteria and precipitated iron and manganese which could cause tuberculation of the pipes resulting in reduced flow capacity. Although metallic pipes are at a higher risk of tuberculation, this phenomenon occurs in all types of pipe.

3. Fire Protection

Currently, there is inadequate fire protection as the result of small lines located throughout the system. According the 2004 Master Plan, the existing system will support a fire flow of only 250 gpm. Although the current modeling efforts did not confirm the rate of 250 gpm, it did indicate the system will not support the Lincoln County fire flow of 500 gpm without improvement. Lincoln County requires a maximum of 1,000 foot spacing of fire hydrants. The improvements presented in this PER are based on the updated Lincoln County Subdivision Ordinance.

D. Financial Status of any Operating Central Facilities

The ALW&SD purchased the water system from the Alto Lakes Water Corporation in April 2008. The District funded the purchase with a \$4 million Drinking Water Revolving Loan at 2% to be re-paid over 20 years. \$2.5 million was used to complete the acquisition and \$1.5 million remains available for system improvements. The District pays interest only pending completion of the improvements. At this time, the District is saving revenue, monthly, in the amount that will be necessary to pay back the loan over the next 20 years. This early savings is currently serving as operating reserve and some may be used for capital projects needed in the near future. The District has no other debt outstanding.

The District's monthly rate of \$49.24 for 6,000 gallons is among the highest in New Mexico. According to NMED's 2007 Water and Sewer Charge Survey, "The average residential rate reported for rates in 2007 for 6000 gallons of water was \$21.70 per month". The highest monthly rate shown in the study is \$50.00 in San Ysidro which has just 81 connections.

The District's first annual operating budget for FY 2009 (beginning July 1, 2008) provides for Revenues of \$1,195,759, Operating Expense of \$781,544, and Net Income From Operations of \$414,214.

IV. NEED FOR PROJECT

A. Health and Safety

The water treatment and distribution projects identified in this PER address health and safety issues such as iron, manganese and TDS concentrations that are above the secondary standards, system integrity, reliability, and improved fire protection capability. Due to the location of Alto Lakes within the forested areas of the Sacramento Mountains, the potential for fire during dry periods is high. Forest fires present a threat that may be larger than a system that meets Lincoln County fire protection standards can handle. The Lincoln County fire protection requirements are meant to guard against house fires contained to a single dwelling and not large scale forest fires such as the 800 acre Kokopelli Fire, which started in Alto Lakes in March 2002, burned 22 homes in Alto Lakes and 6 in adjacent communities.

A water treatment plant is proposed to remove the iron, manganese, TDS and hardness. It is likely that the treatment will be implemented in two phases due to the problems associated with disposal of brine from the TDS removal (desalination) portion of the treatment plant. Phase I will consist of iron and manganese removal will help prevent tuberculation of the pipes caused by precipitated iron and manganese as well as eliminate the staining fixtures and clothes as well as mitigate taste and odor issues associated with the decaying iron and manganese bacteria. Phase II will consist include removal of TDS and hardness through the use of desalination and will lower the TDS to levels specified in the New Mexico secondary standards and result in elimination of household water softeners which contaminate septic systems and potentially impact area groundwater. Lincoln County has been designated a Critical Groundwater Management Area by NMED.

B. System O&M

The existing distribution system has experienced amounts of un-accounted for water due to leaks that exceed 10% of the production. The proposed water distribution system improvements will

reduce leaks in the areas where the new piping is installed. The pressure criteria implemented (50 to 80 psi) will reduce the amount of water leaking in areas that currently experience pressures in excess of 100 psi. Maintenance costs in areas where new piping is installed should be reduced as a result of the new pipe.

Operating costs will increase by approximately \$0.25 per 1,000 gallons for each of Phase I and Phase II water treatment. These costs will be more than offset by household savings in softener salt purchases alone.

C. Growth

Water demands from 1998 to 2007 were provided by ALW&SD. Over this period there has been a consistent increase in the number of meters. The average water usage per meter sharply declined in 2004 as the result of a tiered conservation rate. The higher rates lead to a 17% decline in per-meter-usage. Per-meter-usage has continued to decline at a faster rate than meter growth resulting in a 2007 total domestic demand that was less than 1998 total demand. It is expected, however, that the meter growth will continue at an average of 3.8% while the per-meter-usage will only reduce 1% annually until build out. Build out is expected to occur when the total number of meters reaches 1,800. This is expected to occur around 2018.

See Appendix A for a table detailing the total demands and demand breakout by type (Large Com., Small Com., and Residential)

V. ALTERNATIVES CONSIDERED

A. Design Criteria (Water Distribution)

The leading design objective was to replace small and substandard system piping. To develop design criteria for improved fire flow, State and County standards were reviewed as well as the standards of the American Water Works Association (AWWA) Standards. District personnel met with the Bonito Volunteer Fire Department officials to determine acceptable fire protection scenarios. Lincoln County currently requires new subdivisions to be fitted with minimum 6" distribution lines that will support a minimum 500 gpm fire flow with maximum 1,000 foot spacing on the hydrants. For the ALW&SD system, the fire department agreed that providing 750 gpm hydrants on a minimum 6-inch line with 1,000 foot spacing along major thoroughfares would be a major improvement over the existing system. Additional hydrants capable of at least 300 gpm with 1,000 foot spacing throughout the rest of the development would be an added benefit. The fire department strongly prefers that the entire District conform to County standards.

Three system Alternatives were developed that use the same pressure criteria while the fire flow requirements were different for each.

- ❖ Pressure Criteria
 - Minimum System Pressure = 50 psi Under Normal Conditions.
 - Maximum System Pressure = 80 psi Under Normal Conditions.
 - Minimum System Pressure under Peak/Fire Conditions = 20 psi.
- ❖ Minimize Number of Pressure Reducing Stations
- ❖ Use WTP Location as Distribution Input in Ultimate Model

- ❖ Fire Flows
 - Alternative 1 – Minimum Coverage: Deer Park and High Mesa upgrades
 - Fire Flow along 6 and 8-inch lines = 750 gpm minimum
 - Fire Flow at multi-family dwellings = 1500 gpm
 - Fire Flow in areas with smaller pipes = not addressed
 - Alternative 2 – Full Coverage Phase I: Entire system with minimal coverage
 - Fire Flow along 6 and 8-inch lines = 750 gpm minimum
 - Fire Flow at multi-family dwellings = 1500 gpm
 - Fire Flow in areas with smaller pipes = minimum of 300 gpm
 - Alternative 3 – Full Coverage Phase I & II: system meeting Lincoln County flow requirements
 - Fire Flow in all areas = 750 gpm minimum
 - Fire Flow at multi-family dwellings = 1500 gpm

B. Description (Water Distribution)

The water distribution projects identified in this PER consist of three alternatives that replace small and substandard piping and provide different levels of improved fire protection capability. Each of the alternatives meets the pressure requirements of between 50 and 80 psi. In addition, all of the alternatives will provide a hydrant located at the water tank site that is capable of flowing large amounts of water to fill the fire department's water transporters.

With the given pressure criteria of maintaining between 50 and 80 psi at the customers meter, the system is divided into approximately 10 pressure zones. Due to the spread out nature of the distribution system and severe changes in elevation, multiple pressure reducing stations are needed for each of the zones. The pressure reducing stations were placed in the model in the areas where they were needed. The location and pressure settings were adjusted through multiple model runs to keep the nodes in the model within the pressure criteria.

Alternative 1 – Minimum Fire Coverage: This alternative would provide fire flows of 750 gpm along Deer Park and High Mesa as well as any areas that have 6-inch pipe. The pressure zones would be regulated between 50 and 80 psi with a minimum residual pressure of 20 psi during a fire flow event. This alternative provides some direct fire coverage but more importantly places higher capacity hydrants closer to all areas of Alto Lakes which the fire department can use to fill their water tenders or through the extension of hoses.. The proposed piping and hydrant coverage is shown in Figure 3 and 4 respectively.

Alternative 2 – Full Fire Coverage – Phase I: This alternative would provide 750 gpm of fire protection in the areas identified in alternative I and add hydrants on the smaller lines to achieve a minimum of 300 gpm of fire protection throughout the development. This alternative increases the amount of 6-inch line and 750 gpm hydrants from Alternative I in order to achieve the 300 gpm with a minimum residual pressure of 20 psi in areas with smaller lines. The proposed piping and hydrant coverage is shown in Figure 5 and 6 respectively.

Alternative 3 – Full Fire Coverage Phase I & II: This alternative provides coverage of the entire service area with hydrants capable of 750 gpm of fire flow with a minimum residual pressure of 20 psi. In this alternative, most properties are within 500-600' of a hydrant and all properties are within 1,000 feet of a hydrant along the route of access. The normal system

Legend

— Line Improvements (8-inch)

— Existing Lines

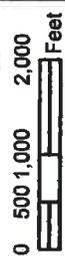
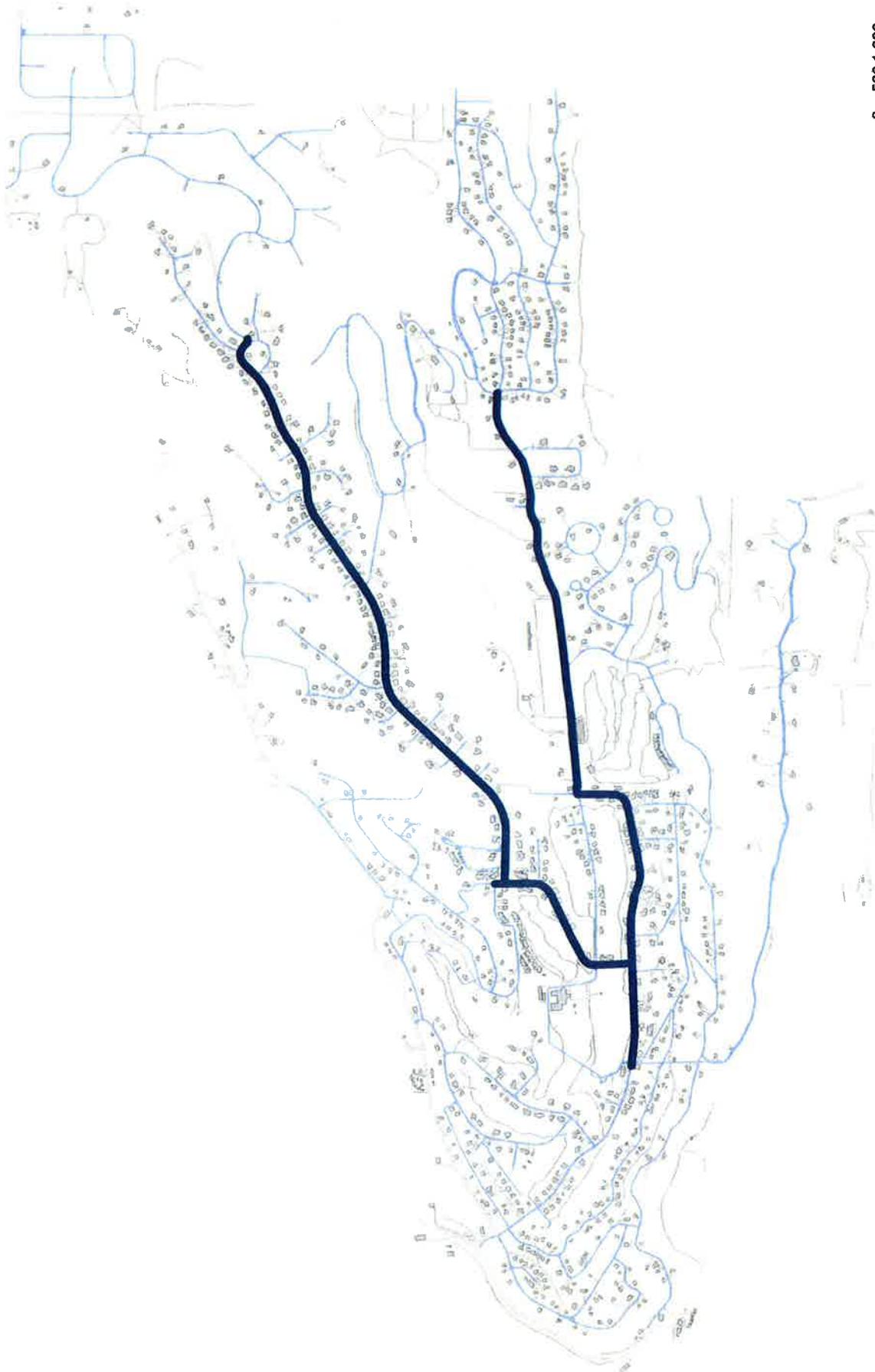
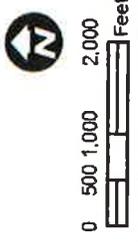


FIGURE 3
Water Lines - Alternative 1



Legend

-  Existing Hydrants (< 750 gpm)
-  Existing Hydrants 6-inch
-  Proposed Hydrants
-  Existing Lines



Legend

- Line Improvements (8-inch)
- Line Improvements (6-inch)
- Existing Lines

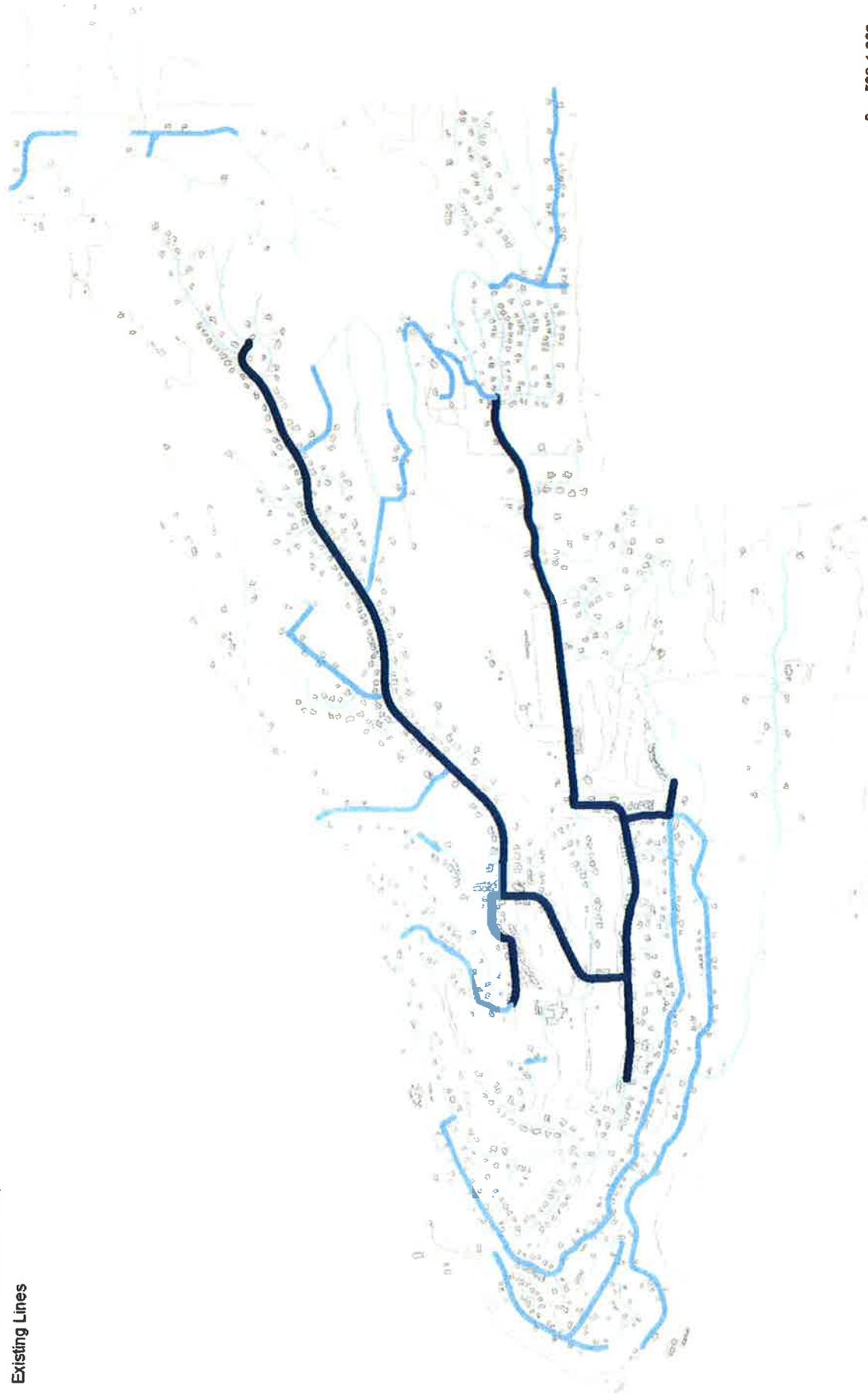
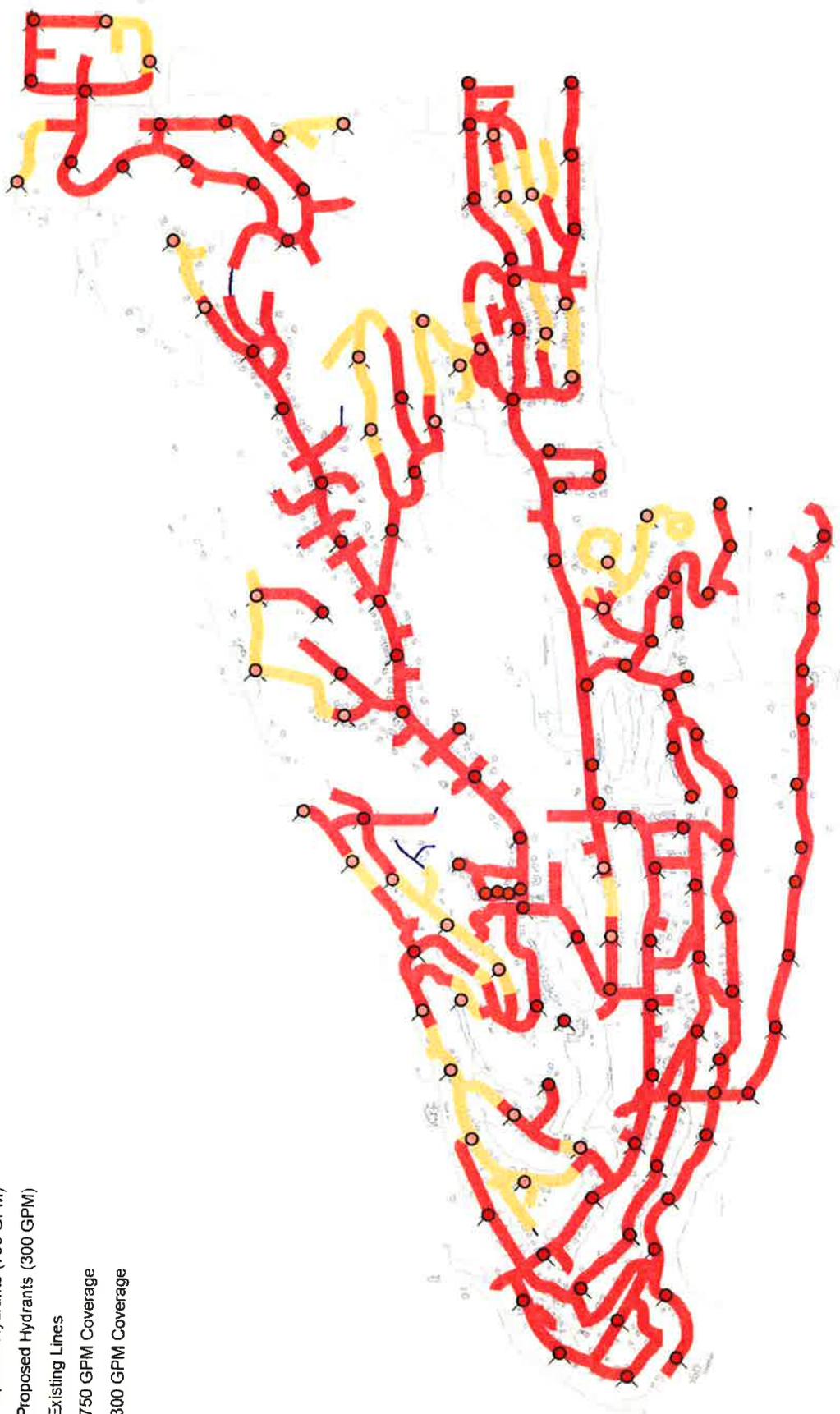


FIGURE 5
Water Lines - Alternative 2



Legend

-  Existing Hydrants 6-inch
-  Proposed Hydrants (750 GPM)
-  Proposed Hydrants (300 GPM)
-  Existing Lines
-  750 GPM Coverage
-  300 GPM Coverage



Legend

- Line Improvements (8-inch)
- Line Improvements (6-inch)
- Existing Lines

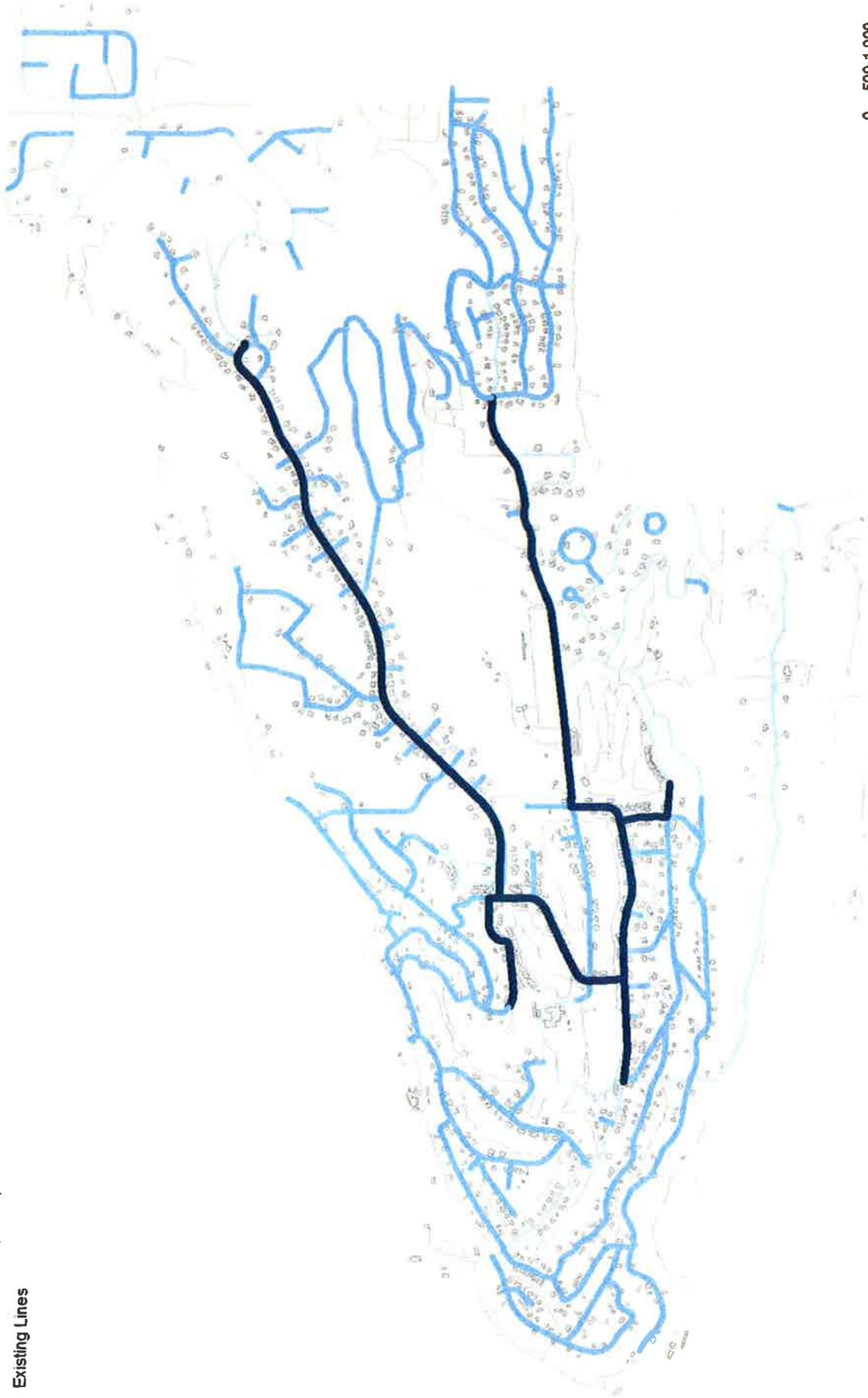
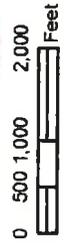
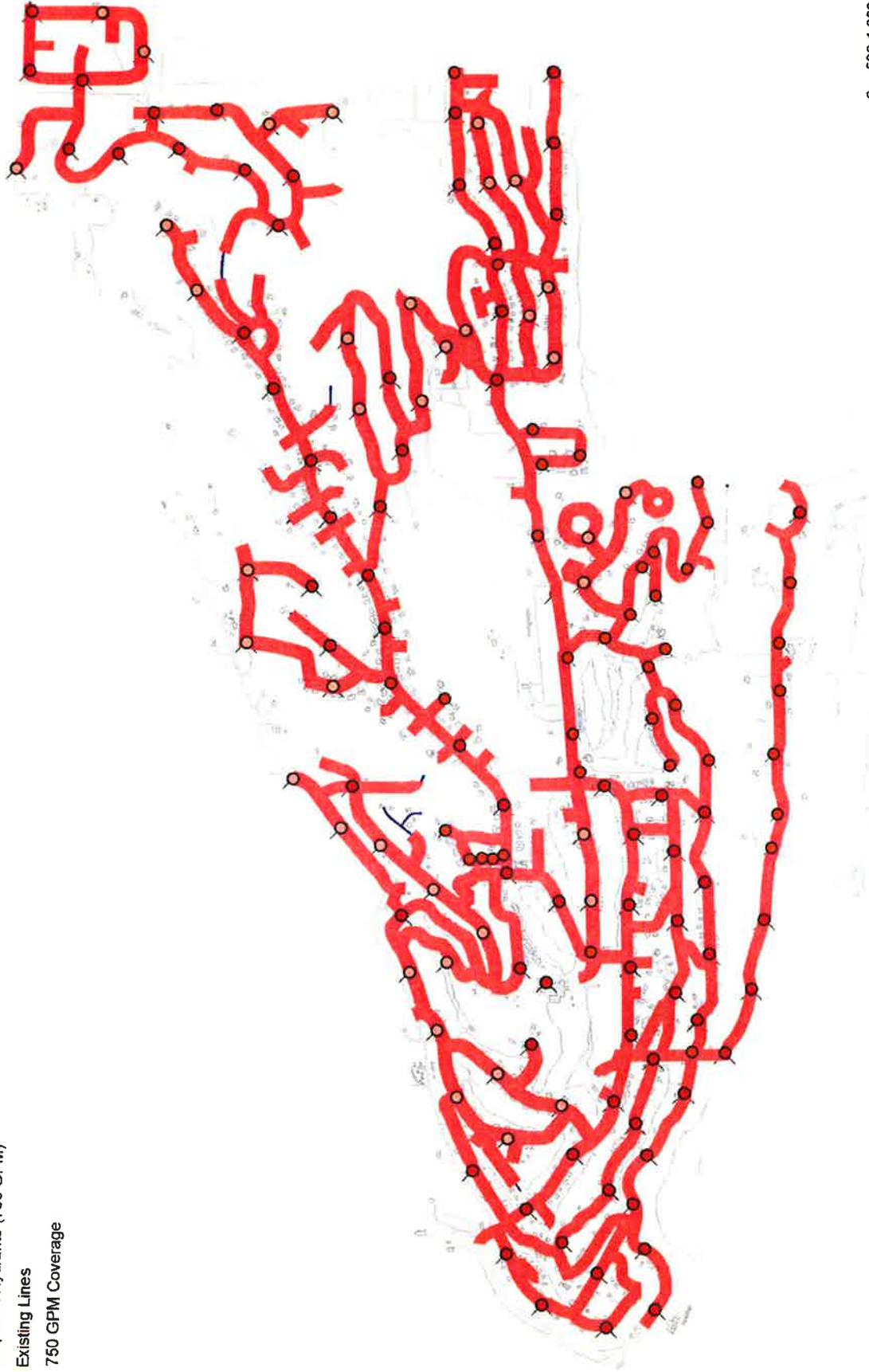


FIGURE 7
Water Lines - Alternative 3



Legend

-  Existing Hydrants 6-inch
-  Proposed Hydrants (750 GPM)
-  Existing Lines
-  750 GPM Coverage



operating pressures were modeled between 50 and 80 psi. The proposed piping and hydrant coverage is shown in Figure 7 and 8 respectively.

C. Schematic layout (Water Distribution)

Figures 3 through 8 show each of the water distribution system alternatives including piping layouts, proposed pipe sizes and the respective fire coverage.

D. Environmental Impacts (Water Distribution)

A cultural resource study was performed by Zia Environmental and is included as an Appendix to the Preliminary Environmental Report. During the walkthrough, there were not any cultural resources identified.

While the installation of the proposed facilities will be accomplished in previously disturbed areas, the following short term environmental impacts can be anticipated as a result of construction.

- Construction noise
- Detours and delays in traffic
- Dust (minimized through use of dust control)
- Water system outages when switching over to new pipe

The long term impacts include the use of non-renewable resources such as fuel during the construction period and reduced water consumption by eliminating leaks in the existing system by replacing it with new pipe. The Environmental Report prepared for this project presents a more detailed look at the environmental impacts of this project.

E. Land Requirements (Water Distribution)

Additional easements will not be required since the identified improvements will occur in existing right-of-way or existing easements.

F. Construction Problems (Water Distribution)

Water distribution lines will be placed in existing roadways, shoulders and utility easements. These areas have been previously disturbed. The area has a significant amount of rock and cobbles that may require the Contractor to import backfill in order to properly install the pipe. Driveways, paving, fences and other landscape features may be impacted as a result of the construction. It is anticipated that these features will be replaced as found prior to construction.

G. Cost Opinions (Water Distribution)

1. Construction

The following tables show the opinion of probable cost for each of the Alternatives considered.

Table 2 – Alternative 1 Cost Opinion

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	Deer Park Dr (8-inch)	FT	10534	\$ 44.28	\$ 466,413.92
2	High Mesa (8-inch)	FT	10060	\$ 44.28	\$ 445,426.62
3	Service Connections	EA	279	\$ 276.75	\$ 77,212.41
4	Pressure Reducing Stations	EA	23	\$ 6,066.36	\$ 139,526.28
5	Valves	EA	8	\$ 4,428.00	\$ 35,424.00
6	Pavement/Driveway Replacement	SY	2288	\$ 5.41	\$ 12,379.28
7	Fire Hydrants	EA	36	\$ 5,535.00	\$ 199,260.00
8	Mobilization (5%)	LS	1	\$ 68,782.13	\$ 68,782.13
9	Contingency (10%)	LS	1	\$ 144,442.46	\$ 144,442.46
10	Engineering/Admin (15%)	LS	1	\$ 238,330.07	\$ 238,330.07
					\$ 1,827,197.17

Table 3 – Alternative 2 Cost Opinion

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	Deer Park Dr (8-inch)	FT	10534	\$ 44.28	\$ 466,445.52
2	Midiron Condos (8-inch)	FT	1565	\$ 44.28	\$ 69,298.20
3	Kokopeli Condos (8-inch)	FT	1127	\$ 44.28	\$ 49,903.56
4	High Mesa (8-inch)	FT	10060	\$ 44.28	\$ 445,456.80
5	Brentwood Dr (6-inch)	FT	4013	\$ 44.28	\$ 177,695.64
6	Lakeshore Dr (6-inch)	FT	8266	\$ 44.28	\$ 366,018.48
7	Other 6-inch Pipe	FT	27504	\$ 44.28	\$ 1,217,877.12
8	Service Connections	EA	429	\$ 276.75	\$ 118,725.75
9	Pressure Reducing Stations	EA	30	\$ 6,066.36	\$ 181,990.80
10	Valves	EA	8	\$ 4,428.00	\$ 35,424.00
11	Pavement/Driveway Replacement	SY	7008	\$ 5.41	\$ 37,934.25
12	Fire Hydrants	EA	112	\$ 5,535.00	\$ 619,920.00
13	Mobilization (5%)	LS	1	\$ 189,233.61	\$ 189,233.61
14	Contingency (10%)	LS	1	\$ 397,592.37	\$ 397,592.37
15	Engineering/Admin (15%)	LS	1	\$ 656,027.42	\$ 656,027.42
					\$ 5,029,543.52

Table 4 - Alternative 3 Cost Opinion

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	Deer Park Dr (8-inch)	FT	10534	\$ 44.28	\$ 466,445.52
2	Midiron Condos (8-inch)	FT	1565	\$ 44.28	\$ 69,298.20
3	Kokopeli Condos (8-inch)	FT	1127	\$ 44.28	\$ 49,903.56
4	High Mesa (8-inch)	FT	10060	\$ 44.28	\$ 445,456.80
5	Brentwood Dr (6-inch)	FT	4013	\$ 44.28	\$ 177,695.64
6	Lakeshore Dr W (6-inch)	FT	8266	\$ 44.28	\$ 366,018.48
7	Other 6-inch Pipe	FT	101680	\$ 44.28	\$ 4,502,390.40
8	Service Connections	EA	1086	\$ 276.75	\$ 300,550.50
9	Pressure Reducing Stations	EA	34	\$ 6,066.36	\$ 206,256.24
10	Valves	EA	8	\$ 4,428.00	\$ 35,424.00
11	Pavement/Driveway Replacement	SY	15249	\$ 5.41	\$ 82,549.06



12	Fire Hydrants	EA	112	\$ 5,535.00	\$ 619,920.00
13	Mobilization (5%)	LS	1	\$ 366,095.42	\$ 366,095.42
14	Contingency (10%)	LS	1	\$ 768,800.38	\$ 768,800.38
15	Engineering/Admin (15%)	LS	1	\$ 1,268,520.63	\$ 1,268,520.63
					\$ 9,725,324.83

2. Annual Operation and Maintenance (Water Distribution)

The annual O&M for the distributions system should not increase as a result of this project. The new pipe and pressure reducing facilities should reduce the number of hours needed to maintain the system compared with the existing infrastructure. Testing of the additional hydrants and maintenance on the new pressure reducing stations should not increase the total O&M costs given the reduced line maintenance.

3. Present Worth based on Federal discount rates (Water Distribution)

The present worth of the distribution system alternatives based on the current Federal discount rate of 2.25% (September, 2008) taken over the 20 year life of the loan is as follows:

Table 5 - Present Worth of Distribution Alternatives

	Present Worth	Fed. Rate	Term (years)	Payment	Sum of Payments
Alternate 1	\$ 1,827,197.17	2.25%	20	\$114,459.41	\$2,289,188.29
Alternate 2	\$ 5,029,543.52	2.25%	20	\$315,061.02	\$6,301,220.42
Alternate 3	\$ 9,725,324.83	2.25%	20	\$609,214.49	\$12,184,289.72

H. Design Criteria (Water Treatment)

The water quality criteria recommended as the ultimate goal for the ALW&SD water supply is shown in the following table along with the existing well water quality.

Table 6 - Water Treatment Design Criteria

Constituent	Secondary Std.	Alto Lakes Well	
		Water Concentration	ALW&SD Goal
Iron	0.3 mg/L	0.9 mg/L	<0.3 mg/L
Manganese	0.05 mg/L	0.08 mg/L	<0.05 mg/L
TDS	500 mg/L	1320 mg/L	<500 mg/L
Hardness	N/A	850 mg/L	<100 mg/L

Due to the difficulties in disposing of the brine stream produced by TDS removal, the treatment will be phased. Phase I will correct the iron and manganese problems. The TDS and hardness removal will be implemented in Phase II when more feasible brine disposal alternatives become available.

I. Description (Water Treatment)

Since the entire water supply for the ALW&SD service area comes from ground water sources, it contains several constituents in concentrations that exceed the State of New Mexico secondary

standard. These constituents are iron, manganese, total dissolved solids (TDS) and hardness. There is no single treatment technology capable of reliably treating the source water therefore a two step treatment is necessary. The first stage of treatment will provide removal of iron and manganese while the second stage will remove TDS and hardness. The TDS removal process will require facilities to dispose of a constant brine stream from the process. The schematic in Figure 9 shows the proposed treatment train to meet the ultimate goals of the ALW&SD. In addition to the process train shown in the figure there may be the need for chemical addition at various stages of the process in order to prevent clogging or fouling of the media.

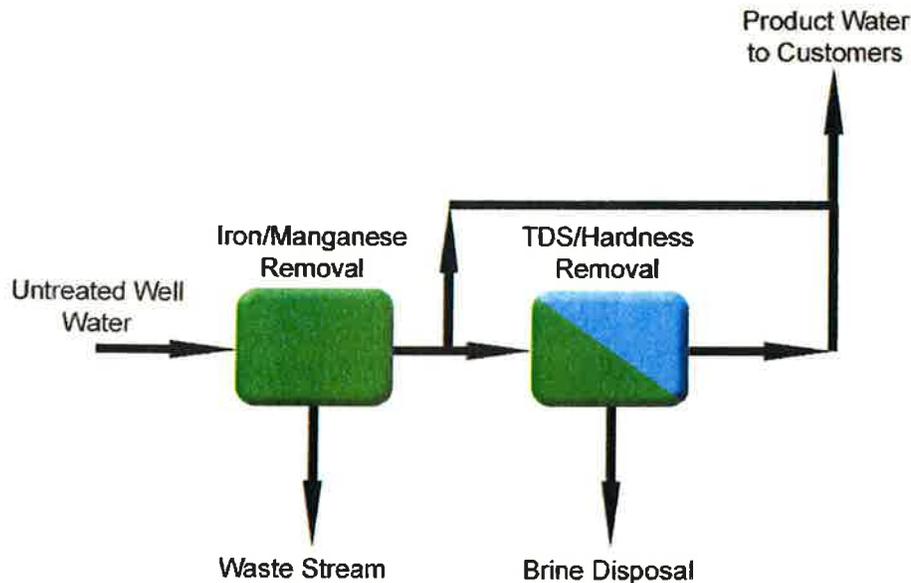


Figure 9 - Treatment Schematic

1. Iron and Manganese Removal Options

For the purpose of this report, four alternatives for iron and manganese removal were evaluated.

a) Ion Exchange (Softening)

Ion exchange should be considered only for the removal of small quantities of iron and manganese. For practical purposes in an everyday working softener, the upper limit is about 5 to 7 parts per million of iron. The ALW&SD water shows iron concentrations less than 1 mg/L. Ion exchange involves the use of resins where an ion on the resin is exchanged for the unwanted ions in the water. One of the issues in using this method for controlling iron and manganese is that if oxidation occurs during the process, the resulting precipitate can clog or foul the media which would require chemical cleaning.

While this technology is appropriate for the Alto Lakes water based on available iron and manganese data, the process raises the TDS of the treated water and also produces a waste brine stream from the media recharge. Increased TDS and brine waste stream are both undesirable attributes for the Alto Lakes Water and Sanitation District which ruled out this Alternative.

b) Oxidation/Filtration

Oxidation followed by filtration is a simple process in which an oxidant chemically oxidizes the iron or manganese to form a particle which is then filtered out.

Before iron and manganese can be filtered, they need to be oxidized to a state in which they can form insoluble particles. Oxidation involves the transfer of electrons from the iron, manganese, or other chemicals being treated to the oxidizing agent. The oxidizing agent proposed for this process is chlorine or a hypochlorite solution. This process is suitable for the ALW&SD water.

Chlorination - Chlorine will be introduced into water as sodium hypochlorite. The treated water is then held in a retention tank where the iron precipitates out and is then removed by filtering. A dosage of one part of chlorine to each part of iron is used and 0.2 parts of potassium permanganate per part of iron is fed into the water downstream of the chlorine. The potassium permanganate and any chlorine residual serve to continuously regenerate the greensand.

Oxidizing Filtration Media – Greensand, the most common chemical oxidant has a relatively high capacity for iron removal and can operate at high flow rates with moderate backwash requirements. Greensand is a processed material consisting of nodular grains of the zeolite mineral glauconite. The material is coated with manganese oxide. This treatment gives the media a catalytic effect in the chemical oxidation reduction reactions necessary for iron and manganese removal. This coating is maintained through regeneration with chlorine and backwashing of the filter. In this process, the backwash water can be put in a small tank where the iron and manganese settle out and the clean water from the tank is recycled to the front of the plant. With this process, very little water is wasted making this option sustainable where waste disposal is a concern.

c) Membrane Softening

Membrane softening provides removal of iron and manganese as well as reducing hardness in the product water. This process is similar to the reverse osmosis (R.O.) process with the exception of the membrane being much looser and not removing as much of the TDS as R.O. As with any membrane process, the potential for fouling the membrane is a concern. Scale, iron and manganese deposits can foul the membranes easily making chemical addition a necessity prior to filtering the water. Pumping costs to develop the pressure necessary for the membranes to function are higher than the other alternatives. The process produces a brine stream that is constant which creates the need for brine disposal which at this time is not feasible.

d) Coagulation/Sedimentation

The coagulation/sedimentation is a time tested technique for softening water and removing iron and manganese in the process. In the case of groundwater treatment, it may be necessary to employ aeration at the front of the plant in order to remove excess CO₂ that is found in some ground waters. After the excess CO₂ is removed, lime in the form of quicklime or hydrated lime is added to the water in a large mixing basin which gently mixes the lime and water to bring the lime into contact with the ions in the water where they attach to the lime. The water then progresses into a sedimentation tank where the lime is settled out along with the hardness, iron and manganese. This process leaves the water in a very caustic state which requires the addition of CO₂ to “re-carbonate” the water and lower the pH of the finished water to prevent scaling of the distribution system. The settled lime sludge is removed from the sedimentation basin and

placed on drying beds where the water drains and evaporates leaving a semi-solid product to dispose of. Disposal of this waste can be accomplished through land filling.

e) Alternative Analysis

The iron and manganese removal technologies were ranked as shown in the following table. The preferred alternative based on the ultimate system for the ALW&SD is the technology with the lowest score which from the table is the selected Oxidation/Filtration Alternative.

Table 7 - Iron Removal Alternative Screening

Criteria	Ion Exchange	Oxidation/ Filtration	Membrane Softening	Coagulation/ Sedimentation
Ease of Operation	1	2	2	4
Chemical Usage	2	2	3	3
Waste Stream	4	1	4	4
Media Life Expectancy	1	2	1	1
Process Space Req.	2	2	1	4
Total	10	9	11	16

Note: Lowest number is best option.

2. TDS and Hardness Removal

The process selected for TDS and Hardness removal is Reverse Osmosis (R.O.). While other options such as electro dialysis reversal (EDR) will provide similar results to the R.O. process, the R.O. process has been proven over time to be a more cost effective solution for removal of TDS. The R.O. process was evaluated with an influent TDS of 1,800 mg/L with the system sized to provide the build-out flow of 140 gpm and a TDS of less than 500 mg/L. The diagram in Figure 10 shows the mass balance of the R.O. system that meets these criteria.

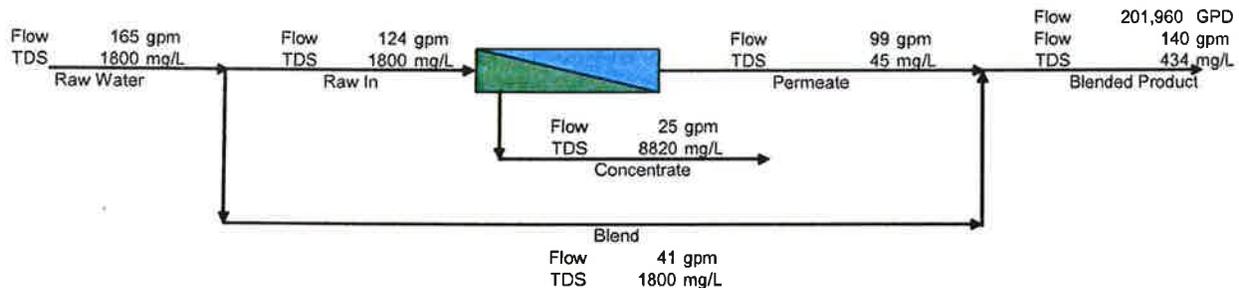


Figure 10 - R.O. Mass Balance

The parameters used to develop the mass balance include an 80% recovery rate (based on existing water quality data and saturation indexes) which means for every 100 gallons put through the plant, 80 gallons is treated and the other 20 are wasted. Increasing the recovery rate forces more water through the membrane resulting in a smaller, more concentrated waste stream. It is anticipated that recovery rates of up to about 87% would be achievable with anti-scalant addition. The addition of chemical anti-scalant prevents the membranes from fouling due to precipitation of solids (scale) which can build up on the membranes. It is anticipated that the recovery will be increased with chemical addition but small scale testing would be needed to determine the recovery rate that is possible without degrading the membrane life. The lower

recovery rate is used here as a worst case scenario for brine disposal needs. The ultimate design will balance the recovery rate with chemical costs and membrane life expectancy.

3. Brine Disposal

In cases where R.O. is used for treating brackish water such as that found in Alto Lakes, the most difficult task is determining how to dispose of the waste stream. In small communities with wastewater collection systems the disposal is fairly simple. In these situations the brine stream can be blended with the wastewater treatment effluent resulting in blended water having close to the same salinity as the raw well water. In coastal communities the brine can be disposed of in the saline ocean waters. Alto Lakes does not have any characteristics that make for simple brine disposal. The options considered for disposing of the brine in Alto Lakes are as follows:

a) Blend for Golf Course Irrigation

This alternative would blend the brine with the raw well water in the irrigation ponds at the golf course. The resultant TDS concentration that could be expected with a brine concentration of 8820 mg/L at a flow rate of 25 gallons per minute as shown in Figure 11 below is 3041 mg/L.

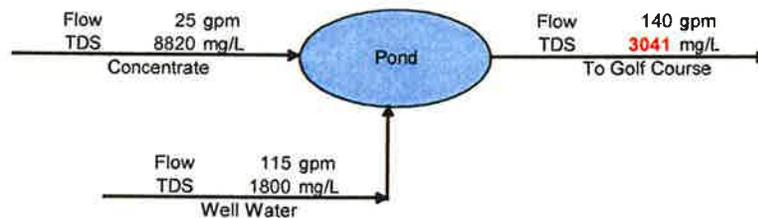


Figure 11 - Brine Disposal to Golf Course Irrigation

This TDS is high for application on general turf as found on the golf course. Special consideration and turf maintenance programs would be needed to be sure that the application of this saline water does not damage the turf. In addition, the golf course is not irrigated during the winter months and the brine would have to be stored while not being used on the golf course. This method may be combined with other disposal methods to minimize impact on turf while gaining some reduction in brine disposal to either an evaporation pond or through enhanced evaporation.

b) Evaporation Ponds

Evaporation pond sizing takes the natural water cycle of the area into account in order to determine the pond surface area needed to evaporate all of the brine. Alto Lakes receives an annual average of just over 22 inches of precipitation and evaporates 65 inches per year. This yields a net evaporation rate of just less than 43 inches per year. Considering these facts the surface area necessary to evaporate the amount of brine being produced is 11 acres. Additional land will be needed to create a buffer zone around this pond. This is a large area and the ALW&SD does not currently own a parcel of land large enough to implement this disposal method.

c) Enhanced Evaporation

Based on similar calculation as the evaporation pond, the enhanced evaporation works by using a pump and blower to produce a mist of the brine stream that shoots up to 25 feet in the air where it is evaporated. By producing a mist, the effective surface area exposed for evaporation is drastically increased. This process could be accomplished with a 2 acre pond and two evaporators. The drawback to this process is distance that the salts may travel in the air during windy conditions. Salts deposited on trees and bushes could potentially harm or deform them. Winds of up to 5 mile per hour could be tolerated with deposits falling back on the pond area. Plume controls could be implemented to control the height of the plume during windier conditions but reducing the flow to the nozzles also reduces the evaporation rate. In addition to the 2 acre pond, a buffer area around the pond would be needed.

d) Flash Evaporators

Flash evaporators work by using heat and pressure to increase the rate of evaporation. The water evaporated is then removed and condensed back to liquid form while the solids are crystallized and removed from the system. This process uses either natural gas or electricity to heat and evaporate the water and requires additional cooling water to facilitate the condensation of the evaporated water. Periodic maintenance to remove sediment and scale from the evaporator is required but can be minimized through the use of chemicals and also by selecting evaporators constructed of materials that are more resistant to scaling. The capital equipment cost for this process is in excess of \$1 million for a 25 gallon per minute waste stream with and operating cost of between \$8 and \$20 per 1000 gallons evaporated. This process is very sensitive to fluctuations in energy costs.

e) Alternative Analysis

The four alternatives for brine disposal are analyzed in the following decision matrix using non-monetary criteria. As before, the alternative with the lowest score is ranked as the preferred alternative. As shown in the table, the preferred alternative for brine disposal at this time is the enhanced evaporation alternative.

Table 8 - Brine Disposal Alternative Analysis

Criteria	Blend for G.C. Irrigation	Evaporation Pond	Enhanced Evaporation Pond	Flash Evaporators
Ease of Operation	4	3	3	6
Power Consumption	2	1	3	8
Effect on Surroundings	4	5	3	1
Required Buffer Area	2	2	2	1
Land Requirements	1	4	1	1
Total	13	15	12	17

Note: Lowest number is best option.

J. Location Map (Water Treatment)

The proposed water treatment site is located adjacent to the existing storage yard for the District along High Mesa across from the Kokopelli Pods storage buildings. The site is shown in Figure 12.

K. Environmental Impacts (Water Treatment)

The environmental impacts of treating the drinking water lie in the disposal of the waste stream generated by the treatment. Environmental impacts are minimized in Phase I since the removal of iron and manganese generates very little waste. Environmental impacts in Phase II will be considered when a suitable site is acquired.

The water treatment plant site is partially forested and may require clearing of some trees. The forested area surrounding the proposed plant site will provide adequate habitat for any small animals and avian species that may be displaced by the clearing of the trees. It is not anticipated that any endangered species or critical habitats will be affected by the clearing of the water treatment plant site.

L. Land Requirements (Water Treatment)

The proposed water treatment plant will be housed in a building that covers 2,000 square feet of the site. The treatment plant site is currently owned by the District and is adequate for the needs of Phase I.

Phase II requires a brine pond which could require as much as 11 acres in order to dispose of the brine stream. Any of the brine disposal options will require land acquisition ranging from 4 to 11 acres depending on whether evaporation enhancement is used or not. The process equipment for Phase II will be contained in the building identified for Phase I.

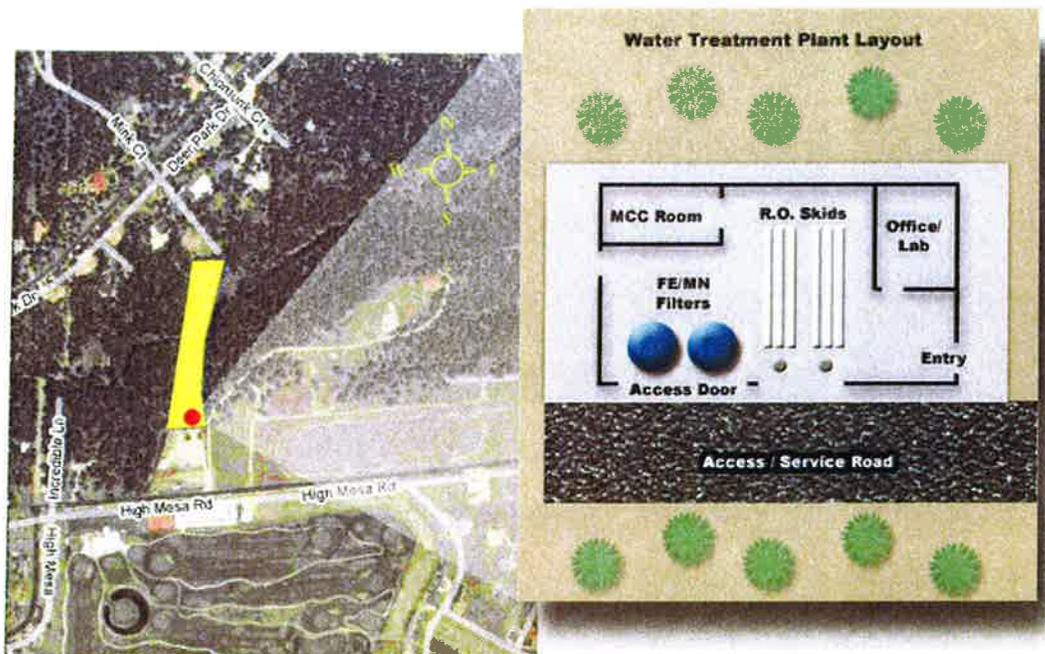


Figure 12 - Water Treatment Plant Site

M. Construction Problems (Water Treatment)

The proposed water treatment plant site is located on a slope which could require a terraced site design in order to support the necessary tankage and plant building.

N. Cost Opinions (Water Treatment)

The water treatment is proposed to be handled in two phases. Phase I will provide iron and manganese removal while Phase II will provide for TDS and hardness removal as well as some form of brine disposal. The following tables show the cost opinions for each phase.

1. Construction.

Table 9 – Phase I Water Treatment Plant Cost Opinion

Description	QTY	Units	Unit Cost	Total
Raw Water Storage Tank (60,000 gal)	1	LS	\$ 102,009.60	\$ 102,009.60
Site Work/Grading	2.5	AC	\$ 12,650.00	\$ 31,625.00
Treatment Plant Building (2000 sf)	1	LS	\$ 99,000.00	\$ 99,000.00
Iron Removal Process	200,000	GPD	\$ 0.86	\$ 172,000.00
Chlorination System	1	LS	\$ 9,516.25	\$ 9,516.25
Finish Wtr Pumping Station (140 gpm)	1	LS	\$ 53,475.00	\$ 53,475.00
8-inch Finish Water Pipeline	4610	LF	\$ 50.60	\$ 233,266.00
Electrical and HVAC	1	LS	\$ 31,625.19	\$ 31,625.19
			Sub Total	\$ 732,517.04
			Contingency (10%)	\$ 73,251.70
			Engineering & Admin (15%)	\$ 120,865.31
			Total Capital Cost	\$ 926,634.06

Table 10 - Phase II Water Treatment Cost Opinion

Description	QTY	Units	Unit Cost	Total
Reverse Osmosis Process	150,000	GPD	\$ 1.34	\$ 201,600.00
4-inch Brine Pipeline	8000	LF	\$ 32.90	\$ 263,200.00
Electrical and HVAC	1	LS	\$ 22,674.40	\$ 22,674.40
Site Work/Grading	2.5	AC	\$ 12,320.00	\$ 30,800.00
Brine Disposal Pond	52900	SF	\$ 5.21	\$ 275,503.20
Evaporation Enhancers w/Wind Ctrl	2	EA	\$ 37,714.00	\$ 75,428.00
			Sub Total	\$ 869,205.60
			Contingency (10%)	\$ 86,920.56
			Engineering & Admin (15%)	\$ 143,418.92
			Total Capital Cost	\$ 1,099,545.08



Table 11 - Water Treatment Summary Opinion of Cost

Description	Total Cost
Phase I Water Treatment	\$ 926,634.06
Phase II Water Treatment	\$ 1,099,545.08
Total Capital Cost	\$ 2,026,179.14

2. Annual Operation and Maintenance

Annual operation and maintenance cost for the water treatment plant vary with the level of treatment that is accomplished. The following tables identify the treatment plant O&M costs for the initial and final phases respectively.

Table 12 - Initial Phase O&M Costs

Item	QTY	Units	Unit Cost	Total
Electricity	57,758	kWh	\$ 0.11	\$ 6,353.43
Labor	260	Hours	\$ 25.00	\$ 6,500.00
Parts	1	L.S.	\$ 800.00	\$ 800.00
Chemicals	1	L.S.	\$1,015.00	\$ 1,015.00
Media Replacement	1	L.S.	\$1,200.00	\$ 1,200.00
Total Cost				\$ 15,868.43

Table 13 - Final Phase O&M Costs

Item	QTY	Units	Unit Cost	Total
Electricity	129,957	kWh	\$ 0.11	\$ 14,295.23
Labor	520	Hours	\$ 25.00	\$ 13,000.00
Parts	1	L.S.	\$1,500.00	\$ 1,500.00
Chemicals	1	L.S.	\$2,515.00	\$ 2,515.00
Media Replacement	1	L.S.	\$1,200.00	\$ 1,200.00
Total Cost				\$ 32,510.23

Phase I is estimated to add \$0.25 per 1,000 gallons to operating and maintenance cost. Phase II is estimated to add \$0.25 per 1,000 gallons to operating and maintenance costs.

3. Present Worth, based on Federal discount rates

The present worth of the water treatment phases based on the current Federal discount rate of 2.25% taken over the 20 year life of the loan is as follows:

Table 14 - Present Worth of Water Treatment System

Description	Total Cost	Fed. Rate	Term (Years)	Payment	Sum of Payments
Iron & Manganese Removal	\$ 926,634.06	2.25%	20	\$58,046.28	\$1,160,925.52
Reverse Osmosis	\$ 1,099,545.08	2.25%	20	\$68,877.78	\$1,377,555.62
Total Capital Cost	\$ 2,026,179.14	2.25%	20	\$126,924.06	\$2,538,481.14

VI. PROPOSED PROJECT (RECOMMENDED ALTERNATIVE)

A. Project Design

1. Water Supply

At this time the District has sufficient water supply to meet their demands through the planning period. The hydrogeological report included in Appendix E indicates the areas in which the District is most likely to find well sites that will produce consistent amounts and quality of water. The District should explore these areas in the future as funds become available in order to develop some backup water sources for their system in the event that they lose any of their existing sources.

2. Water Treatment

The proposed water treatment plant project consists of two phases:

Phase I will incorporate iron and manganese removal, raw water storage and finished water pumping. The recommended alternative for iron and manganese removal is the oxidizing filtration (manganese-green sand) media option. The waste stream can be mixed into the irrigation water.

Phase II will reduce TDS and hardness. This phase requires the acquisition of a site for brine disposal.

3. Water Storage

Additional storage will be provided at the water treatment plant to help minimize the fluctuation in feed water quality to the plant. This tank is proposed to be a 60,000 gallon ground storage tank and will be located at the water treatment plant site.

4. Water Pumping Stations

The existing booster pump station located at the existing tank site will provide 800 gpm. The proposed finished water pump station at the proposed water treatment plant will be sized to supply the treatment capacity of 140 gpm to the system and the existing storage tanks via a new finished water pipeline. Fire flows will be fed by a combination of pumped flow and draw from the storage tanks. The areas requiring 1500 gpm fire flow will be on a pressure plane that can be served by gravity flow from the storage tanks.

5. Water Distribution Layout

The layout for the proposed improvements is shown in Figures 7 and 8. The proposed alternative is Alternate 3 which provides a minimum of 6" distribution lines and provides 750 gpm fire flow protections throughout the District. This alternative also regulates the pressures throughout the system to be between 50 and 80 psi under normal demand conditions. The actual implementation of the distribution system may be phased due to funding constraints.

6. Hydraulic Calculations

The hydraulics analysis of the distribution system was developed through the use of MWH Soft's H2OMap Water. The model results are included in Appendix D.

B. Cost Opinion

Table 15 - Project Costs

PROJECT	COST
Water Treatment Plant (Phase I)	\$ 926,634
Water Distribution (Alternative 3)	\$ 9,725,325
Water Treatment Plant (Phase II)	\$ 1,099,545
TOTAL	\$ 11,751,504

C. Annual Operating Budget

1. Net Income From Operations

While the District was formed in January of 2005, the District did not begin operating water and wastewater systems until it acquired the water and wastewater system assets on April 1, 2008. The District's first full-year operating budget was developed for FY 2009 (beginning July 1, 2008). The budget provides for Net Income From Operations (NIFO = funds available to cover debt service and capital improvements) of \$414,214. The District's Ordinance provides for annual rate adjustments based on the CPI-U which are intended to maintain the District's operating margins.

Operating and Maintenance costs will increase by \$15,868 for Phase I Water Treatment and by \$16,642 for Phase II Water Treatment. The District Board expects to increase rates by approximately \$0.25 per 1,000 gallons for each phase as improvements are brought on line.

Additional connections are expected to more than offset per household decreases in consumptive use due to conservation.

2. Capital Improvements

The capital improvements identified in this PER are as follows:

Water Treatment Phase I (Iron and Manganese removal)	\$926,634
Full Distribution System Upgrade	\$9,725,325
Water Treatment Phase II (Hardness removal)	\$1,099,545
Total	\$11,751,504

Water Treatment Phase I and a portion of the Distribution System Upgrade can be funded from existing cash and \$1.5 million remaining on the District's Drinking Water Revolving Loan.

3. Debt service

The District purchased the water system assets from the Alto Lakes Water Corporation using approximately \$2.5 million of a \$4 million Drinking Water Revolving Loan which is to be repaid

over 20 years with an interest rate of 2%. The District will pay interest only (\$4,267 monthly) until the remainder of the loan is drawn at which time the District's debt service will increase to \$20,833 monthly.

The remaining \$1.5 million will be used to fund Water Treatment Phase I and a portion of the Distribution System Upgrade. The District Board plans to fund the remainder of the Capital Improvements through loans and grants, and to a small degree, through Net Income From Operations (NIFO).

4. Reserve

The District began FY 2009 with a cash reserve of \$640,022. Non-PER capital projects are budgeted at \$452,259 for FY 2009 and NIFO is budgeted at \$414,214. The District expects to end FY 2009 with a cash reserve of \$601,977.

5. Effect on Rates

The District Board plans to implement a System Upgrade Fee which will be used to provide the additional NIFO required to fund planned Capital Improvements from system operating revenues. The District Board estimates that the System Upgrade Fee will be composed of the following:

Water Treatment Phase I (Iron and Manganese removal)	\$0
Water Treatment Phase II (TDS and Hardness removal)	\$2 per month
Full Distribution System Upgrade	\$18 per month

Fees will be lower to the degree that the District Board is able to obtain grant funds. Income from additional service connections can also be used to lower Fee's in later years.

VII. CONCLUSIONS AND RECOMMENDATIONS

The Alto Lakes Water & Sanitation District has a sufficient supply of water to last for the planning period of this PER.

The water quality suffers from high iron, manganese, TDS and hardness which affects the customers by staining fixtures and clothing and at times emits an odor. The distribution system is also impacted by the high iron and manganese concentrations due to the possibility of precipitation of oxidized iron and manganese which attaches to the inside of the pipes and building up over time which reduces the capacity of the pipes.

The water distribution system contains a significant amount of substandard 2 and 3-inch thin walled pipe, which is susceptible to breakages at higher operating pressures and may not provide adequate volume to users, depending on how many are using the line. Operating pressures are highly variable and in some locations excessive. Additionally, residents in a large portion of the development do not have fire coverage of any type due to the Fire Departments inability to use the standpipes in the system.

It is recommended that the priority project be the implementation Phase I Water Treatment for iron and manganese removal as it will benefit the customers and be the most noticeable

improvement identified. It will also prevent further degradation of the pipes in the distribution system due to sediment build-up.

The second project recommended is the full distribution system upgrade as identified in Alternative 3 – Phase I & II of the distribution system analysis. This will replace undersized and substandard lines, provide more stable system pressures and improved fire protection throughout the community.

The third project recommended is Phase II Water Treatment to bring TDS within the State's secondary standards and reduce hardness to levels which will permit elimination of household water softeners. This will greatly reduce brine contamination of household septic systems and area potential contamination of groundwater.

APPENDIX A
WATER USAGE BY USER TYPE

ALTO LAKES CURRENT AND PROJECTED WATER DEMANDS

RESIDENTIAL AND COMMERCIAL TOTAL FLOW

YEAR	DOMESTIC FLOW (GAL)	METERS	USAGE (GAL/METER/DAY)	USAGE CHANGE	METER GROWTH
2000	58,611,470	951	168.85	3.99%	4.16%
2005	52,819,550	1138	127.16	-7.45%	4.21%
2007	50,847,921	1214	114.75	-2.73%	2.10%
2010	55,189,933	1358	111.34	-1.00%	3.80%
2015	63,229,445	1636	105.89	-1.00%	3.80%
2020	69,567,849	1800	105.89	0.00%	0.00%
2025	69,567,849	1800	105.89	0.00%	0.00%
2030	69,567,849	1800	105.89	0.00%	0.00%

LARGE COMMERCIAL FLOW

YEAR	L COMM FLOW (GAL)	METERS	USAGE (GAL/METER/DAY)	AVG FLOW (GAL/MINUTE)
2000	3,506,573	2	4803.52	6.67
2005	3,160,057	2	4328.85	6.01
2007	3,042,100	2	4167.26	5.79
2010	3,301,871	2	4523.11	6.28
2015	3,782,855	2	5181.99	7.20
2020	4,162,065	2	5701.46	7.92
2025	4,162,065	2	5701.46	7.92
2030	4,162,065	2	5701.46	7.92

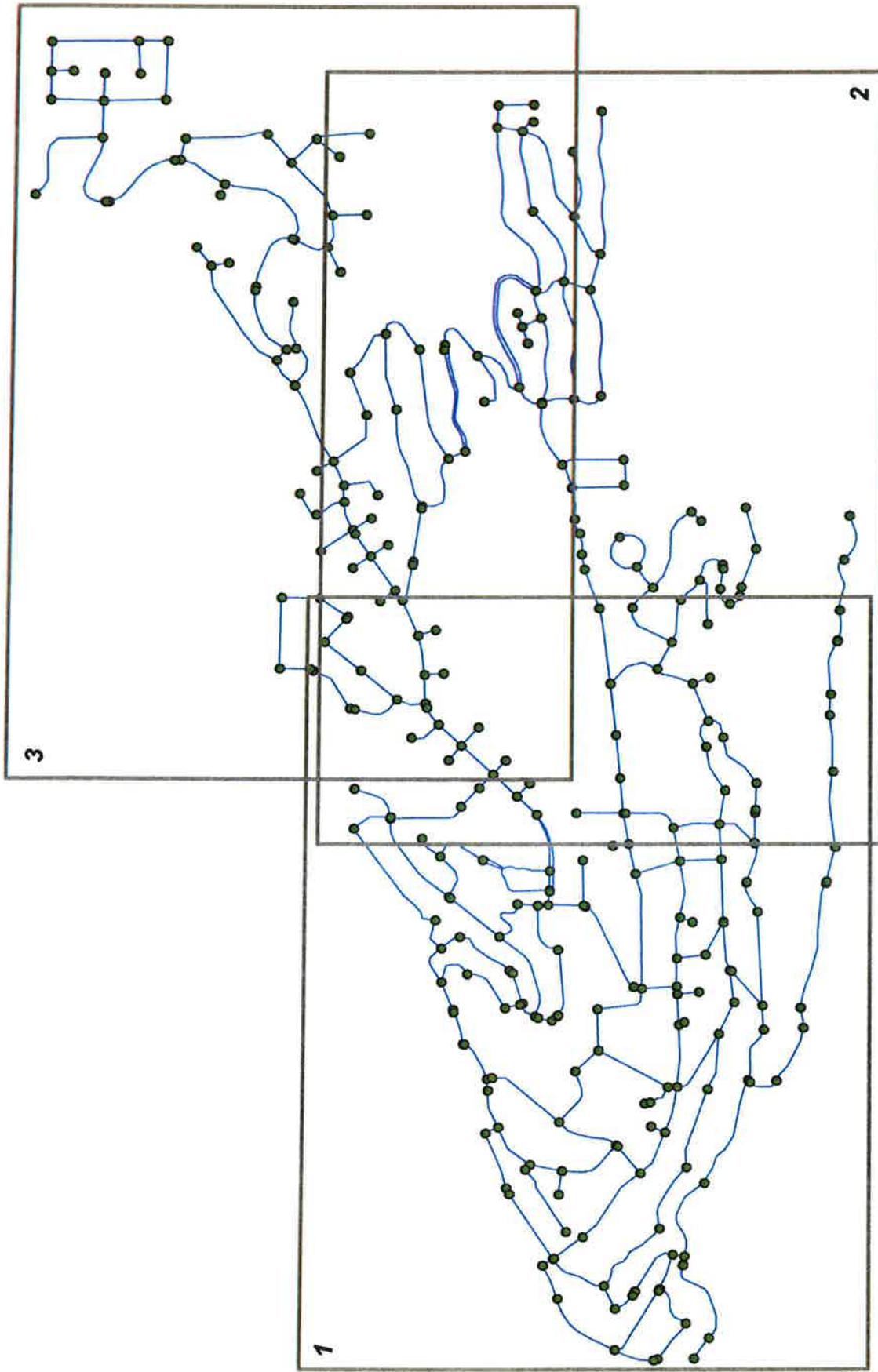
SMALL COMMERCIAL FLOW

YEAR	S COMM FLOW (GAL)	METERS	USAGE (GAL/METER/DAY)	AVG FLOW (GAL/MINUTE)
2000	1,452,483	20	198.97	2.76
2005	1,308,950	20	179.31	2.49
2007	1,260,090	20	172.62	2.40
2010	1,367,692	20	187.36	2.60
2015	1,566,923	20	214.65	2.98
2020	1,723,999	20	236.16	3.28
2025	1,723,999	20	236.16	3.28
2030	1,723,999	20	236.16	3.28

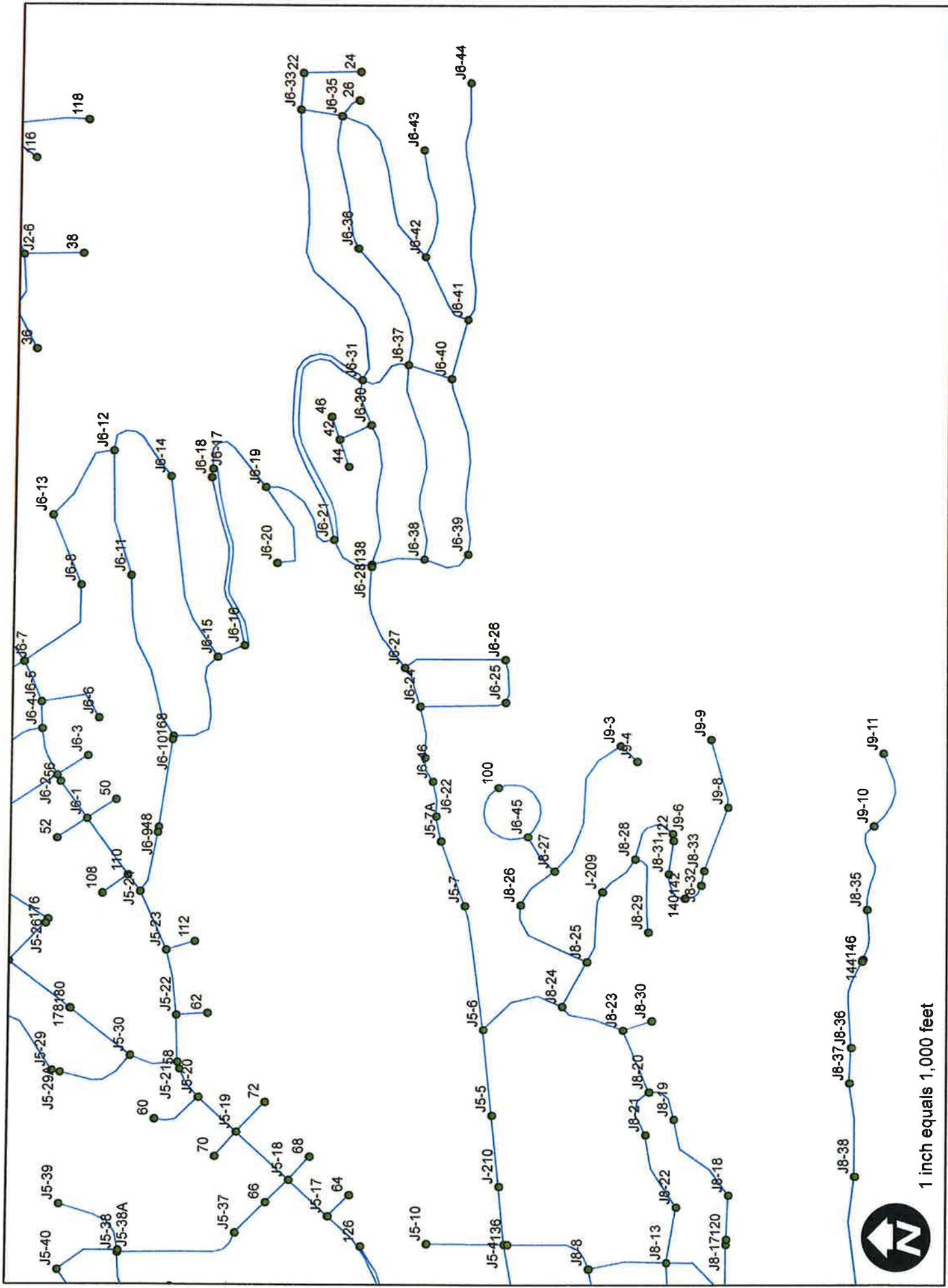
RESIDENTIAL FLOW

YEAR	RES FLOW (GAL)	METERS	USAGE (GAL/METER/DAY)	AVG FLOW (GAL/MINUTE)
2000	53,652,414	929	158.23	102.08
2005	48,350,543	1,116	118.70	91.99
2007	46,545,731	1,192	106.98	88.56
2010	50,520,370	1,336	103.60	96.12
2015	57,879,667	1,614	98.25	110.12
2020	63,681,785	1,778	98.13	121.16
2025	63,681,785	1,778	98.13	121.16
2030	63,681,785	1,778	98.13	121.16

APPENDIX B
WATER MODELING DATA



1 inch equals 2,000 feet



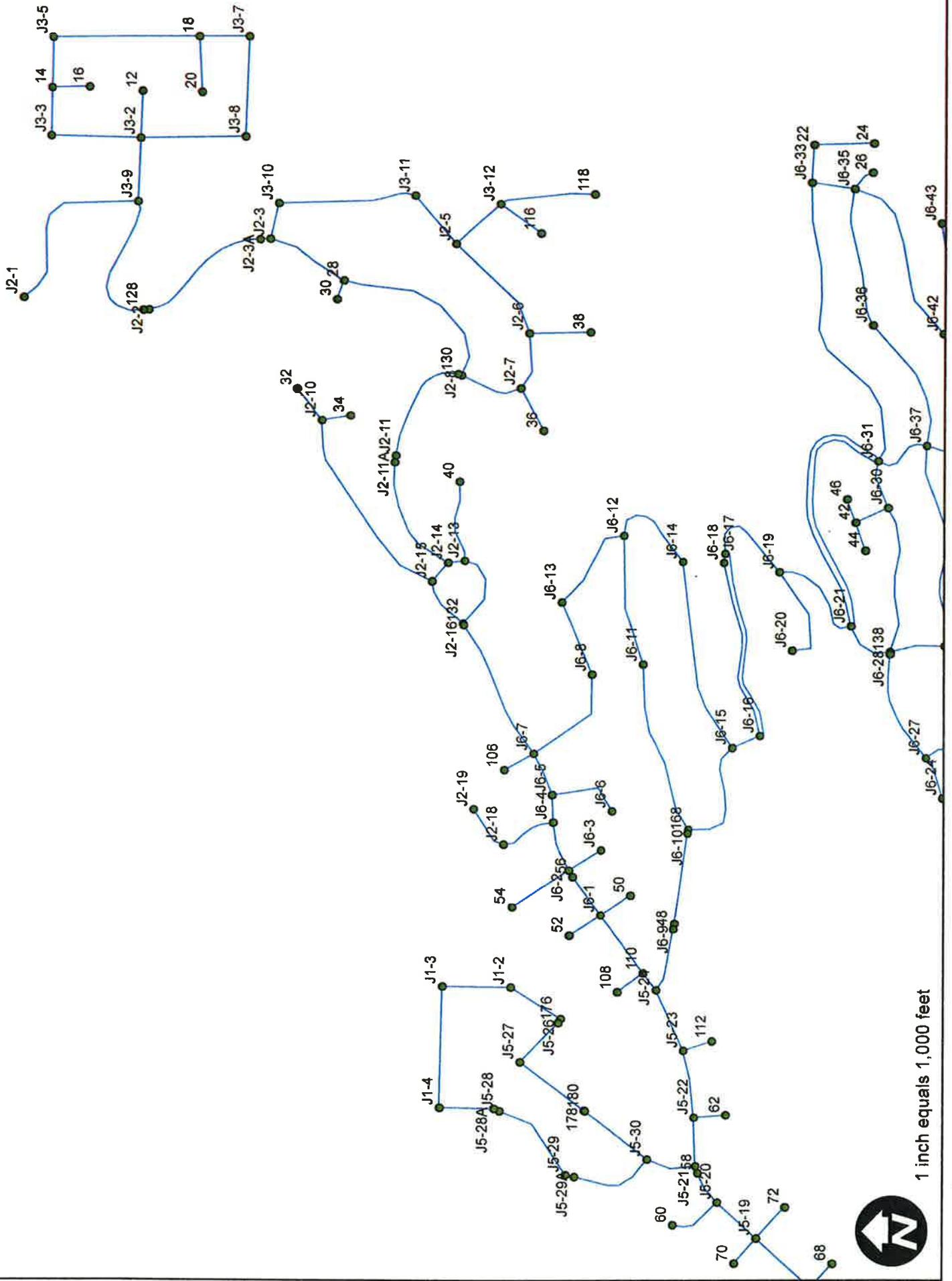


FIGURE
Nodes 3 of 3

**Alto Lakes
Node Report - Buildout**

12/11/2008

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
12	1.98	6,927.00	7,107.98	78.26
14	1.14	6,938.00	7,107.98	73.51
16	1.39	6,929.00	7,107.98	77.40
18	4.90	6,930.00	7,107.98	76.97
20	0.00	6,932.00	7,107.98	76.10
22	0.78	7,316.00	7,461.60	62.96
24	2.65	7,300.00	7,461.60	69.88
26	0.78	7,312.00	7,461.60	64.69
28	4.70	7,058.00	7,192.23	58.05
30	0.00	7,076.00	7,192.23	50.26
32	1.70	7,256.00	7,434.61	77.24
34	0.64	7,268.00	7,434.61	72.05
36	1.14	7,074.00	7,192.24	51.13
38	0.00	7,070.00	7,192.24	52.86
40	2.03	7,274.00	7,434.61	69.45
42	0.61	7,342.00	7,461.61	51.72
44	0.95	7,346.00	7,461.61	49.99
46	0.64	7,337.00	7,461.61	53.89
48	1.39	7,336.00	7,514.27	77.09
50	0.00	7,360.00	7,514.17	66.67
52	0.00	7,350.00	7,514.17	70.99
54	0.00	7,342.00	7,468.62	54.76
56	1.23	7,353.00	7,514.12	69.67
58	1.84	7,399.00	7,581.49	78.92
60	0.00	7,398.00	7,581.58	79.39
62	1.39	7,388.00	7,514.53	54.71
64	0.00	7,416.00	7,582.10	71.83
66	0.00	7,424.00	7,581.93	68.29
68	0.00	7,418.00	7,581.93	70.89
70	0.00	7,410.00	7,581.73	74.26
72	0.00	7,410.00	7,581.73	74.26
74	0.95	7,312.00	7,483.62	74.22
76	0.61	7,372.00	7,529.62	68.16
78	0.00	7,314.00	7,429.62	50.00
80	0.00	7,464.00	7,597.62	57.78
82	0.00	7,414.00	7,597.62	79.40
84	4.77	7,390.00	7,581.62	82.86
86	1.73	7,400.00	7,581.58	78.52
88	1.73	7,452.00	7,595.13	61.89
90	1.53	7,450.00	7,573.62	53.46
92	1.53	7,501.00	7,650.05	64.45
94	0.31	7,530.00	7,651.09	52.36
96	1.73	7,522.00	7,650.53	55.58
98	0.00	7,544.00	7,652.16	46.77
100	4.43	7,391.00	7,572.70	78.57
102	0.00	7,538.00	7,654.44	50.35
104	0.00	7,346.00	7,483.62	59.51
106	1.87	7,316.00	7,468.52	65.95
108	0.00	7,348.00	7,514.25	71.89
110	1.25	7,371.00	7,514.25	61.95
112	1.25	7,359.00	7,514.40	67.20
114	0.00	7,410.00	7,525.62	50.00
116	0.92	7,116.00	7,192.23	32.97
118	0.81	7,136.00	7,192.23	24.32
120	0.00	7,390.00	7,572.71	79.01
122	0.00	7,392.00	7,507.62	50.00
124	1.89	7,316.00	7,515.62	86.32
126	2.20	7,441.00	7,582.62	61.24
128	0.00	6,960.00	7,108.00	64.00
130	0.00	7,072.00	7,260.46	81.50
132	0.00	7,319.00	7,468.42	64.61
134	0.00	7,467.00	7,612.36	62.86
136	0.00	7,458.00	7,649.28	82.72
138	0.00	7,346.00	7,504.22	68.42
140	0.00	7,323.00	7,507.62	79.84
142	0.00	7,323.00	7,438.62	50.00
144	0.00	7,094.00	7,209.62	50.00
146	0.00	7,094.00	7,279.62	80.27
148	0.00	7,164.00	7,349.62	80.27
150	0.00	7,164.00	7,279.62	50.00
152	0.00	7,234.00	7,419.62	80.27
154	0.00	7,304.00	7,419.62	50.00
156	0.00	7,466.00	7,652.01	80.44
158	0.00	7,482.00	7,652.06	73.54
160	0.00	7,414.00	7,529.62	50.00
162	0.00	7,414.00	7,612.41	85.80
164	0.00	7,340.00	7,515.62	75.94
166	0.00	7,340.00	7,455.62	50.00
168	0.00	7,208.00	7,451.62	105.35
170	0.00	7,468.00	7,595.19	55.00
172	0.00	7,356.00	7,471.62	50.00
174	0.00	7,356.00	7,541.62	80.27
176	0.00	7,172.00	7,459.62	124.38
178	0.00	7,344.00	7,459.62	50.00
180	0.00	7,344.00	7,514.62	73.78

**Alto Lakes
Node Report - Buildout**

12/11/2008

182	0.00	7,288.00	7,483.61	84.59
184	0.00	7,468.00	7,612.44	62.46
J1-2	0.64	7,140.00	7,287.62	63.84
J1-3	0.97	7,096.00	7,265.62	73.35
J1-4	2.76	7,092.00	7,265.62	75.08
J-209	1.28	7,415.00	7,572.71	68.20
J2-1	0.00	6,992.00	7,107.99	50.16
J-210	2.09	7,450.00	7,573.34	53.34
J2-10	6.24	7,270.00	7,434.61	71.18
J2-11	0.00	7,168.00	7,260.50	40.00
J2-11A	0.50	7,150.00	7,434.57	123.06
J2-13	1.56	7,306.00	7,434.61	55.62
J2-14	0.00	7,300.00	7,434.61	58.21
J2-15	2.31	7,308.00	7,434.61	54.75
J2-16	4.18	7,319.00	7,434.62	50.00
J2-18	0.95	7,336.00	7,468.58	57.33
J2-19	1.87	7,312.00	7,468.58	67.71
J2-2	2.92	6,960.00	7,149.61	81.99
J2-3	1.75	7,034.00	7,192.23	68.42
J2-3A	0.00	7,034.00	7,149.62	50.00
J2-5	3.56	7,014.00	7,192.23	77.07
J2-6	1.81	7,046.00	7,192.24	63.24
J2-7	0.64	7,058.00	7,192.24	58.05
J2-8	1.81	7,072.00	7,192.25	52.00
J3-10	2.87	7,004.00	7,192.23	81.40
J3-11	1.00	7,000.00	7,192.23	83.13
J3-12	0.00	7,052.00	7,192.23	60.64
J3-2	2.48	6,932.00	7,107.98	76.10
J3-3	1.64	6,949.00	7,107.98	68.75
J3-5	1.89	6,929.00	7,107.98	77.40
J3-7	0.50	6,938.00	7,107.98	73.51
J3-8	2.62	6,962.00	7,107.98	63.13
J3-9	1.89	6,940.00	7,107.99	72.64
J4-1	12.06	7,428.00	7,581.59	66.42
J4-10	0.92	7,438.00	7,597.62	69.03
J4-11	1.39	7,422.00	7,597.62	75.95
J4-12	2.95	7,384.00	7,515.62	56.92
J4-13	0.64	7,344.00	7,515.62	74.22
J4-14	2.62	7,360.00	7,515.62	67.30
J4-15	3.09	7,438.00	7,597.61	69.02
J4-16	2.48	7,444.00	7,597.61	66.43
J4-17	0.31	7,400.00	7,515.62	50.00
J4-17A	1.92	7,400.00	7,515.62	50.00
J4-18	3.59	7,400.00	7,597.60	85.45
J4-19	1.56	7,312.00	7,429.62	50.86
J4-2	0.00	7,484.00	7,595.13	48.06
J4-3	5.38	7,468.00	7,595.13	54.97
J4-4	2.20	7,464.00	7,581.61	50.86
J4-5	0.31	7,464.00	7,581.62	50.86
J4-6	1.56	7,466.00	7,581.62	50.00
J4-7	4.63	7,481.00	7,652.03	73.96
J4-8	2.98	7,470.00	7,597.62	55.19
J4-9	3.09	7,482.00	7,597.62	50.00
J5-1	37.35	7,512.00	7,650.89	60.06
J5-10	1.75	7,372.00	7,573.62	87.19
J5-11	4.18	7,484.00	7,612.42	55.53
J5-11A	4.90	7,400.00	7,529.62	56.05
J5-12	1.61	7,470.00	7,612.44	61.60
J5-13	0.00	7,467.00	7,582.62	50.00
J5-15	4.81	7,436.00	7,582.58	63.39
J5-16	1.31	7,460.00	7,582.56	53.00
J5-17	2.79	7,436.00	7,582.10	63.18
J5-18	2.51	7,428.00	7,581.93	66.56
J5-19	4.49	7,416.00	7,581.73	71.67
J5-2	0.00	7,500.00	7,650.24	64.97
J5-20	3.54	7,408.00	7,581.58	75.06
J5-21	0.00	7,399.00	7,514.62	50.00
J5-22	1.53	7,392.00	7,514.53	52.98
J5-23	2.01	7,386.00	7,514.40	55.52
J5-24	2.31	7,374.00	7,514.28	60.66
J5-26	1.11	7,172.00	7,287.62	50.00
J5-27	4.01	7,276.00	7,459.62	79.41
J5-28	0.92	7,240.00	7,475.62	101.89
J5-28A	0.00	7,150.00	7,265.62	50.00
J5-29	0.00	7,360.00	7,475.62	50.00
J5-29A	2.93	7,360.00	7,514.62	66.86
J5-3	2.31	7,464.00	7,573.62	47.41
J5-30	1.09	7,390.00	7,514.62	53.89
J5-31	0.31	7,468.00	7,649.33	78.41
J5-31A	1.28	7,460.00	7,612.44	65.92
J5-33	3.45	7,328.00	7,483.62	67.29
J5-34	2.70	7,288.00	7,403.62	50.00
J5-35	2.51	7,384.00	7,582.58	85.87
J5-36	1.75	7,388.00	7,582.58	84.14
J5-37	2.98	7,324.00	7,581.93	111.54
J5-38	4.32	7,272.00	7,403.62	56.92
J5-38A	0.00	7,250.00	7,365.62	50.00

**Alto Lakes
Node Report - Buildout**

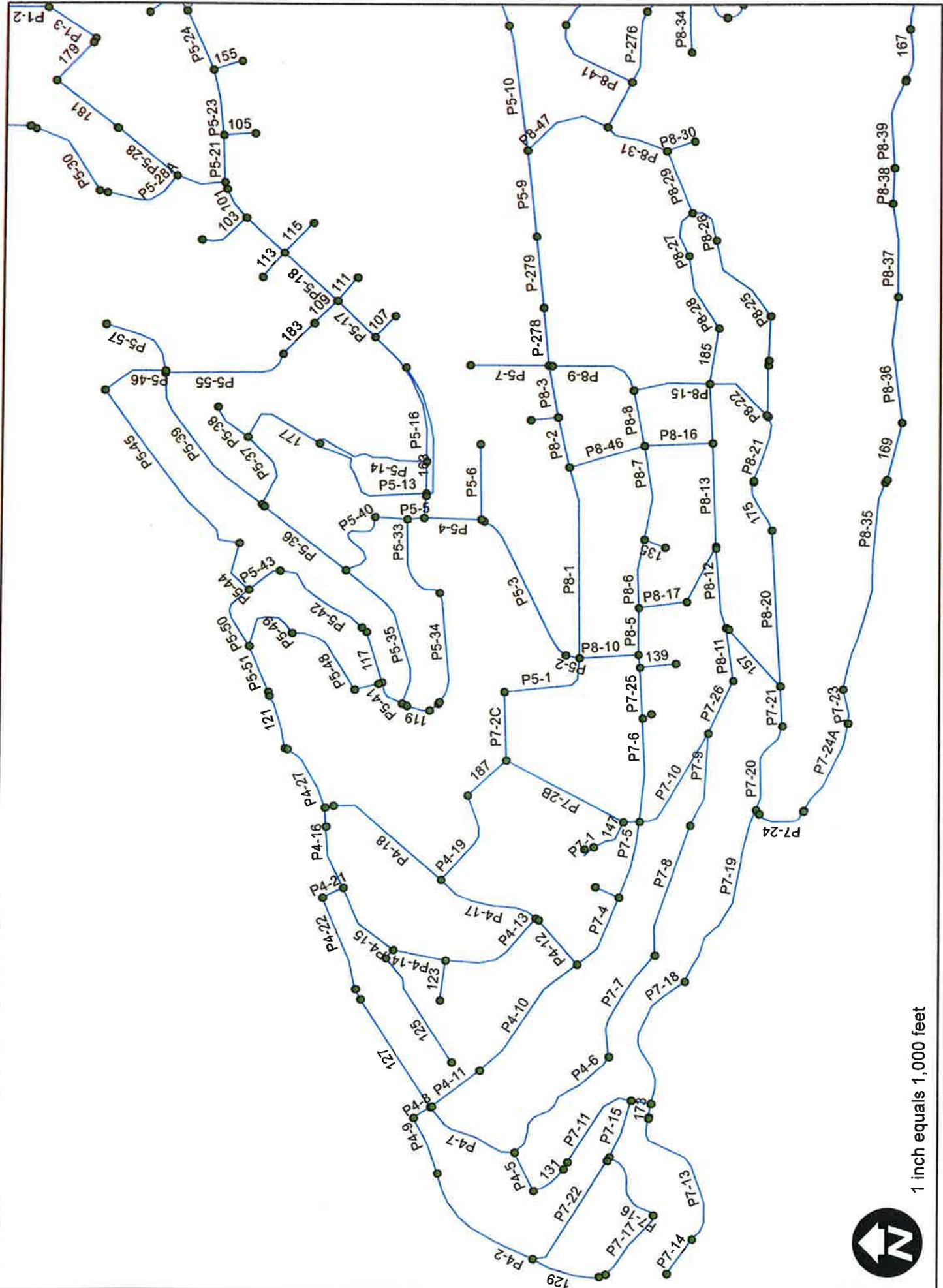
12/11/2008

J5-39	2.23	7,228.00	7,365.62	59.51
J5-4	3.43	7,458.00	7,573.62	50.00
J5-40	4.12	7,168.00	7,365.62	85.46
J5-41	0.00	7,232.00	7,427.19	84.41
J5-42	1.42	7,280.00	7,427.19	63.65
J5-43	2.98	7,248.00	7,427.19	77.49
J5-44	0.61	7,346.00	7,483.62	59.51
J5-44A	0.00	7,300.00	7,427.19	55.00
J5-45	0.00	7,368.00	7,483.62	50.00
J5-46	2.03	7,360.00	7,483.62	53.46
J5-47	0.78	7,348.00	7,483.62	58.65
J5-48	1.25	7,308.00	7,427.19	51.54
J5-48A	1.11	7,300.00	7,427.19	55.00
J5-5	37.03	7,439.00	7,573.00	57.95
J5-50	0.00	7,525.00	7,651.46	54.69
J5-6	1.84	7,428.00	7,572.73	62.59
J5-7	1.87	7,402.00	7,572.49	73.73
J5-7A	2.67	7,395.00	7,572.36	76.70
J5-8	2.65	7,474.00	7,612.75	60.00
J5-9	3.40	7,444.00	7,612.75	72.97
J6-1	4.77	7,362.00	7,514.17	65.80
J6-10	1.87	7,208.00	7,323.62	50.00
J6-11	4.51	7,160.00	7,323.62	70.76
J6-12	1.14	7,112.00	7,323.62	91.51
J6-13	1.95	7,152.00	7,323.62	74.22
J6-14	1.14	7,200.00	7,323.62	53.46
J6-15	7.21	7,196.00	7,323.62	55.19
J6-16	2.48	7,222.00	7,420.50	85.84
J6-17	5.96	7,326.00	7,461.61	58.64
J6-18	0.00	7,328.00	7,420.50	40.00
J6-19	0.50	7,320.00	7,461.61	61.24
J6-2	2.65	7,353.00	7,468.62	50.00
J6-20	3.04	7,354.00	7,461.61	46.53
J6-21	8.57	7,296.00	7,461.61	71.62
J6-22	1.25	7,389.00	7,504.62	50.00
J6-23	0.33	7,382.00	7,504.52	52.98
J6-24	1.39	7,376.00	7,504.43	55.54
J6-25	1.84	7,383.00	7,504.42	52.50
J6-26	0.17	7,382.00	7,504.41	52.93
J6-27	2.37	7,368.00	7,504.39	58.98
J6-28	2.37	7,346.00	7,461.62	50.00
J6-3	1.09	7,352.00	7,468.62	50.43
J6-30	6.02	7,340.00	7,461.61	52.59
J6-31	0.47	7,332.00	7,461.61	56.05
J6-33	8.52	7,323.00	7,461.60	59.93
J6-35	1.09	7,318.00	7,461.60	62.10
J6-36	9.70	7,326.00	7,461.60	58.64
J6-37	8.61	7,334.00	7,461.60	55.18
J6-38	1.23	7,328.00	7,461.61	57.78
J6-39	2.20	7,314.00	7,461.61	63.83
J6-4	1.09	7,344.00	7,468.58	53.87
J6-40	7.72	7,320.00	7,461.60	61.23
J6-41	2.06	7,308.00	7,461.60	66.42
J6-42	6.77	7,264.00	7,461.60	85.45
J6-43	3.69	7,240.00	7,461.60	95.83
J6-44	10.36	7,306.00	7,461.59	67.28
J6-45	0.00	7,401.00	7,572.70	74.25
J6-46	0.00	7,391.00	7,504.56	49.11
J6-5	0.31	7,342.00	7,468.55	54.73
J6-6	3.09	7,344.00	7,468.55	53.86
J6-7	1.23	7,336.00	7,468.52	57.31
J6-8	2.20	7,280.00	7,468.52	81.52
J6-9	0.00	7,336.00	7,451.62	50.00
J7-10	4.07	7,444.00	7,595.15	65.36
J7-11	0.00	7,448.00	7,563.62	50.00
J7-12	3.23	7,368.00	7,515.62	63.83
J7-13	3.18	7,392.00	7,515.62	53.46
J7-13A	0.00	7,400.00	7,548.60	64.26
J7-14	2.20	7,400.00	7,515.62	50.00
J7-15	0.00	7,400.00	7,515.62	50.00
J7-16	1.87	7,296.00	7,455.62	69.03
J7-17	3.04	7,300.00	7,455.62	67.30
J7-18	2.53	7,344.00	7,515.62	74.21
J7-19	0.00	7,380.00	7,515.62	58.64
J7-2	0.61	7,540.00	7,652.53	48.66
J7-20	4.68	7,308.00	7,471.60	70.75
J7-21	3.34	7,320.00	7,471.61	65.56
J7-22	0.31	7,234.00	7,349.62	50.00
J7-23	0.17	7,180.00	7,349.62	73.35
J7-3	0.00	7,506.00	7,652.07	63.17
J7-4	4.96	7,549.00	7,652.16	44.61
J7-5	0.00	7,538.00	7,652.25	49.41
J7-6	2.76	7,530.00	7,651.09	52.36
J7-7	5.63	7,468.00	7,595.13	54.97
J7-8	5.29	7,476.00	7,595.13	51.52
J7-9	6.24	7,444.00	7,595.14	65.36
J8-1	0.17	7,502.00	7,650.31	64.14

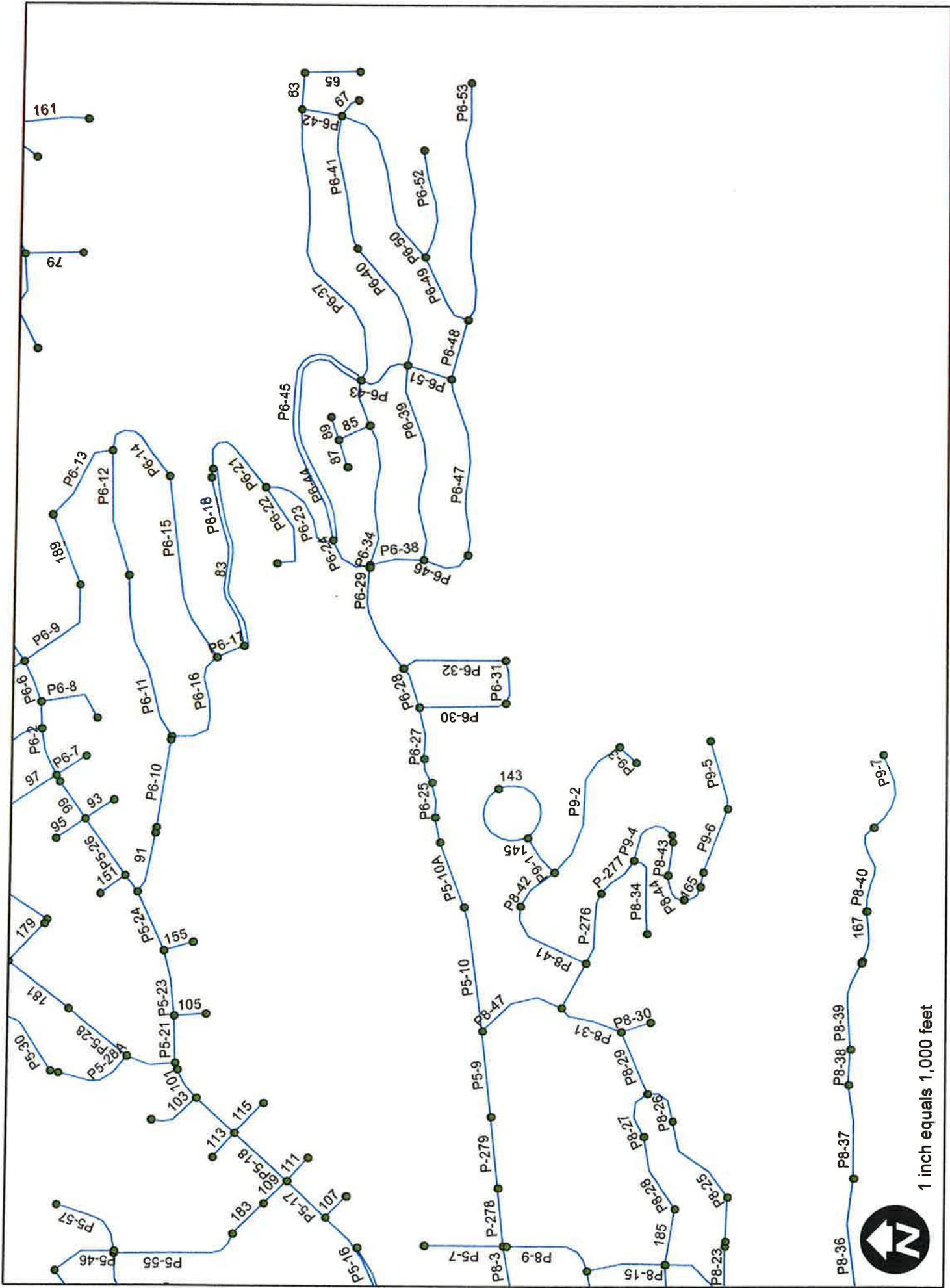
**Alto Lakes
Node Report - Buildout**

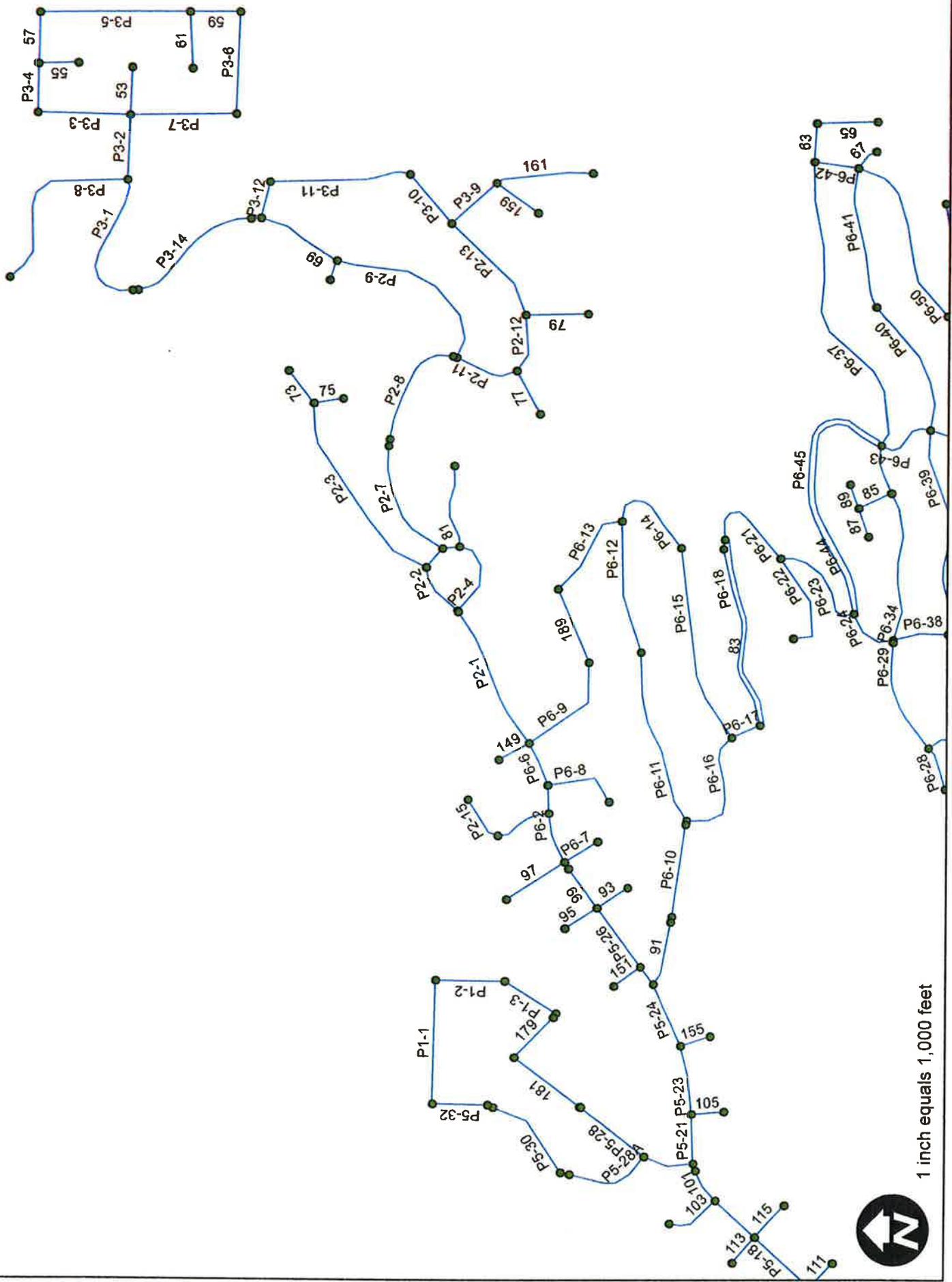
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J8-10	1.09	7,412.00	7,595.17	79.21
J8-11	2.51	7,468.00	7,649.97	78.69
J8-12	6.02	7,480.00	7,649.90	73.47
J8-13	7.08	7,473.00	7,649.81	76.46
J8-13A	0.00	7,475.00	7,649.80	75.59
J8-14	1.59	7,332.00	7,471.61	60.37
J8-15	4.74	7,340.00	7,471.62	56.92
J8-16	3.18	7,426.00	7,541.62	50.00
J8-17	0.97	7,390.00	7,541.62	65.57
J8-18	1.17	7,384.00	7,572.71	81.61
J8-19	1.50	7,420.00	7,572.71	66.04
J8-2	5.88	7,470.00	7,650.03	77.85
J8-20	0.50	7,446.00	7,572.71	54.79
J8-21	1.59	7,452.00	7,572.71	52.20
J8-22	5.85	7,464.00	7,649.81	80.35
J8-23	1.34	7,434.00	7,572.71	59.98
J8-24	4.60	7,426.00	7,572.71	63.44
J8-25	0.33	7,418.00	7,572.71	66.90
J8-26	2.31	7,410.00	7,572.70	70.36
J8-27	1.56	7,402.00	7,572.70	73.82
J8-28	1.25	7,410.00	7,572.71	70.36
J8-29	1.28	7,422.00	7,572.71	65.17
J8-3	0.31	7,520.00	7,650.53	56.44
J8-30	0.17	7,436.00	7,572.71	59.12
J8-31	0.00	7,356.00	7,507.62	65.57
J8-32	0.50	7,304.00	7,438.62	58.22
J8-33	0.00	7,301.00	7,438.62	59.51
J8-35	2.20	7,088.00	7,209.62	52.59
J8-36	0.61	7,112.00	7,279.62	72.48
J8-37	1.53	7,116.00	7,279.62	70.76
J8-38	1.56	7,132.00	7,279.62	63.84
J8-39	0.81	7,148.00	7,279.62	56.92
J8-4	0.31	7,518.00	7,650.39	57.25
J8-40	0.00	7,184.00	7,349.62	71.62
J8-41	1.25	7,510.00	7,650.07	60.57
J8-5	1.09	7,510.00	7,650.14	60.60
J8-6	1.11	7,496.00	7,650.05	66.62
J8-7	3.40	7,480.00	7,649.92	73.48
J8-8	1.56	7,470.00	7,649.77	77.74
J8-9	2.31	7,445.00	7,595.16	64.94
J9-10	0.64	7,068.00	7,209.62	61.24
J9-11	1.09	7,024.00	7,209.62	80.27
J9-3	3.87	7,392.00	7,572.70	78.14
J9-4	1.23	7,396.00	7,572.70	76.41
J9-6	1.39	7,396.00	7,572.71	76.41
J9-8	0.33	7,288.00	7,438.62	65.14
J9-9	1.34	7,290.00	7,438.62	64.27



1 inch equals 1,000 feet





1 inch equals 1,000 feet



FIGURE
Pipes 3 of 3



**Alto Lakes
Pipe Report - Buildout**

12/11/2008

ID	From Node	To Node	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)	HL/1000 (ft/kft)	Status
53	J3-2	12	371.53	8.00	150.00	1.98	0.01	0.00	0.00	Open
55	14	16	100.00	8.00	150.00	1.39	0.01	0.00	0.00	Open
57	14	J3-5	396.11	8.00	150.00	3.17	0.02	0.00	0.00	Open
59	18	J3-7	380.72	8.00	150.00	(3.63)	0.02	0.00	0.00	Open
61	20	18	436.91	8.00	150.00	0.00	0.00	0.00	0.00	Open
63	J6-33	22	298.22	8.00	150.00	3.43	0.02	0.00	0.00	Open
65	22	24	452.00	8.00	150.00	2.65	0.02	0.00	0.00	Open
67	J6-35	26	190.51	8.00	150.00	0.78	0.00	0.00	0.00	Open
69	28	J2-3	664.56	8.00	150.00	17.23	0.11	0.01	0.01	Open
71	30	28	157.23	8.00	150.00	(0.01)	0.00	0.00	0.00	Open
73	J2-10	32	312.85	8.00	150.00	1.70	0.01	0.00	0.00	Open
75	J2-10	34	225.64	8.00	150.00	0.64	0.00	0.00	0.00	Open
77	J2-7	36	377.96	8.00	150.00	1.14	0.01	0.00	0.00	Open
79	38	J2-6	461.76	8.00	150.00	0.00	0.00	0.00	0.00	Open
81	J2-13	40	649.78	8.00	150.00	2.03	0.01	0.00	0.00	Open
83	J6-16	J6-17	1,550.57	8.00	150.00	0.00	0.00	0.00	0.00	Closed
85	J6-30	42	271.56	8.00	150.00	2.20	0.01	0.00	0.00	Open
87	42	44	233.06	8.00	150.00	0.95	0.01	0.00	0.00	Open
89	42	46	196.24	8.00	150.00	0.64	0.00	0.00	0.00	Open
91	J5-24	48	504.71	8.00	150.00	19.20	0.12	0.00	0.01	Open
93	50	J6-1	275.61	8.00	150.00	0.00	0.00	0.00	0.00	Open
95	52	J6-1	286.19	8.00	150.00	0.00	0.00	0.00	0.00	Open
97	54	J6-2	511.19	8.00	150.00	0.00	0.00	0.00	0.00	Open
99	J6-1	56	369.30	8.00	150.00	81.12	0.52	0.05	0.13	Open
101	J5-20	58	278.58	8.00	150.00	131.10	0.84	0.09	0.33	Open
103	60	J5-20	424.00	8.00	150.00	0.00	0.00	0.00	0.00	Open
105	J5-22	62	247.17	8.00	150.00	1.39	0.01	0.00	0.00	Open
107	64	J5-17	235.45	8.00	150.00	0.00	0.00	0.00	0.00	Open
109	66	J5-18	253.85	8.00	150.00	(2.98)	0.02	0.00	0.00	Open
111	68	J5-18	246.27	8.00	150.00	(0.01)	0.00	0.00	0.00	Open
113	70	J5-19	258.13	8.00	150.00	0.00	0.00	0.00	0.00	Open
115	72	J5-19	329.92	8.00	150.00	0.00	0.00	0.00	0.00	Open
117	J5-44	74	429.27	8.00	150.00	0.95	0.01	0.00	0.00	Open
119	J5-11A	76	184.47	8.00	150.00	21.81	0.14	0.00	0.01	Open
121	78	J4-19	444.57	8.00	150.00	8.33	0.05	0.00	0.00	Open
123	80	J4-10	324.94	8.00	150.00	(0.01)	0.00	0.00	0.00	Open
125	82	J4-6	1,002.56	8.00	150.00	2.98	0.02	0.00	0.00	Open
127	J4-6	84	1,037.63	8.00	150.00	4.77	0.03	0.00	0.00	Open
129	J4-1	86	543.77	8.00	150.00	17.77	0.11	0.00	0.01	Open
131	J4-2	88	294.87	8.00	150.00	1.73	0.01	0.00	0.00	Open
133	J5-3	90	212.28	8.00	150.00	1.53	0.01	0.00	0.00	Open
135	J8-6	92	175.28	8.00	150.00	1.53	0.01	0.00	0.00	Open
137	J7-6	94	76.03	8.00	150.00	0.31	0.00	0.00	0.00	Open
139	J8-3	96	283.29	8.00	150.00	1.73	0.01	0.00	0.00	Open
141	98	J7-4	201.37	8.00	150.00	0.00	0.00	0.00	0.00	Open
143	J6-45	100	702.55	8.00	150.00	2.22	0.01	0.00	0.00	Open
145	J6-45	100	712.59	8.00	150.00	2.21	0.01	0.00	0.00	Open
147	102	J7-2	334.34	8.00	150.00	616.21	3.93	1.91	5.72	Open
149	J6-7	106	254.94	8.00	150.00	1.87	0.01	0.00	0.00	Open
151	108	110	245.33	8.00	150.00	0.00	0.00	0.00	0.00	Open
153	J5-24	110	166.85	8.00	150.00	87.16	0.56	0.03	0.15	Open
155	J5-23	112	237.03	8.00	150.00	1.25	0.01	0.00	0.00	Open
157	114	J8-14	619.71	8.00	150.00	0.00	0.00	0.00	0.00	Closed
159	J3-12	116	386.58	8.00	150.00	0.92	0.01	0.00	0.00	Open
161	J3-12	118	725.69	8.00	150.00	0.81	0.01	0.00	0.00	Open
163	J5-13	126	1,117.72	8.00	150.00	2.20	0.01	0.00	0.00	Open
165	142	J8-32	182.24	8.00	150.00	2.17	0.01	0.00	0.00	Open
167	144	J8-35	416.57	8.00	150.00	3.93	0.03	0.00	0.00	Open
169	150	J8-39	477.93	8.00	150.00	8.44	0.05	0.00	0.00	Open
171	160	J5-11A	90.08	8.00	150.00	26.71	0.17	0.00	0.02	Open
173	J7-18	164	111.26	8.00	150.00	4.90	0.03	0.00	0.00	Open
175	172	J8-15	433.31	8.00	150.00	23.26	0.15	0.01	0.01	Open
177	J5-15	J5-35	729.71	8.00	150.00	4.26	0.03	0.00	0.00	Open
179	J5-27	176	417.79	8.00	150.00	1.75	0.01	0.00	0.00	Open
181	178	J5-27	615.62	8.00	150.00	5.77	0.04	0.00	0.00	Open
183	66	J5-37	343.09	8.00	150.00	2.98	0.02	0.00	0.00	Open
185	J8-13	J8-22	455.92	8.00	150.00	5.85	0.04	0.00	0.00	Open
187	J5-50	J4-16	413.83	6.00	150.00	0.00	0.00	0.00	0.00	Closed
189	J6-8	J6-13	615.03	6.00	150.00	0.00	0.00	0.00	0.00	Closed
P1-1	J1-4	J1-3	956.97	8.00	150.00	0.97	0.01	0.00	0.00	Open
P1-2	J1-3	J1-2	516.69	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P1-3	J1-2	J5-26	448.79	8.00	150.00	(0.64)	0.00	0.00	0.00	Open
P2-1	J6-7	132	1,152.54	8.00	150.00	63.54	0.41	0.10	0.09	Open
P2-11	J2-8	J2-7	493.94	8.00	150.00	20.65	0.13	0.00	0.01	Open
P2-12	J2-7	J2-6	458.23	8.00	150.00	18.86	0.12	0.00	0.01	Open
P2-13	J2-6	J2-5	926.13	8.00	150.00	17.05	0.11	0.01	0.01	Open
P2-14	J6-4	J2-18	426.50	8.00	150.00	2.81	0.02	0.00	0.00	Open
P2-15	J2-18	J2-19	373.35	8.00	150.00	1.87	0.01	0.00	0.00	Open
P2-2	J2-16	J2-15	424.37	8.00	150.00	32.60	0.21	0.01	0.02	Open
P2-3	J2-15	J2-10	1,615.02	8.00	150.00	8.58	0.05	0.00	0.00	Open
P2-4	J2-16	J2-13	641.29	8.00	150.00	26.78	0.17	0.01	0.02	Open
P2-5	J2-13	J2-14	129.28	8.00	150.00	23.19	0.15	0.00	0.02	Open
P2-6	J2-14	J2-15	190.81	8.00	150.00	(21.71)	0.14	0.00	0.01	Open
P2-7	J2-14	J2-11A	968.24	8.00	150.00	44.89	0.29	0.04	0.04	Open
P-276	J8-25	J-209	592.72	8.00	150.00	7.38	0.05	0.00	0.00	Open

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P-277	J-209	J8-28	369.56	8.00	150.00	6.10	0.04	0.00	0.00	Open
P-278	J5-4	J-210	471.01	8.00	150.00	182.58	1.17	0.28	0.60	Open
P-279	J-210	J5-5	582.44	8.00	150.00	180.49	1.15	0.34	0.59	Open
P2-8	J2-11	130	901.20	8.00	150.00	44.37	0.28	0.04	0.04	Open
P2-9	J2-8	28	1,431.35	8.00	150.00	21.94	0.14	0.02	0.01	Open
P3-1	128	J3-9	1,125.82	8.00	150.00	20.44	0.13	0.01	0.01	Open
P3-10	J2-5	J3-11	500.16	8.00	150.00	11.76	0.08	0.00	0.00	Open
P3-11	J3-11	J3-10	1,072.50	8.00	150.00	10.76	0.07	0.00	0.00	Open
P3-12	J3-10	J2-3	290.57	8.00	150.00	7.89	0.05	0.00	0.00	Open
P3-14	J2-3A	J2-2	1,050.98	8.00	150.00	23.35	0.15	0.01	0.01	Open
P3-2	J3-9	J3-2	498.82	8.00	150.00	18.55	0.12	0.00	0.01	Open
P3-3	J3-2	J3-3	696.19	8.00	150.00	7.35	0.05	0.00	0.00	Open
P3-4	J3-3	14	379.74	8.00	150.00	5.71	0.04	0.00	0.00	Open
P3-5	J3-5	18	1,136.62	8.00	150.00	1.28	0.01	0.00	0.00	Open
P3-6	J3-7	J3-8	790.23	8.00	150.00	(4.13)	0.03	0.00	0.00	Open
P3-7	J3-8	J3-2	805.29	8.00	150.00	(6.75)	0.04	0.00	0.00	Open
P3-8	J3-9	J2-1	1,444.54	8.00	150.00	0.00	0.00	0.00	0.00	Open
P3-9	J3-12	J2-5	467.09	8.00	150.00	(1.73)	0.01	0.00	0.00	Open
P4-10	J7-3	J4-7	1,152.74	8.00	150.00	43.29	0.28	0.05	0.04	Open
P4-11	J4-7	J4-7	473.73	8.00	150.00	38.67	0.25	0.02	0.03	Open
P4-12	J7-3	158	467.37	8.00	150.00	36.22	0.23	0.01	0.03	Open
P4-13	J4-10	J4-9	858.34	8.00	150.00	(5.30)	0.03	0.00	0.00	Open
P4-14	J4-10	J4-11	423.46	8.00	150.00	4.37	0.03	0.00	0.00	Open
P4-15	J4-11	J4-14	661.60	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P4-16	J4-14	J4-17A	524.92	8.00	150.00	(6.21)	0.04	0.00	0.00	Open
P4-17	J4-9	J4-15	833.92	8.00	150.00	27.83	0.18	0.02	0.02	Open
P4-18	J4-15	J4-18	1,084.49	8.00	150.00	22.26	0.14	0.01	0.01	Open
P4-19	J4-15	J4-16	808.37	8.00	150.00	2.47	0.02	0.00	0.00	Open
P4-2	J4-4	J4-1	1,066.62	8.00	150.00	29.83	0.19	0.02	0.02	Open
P4-20	J4-11	82	86.60	8.00	150.00	2.98	0.02	0.00	0.00	Open
P4-21	J4-14	J4-13	179.46	8.00	150.00	3.59	0.02	0.00	0.00	Open
P4-22	J4-13	J4-12	788.00	8.00	150.00	2.95	0.02	0.00	0.00	Open
P4-27	J4-17	124	568.21	8.00	150.00	10.22	0.07	0.00	0.00	Open
P4-5	J4-2	J4-3	341.93	8.00	150.00	(1.73)	0.01	0.00	0.00	Open
P4-6	J4-3	J7-7	1,109.19	8.00	150.00	(7.11)	0.05	0.00	0.00	Open
P4-7	J4-6	J4-3	783.75	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P4-8	J4-6	J4-5	157.37	8.00	150.00	32.34	0.21	0.00	0.02	Open
P4-9	J4-5	J4-4	488.43	8.00	150.00	32.03	0.20	0.01	0.02	Open
P5-1	J5-1	J8-1	758.54	8.00	150.00	207.05	1.32	0.58	0.76	Open
P5-10	J5-6	J5-7	1,022.19	8.00	150.00	109.65	0.70	0.24	0.23	Open
P5-10A	J5-7	J5-7A	559.48	8.00	150.00	107.78	0.69	0.13	0.23	Open
P5-12	J5-12	134	179.76	8.00	150.00	160.02	1.02	0.08	0.47	Open
P5-13	J5-13	J5-15	1,107.87	8.00	150.00	41.83	0.27	0.04	0.04	Open
P5-14	J5-15	J5-16	925.83	8.00	150.00	32.76	0.21	0.02	0.02	Open
P5-15	J5-13	J5-16	256.70	8.00	150.00	115.98	0.74	0.07	0.26	Open
P5-16	J5-16	J5-17	1,143.19	8.00	150.00	147.43	0.94	0.46	0.40	Open
P5-17	J5-17	J5-18	422.04	8.00	150.00	144.63	0.92	0.16	0.39	Open
P5-18	J5-18	J5-19	566.83	8.00	150.00	139.15	0.89	0.21	0.36	Open
P5-19	J5-19	J5-20	412.04	8.00	150.00	134.65	0.86	0.14	0.34	Open
P5-2	J8-1	J5-2	106.97	8.00	150.00	200.16	1.28	0.08	0.72	Open
P5-21	J5-21	J5-22	382.54	8.00	150.00	114.87	0.73	0.10	0.25	Open
P5-23	J5-22	J5-23	536.57	8.00	150.00	111.94	0.71	0.13	0.24	Open
P5-24	J5-23	J5-24	523.02	8.00	150.00	108.68	0.69	0.12	0.23	Open
P5-26	110	J6-1	563.88	8.00	150.00	85.90	0.55	0.08	0.15	Open
P5-27	J5-21	J5-30	389.67	8.00	150.00	14.43	0.09	0.00	0.01	Open
P5-28	J5-30	180	1,234.30	8.00	150.00	5.77	0.04	0.00	0.00	Open
P5-28A	J5-30	J5-29A	648.21	8.00	150.00	7.58	0.05	0.00	0.00	Open
P5-3	J5-2	J5-31	1,276.98	8.00	150.00	200.16	1.28	0.91	0.71	Open
P5-30	J5-29	J5-28	739.47	8.00	150.00	4.65	0.03	0.00	0.00	Open
P5-32	J5-28A	J1-4	411.36	8.00	150.00	3.73	0.02	0.00	0.00	Open
P5-33	184	J5-11	744.39	8.00	150.00	30.88	0.20	0.02	0.02	Open
P5-34	J5-11	162	907.62	8.00	150.00	26.71	0.17	0.02	0.02	Open
P5-35	J5-45	J5-33	1,283.01	8.00	150.00	16.82	0.11	0.01	0.01	Open
P5-36	J5-33	182	819.68	8.00	150.00	13.37	0.09	0.00	0.00	Open
P5-37	J5-34	J5-35	659.14	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P5-38	J5-35	J5-36	346.34	8.00	150.00	1.75	0.01	0.00	0.00	Open
P5-39	J5-34	J5-38	1,359.64	8.00	150.00	10.66	0.07	0.00	0.00	Open
P5-4	J5-8	J5-12	460.07	8.00	150.00	193.80	1.24	0.31	0.67	Open
P5-40	J5-33	J5-31A	761.15	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P5-41	J5-45	J5-44	254.50	8.00	150.00	4.38	0.03	0.00	0.00	Open
P5-42	J5-44A	J5-43	815.29	8.00	150.00	0.00	0.00	0.00	0.00	Open
P5-43	J5-42	J5-43	291.48	8.00	150.00	2.98	0.02	0.00	0.00	Open
P5-44	J5-41	J5-42	448.16	8.00	150.00	0.00	0.00	0.00	0.00	Open
P5-45	J5-41	J5-40	1,694.52	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P5-46	J5-38A	J5-40	534.46	8.00	150.00	4.12	0.03	0.00	0.00	Open
P5-48	J5-47	J5-46	720.62	8.00	150.00	(0.78)	0.00	0.00	0.00	Open
P5-49	J5-48	J5-47	554.76	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P5-5	J5-12	184	133.90	8.00	150.00	32.16	0.21	0.00	0.02	Open
P5-50	J5-42	J5-48	558.13	8.00	150.00	(4.40)	0.03	0.00	0.00	Open
P5-51	J5-48	J5-48A	401.61	8.00	150.00	(5.66)	0.04	0.00	0.00	Open
P5-55	J5-38	J5-37	998.02	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P5-57	J5-38A	J5-39	672.30	8.00	150.00	2.23	0.01	0.00	0.00	Open
P5-6	J5-8	J5-9	612.35	8.00	150.00	3.40	0.02	0.00	0.00	Open
P5-7	J5-4	J5-10	615.22	8.00	150.00	1.75	0.01	0.00	0.00	Open
P5-9	J5-5	J5-6	699.84	8.00	150.00	143.46	0.92	0.27	0.38	Open
P6-10	J6-9	168	718.82	8.00	150.00	17.81	0.11	0.01	0.01	Open
P6-11	J6-10	J6-11	1,373.15	8.00	150.00	7.05	0.04	0.00	0.00	Open

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P6-12	J6-11	J6-12	1,037.05	8.00	150.00	2.54	0.02	0.00	0.00	Open
P6-13	J6-12	J6-13	748.25	8.00	150.00	1.95	0.01	0.00	0.00	Open
P6-14	J6-12	J6-14	746.56	8.00	150.00	(0.55)	0.00	0.00	0.00	Open
P6-15	J6-14	J6-15	1,550.10	8.00	150.00	(1.69)	0.01	0.00	0.00	Open
P6-16	J6-10	J6-15	918.77	8.00	150.00	8.89	0.06	0.00	0.00	Open
P6-17	J6-15	J6-16	232.58	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P6-18	J6-18	J6-16	1,422.05	8.00	150.00	2.48	0.02	0.00	0.00	Open
P6-2	J6-2	J6-4	402.12	8.00	150.00	76.14	0.49	0.05	0.12	Open
P6-21	J6-19	J6-17	775.51	8.00	150.00	8.43	0.05	0.00	0.00	Open
P6-22	J6-19	J6-20	812.25	8.00	150.00	3.04	0.02	0.00	0.00	Open
P6-23	J6-21	J6-19	792.22	8.00	150.00	11.97	0.08	0.00	0.00	Open
P6-24	J6-28	J6-21	408.96	8.00	150.00	37.91	0.24	0.01	0.03	Open
P6-25	J6-46	J6-22	287.34	8.00	150.00	(103.86)	0.66	0.06	0.21	Open
P6-26	J6-46	J6-23	207.95	8.00	150.00	103.86	0.66	0.04	0.21	Open
P6-27	J6-23	J6-24	424.46	8.00	150.00	103.52	0.66	0.09	0.21	Open
P6-28	J6-24	J6-27	347.00	8.00	150.00	71.94	0.46	0.04	0.11	Open
P6-29	J6-27	138	898.39	8.00	150.00	97.75	0.62	0.17	0.19	Open
P6-30	J6-24	J6-25	688.51	8.00	150.00	30.19	0.19	0.01	0.02	Open
P6-31	J6-25	J6-26	355.07	8.00	150.00	28.35	0.18	0.01	0.02	Open
P6-32	J6-26	J6-27	827.60	8.00	150.00	28.18	0.18	0.02	0.02	Open
P6-34	J6-28	J6-30	1,169.08	8.00	150.00	23.27	0.15	0.02	0.01	Open
P6-35	J6-30	J6-31	386.99	8.00	150.00	15.05	0.10	0.00	0.01	Open
P6-37	J6-31	J6-33	2,397.72	8.00	150.00	12.83	0.08	0.01	0.00	Open
P6-38	J6-28	J6-38	424.61	8.00	150.00	34.20	0.22	0.01	0.03	Open
P6-39	J6-38	J6-37	1,626.96	8.00	150.00	15.69	0.10	0.01	0.01	Open
P6-4	J6-4	J6-5	218.19	8.00	150.00	72.24	0.46	0.02	0.11	Open
P6-40	J6-37	J6-36	1,089.86	8.00	150.00	14.19	0.09	0.01	0.01	Open
P6-41	J6-35	J6-36	1,100.75	8.00	150.00	(4.49)	0.03	0.00	0.00	Open
P6-42	J6-33	J6-35	329.46	8.00	150.00	0.88	0.01	0.00	0.00	Open
P6-43	J6-31	J6-37	443.53	8.00	150.00	19.12	0.12	0.00	0.01	Open
P6-44	J6-31	J6-21	2,031.46	8.00	150.00	(8.75)	0.06	0.00	0.00	Open
P6-45	J6-31	J6-21	2,089.33	8.00	150.00	(8.62)	0.06	0.00	0.00	Open
P6-46	J6-38	J6-39	411.41	8.00	150.00	17.28	0.11	0.00	0.01	Open
P6-47	J6-39	J6-40	1,460.82	8.00	150.00	15.08	0.10	0.01	0.01	Open
P6-48	J6-40	J6-41	497.67	8.00	150.00	19.38	0.12	0.00	0.01	Open
P6-49	J6-41	J6-42	646.36	8.00	150.00	6.95	0.04	0.00	0.00	Open
P6-50	J6-35	J6-42	1,420.08	8.00	150.00	3.50	0.02	0.00	0.00	Open
P6-51	J6-37	J6-40	366.47	8.00	150.00	12.01	0.08	0.00	0.00	Open
P6-52	J6-42	J6-43	902.66	8.00	150.00	3.69	0.02	0.00	0.00	Open
P6-53	J6-41	J6-44	1,962.36	8.00	150.00	10.36	0.07	0.01	0.00	Open
P6-6	J6-5	J6-7	355.02	8.00	150.00	68.84	0.44	0.03	0.10	Open
P6-7	J6-2	J6-3	289.09	8.00	150.00	1.09	0.01	0.00	0.00	Open
P6-8	J6-5	J6-6	563.62	8.00	150.00	3.09	0.02	0.00	0.00	Open
P6-9	J6-7	J6-8	844.29	8.00	150.00	2.20	0.01	0.00	0.00	Open
P7-1	TANK_1	102	97.96	8.00	150.00	616.21	3.93	0.56	5.72	Open
P7-10	J7-5	J7-10	939.56	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P7-11	J7-11	J7-12	761.22	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P7-12	J7-12	J7-18	154.76	8.00	150.00	7.44	0.05	0.00	0.00	Open
P7-13	166	J7-17	1,356.69	8.00	150.00	4.90	0.03	0.00	0.00	Open
P7-14	J7-17	J7-16	337.45	8.00	150.00	1.87	0.01	0.00	0.00	Open
P7-15	J7-12	J7-13	489.01	8.00	150.00	(10.67)	0.07	0.00	0.00	Open
P7-16	J7-14	J7-13	632.06	8.00	150.00	13.84	0.09	0.00	0.00	Open
P7-17	J7-15	J7-14	608.71	8.00	150.00	16.04	0.10	0.00	0.01	Open
P7-18	J7-19	J7-18	1,171.49	8.00	150.00	0.00	0.00	0.00	0.00	Open
P7-19	J7-19	J7-20	1,531.98	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P7-20	J7-20	J7-21	746.47	8.00	150.00	(13.59)	0.09	0.00	0.00	Open
P7-21	J7-21	J8-14	320.73	8.00	150.00	(16.94)	0.11	0.00	0.01	Open
P7-22	J7-13A	J4-1	1,008.59	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P7-23	J7-23	J8-40	277.81	8.00	150.00	8.44	0.05	0.00	0.00	Open
P7-24	154	152	407.35	8.00	150.00	8.92	0.06	0.00	0.00	Open
P7-24A	J7-22	J7-23	798.17	8.00	150.00	8.61	0.05	0.00	0.00	Open
P7-25	J7-6	J8-3	411.28	8.00	150.00	283.66	1.81	0.56	1.36	Open
P7-26	J7-10	J8-9	468.23	8.00	150.00	(28.34)	0.18	0.01	0.02	Open
P7-2B	J7-2	J5-50	1,034.58	8.00	150.00	244.40	1.56	1.07	1.03	Open
P7-2C	J5-50	J5-1	554.78	8.00	150.00	244.40	1.56	0.57	1.03	Open
P7-3	J7-2	J7-5	124.73	8.00	150.00	371.20	2.37	0.28	2.24	Open
P7-4	J7-3	J7-4	649.68	8.00	150.00	(79.51)	0.51	0.08	0.13	Open
P7-5	J7-5	J7-4	636.43	8.00	150.00	84.48	0.54	0.09	0.14	Open
P7-6	J7-5	J7-6	839.13	8.00	150.00	286.73	1.83	1.16	1.38	Open
P7-7	J7-7	J7-8	937.40	8.00	150.00	(12.74)	0.08	0.00	0.00	Open
P7-8	J7-8	J7-9	1,098.69	8.00	150.00	(18.03)	0.12	0.01	0.01	Open
P7-9	J7-9	J7-10	775.63	8.00	150.00	(24.27)	0.15	0.01	0.01	Open
P8-1	J8-1	J8-2	1,555.06	8.00	150.00	96.95	0.62	0.29	0.19	Open
P8-10	J8-1	J8-4	459.48	8.00	150.00	(90.22)	0.58	0.07	0.16	Open
P8-11	J8-9	J8-10	434.18	8.00	150.00	(30.65)	0.20	0.01	0.02	Open
P8-12	170	J8-10	652.42	8.00	150.00	31.74	0.20	0.02	0.02	Open
P8-13	J8-11	J8-12	837.66	8.00	150.00	62.90	0.40	0.07	0.08	Open
P8-14	J8-12	J8-13	481.57	8.00	150.00	98.44	0.63	0.09	0.19	Open
P8-15	J8-8	J8-13	611.97	8.00	150.00	(58.10)	0.37	0.04	0.07	Open
P8-16	J8-7	J8-12	544.78	8.00	150.00	41.56	0.27	0.02	0.04	Open
P8-17	J8-5	J8-41	380.50	8.00	150.00	98.40	0.63	0.07	0.19	Open
P8-18	J8-41	J8-11	506.53	8.00	150.00	97.15	0.62	0.09	0.19	Open
P8-2	J8-2	J5-3	413.81	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P8-20	J8-14	J8-15	1,265.78	8.00	150.00	(18.52)	0.12	0.01	0.01	Open
P8-21	J8-16	174	546.45	8.00	150.00	23.26	0.15	0.01	0.01	Open
P8-22	J8-13A	J8-13	563.83	8.00	150.00	(27.41)	0.17	0.01	0.02	Open
P8-23	J8-16	J8-17	415.03	8.00	150.00	0.97	0.01	0.00	0.00	Open

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P8-24	120	J8-18	358.39	8.00	150.00	0.00	0.00	0.00	0.00	Open
P8-25	J8-18	J8-19	793.76	8.00	150.00	(1.17)	0.01	0.00	0.00	Open
P8-26	J8-19	J8-20	350.97	8.00	150.00	(2.67)	0.02	0.00	0.00	Open
P8-27	J8-20	J8-21	411.21	8.00	150.00	1.59	0.01	0.00	0.00	Open
P8-28	J8-21	J8-22	649.80	8.00	150.00	0.00	0.00	0.00	0.00	Closed
P8-29	J8-20	J8-23	545.29	8.00	150.00	(4.76)	0.03	0.00	0.00	Open
P8-3	J5-3	J5-4	424.72	8.00	150.00	(3.85)	0.02	0.00	0.00	Open
P8-30	J8-23	J8-30	237.43	8.00	150.00	0.17	0.00	0.00	0.00	Open
P8-31	J8-23	J8-24	518.91	8.00	150.00	(6.26)	0.04	0.00	0.00	Open
P8-32	J8-24	J8-25	408.18	8.00	150.00	21.12	0.13	0.00	0.01	Open
P8-34	J8-28	J8-29	654.45	8.00	150.00	1.28	0.01	0.00	0.00	Open
P8-35	J8-40	148	1,719.22	8.00	150.00	8.44	0.05	0.00	0.00	Open
P8-36	J8-39	J8-38	1,022.76	8.00	150.00	7.64	0.05	0.00	0.00	Open
P8-37	J8-38	J8-37	762.74	8.00	150.00	6.07	0.04	0.00	0.00	Open
P8-38	J8-37	J8-36	285.99	8.00	150.00	4.54	0.03	0.00	0.00	Open
P8-39	J8-36	146	725.83	8.00	150.00	3.93	0.03	0.00	0.00	Open
P8-4	J8-3	J8-4	103.23	8.00	150.00	281.63	1.80	0.14	1.34	Open
P8-40	J8-35	J9-10	734.01	8.00	150.00	1.73	0.01	0.00	0.00	Open
P8-41	J8-25	J8-26	764.71	8.00	150.00	13.40	0.09	0.00	0.00	Open
P8-42	J8-26	J8-27	388.01	8.00	150.00	11.09	0.07	0.00	0.00	Open
P8-43	122	J8-31	272.11	8.00	150.00	2.17	0.01	0.00	0.00	Open
P8-44	J8-31	140	265.97	8.00	150.00	2.17	0.01	0.00	0.00	Open
P8-45	J8-32	J8-33	119.83	8.00	150.00	1.67	0.01	0.00	0.00	Open
P8-46	J8-2	J8-7	606.20	8.00	150.00	91.06	0.58	0.10	0.17	Open
P8-47	J5-6	J8-24	737.10	8.00	150.00	31.97	0.20	0.02	0.02	Open
P8-5	J8-4	J8-5	379.88	8.00	150.00	191.10	1.22	0.25	0.65	Open
P8-6	J8-5	J8-6	559.83	8.00	150.00	91.61	0.58	0.09	0.17	Open
P8-7	J8-6	J8-7	771.60	8.00	150.00	88.96	0.57	0.12	0.16	Open
P8-8	J8-7	J8-8	457.78	8.00	150.00	135.07	0.86	0.16	0.34	Open
P8-9	J8-8	136	737.31	8.00	150.00	191.61	1.22	0.48	0.66	Open
P9-1	J6-45	J8-27	353.77	8.00	150.00	(4.43)	0.03	0.00	0.00	Open
P9-2	J8-27	J9-3	1,204.99	8.00	150.00	5.10	0.03	0.00	0.00	Open
P9-3	J9-3	J9-4	181.63	8.00	150.00	1.23	0.01	0.00	0.00	Open
P9-4	J8-28	J9-6	511.07	8.00	150.00	3.56	0.02	0.00	0.00	Open
P9-5	J9-8	J9-9	574.19	8.00	150.00	1.34	0.01	0.00	0.00	Open
P9-6	J8-33	J9-8	550.73	8.00	150.00	1.67	0.01	0.00	0.00	Open
P9-7	J9-10	J9-11	662.92	8.00	150.00	1.09	0.01	0.00	0.00	Open
ZBV4-1	J4-17A	J4-17	155.04	8.00	150.00	(8.14)	0.05	0.00	0.00	Open
ZBV5-1	104	J5-46	194.35	8.00	150.00	2.81	0.02	0.00	0.00	Open
ZBV5-2	184	J5-31A	260.39	8.00	150.00	1.28	0.01	0.00	0.00	Open

APPENDIX C
HYDROGEOLOGIC STUDY



June 23, 2008

Keith Rutherford, P.E., Corporate Associate
Parkhill, Smith & Cooper, Inc.
810 E. Yandell
El Paso, Texas 79902

Re: Geologic Evaluation, Alto Lakes Golf and Country Club
Ruidoso, New Mexico

Dear Mr. Rutherford:

At the request of Parkhill, Smith & Cooper, Inc. (PSC), Daniel B. Stephens & Associates, Inc. (DBS&A) has evaluated the geology in the vicinity of the Alto Lakes Golf and Country Club (Alto Lakes) near Ruidoso, New Mexico. The purpose of the evaluation was to develop recommendations regarding the potential to deepen existing supply wells or drill new wells on the eastern part of Alto Lakes. DBS&A collected lithologic logs for supply wells in the vicinity of Alto Lakes, interpreted the geology, and updated a geologic cross section originally prepared by John Shomaker and Associates, Inc. The investigation methods and results are described in the attached draft report.

We appreciate the opportunity to assist PSC with this project. Please contact me at (505) 822-9400 with any questions.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

Christopher Wolf
Senior Geochemist
Water Resources Division

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Geologic Evaluation Alto Lakes Golf and Country Club Ruidoso, New Mexico

At the request of Parkhill, Smith & Cooper, Inc. (PSC), Daniel B. Stephens & Associates, Inc. (DBS&A) has evaluated the geology in the vicinity of the Alto Lakes Golf and Country Club (Alto Lakes) located in the Sacramento Mountains near Ruidoso, New Mexico. The purpose of the evaluation was to develop recommendations regarding the potential to deepen existing supply wells or drill new wells on the eastern part of Alto Lakes. DBS&A collected lithologic logs for supply wells in the vicinity of Alto Lakes, interpreted the geology, and updated a geologic cross section originally prepared by John Shomaker and Associates, Inc. (JSAI) (LA and JSAI, 2004).

1. Site Geology

The geology of the area around Alto Lakes is characterized by a sequence of sedimentary rocks that have been faulted and folded, with many of the fault blocks rotated so that the beds are dipping. Igneous rocks, including Sierra Blanca volcanics and associated intrusive formations, are commonly encountered in the area. Sedimentary rocks that are in contact with these intrusive formations are commonly metamorphosed (altered by high heat and/or pressure).

Typically, supply wells in the Alto Lakes area obtain water from the following geologic formations:

- Cretaceous Mesaverde Formation, Mancos shale and/or Dakota sandstone, and any igneous intrusions that may yield water at a given location (collectively referred to as the Cretaceous aquifer).
- Permian San Andres Formation, Hondo sandstone and/or Yeso Formation (collectively referred to as the Permian aquifer).



Alto Lakes is located on the edge of the Sierra Blanca intrusion. The study area has undergone extensive faulting, resulting in a complex structural setting not easily simplified for a geologic cross section. As shown in the geologic map of Kelley (1971) (Figure 1) and JSAI's cross section (Figure 2 [Figure 3.4 in LA and JSAI, 2004]), the subject area has several faults that strike through the eastern side of Alto Lakes. These faults have dramatically affected geology and hydrology in the eastern portion of Alto Lakes (NE quadrant of NE quadrant of Section 32 of T10S R14S).

Geologic logs were available for six wells located on the eastern side of the Ruidoso fault zone (Table 1). Two of the wells (H-3946 and H-3933) have similar water production zones, penetrating sequences of limestone and shale. Well H-3946, located near the fault, penetrates igneous intrusives and metamorphosed rock. Expected production rates for wells completed similarly to these two wells are moderate, ranging from approximately 10 to 50 or more gallons per minute (gpm).

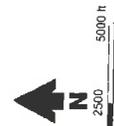
A well (H-0694S) completed for the nearby Lincoln Hills Subdivision penetrates the San Andres Limestone and Hondo Sandstone and lies east of the Ruidoso fault zone. This well has a total depth of 1,550 feet and static water level of 1,029 feet below ground surface (bgs) (DBS&A, 2005). The production rate of this well was tested at 270 gpm, but it was predicted that the well could produce more than 300 gpm (DBS&A, 2005).

With total dissolved solids (TDS) concentrations near 1,000 milligrams per liter (mg/L), water quality in the San Andres Formation may be marginal (Mourant, 1963). In 2003 the New Mexico Office of the State Engineer (OSE) prepared a memorandum concerning the water rights associated with well H-1122 in the Rainmakers Subdivision (Rappuhn, 2003). This memorandum included water quality information for two wells completed in the San Andres Formation that indicated TDS concentrations of 1,400 mg/L and sulfate concentrations of 540 mg/L.

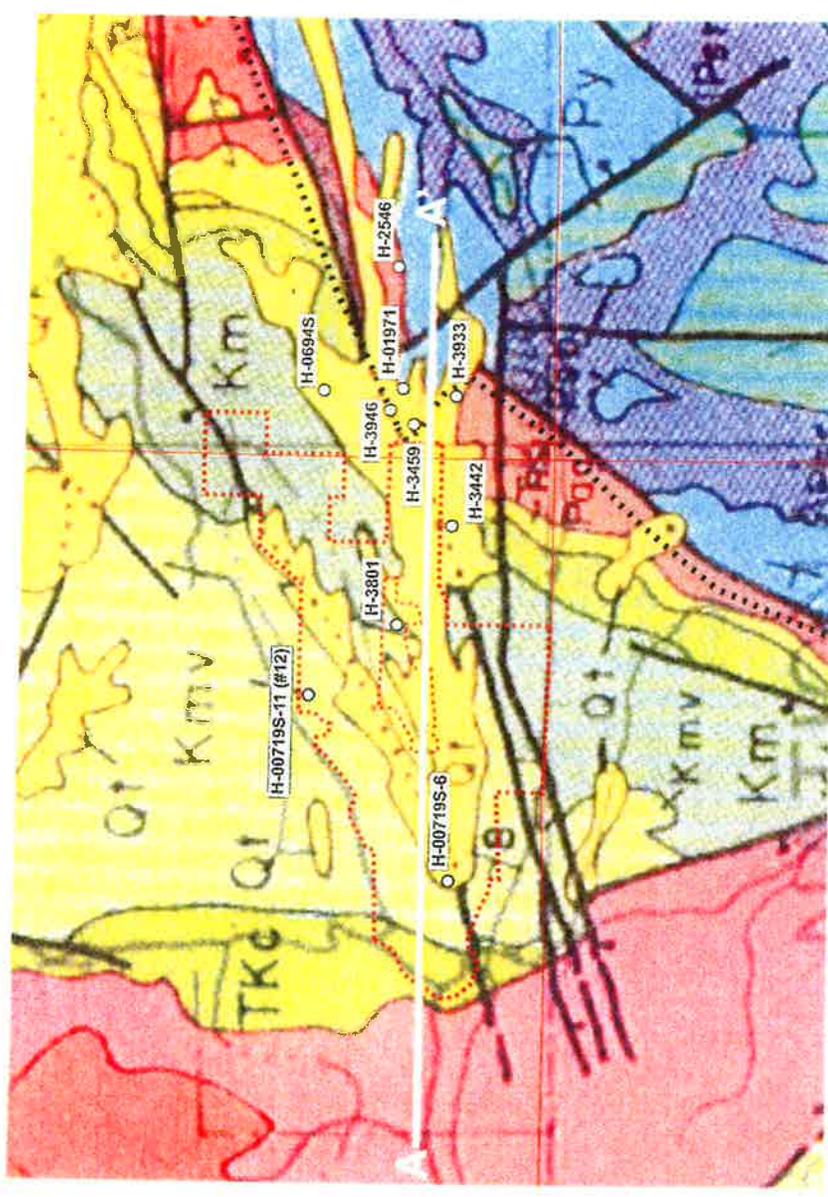
Qa Q	o = alluvium; t = terrace gravels
Tsb	Sierra Blanco Volcanics
Ttk, Ttr, Ttm, Ttg	Intrusions
Tkc	Cub Mountain Fm.
Kmv	Mesa Verde Group
Km, Kd	Mancoos Shale and Dakota Sandstone
Tkc	Chinle Shale
Tks	Triassic Undifferentiated
Paq, Pab, Paa	Santa Rosa Sandstone
Pa	Artesia Group
Pa, Pab, Paa	Son Andres Fm.
Py	Yeso Fm.

Tertiary/
Cretaceous
Aquifer
System

Permian
Aquifer
System



- Explanation**
- Monitor well
 - Alto Lakes property boundary
 - Main fault

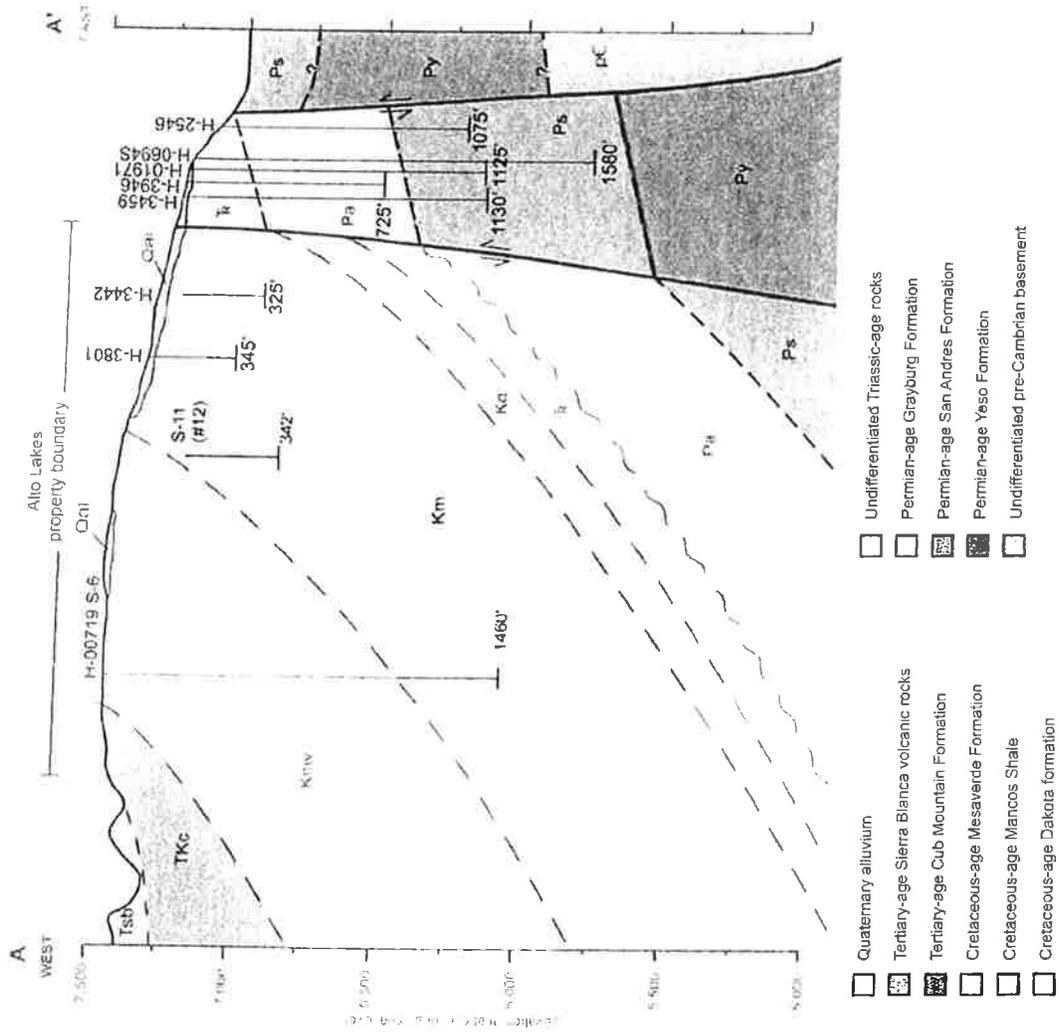


Source: Geology from Kelley, 1971; Figure modified from LA & JSAI, 2004; Figure 3 3

Figure 1

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ALTO LAKES WELL STUDY
Geologic Cross Section and Well Locations



Source: Modified from LA & JSAL, 2004, Figure 3.4

Note: West-to-east geologic cross sections through Alto Lakes property.



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ALTO LAKES WELL STUDY
Geologic Cross Section

Figure 2



**Table 1. Summary of Geology and Production Rates for Selected Wells
Alto Lakes, New Mexico**

Well Number	Geologic Unit ^a	Lithology	Depth (ft bgs)	Water Production ^b (gpm)
<i>East of Ruidoso Fault Zone</i>				
H-3946	San Andres	Sandstone	431-476	1
		Sandstone	613-624	2
		Sand/gravel	701-724	10-20
	Intrusive	Igneous	232-288 563-613	0
H-3933	Grayburg Formation	Limestone	612-613	5
	San Andres	Gravel	798-813	20
		Gravel	822-831	50+
H-1971	San Andres	Limestone	1,035-1,125	8
H-3459	San Andres	Sandstone	1,000-1,110 1,123-1,150	10
H-0694S	San Andres	Sandstone	1,377-1,435 1,530-1,547	50-270+
H-2546	San Andres	Limestone	985-1,075	25
<i>West of Ruidoso Fault Zone</i>				
H-3442	Mancos Shale	Shale/sandstone	280-320	10
H-3801	Igneous	Granite?	250-265	15
		Basalt	295-310	10

^a Mancos shale and igneous intrusions are included in the Cretaceous aquifer
San Andres and Grayburg Formations are included in the Permian aquifer

^b Based on estimates listed on drillers' logs

ft bgs = Feet below ground surface
gpm = Gallons per minute



2. Supply Well Recommendation

Based on the geology, hydrology, and available land in the area, a new well should be located on the eastern side of Alto Lakes to target the San Andres Formation east of the Ruidoso fault zone in the Permian aquifer. The preferred location is at the RV park on Rainbo Court, where Alto Lakes has obtained access for drilling. The proposed well would be completed similarly to well H-694S with a target depth of approximately 1,500 feet bgs. The expected yield is 250 to 300 gpm with a static water level of 1,050 feet bgs.

An alternate location for a new supply well is in the very eastern portion of the Alto Lakes property near wells H-3946 and H-3459. The recommended target depth at this location is 1,150 feet bgs but may vary depending on the lithology encountered.

Potential low well yield from aquifers east of the Ruidoso fault zone may be improved by acidifying and hydrofracturing the target production zones, especially rocks composed of or cemented by carbonate minerals. This technique increases permeability near the well by using acid and pressure to connect existing higher-porosity areas in the formation.

Regardless of the location, an exploratory permit from the NM OSE will be required before drilling begins.

3. Deepening of Wells

One alternative to obtain additional water supply at Alto Lakes is to deepen one or more of the shallow existing wells west of the Ruidoso fault zone, such as E-2, which are completed in Cretaceous bedrock. Whereas the younger rocks on the east side of the fault have been eroded and the San Andres Formation is near ground surface, penetrating the aquifer in the Permian units to the west of the fault requires deeper wells.

Deepening existing Cretaceous wells is feasible, but may be difficult to implement due to the complex nature of water rights, which are informally divided by aquifer. In addition, deepening a



well will require costly drilling of an additional 1,200 feet to the bottom of the San Andres Formation. A new well east of the fault is thus preferred over deepening existing wells.

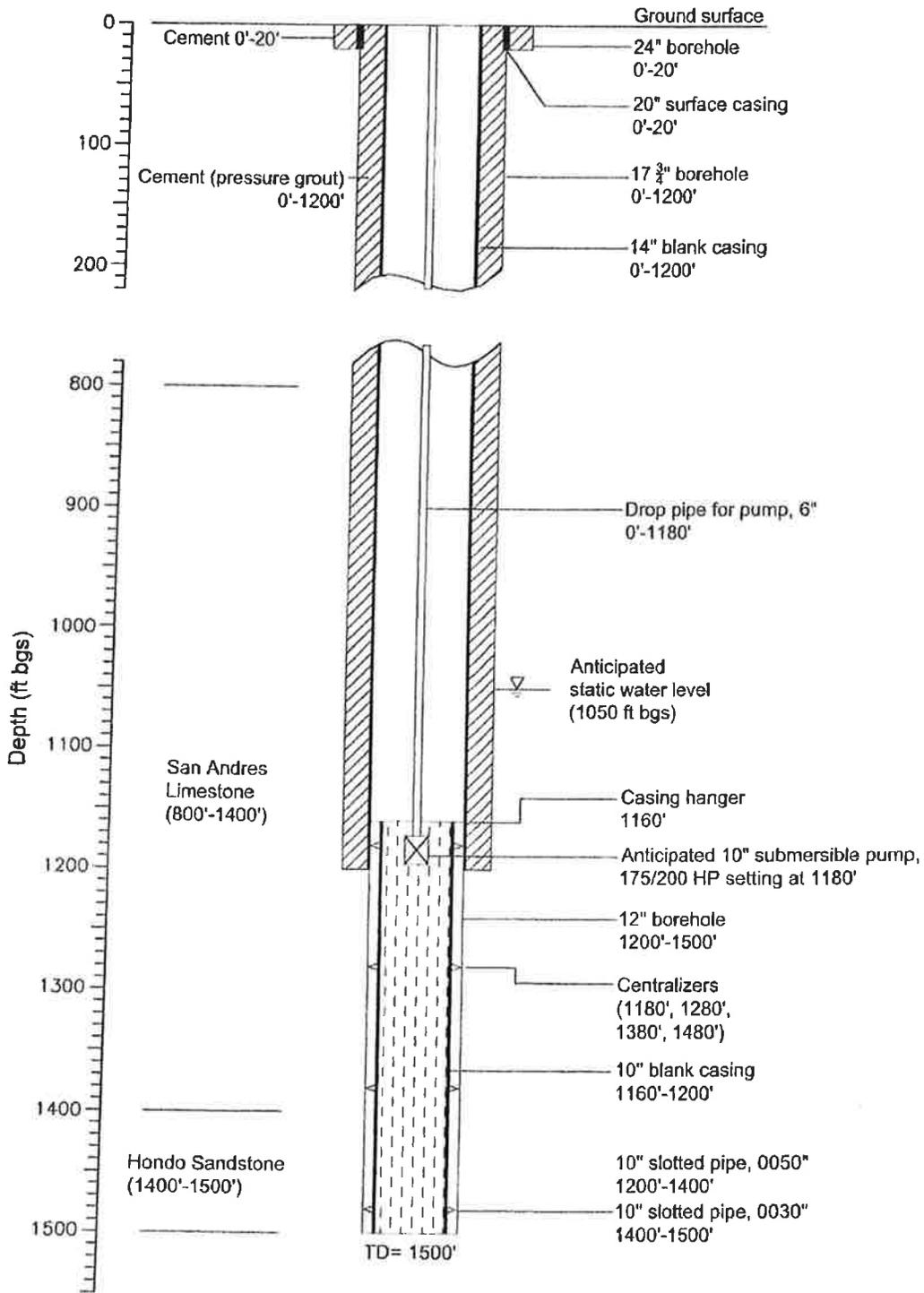
4. Preliminary Design at Preferred Location

Figure 3 shows the preliminary design for a new supply well completed at the end of Rainbo Court. The recommended supply well total depth of 1,500 feet will target the San Andres Limestone and Hondo Sandstone units of the Permian aquifer, which is an attainable target production zone for this well. The geologic contacts for the San Andres Limestone and Hondo Sandstone are expected to be encountered at the following depths:

- Grayburg (Artesia) Formation-San Andres: 800 feet bgs
- San Andres-Hondo Sandstone: 1400 feet bgs
- Hondo Sandstone-Yeso Formation: 1500 feet bgs

The static water level is estimated to be encountered at 1,050 feet bgs within the San Andres Limestone and is expected to remain at that level. Accordingly, the Non-Artesian Well Requirements (NMAC 19.27.4.30) will be followed for design. A combination of mud and air rotary drilling methods is recommended for this well:

- Initially, mud rotary will be used to run an 8-inch pilot hole to 1,500 feet bgs followed by geophysical logging.
- The boring will then be reamed to a 16-inch diameter to approximately 1,200 feet bgs, into the upper portion of the San Andres Formation.
- To seal off all units above the San Andres Limestone, 14-inch blank casing will be pressure grouted into place.
- Below the bottom of the blank casing the pilot hole will be reamed to 12 inches in diameter using air rotary drilling methods.



Note: Final design will be based on lithology and conditions encountered during drilling.

Not to Scale



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**ALTO LAKES WELL STUDY
Preliminary Well Design**

Figure 3

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- Air-lifting will follow to remove as much loose sand as possible from the Hondo Sandstone near the bottom of the borehole. This step is critical for minimizing sand production in the future.
- A screen section will be hung in the open hole off a casing hanger within the blank casing. Due to the competent nature of the bedrock, a gravel pack will not be required.

Once the screen is installed, additional development by air-lifting is planned. A test pump will be installed temporarily for additional development and pump tests (step-test and constant rate). The well will be disinfected while the test pump is still installed. Water quality samples will be collected during the constant rate test.

A cost estimate for well installation is provided in Table 2.

5. Water Rights

Water rights in New Mexico are administered by the New Mexico OSE. Alto Lakes is located in the OSE-declared Hondo Underground Water Basin, and permitted water rights are thus required for all withdrawals from the basin. Currently the OSE considers water from the Cretaceous and Permian aquifers to be two separate sources, a position that has to be considered during the process of applying for a new point of diversion at any new wells. For a new well, an exploratory well permit will be required before drilling begins, and water rights must be transferred to the new point of diversion before water from the well may be put to beneficial use.



**Table 2. Preliminary Cost Estimate
Water Supply Well, Alto Lakes**

Item No	Description	Unit ^a	Quantity	Cost (\$)	
				Unit	Total
1	Mobilization/demobilization	ls	1	45,000	45,000
2	Drill 24-in. borehole for surface casing	lf	20	200	4,000
3	20-in surface casing, cement in place	lf	20	300	6,000
4	Drill 8-in. pilot hole	lf	1,500	55	82,500
5	Geophysics in pilot hole	ls	1	12,000	12,000
6	Ream pilot hole to 16-in.	lf	1,200	80	96,000
7	Install 14-in. blank well casing, in place	lf	1,200	100	120,000
8	Cement seal by pressure grout, in place	lf	1,200	50	60,000
9	Drill 12-in. borehole	lf	300	85	25,500
10	Air-lift sand from bottom of 12-in. hole	hr	16	550	8,800
11	Install 10-in. well screen with casing hanger, in place	lf	300	245	73,500
12	Well development by zone air lifting	hr	60	550	33,000
13	Well development by pumping	hr	8	375	3,000
14	Supply, install, and remove test pump and appurtenances	ls	1	25,000	25,000
15	Test pumping Step test	hr	14	375	5,250
16	Sustained yield test	hr	24	375	9,000
17	Disinfection	ls	1	2,000	2,000
18	Water quality analysis	ls	1	3,500	3,500
19	Video survey	ls	1	2,500	2,500
				<i>Subtotal</i>	<i>616,550</i>
20	Geologic oversight, analysis and reporting	ls	1	30,000	30,000
				<i>Total</i>	<i>646,550</i>

^a ls = Lump sum
lf = Linear feet
in = Inches
hr = Hours



Daniel B. Stephens & Associates, Inc.

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