

Date: December 29, 2023
(Updated May 24, 2024)

TECHNICAL MEMORANDUM

To: Mark Chow, Principal Civil Engineer, San Mateo County Department of Public Works

From: Gus Yates PG, CHG, Senior Hydrologist
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Re: **Pescadero (CSA-11) Water Supply Yield and Sustainability Study
Task 9, Screening Analysis of Future Water Supply Options**

TABLE OF CONTENTS

1. Introduction
 - 1.1 Scope of Work
 - 1.2 Water Supply Performance Objectives
 - 1.3 Overview of Water Supply Alternatives
 - 1.4 Distribution Connections for Supply Alternatives
2. Alternative Descriptions, Estimated Costs and Feasibility
 - 2.1 Global Cost Assumptions
 - 2.2 Water Supply Alternatives
3. Screening of Alternatives
 - 3.1 Methodology and Assumptions
 - 3.2 Alternative Preliminary Rankings
4. References

Attachments

Figure 1 – Locations of Water Supply Alternatives
Figure 2 – Lake Lucerne Mutual Water Company Annual Water Use
Figure 3 – Simulated Pescadero Creek Diversions

1. INTRODUCTION

In March 2021, Todd Groundwater (Todd) completed the first eight tasks of a Water Supply Yield and Sustainability Study for the San Mateo County Service Area 11 - Pescadero (CSA-11). The study investigated current and future water supply issues for the County-owned

and operated public water supply system (CSA-11) that serves the community of Pescadero on the San Mateo County coast. The CSA-11 water system source is currently comprised of three bedrock groundwater supply wells located on Butano Ridge west of the main Pescadero service area (**Figure 1**). Wells Nos. 1 and 2 were installed in the 1990's and are 260 and 247 feet deep, respectively, while Well No. 3 was installed in 2018 and is 360 feet deep.

The first eight tasks of the project addressed the performance of the current groundwater supply and the potential impacts on sustainability of connecting the County fire station and Pescadero Middle/High School to the system. The report documenting those tasks showed that long-term water-level declines are likely in the system supply wells with or without connecting the fire station and school and that future growth would certainly require additional supplies (Todd Groundwater, 2021).

Task 9 consists of a reconnaissance level feasibility analysis of a range of possible future water supply options. The most recent comprehensive study of water supply alternatives for Pescadero was in 1987 (Kennedy/Jenks/Chilton Engineers, 1987; Thomas Reid Associates, 1987). The recommended alternative that emerged from that analysis was the "Wahrheit Well" alternative and associated storage tanks and water treatment facilities. That alternative was implemented and is now the CSA-11 water system, currently with two active and one stand-by supply wells on Butano Ridge, two nearby storage tanks and a small disinfection/corrosion control building. Also, CSA-11 was formed pursuant to a recommendation in that study to enable the County to obtain State funding for the project through the Safe Drinking Water Bond Act of 1984.

Some of the water supply alternatives evaluated in this analysis are similar to the ones considered but not selected in the 1987 study. Circumstances that have changed since 1987 include the following:

- Yield quantity objectives are much lower, partly due to water conservation measures that have been implemented since 1987 and partly because new alternatives will need only to supplement the existing supply, not meet the entire existing demand. The present yield objective to meet existing demand (described below) is only 6 percent of the then-current demand assumed in the 1987 study. The yield now estimated to supply future growth in the present analysis is only 30 percent of the future growth water demand assumed in 1987.
- Seasonal and annual supply reliability requirements are now more relaxed because the new alternative will supplement the existing CSA-11 wells. The primary function of the new alternative is to decrease average annual production from the existing wells to their sustainable yields. Thus, the new supply can operate only seasonally, or operate at a steady level year-round with the wells supplying daily and seasonal peak demands.
- Connection of Pescadero Middle/High School to the CSA-11 distribution system—including a pipeline extending out to the school—is already planned.

- For small treatment systems, membrane technology is now more cost-effective than the traditional combination of flocculation, coagulation, sedimentation and filtration.

Scope of Work

The scope of this evaluation included the following:

- Definition of water quantity and quality objectives
- Identification of six water supply alternatives
- Feasibility evaluation and identification of uncertainties for each alternative
- Development of conceptual capital and operating cost estimates for each alternative
- Screening and preliminary ranking of alternatives

1.2 Water Supply Performance Objectives

Water supply alternatives were only considered if they would be capable of meeting water quantity and quality objectives. Yield was evaluated in terms of both maximum day demand (in gallons per day [gpd]) and as a reliable annual volume (in acre-feet per year [AFY]). Two yield thresholds were considered:

- **Low yield objective: correct existing overdraft.** Recent (2015-2019) CSA-11 water use averaged 19,442 gallons per day (gpd – Todd Groundwater, 2021). Water levels in the CSA-11 supply wells (Well Nos. 1, 2, and 3) have been chronically declining at a rate of about 0.50 feet per year since 2012 and at a slightly higher rate before that. The report for Tasks 1-8 of this Water Supply Yield and Sustainability Study tentatively estimated that the storage depletion associated with the water-level decline has been approximately 2,570 gpd, or about 13 percent of pumping from the two wells (Todd Groundwater, 2021). It is assumed here that water demands for the Middle/High School (832 gpd) and fire station relocation (8 gpd) will also need to be met. Thus, the total additional water supply needed to meet current demands is 3,410 gpd on an average basis, 6,820 gpd on the maximum demand day¹ and 3.8 AFY on an annual basis.
- **High yield objective: supply future growth.** The Local Coastal Plan anticipates growth in Pescadero that would add 28,262 gpd of new water demand at buildout. Because this is in addition to correcting existing overdraft, the total yield required for this threshold is 31,672 gpd on an average basis, 63,344 gpd on the maximum demand day, and 35.5 AFY on an annual basis.

¹ The analysis for the Tasks 1-8 report conservatively assumed a maximum day demand two times greater than the average day demand (Todd Groundwater, 2021).

The water quality objective is that water delivered from the new source meet State of California standards for public water supplies (Title 22, Chapter 15 of the California Code of Regulations).

Other objectives are qualitative or relative; for example, that the supply have high certainty of partner and regulatory approval, low environmental impacts, low capital costs, and low operating costs.

1.3 Overview of Water Supply Alternatives

An initial list of water supply alternatives was developed by reviewing previous Pescadero-area water supply studies and new consideration of possible water supply opportunities in the context of local surface water and groundwater conditions, along with current regulations and technologies. **Figure 1** shows locations mentioned in the descriptions of alternatives. Some alternatives are already associated with specific locations, whereas other have only generalized, conceptual locations. Previous studies are summarized below.

Previous Pescadero Water Supply Studies

A local groundwater study by the United States Geological Survey (USGS) in 1981 suggested that a well near the confluence of Honsinger Creek and Pescadero Creek and completed in the relatively deep alluvium at that location (that is, screened roughly 60-125 feet below the ground surface) might supply water low in nitrate at a capacity of up to 100 gallons per minute (Akers, 1981).

San Mateo County reportedly drilled four test wells in the Pescadero area between 1981 and 1987. A project completion report summarizing that activity has not been found. The County test wells were mentioned in a water supply alternatives study by Kennedy/Jenks/Chilton Engineers (1987). The study considered five alternatives and selected three for detailed analysis. The recommended alternative was the “Wahrheit Well” alternative, which was eventually selected and developed into the current CSA-11 well field. The second was treatment of local alluvial groundwater to meet drinking water standards. The third was diversion and treatment of flow from Honsinger Creek in winter combined with treatment of brackish groundwater in summer.

Thomas Reid Associates (1987) completed an environmental impact analysis of the three water supply options evaluated by Kennedy/Jenks/Chilton Engineers.

A 2016 evaluation of water quality issues at the existing Pescadero School well recommended adding a second in-line calcite filter for pH control to minimize leaching of copper and lead from plumbing in the building (Hydroscience, 2016). The report also described an anion-exchange nitrate removal system based on Culligan water softening equipment with a nitrate-selective resin. However, the report ultimately suggested that better groundwater quality might be found toward the west end of the school site. A test well was drilled in the western part of the site in 2019. The well yield was low and water quality samples from the well indicated elevated aluminum, arsenic, iron and manganese

(Smith, 2019). However, the poor yield and water quality may be related to test well construction and lack of adequate development, as discussed further below.

The list of alternatives generated for evaluation in this study includes variations of the historical alternatives, as well as new concepts. The alternatives are briefly described here and evaluated in greater detail in subsequent sections.

Alternative 1 - New well at Pescadero Middle/High School with Treatment

The concept for this alternative is to install a new well next to or near the existing well at Pescadero Middle/High School and use it to supply not only the school and new fire station but also the entire CSA-11 system. In other words, this alternative turns the school from a demand on the water system to a source of supply for the system. A pipeline between the school site and the CSA-11 distribution system is already planned for construction, and presumably could be used to convey water from a school well source to other portions of the distribution system.

Alternative 2 - Other New Alluvial Well with Treatment

This alternative is similar to the Middle/High School well alternative except that the well would be at some other location in the alluvium associated with Pescadero Creek. The most likely location in terms of cost and water quality would be northwest of the Middle-High School along the planned pipeline extending the CSA-11 distribution system to the school (**Figure 1**).

Alternative 3 - New Purisima Formation Well with or without Treatment

This alternative consists of a new well or wells drilled into the Purisima Formation near the town of Pescadero, north or south of Pescadero Creek. General locations where this formation is present and pipeline distances could be reasonable are shown in **Figure 1**.

Alternative 4 - New well in Brackish Coastal Groundwater Area with Desalination

The concept for this alternative is a brackish water desalination facility that treats groundwater extracted from alluvium where Pescadero Creek reaches the Pacific Ocean. The general location would be near the Highway 1 bridge (**Figure 1**), and an exact location would depend on local hydrogeologic conditions and the willingness of agencies that own land in the area (for example, Caltrans and the California Department of Parks and Recreation) to cooperate with the project. Water would be supplied by a shallow alluvial well, desalination equipment would be housed in a small nearby building, and the product water would be conveyed to the existing CSA-11 distribution system by a new pipeline along Highway 1 and Pescadero Creek Road.

Alternative 5 - Artificial recharge on Butano Ridge with Conveyed Lake Lucerne Mutual Water Company Water

Lake Lucerne Mutual Water Company (LLMWC) provides irrigation water to agricultural lands on Butano Ridge close to the existing CSA-11 supply wells (**Figure 1**). The concept for this alternative is to obtain surplus water in winter from LLMWC and percolate it into the ground a short distance upslope of the existing CSA-11 wells Nos. 1-3. The additional recharge would supplement the yield of the wells, eliminate the current overdraft and potentially support greater amounts of pumping.

Alternative 6 - Creek Diversion with Treatment

Pescadero Creek has flows that sometimes are surplus to the needs and water rights of existing users. Under this alternative, water would be diverted from surplus flow—probably by a subsurface infiltration gallery—to a temporary storage pond. A surface water treatment plant would bring the water up to potable quality, and a pipeline would convey it to the CSA-11 distribution system.

Recycled Water Alternative

One alternative that was initially considered but not carried forward due to probable high cost is collection and treatment of municipal wastewater and exchange for potable groundwater presently used for irrigation (by some nearby agricultural landowner or other entity). While conceptually possible, this alternative would involve three major capital projects: sewerage the community, constructing a wastewater treatment plant (likely requiring purchasing a land parcel), and constructing pipelines to and from a neighboring landowner. Consequently, this alternative would almost certainly cost more than the other alternatives.

1.4 Distribution Connections for Supply Alternatives

For all of the alternatives except recharge on Butano Ridge, the new source of water would connect to the CSA-11 distribution system at a different location than the current supply, which flows from two storage tanks on Butano Ridge to Pescadero via a pipeline along Bean Hollow Road and Pescadero Road. All of the new sources of supply would use the existing storage tanks to absorb hourly and daily fluctuations in water demand. The selected supply would pump into the distribution system at the existing distribution system pressure. When demand exceeds the flow of the new source, additional water would flow from the tanks as usual. To physically store water from the new source could require a booster pump near the bottom of Butano Ridge to lift the water up to the storage tanks without over-pressuring the distribution system. With the new source, flow in some distribution system pipes could be in different directions at different times, leading to additional variability in the residence time of water in the pipes, with implications for maintaining chlorine residual. These types of distribution system issues would need to be considered in the design process for the selected water supply.

Each of these alternatives is described in the next section at a level of detail sufficient to support a ranking approach for the screening analysis. The list of alternatives is not exhaustive but includes the options deemed most likely to meet yield and quality objectives with reasonable cost-effectiveness and reasonable certainty of successful permitting.

2. ALTERNATIVE DESCRIPTIONS, ESTIMATED COSTS AND FEASIBILITY

The water supply alternatives are described here at a concept level and evaluated with respect to several cost and feasibility issues. No landowners or agency staff that would be involved in developing and permitting the project have been contacted. Cost estimates are inferred from similar projects in other areas or classified as likely higher or lower than costs for other options. Background information regarding technical feasibility, potential environmental impacts, permitting processes and cost was compiled to a degree considered sufficient to support a relative ranking of the alternatives. Cost estimates were originally calculated for 2021 dollars and later updated to December 2023 dollars using the California Construction Cost Index. A discount rate of 5 percent was assumed for amortization and for borrowing costs.

2.1 Water Supply Alternatives

Six alternatives were evaluated. Four of the alternatives involve installation of new water supply wells (school site, alluvial aquifer, Purisima Formation aquifer and brackish groundwater), one comprises recharge of surface water on Butano Ridge, and one is diversion of surface water from Pescadero Creek. Except for the Butano Ridge recharge alternative all other alternatives require treatment of the produced water, and conveyance from the source to the CSA-11 water distribution system.

Alternative 1: New Well at Pescadero Middle/High School with Treatment

The concept for this alternative is to install a new alluvial well next to or near the existing well at Pescadero Middle/High School and use it to supply not only the school and new fire station but also the entire CSA-11 system. In other words, this alternative turns the school from a demand on the water system to a source of supply for the system. The existing well has reasonable yield and known water quality. However, the well facility is at least several decades old and its construction is undocumented. Therefore, it would be prudent to drill a new well that meets construction standards for municipal supply wells.

An evaluation of water quality issues at the existing school well was completed in 2016 (Hydroscience, 2016). That report suggested that better water quality might be obtained in the southwestern part of the school property. Acting upon that recommendation, the County had a test well drilled in that area in 2019. The well drilling report indicated that yield was low (1.2 gpm) and aluminum, arsenic, iron and manganese exceeded drinking water MCLs (Smith, 2019). Based on a review of that report, it is possible that the low yield and poor water quality resulted from well construction methods and inadequate well development. Specifically, a 5-inch screen was installed in a 12-inch borehole, which

resulted in a gravel pack thickness of 3.5 inches. Thick gravel packs require extensive well development to completely remove bentonite drilling mud from the filter material. Well development was not documented in the report, but it is possible that sufficient drilling mud remained after development to limit groundwater inflow to the well screen. This was evidenced by the pump test, which completely dewatered the casing and screen, indicating that water was entering the well at a rate less than the average reported pumping rate of 1.2 gpm. In contrast, the existing school well has a capacity of at least 11 gpm, which is limited by the pump capacity not the well capacity (Hydroscience, 2016).

Another indication of incomplete development is that water pumped for water quality testing had high residual turbidity (24 NTU). The high turbidity could also have resulted from well construction. The well screen extended a total of 25 feet above and below the only coarse-grained aquifer layer encountered, which was only 15 feet thick. Consequently, 62 percent of the screen was adjacent to clay layers that could also have been a source of turbidity in the well water. The high turbidity may explain why the concentrations of various ions were high. For example, electrical conductivity was 1,600 $\mu\text{S}/\text{cm}$, versus 590-850 $\mu\text{S}/\text{cm}$ in the existing well. Electrical conductivity correlates with total dissolved solids (TDS). High TDS is associated with high concentrations of individual ionic constituents, including the ones reported as exceeding their MCLs. Notably, however, nitrate was not high in the water sample: 0.23 mg/L as N (the MCL is 10 mg/L).

A new alluvial well could be installed at the school site, that meets the low-yield objective and potentially a significant portion of the high yield objective. The new well would be installed to a depth of approximately 100 ft bgs and constructed of 8-inch diameter PVC or HDPE casing with stainless steel well screen. Operating 50 percent of the time, the well yield would need to be at least 5 gpm to meet the low yield objective and at least 50 gpm to meet the high yield objective.

It is anticipated that like the existing school well groundwater produced from the new well will contain elevated nitrate concentrations. The nitrate concentration at the existing well slightly exceeded the drinking water maximum contaminant level (MCL) for several months in 2015 but has remained below the MCL since then. A cost-effective approach to treating for sporadic high nitrate in a new well at the school or other location would be to monitor nitrate concentrations continuously using an on-line analyzer and treat the well discharge using an anion exchange resin system whenever the concentration exceeds the MCL. If potassium chloride is used as the anion exchange compound, on-site discharge of the cartridge regeneration solution could possibly be permitted (such as by blending it into irrigation water for the playing field).

An anion exchanger treating 3,410 gpd of well water containing 14 mg/L of nitrate would produce 0.323 pounds per day of nitrate (containing 0.073 pounds per day of nitrogen). The volume of water used for backflushing to regenerate the resin would be approximately five bed volumes for every 480 bed volumes treated (SWRCB, 2020). This equals 1.04% of the well discharge, or 35 gpd for the lower yield objective. If the anion exchanger operated continuously for one year, it would discharge 27 pounds of nitrogen in the waste stream. If this were applied to the 5.7 acres of playing field at the school, it would equal 5 pounds per

acre per year, which is far below the normal fertilization rate of 40-260 pounds per acre per year (University of California Cooperative Extension, 2021).

Otherwise, offsite disposal of wastes may be required. The discharges would be small in any case. Regardless, until such time as a new well is installed, tested, and operated, nitrate and other water quality parameter concentrations and associated treatment requirements are unknown.

A 1.15-mile pipeline from the existing CSA-11 distribution system to the Middle/High School is already planned for construction. Therefore, for the purposes of the cost estimate it is assumed that no additional pipeline construction is needed for this alternative. Treated water from the new well would be introduced to the distribution system directly, rather than pumped to the Butano Ridge storage tanks.

The new well would allow pumping from the existing municipal wells on Butano Ridge to be decreased to the point that their water levels no longer chronically decline. The yield of a new well at the school (15 gpm or more) exceeds the estimated overdraft at the Butano Ridge wells (8 gpm or less).

Estimated Annualized Cost

The estimated costs for a well and treatment equipment sized to meet the low-yield objective are shown in **Table 1a** and the high-yield objective in **Table 1b**. Capital costs are annualized to obtain an equivalent basis of comparison among alternatives.

The item costs listed in the tables are the global standard costs listed in Section 2.2. There are no land acquisition costs for this alternative because the Middle/High School is already publicly owned. It is assumed that the La Honda-Pescadero School District would agree to an easement for the well because the well would solve the school's current problem of non-compliance with drinking water standards. It is assumed here that the proposed pipeline from Pescadero to the school has already been budgeted and will be built. To minimize pressure loss along its 1.2-mile length, it is unlikely that a pipeline less than 3 inches in diameter would be installed, and 3 inches would be ample to convey 15 gpm (at a velocity of 0.7 ft/s). Thus, conveying 15 gpm from the school would not require a larger pipe diameter than conveying a smaller flow to the school.

Table 1a. Estimated Cost of High School Well Alternative: 3,410 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Alluvial well	1	each	\$125,123	\$125,123
Nitrate analyzer	1	each	\$12,262	\$12,262
Anion exchanger - 3,410 gpd	1	each	\$75,074	\$75,074
Utility building	1	each	\$31,281	\$31,281
Pipeline	0	foot	\$194	\$0
Subtotal				\$243,739
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$575,224
Annualized capital cost				\$37,419
Annual Operating Costs				
Electricity	574	kWh	\$0.31	\$179
Water system operator - T2	0.075	FTE	\$131,379	\$9,853
Chemicals				\$1,100
Total operating costs				\$11,133
Total Annual Cost				
Total annual cost				\$48,552

Table 1b. Estimated Cost of High School Well Alternative: 31,672 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Alluvial well	2	each	\$125,123	\$250,245
Nitrate analyzer	1	each	\$12,262	\$12,262
Anion exchanger - 31,672 gpd	1	each	\$125,123	\$125,123
Utility building	1	each	\$31,281	\$31,281
Pipeline	0	foot	\$194	\$0
Subtotal				\$418,911
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$988,629
Annualized capital cost				\$64,312
Annual Operating Costs				
Electricity	5,327	kWh	\$0.31	\$1,666
Water system operator - T2	0.075	FTE	\$131,379	\$9,853
Chemicals				\$10,217
Total operating costs				\$21,737
Total Annual Cost				
Total annual cost				\$86,048

A Recommended treatment system would include the following components (Aqua Clear Water Treatment Specialists, 2021):

- Duplex Nitrate Removal Media Filters (anion exchange cannisters filled with resin)
- Cartridge Filter
- UV Disinfection
- Chlorine Injection System
- Chlorine Analyzer
- Control valves

These components would pre-plumbed on a steel frame mounted on a skid. The system would be sized to treat 10 gpm continuously, with remaining system demand provided by the existing CSA-11 wells. A nitrate analyzer would be added at the wellhead to determine when flow should be routed through the nitrate removal system, which based on historical water quality would likely be for months at a time. The existing 7,000-gallon storage tank or a new tank (tank cost not included) at the school well site would be used as a time-of-day storage buffer to allow intermittent pumping of the well while the treatment equipment operates at a continuous rate.

Operation of the treatment system would consist of reading the nitrate analyzer and switching on the anion exchanger whenever the nitrate concentration approached or exceeded 10 mg-N/L. Once switched on, the equipment would likely operate continuously for a few months, with periodic automated regeneration of the anion exchange resin. The disinfection unit controls could also be checked daily. It is assumed here that maintenance of the disinfection and anion exchange equipment would be done by the existing CSA-11 water system operator (T2 level operator), adding an average of three hours to the weekly visit.

The consumable materials for this alternative would consist of regeneration compound for the anion exchanger and a chemical for the disinfection unit. A likely choice for regeneration compound would be potassium chloride. Sodium chloride is less expensive but could adversely impact soil chemistry if used for irrigation. Assuming the anion exchanger removes an average of 15 mg-N/L from 7.5 gpm for 1 month, a total of 0.021 ton of nitrogen would be removed. The corresponding mass of potassium chloride needed to replace the nitrogen on the exchange resin would be 0.11 ton. Assuming one 4-month high-nitrate event every 3 years, the average annual use of potassium chloride would be 0.15 ton per year. This would cost roughly \$625 per year if purchased in semi-bulk quantities.

Uncertainties for Implementation

A County permit would be required to drill a new well, and its issuance would be ministerial. Use of the well and treatment system for municipal supply would need to be approved by DDW. The new well would meet municipal well construction standards, and the anion exchange process is commonly used for nitrate removal. Thus, DDW would likely issue a permit. One of the largest uncertainties with this alternative is whether the SFRWQCB would

approve on-site disposal of the anion exchange regeneration solution. Technical analysis would be needed to verify whether impacts would be negligible. Because pumping would be greater than the amounts pumped from the existing well, the project would not likely qualify for a categorical exemption under CEQA, which means an EIR would need to be prepared. The EIR likely would address a range of potential impacts such as depletion of flow in Pescadero Creek.

Alternative 2: Other New Alluvial Well with Treatment

This alternative is similar to the Middle/High School well alternative except that the well would be at some other location in the alluvium associated with Pescadero Creek. It is assumed that it would be located close to an existing CSA-11 water main or the proposed pipeline going to the school. One location recommended as promising in a previous groundwater investigation was the area near the confluence of Pescadero and Honsinger Creeks, which is between Pescadero and the school. The yield and quality of groundwater are less certain for this alternative than for the Middle/High School alternative because of the information available from the existing school well.

Additional study and hydrogeologic site investigations would be required to identify candidate sites and profile hydrogeologic conditions and water quality. Similar to the school well alternative, the new alluvial well would be installed to a depth of approximately 100 ft bgs and constructed of 8-inch diameter PVC or HDPE casing with stainless well screen. Operating 50 percent of the time, the well yield would need to be at least 5 gpm to meet the low yield objective and at least 50 gpm to meet the high yield objective.

It is assumed that a well lot 0.15 acre in size would need to be purchased from a private landowner for the well, equipment building and access driveway. If a well lot is purchased, no additional rights of way would be needed for the pipeline from the well to an existing CSA-11 water main or the pipeline to the school. Beyond the well lot, any pipelines would be along public roads.

It is assumed that water from the new alluvial well would need to be disinfected and treated for nitrate. Nitrate treatment would potentially be necessary more of the time than for the Middle/High School well alternative because this site would be closer to current and historical agricultural activities. However, for comparison purposes it is assumed that anion exchange regeneration brine could also be disposed of on-site. If regeneration brine is disposed of by blending into irrigation water, an agreement would need to be made with an adjacent landowner to accept the brine for that purpose. Alternatively, a larger well lot would need to be obtained to provide irrigable area.

Estimated Annualized Cost

The estimated costs for an alluvial well and treatment equipment sized to meet the low-yield objective are shown in **Table 2a** and the high-yield objective in **Table 2b**. Capital costs are annualized to obtain an equivalent basis of comparison among alternatives.

Table 2a. Estimated Cost of Alluvial Well Alternative: 3,410 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site evaluation	1	each	\$50,000	\$50,000
Land	0.22	acre	\$816,017	\$179,524
Alluvial well	1	each	\$125,123	\$125,123
Nitrate analyzer	1	each	\$12,262	\$12,262
Anion exchanger - 3,410 gpd	1	each	\$75,074	\$75,074
Utility building	1	each	\$31,281	\$31,281
Pipeline	1,000	foot	\$194	\$193,940
Subtotal				\$667,203
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$1,574,599
Annualized capital cost				\$102,430
Annual Operating Costs				
Electricity	574	kWh	\$0.31	\$179
Water system operator - T2	0.075	FTE	\$131,379	\$9,853
Chemicals				\$1,100
Total operating costs				\$11,133
Total Annual Cost				
Total annual cost				\$113,563

Table 2b. Estimated Cost of Alluvial Well Alternative: 31,672 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site evaluation	1	each	\$50,000	\$50,000
Land	0.3	acre	\$816,017	\$244,805
Alluvial well	2	each	\$125,123	\$250,245
Nitrate analyzer	1	each	\$12,262	\$12,262
Anion exchanger - 31,672 gpd	1	each	\$125,123	\$125,123
Utility building	1	each	\$31,281	\$31,281
Pipeline	1,000	foot	\$194	\$193,940
Subtotal				\$907,656
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$2,142,068
Annualized capital cost				\$139,345
Annual Operating Costs				
Electricity	5,327	kWh	\$0.31	\$1,666
Water system operator - T2	0.075	FTE	\$131,379	\$9,853
Chemicals				\$10,217
Total operating costs				\$21,737
Total Annual Cost				
Total annual cost				\$161,081

The item costs listed in the tables are the global standard costs. For the purpose of comparing alternatives, staffing costs for this alternative are assumed to be the same as for the Middle/High School well alternative. That is, one weekly 3-hour visit by the CSA-11 water system operator (level T2) would be sufficient. In terms of cost, the principal differences between this alternative and the Middle/High School well alternative are the need for a preliminary hydrogeologic study, the need to purchase a well lot, and the pipeline to connect to the distribution system.

Uncertainties for Implementation

A potential well site(s) will need to be identified and property accessed or purchased. Permitting requirements would be essentially the same as for the Middle/High School well alternative. Potential pumping impacts on Pescadero Creek and lagoon might be greater than at the school because the site would be closer to the marsh and west of the San Gregorio Fault, which is near the western edge of the school property and appears to function as a partial barrier to groundwater flow (Akers, 1980). Environmental studies of potential impacts of pumping will need to be made.

Alternative 3: New Purisima Formation Well with or without Treatment

Excluding the Pigeon Point Formation on Butano Ridge and thin alluvial deposits along local creek valleys, the principal geologic formations in the Pescadero area are the Purisima Formation and the Santa Cruz Mudstone. Of these, only sandstone units within the Purisima Formation are likely to yield water at rates greater than the lower yield objective of 15 gpm continuous flow (Akers, 1980). Previous studies offered different opinions regarding the most promising locations for a well in the Purisima Formation. One study recommended an area south of Pescadero Creek and west of the San Gregorio Fault (Akers, 1980), and the other recommended areas north or northeast of Pescadero (Thomas Reid & Associates, 1987). These two areas are roughly outlined in **Figure 1**. Both of those studies noted the local occurrence of chloride concentrations in excess of the drinking water MCL (250 mg/L), which would require demineralization to be used as a source of municipal supply.

Well yields and water quality are expected to be highly variable in the Purisima Formation. At a concept level, further evaluation of this alternative would involve a hydrogeologic data review and site investigations including drilling of test holes. They are assumed to be located 1 mile from the existing CSA-11 distribution system, either north or south of Pescadero. It is optimistically assumed that the water would only need to be disinfected and not treated to reduce chloride, nitrate, iron, manganese or any other constituents commonly problematic in local groundwater. If demineralization would be required to lower chloride concentrations to below the drinking water standard, this alternative would not likely be competitive on a cost basis.

After completion of the hydrogeologic investigation a siting study would be performed. Site selection would be followed by installation of a well. A new pipeline would convey water

from the wells to the existing CSA-11 distribution system, following public roads to the extent possible.

Estimated Annualized Cost

The estimated costs for wells meeting the low-yield objective are shown in **Table 3a** and the high-yield objective in **Table 3b**. Capital costs are annualized to obtain an equivalent basis of comparison among alternatives.

Table 3a. Estimated Cost of New Purisima Formation Wells: 3,410 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site evaluation	1	each	\$50,000	\$50,000
Land	0.22	acre	\$816,017	\$179,524
Test holes	2	each	\$18,768	\$37,537
Purisima Formation well	1	each	\$250,245	\$250,245
Pump house	1	each	\$15,015	\$15,015
Pipeline	5,000	foot	\$194	\$969,700
Subtotal				\$1,502,021
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$3,544,770
Annualized capital cost				\$230,592
Annual Operating Costs				
Electricity	424	kWh	\$0.31	\$133
Water system operator - T2	0.075	FTE	\$131,379	\$9,853
Chemicals				\$1,100
Total operating costs				\$11,086
Total Annual Cost				
Total annual cost				\$241,678

Table 3b. Estimated Cost of New Purisima Formation Wells: 31,672 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site evaluation	1	each	\$50,000	\$50,000
Land	0.88	acre	\$816,017	\$718,095
Test holes	8	each	\$18,768	\$150,147
Purisima Formation well	4	each	\$250,245	\$1,000,981
Pump house	4	each	\$15,015	\$60,059
Pipeline	8,000	foot	\$194	\$1,551,521
Subtotal				\$3,530,803
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$8,332,696
Annualized capital cost				\$542,054
Annual Operating Costs				
Electricity	3,935	kWh	\$0.31	\$1,231
Water system operator - T2	0.075	FTE	\$131,379	\$9,853
Chemicals				\$10,217
Total operating costs				\$21,301
Total Annual Cost				
Total annual cost				\$563,355

The average yield of a well completed in the Purisima Formation is approximately 14 gpm, which is the average yield of 52 wells located in six land sections near Pescadero that are mostly or entirely overlying Purisima Formation. The cost estimate assumes one well would be needed to produce the low yield target of 3,410 gpd (at 10 gpm pumping 2.8 hours per day). Four 10-gpm wells would need to pump 13.2 hours per day to obtain the higher yield objective of 31,672 gpd. It is assumed that two test holes would need to be drilled for every completed well. The test borings are assumed to be drilled in one mobilization. Drilling through bedrock is slower than through alluvium, and the well depths would be deeper (possibly 300 feet versus 100 feet for alluvium). A cost of \$18,800 per borehole is assumed.

Water treatment is assumed to consist only of disinfection and possibly corrosion control. Labor inputs for this alternative would be relatively small, requiring only a weekly visit by a T2 level water system operator to check on well, pump and chemical feed equipment and controls. This would add 2 hours to the operator’s existing weekly visit to maintain the existing CSA-11 wells (4 hours for the high-yield option).

Uncertainties for Implementation

The most significant uncertainty for this alternative is the quality of water obtained from the Purisima Formation. The sandstone member of the formation is the most productive but commonly has a chloride concentration two- to three times the drinking water standard (Akers, 1980). The water would need to be demineralized to use it for municipal supply,

which would require a membrane process similar to that for the brackish water demineralization alternative. At the inland sites where these wells would be located, on-site disposal of the reject brine from the demineralization process would not likely be permissible. Alternatively, the brine could be trucked to an off-site disposal site (probably a permitted ocean outfall somewhere nearby) at a cost likely to render this alternative prohibitively expensive.

An additional significant source of uncertainty is the willingness of landowners in the well site exploration area to agree to test drilling and to sell or execute easements for well lots.

Permitting requirements would be relatively minimal for this alternative. Well construction permits can readily be obtained from the County. Land disturbance would be negligible. A Coastal Development Permit might be needed. A negative declaration might suffice for CEQA compliance, assuming construction impacts are avoided through best management practices and that there is no water quality treatment process that produces a waste fluid. With no waste stream, a permit from the Regional Water Quality Control Board would not be needed.

Alternative 4: New Well in Brackish Coastal Groundwater Area with Desalination

The concept for this alternative is a brackish water desalination facility that treats groundwater produced from a groundwater well completed in alluvium near Pescadero Creek where it reaches the Pacific Ocean near the Highway 1 bridge (**Figure 1**). The new well would meet the low-yield objective and potentially a significant portion of the high yield objective. It is anticipated that the yield of the new well would be at least 10 gpm in order to allow for the reject brine produced by the demineralization process. The intake would consist of a vertical well completed to a depth of approximately 100 feet below ground surface (ft bgs). The new well would be constructed of 8-inch diameter PVC or HDPE casing and stainless steel well screen, in accordance with County and State well construction standards.

The reverse-osmosis desalination equipment would be housed in a small building nearby. The locations of the well and building would depend on hydrogeologic conditions and the preferences of the land-owning agency (Caltrans or California Department of Parks and Recreation). Reject brine would be disposed of by subsurface percolation into the beach, probably north of the bridge. A 2-mile pipeline would convey the product water along Highway 1 and Pescadero Creek Road to the existing CSA-11 water main at the intersection with Bean Hollow Road.

Reverse osmosis produces water that meets drinking water standards for pathogens and dissolved minerals. Treatment of the product water would likely consist of chlorination and addition of selected minerals to manage corrosivity.

The facility could be sized to meet either the overdraft-control or future-growth yield objectives. For both options, desalination would provide only the amount of supply that cannot be sustainably provided by the existing CSA-11 wells on an annual basis.

Estimated Annualized Cost

The estimated costs for a desalination option sized to produce 3,410 gpd (the low-yield objective) are shown in **Table 4a**, and for 31,672 gpd (the high-yield objective) in **Table 4b**. Capital costs are annualized to obtain an equivalent basis of comparison among alternatives.

Table 4a. Estimated Cost of Desalination Alternative: 3,410 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site investigation	1	each	\$70,000	\$70,000
Alluvial well	1	each	\$125,123	\$125,123
Desalination plant - 3,410 gpd	1	each	\$50,049	\$50,049
Utility building	1	each	\$31,281	\$31,281
Pipeline	11,616	foot	\$194	\$2,252,808
Subtotal				\$2,529,261
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$5,969,055
Annualized capital cost				\$388,296
Annual Operating Costs				
Electricity	7,072	kWh	\$0.31	\$2,212
Water system operator - T4	0.2	FTE	\$205,201	\$41,040
Chemicals				\$1,100
Total operating costs				\$44,352
Total Annual Cost				
Total annual cost				\$432,648

Table 4b. Estimated Cost of Desalination Alternative: 31,672 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site investigation	1	each	\$70,000	\$70,000
Alluvial well	1	each	\$125,123	\$125,123
Desalination plant - 31,672 gpd	1	each	\$200,196	\$200,196
Utility building	1	each	\$30,000	\$30,000
Pipeline	11,616	foot	\$194	\$2,252,808
Subtotal				\$2,678,127
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$6,320,380
Annualized capital cost				\$411,150
Annual Operating Costs				
Electricity	65,684	kWh	\$0.31	\$20,546
Water system operator - T4	0.2	FTE	\$205,201	\$41,040
Chemicals				\$10,217
Total operating costs				\$71,803
Total Annual Cost				
Total annual cost				\$482,953

The item costs listed in the tables are the global standard costs, with a few exceptions. This alternative would require a hydrogeologic study—probably including one or more test borings—to confirm the depth of alluvium, groundwater salinity and permeability. The study would be needed to select appropriate pre-treatment and reverse osmosis equipment, design the intake well and brine leach line, and evaluate potential impacts on lagoon water levels. The lands where the project facilities would be located are publicly owned. If an inter-agency agreement can be made, land may not necessarily need to be purchased, and it is assumed that the cost of an easement would be zero. The 2-mile pipeline from the desalination plant to the existing CSA-11 distribution system pipeline at Bean Hollow Road would follow the Pescadero Creek Road public right-of-way.

Package plant water treatment facilities are typically designed to operate automatically, especially if the intake water quality is stable as would be the case for this alternative. Eight hours per week of labor time by a T4 water system operator is assumed for this comparative analysis. Desalination is the most energy-intensive of the alternatives. Energy inputs for contemporary small brackish water RO units are on the order of 1.5 kWh per cubic meter, or 0.005678 kWh/gallon (Zayyat, 2015). That would amount to 7,077 kWh per year for the low yield objective and 65,684 kWh per year for the high-yield objective. Consumable materials for reverse osmosis consist of pre-treatment and post-treatment chemicals. The amounts and types depend on the chemical nature of the feed water and commonly include filter cartridges, acidification, chlorination, softening, dechlorination, granular activated charcoal and anti-scalants. The RO membranes also eventually need to be replaced. For a 32,000 gpd

plant, those costs could exceed \$13,000 per year (Zayyat, 2015). They are assumed to be proportional to the amount of water produced annually.

Uncertainties for Implementation

Permitting would likely be complex for this alternative. In addition to permission from the California Department of Parks and Recreation or California Department of Transportation (Caltrans), a coastal development permit would be required from San Mateo County. An environmental impact report would be required, and a major issue would be potential impacts of pumping at the brackish water intake well on habitat in Pescadero marsh and lagoon. California Division of Drinking Water (DDW) would need to issue a permit for the desalination process, and the San Francisco Regional Water Quality Control Board (SFRWQCB) would need to issue a permit for the brine discharge. Permission from Caltrans would be needed to suspend the water intake line and brine outflow line on the Highway 1 bridge over Pescadero Creek.

Alternative 5: Artificial Recharge on Butano Ridge with Conveyed Lake Lucerne Mutual Water Company Water

Lake Lucerne Mutual Water Company (LLMWC) provides irrigation water to agricultural lands on Butano Ridge close to the existing CSA-11 supply wells. The concept for this alternative is to obtain surplus water in winter from LLMWC and percolate it into the ground a short distance upslope of the existing CSA-11 wells Nos. 1-3. The additional recharge would eliminate the current overdraft and potentially support greater amounts of pumping.

LLMWC has five water rights permits that allow it to divert water from Little Butano Creek during November 1-May 1 and store the water in three reservoirs on Arroyo de los Frijoles, the largest and lowermost of which is Lake Lucerne (see **Figure 1**). The maximum permitted diversion rate is 6.5 cfs, with an annual total not to exceed 790 AF. The three reservoirs range in size from 430 AF to 577 AF. Pumping plants pump water out of Lake Lucerne to irrigate lands to the north and south. Annual statements of diversion and use filed by LLMWC reveal that the pumping plants do not operate during January-March and often not in April either. Furthermore, total annual diversion and use has been far below the permitted maximum, as shown in **Figure 2**.

Under this alternative, CSA-11 would enroll as a customer of LLMWC and take water only during winter months when there is no irrigation demand on the system. The annual amount used by CSA-11 (4-36 AFY, depending on the yield objective) is only 1%-9% of LLMWC's unused permissible diversion. On Butano Ridge, a short pipeline would convey water from the nearest point on LLMWC's existing distribution system to a percolation basin or leach field perhaps 200 feet upslope (west) of CSA-11 Well No. 1 and Well No. 3 (Figure 1). The water would percolate through 200 feet of unsaturated zone to the water table, where it would comingle with rainfall recharge and irrigation deep percolation, which are the existing sources of recharge supplying the wells.

Estimated Annualized Cost

The estimated costs for purchasing and percolating 3,410 gpd (the low-yield objective) are shown in **Table 5a**, and for the high-yield objective in **Table 5b**. Capital costs are annualized to obtain an equivalent basis of comparison among alternatives.

Table 5a. Estimated Cost of Recharge using Lake Lucerne MWC Water: 3,410 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site evaluation	1	each	\$60,000	\$60,000
Pond excavation	1,600	cu. yd.	\$44	\$70,069
Pipeline	800	foot	\$194	\$155,152
Subtotal				\$285,221
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$673,121
Annualized capital cost				\$43,787
Annual Operating Costs				
Water purchase from LLMWC	4	AF	\$375.37	\$1,434
Water system operator - T2	0.03	FTE	\$131,379	\$3,790
Total operating costs				\$5,224
Total Annual Cost				
Total annual cost				\$49,011

Table 5b. Estimated Cost of using Lake Lucerne MWC Water: 31,672 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site evaluation	1	each	\$60,000	\$60,000
Pond excavation	14,861	cu. yd.	\$44	\$650,796
Pipeline	1,600	foot	\$194	\$310,304
Subtotal				\$1,021,100
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$2,409,797
Annualized capital cost				\$156,761
Annual Operating Costs				
Water purchase from LLMWC	35	AF	\$375.37	\$13,317
Water system operator - T2	0.03	FTE	\$131,379	\$4,295
Total operating costs				\$17,612
Total Annual Cost				
Total annual cost				\$174,373

The item costs listed in the tables are the global standard costs. The CSA-11 wells are on the County's 150-acre parcel that extends upslope 1,800 feet from the wells. This provides ample room for a percolation pond or leach field. No additional land would be needed. A pipeline would need to be constructed from the nearest existing LLMWC distribution line to the percolation facility. A pipeline of 800 feet might be necessary, and if the preferred alignment crosses private property an easement might be needed.

The amount of water delivered to the percolation pond would need to be greater than the target amount recovered at the CSA-11 wells due to evaporation losses and likely losses to lateral escapement of percolated water as it percolates down to bedrock. A conservative estimate is that these losses would amount to 50 percent of the delivered water. For the lower yield objective, this means 7.6 AF of water would be delivered to the percolation pond during the 6-month percolation season. Conservatively assuming an average percolation rate of only 0.1 foot per day, a 0.5-acre pond would be needed. Assuming an average of 2 feet of excavation and perimeter levees constructed from the excavated material, the total volume of earth moving would be approximately 1,600 cubic yards.

The price per acre-foot that LLMWC would charge for water has not been verified. For this alternatives screening analysis, the cost is assumed to be \$375 per acre-foot, which is roughly what San Benito County Water District and Pajaro Valley Water Management District charge for surface water delivered to agricultural users.

Under normal operation, the percolation facility would require almost no labor. The cost estimate allows for one hour of inspection during the T2 level water system operator's existing weekly site visit and one day per year of mowing and disking to control weeds and counteract gradual clogging of the pond bed.

Uncertainties for Implementation

One source of uncertainty with this alternative is the willingness of LLMWC to accept CSA-11 as a new customer and supply water. Two of the five water rights licenses (012188 and 012189) allow use of the water for domestic purposes, although all historical use appears to have been for irrigation. The LLMWC facilities are now owned and operated by the Peninsula Open Space Trust (POST). POST's vision is "creating a network of protected lands where people and nature connect and thrive. These lands are preserved forever so present and future generations benefit from the careful balance of rural and urban landscapes that makes our region extraordinary." Protecting farmland is one of POST's program areas, in which "we are working to reverse the trend of disappearing farmland through a combination of land acquisition, legal land protection and strategic investments in infrastructure." With these organizational objectives, it is possible POST would cooperate with a project that would eliminate existing groundwater overdraft at the CSA-11 wells. It is less likely that POST would support increasing Pescadero's water supply to facilitate growth to the buildout urban water demand contemplated in the Local Coastal Plan.

A water rights evaluation might be needed to confirm that the types of permitted use include the proposed groundwater recharge project. If a pond is constructed for percolation,

one or more County permits might be needed related to slope stability and other geotechnical aspects of design. A coastal development permit might also be needed. An EIR could be needed to evaluate impacts related to increased diversion from Little Butano Creek and also of habitat disturbance at the percolation pond site.

A second source of uncertainty with this alternative relates to subsurface hydrogeology and the ability of water percolated at the land surface to reach the water table 200 feet below without being deflected by relatively impermeable layers in the stratigraphy. A review of twelve prior studies of Butano Ridge hydrogeology noted several indications of limited vertical permeability (Killmartin, 1999). These include the presence of springs and seeps at various locations on Butano Ridge, which suggests limited downward percolation of water from the ground surface. Artesian groundwater conditions in the 75-acre nursery property south of the CSA-11 wells is another indication of limited downward percolation of recharge. The contact between the surficial marine terrace unit and underlying Pigeon Point Formation (in which the CSA-11 wells are completed) is also thought to be a surface that could tend to deflect percolation horizontally. In spite of all these indications of limited vertical permeability, it is widely accepted that deep percolation of rainfall and irrigation water is the primary source of recharge to the depth interval tapped by the CSA-11 wells.

Additional hydrogeologic analysis—probably including test boring, test pits, and infiltration tests—would likely be needed to evaluate stratigraphy and vertical groundwater flow conditions closer to the CSA-11 wells. Even with such a study, there could be lingering uncertainty regarding the ability of the CSA-11 wells to capture all or most of the supplemental recharge at the ground surface. Ultimately, effectiveness of the recharge project would be assessed after several years of operation and well system monitoring.

Alternative 6: Creek Diversion with Treatment

The 1987 water supply alternatives analysis considered a surface diversion from Honsinger Creek. A diversion location upstream of agricultural activities was preferred to minimize potential water quality risks. For the present analysis, Pescadero Creek is preferred because it is a much larger watershed and because the planned CSA-11 water pipeline to Pescadero Middle/High School ends on publicly owned land adjacent to Pescadero Creek upstream of most agricultural activities.

The concept for this alternative is a diversion facility consisting of a subsurface infiltration gallery next to the creek at a location slightly upstream of Pescadero. The Middle/High School would be a good location because it would minimize land acquisition and pipeline costs and offer a possibility for on-site disposal of water treatment backflush water, although other diversion locations may be preferred.

Water would be diverted during periods of moderate to high creek flow by means of a subsurface infiltration gallery installed in the stream bank and stored in a raw water holding pond or tank. The water would be treated pursuant to the requirements of the Surface Water Treatment Rule using a skid-mounted treatment plant that includes filtration and disinfection. The Pescadero Creek watershed upstream of the school is quite pristine, with

little developed land use. A study of water quality and biota in nine San Francisco Bay watersheds found some of the best water quality and taxonomic richness for aquatic and benthic biota in the Pescadero Creek watershed (SFRWQCB, 2007). Specific conductance was 200-500 $\mu\text{S}/\text{cm}$ in winter and spring and around 800 $\mu\text{S}/\text{cm}$ in summer and fall. This meets drinking water standards without demineralization. No toxicity was found in any samples.

Although numerous prior water rights have been filed for diversion from Pescadero Creek, surplus water is available for diversion at least during the non-irrigation season. A search of the State Water Resources Control Board's eWRIMs on-line water rights database identified 28 prior water rights totaling 7.27 cfs of instantaneous diversion, of which 6.64 cfs are downstream of the school. The total annual face value of the prior rights is 833 acre-feet. A spreadsheet operations model was constructed to calculate the yield and reliability of the creek diversion alternative using daily flow data for the Pescadero Creek gage for water years 1952-2019. The model assumes an operating season of November through April, a required bypass flow of 6.64 cfs, a diversion rate of 0.2 cfs (90 gpm), a pond or tank capacity of 1 acre-foot, and a treatment plant capacity of 19,440 gpd (13.5 gpm—equal to the entire existing CSA-11 average daily demand). The system was able to meet this demand in every year, including the minimum-runoff years of 1976-1977. **Figure 3** shows the simulated annual yields for 1952-2019 (upper graph) and simulated pond storage during water years 1975-1979. In other words, this system could meet the entire existing water demand for 6 months of every year, thereby cutting annual pumping at the CSA-11 wells in half and eliminating overdraft. This corresponds to the low yield objective.

The logistical feasibility of this alternative is questionable for the high yield objective. To achieve the annual yield objective of 35.5 AFY while operating only six months of the year would require larger diversion rates, storage pond capacity and treatment plant capacity. For example, increasing the diversion rate from 0.2 to 0.6 cfs, the pond capacity from 1 to 4 AF and the treatment plant capacity from 13 to 44 gpm would achieve the full yield objective in only 53 percent of the simulated years. Ninety percent of the objective would be achieved in 77 percent of the years. In 1976 and 1977, the yield would have been only 48 percent and 20 percent of the objective.

Estimated Annualized Cost

The estimated costs for a yield of 3,410 gpd (the low-yield objective) are shown in **Table 6a**, and for the high-yield objective in **Table 6b**. The latter assumes the creek can supply the high-yield objective simply by scaling up the capacities of the intake, storage pond and treatment facility. This may not be realistic, as explained above. Capital costs are annualized to obtain an equivalent basis of comparison among alternatives.

Table 6a. Estimated Cost of Creek Diversion: 3,410 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site investigation	1	each	\$50,000	\$50,000
Infiltration gallery - 3,410 gpd	1	each	\$125,123	\$125,123
Pond excavation	1613	cu. Yd.	\$44	\$70,638
Water treatment plant - 3,410 gpd	1	each	\$25,025	\$25,025
Utility building	1	each	\$31,281	\$31,281
Pipeline	500	foot	\$194	\$96,970
Subtotal				\$399,036
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$941,725
Annualized capital cost				\$61,261
Annual Operating Costs				
Electricity	574	kWh	\$0.31	\$179
Water system operator - T2	0.075	FTE	\$131,379	\$9,853
Filters and chemicals				\$2,000
Total operating costs				\$12,033
Total Annual Cost				
Total annual cost				\$73,293

Table 6b. Estimated Cost of Creek Diversion: 31,672 gpd Option

Cost Item	Quantity	Units	Unit Cost	Total or Annual Cost
Capital Costs				
Hydrogeologic site investigation	1	each	\$50,000	\$50,000
Infiltration gallery - 31,672 gpd	1	each	\$250,245	\$250,245
Pond excavation	6452	cu. Yd.	\$44	\$282,552
Water treatment plant - 31,672 gpd	1	each	\$187,684	\$187,684
Utility building	1	each	\$40,000	\$40,000
Pipeline	500	foot	\$194	\$96,970
Subtotal				\$907,451
Multiplier for engineering, installation, etc.				2.36
Total capital cost				\$2,141,585
Annualized capital cost				\$139,313
Annual Operating Costs				
Electricity	5,327	kWh	\$0.31	\$1,666
Water system operator - T2	0.075	FTE	\$131,379	\$9,853
Filters and chemicals				\$18,600
Total operating costs				\$30,120
Total Annual Cost				
Total annual cost				\$169,433

Uncertainties for Implementation

Implementing this alternative would require an agreement with La Honda-Pescadero Unified School District to allow installation of the infiltration gallery, raw water storage pond (or tank) and treatment plant utility building on school property. A small amount of geotechnical site investigation would be needed for designing the infiltration gallery and pond. The point on Pescadero Creek closest to the existing well is on an outside bend of the creek and thus at greater risk of scour or bank failure during flood events. An inside bend at the north boundary of the school property might be a more stable site and would require 500 ft of pipe to reach the well and pipeline to Pescadero. Site selection would require an evaluation of stream bank stability at the gallery site during flood events.

An application for an appropriative water right to divert flow from Pescadero Creek would need to be filed with the State Water Resources Control Board. CEQA compliance would be required, probably with a focus on potential impacts of the diversion on downstream aquatic habitat. Permitting requirements would include a streambed alteration permit from the California Department of Fish and Wildlife for installing the infiltration gallery. The water treatment plant would need to be approved by DDW, and disposal of any backflush water or solids removed by the treatment process would require a discharge permit from the SFRWQCB. There are no obvious impediments to successfully completing all of these permitting steps.

Global Cost Assumptions

Many of the water supply alternatives have components in common, such as a well, pipeline, or treatment facility. For the purpose of comparing alternatives, it is not as important to have accurate, detailed cost estimates for each component as it is to know whether the cost for a component would likely be higher or lower than for that same component in another alternative. To support this comparative approach, the following set of cost assumptions and baseline cost estimates were developed, all adjusted to 2024 dollars using the California Construction Cost Index:

- Costs for design and engineering, permitting, general site work, installation of equipment, start-up testing, administrative, legal and contingency costs can be estimated by a single multiplier applied to the capital cost of equipment. A statewide guidance document for small water systems uses a multiplier of 2.36 (SWRCB, 2020), and that multiplier is used for this analysis.
- The land cost for a 100 x 100 foot (0.23-acre) well lot is estimated at \$40,000. As a local land value reference, two 2-11 acre lots along Pescadero Creek Road were for sale in March 2024 at an asking price of \$136,000 to \$143,000 per acre. The prorated cost for a 0.23-acre well lot would be only about \$32,000, but transaction costs for a lot split and sale could increase the cost to \$70,000. Some alternatives, such as brackish water desalination, a new well at the Middle/High School and a creek diversion at the Middle/High School would be on land owned by public agencies. It is assumed that those alternatives would only move forward with the

agreement of the landowning agency and that the cost of an associated easement would be negligible.

- Pipeline costs vary slightly by diameter. For the 15-50 gpm flow range applicable to most of the alternatives, a 3-inch pipe diameter would be plausible with respect to flow velocities and water residence times. Budget allocations for seven pipeline replacement projects considered in 2020 by Coastside County Water District (near Half Moon Bay), averaged about \$400 per linear foot for pipe diameters of 4-6 inches (Coastside County Water District, 2020). However, this includes all of the engineering, design, contingency, etc. markups discussed above. A statewide guidance document for small water project cost estimated that the capital cost for materials and installation for 4-inch distribution pipe alone would be approximately \$155 per linear foot. Applying the multiplier described above for engineering, permitting, administration, etc. and inflating to 2024 dollars would result in a linear foot cost of \$458. It is assumed that the cost for a 3-inch pipeline would be the same.
- An 8-inch diameter alluvial well 100 feet deep with stainless steel wire wound screen, 50-foot sanitary seal and pump sized to produce up to 50 gpm is estimated to cost \$100,000 (Alcartado, 2021), or approximately \$125,000 in 2024
- An 8-inch diameter bedrock well 300 feet deep with stainless steel wire wound screen and a pump sized to produce 15 gpm is estimated to cost \$375,000 each if two wells are drilled in one mobilization.
- A skid-mounted brackish water reverse osmosis plant with an average daily production of 3,410 gpd (the lower yield objective) would cost roughly \$50,000 excluding installation (Pure Aqua, Inc. 2021; inflated to 2024). The cost could be higher or lower depending on water quality characteristics that require pre-treatment. A plant sized to produce 31,672 gpd (the higher yield objective) would cost on the order of \$200,000.
- A water quality treatment system to remove nitrate would consist of an on-line nitrate analyzer and an anion exchanger tank. A cost estimate of \$75,000 for a skid-mounted nitrate removal plus chlorine disinfection system designed to operate nearly continuously at 10 gpm was obtained from Aqua Clear Water Treatment Systems (inflated to 2024 dollars). This excludes installation.
- A water treatment plant with filtration and disinfection processes that meet the requirements of the Surface Water Treatment Rule could also consist of a skid-mounted package plant. Equipment including a pump, backwashing pre-filter, four-stage cartridge filter and chlorine injector would cost on the order of \$25,000 excluding installation (U.S. Water Systems, 2021; inflated to 2024 dollars).
- Excavation of storage or percolation ponds is estimated to cost approximately \$44 per cubic yard (State Water Resources Control Board, 2018; inflated to 2024 dollars).
- Several alternatives would require a utility building to house water treatment equipment, including the desalination, nitrate removal and surface water treatment alternatives. A garage-like building no larger than 200 square feet would likely suffice. Materials and construction are estimated to cost \$32,000.

- The discount rate for annualizing capital costs is assumed to be 5.0 percent. This is the typical interest rate for municipal bonds in California in March 2024. A lower rate might be possible if a California Clean Water State Revolving Fund loan could be obtained, which would have an interest rate approximately half of the market rate for borrowing. If loans are repaid over 30 years, the annual payment equals 4.46 percent of the principal amount.
- Personnel costs for operating a water supply depend on the level of skill required and the number of hours per week of labor. For simpler equipment such as wells and anion exchangers, a T2 level water system operator is assumed to be adequate. For a desalination plant or surface water treatment plant, a T4 level operator is assumed to be needed. The fully-loaded, full-time-equivalent annual cost for agency budgeting purposes is \$131,000 for the T2 operator and \$205,000 for the T4 operator (SWRCB, 2020; inflated to 2024 dollars). For each alternative, the number of hours per week dedicated to operating the new system is used to calculate labor cost as a fraction of full-time-equivalent employment. The County currently contracts with a private firm to operate the CSA-11 system and could continue to do so with an expanded scope of activities.
- Electricity cost estimates assume an average PG&E non-peak commercial rate of \$0.44/kWh. Note that the energy cost of bringing the new supply up to the distribution pressure is the same for all of the water supply alternatives and is omitted from this comparative analysis.

3. SCREENING OF ALTERNATIVES

3.1 Methodology and Assumptions

The water supply alternatives were ranked relative to one another based on cost and the level of difficulty expected for four groups of feasibility factors:

- **Landowner Permission.** This reflects the potential difficulty of finding landowners willing to sell a well lot or negotiate an easement for a well site or pipeline route. In the case of the alternative to supplement recharge on Butano Ridge, it reflects uncertainty regarding LLMWC's willingness to sell water to the project.
- **Technical Uncertainty.** This factor reflects the degree of uncertainty related to subsurface hydrogeologic conditions, groundwater quality, stream bed characteristics (for the creek infiltration gallery), and treatment equipment and costs.
- **DDW and RWQCB Permitting.** These are the two major permits for all of the alternatives. All sources of supply and treatment equipment must meet drinking water standards, and DDW can specify extensive testing and monitoring requirements to demonstrate that. For alternatives with any sort of waste byproduct (desalination reject water, anion exchange regeneration water, pond water filtration backflush, etc.) a discharge permit from the RWQCB is needed. Requirements related to disposing of these waste byproducts can be very expensive and render an alternative infeasible.

- Environmental Issues.** All of the alternatives would require numerous permits, such as to drill a well, grade a utility building site, construct buildings, install pipelines. Many of these are likely obtainable without much difficulty or uncertainty. However, environmental issues can require in-depth studies and garner opposition to the project. For example, the more directly an alternative depletes inflow to Pescadero Marsh, the more likely it would have significant impacts.

The degree of difficulty for each of these feasibility factor groups was ranked qualitatively as low, medium or high. These rankings are based on professional experience and judgement.

3.2 Alternative Preliminary Rankings

The results of the ranking analysis are shown in **Table 7**. The best alternative in terms of cost and feasibility is an alluvial supply well at Pescadero Middle/High School. The low cost is due in part to the assumption that a pipeline will have been built from Pescadero out to the school site. Pipeline construction costs are a major cost factor in the alternatives, so minimizing that item significantly lowers the total cost.

Table 7. Ranking of Water Supply Alternatives

Water Supply Option	Total Annual Cost		Potential Difficulties With:				Overall Rank
	Low Yield Objective	High Yield Objective	Landowner Permission	Technical Uncertainty	DDW and RWQCB Permitting	Environmental Issues	
1. New Well at Pescadero Middle/High School with Treatment	\$29,645	\$54,703	Low	Low	Med	Low	1
2. Other New Alluvial Well with Treatment	\$66,366	\$96,921	Med	Low	Med	Med	3
3. New Purisima Formation Well with or without Treatment	\$136,634	\$317,485	Med	Med	Low	Low	4
4. New well in Brackish Coastal Groundwater Area with Desalination	\$250,154	\$287,096	Low	Med	High	High	6
5. Artificial Recharge on Butano Ridge with Conveyed Lucerne Lake Mutual Water Company Water	\$96,921	\$101,339	High	High	Low	Low	5
6. Creek Diversion with Treatment	\$44,682	\$106,133	Low	Med	Med	Med	2

The creek diversion alternative is ranked second on the assumption that the school district would allow installation of the necessary facilities. It also assumes that treatment is only needed for turbidity and pathogens. If the school district does not allow access for the creek diversion, Alternative 2 (other alluvial well) would rank similar to the creek diversion alternative.

Ranks 3 and 4 are assigned to the alluvial and Purisima Formation well alternatives. Both have considerable uncertainty regarding water quality and treatment needs. The Purisima Formation well option is more expensive than the alluvial well option because the well needs to be deeper and a longer pipeline would be needed to connect it to the distribution system.

Artificial recharge on Butano Ridge is assigned a low ranking largely because the likelihood of cooperation from LLMWC is questionable and because of the hydrogeologic uncertainty regarding flow from the percolation pond down to the fractures tapped by the CSA-11 wells.

The desalination alternative has several factors working against it. Desalination of brackish water is more expensive than the treatment processes required for the other supply alternatives, and the 2-mile pipeline to connect to the distribution system would be expensive. The alternative also has greater uncertainty regarding landowner permission, permitting and environmental impacts than the other alternatives.

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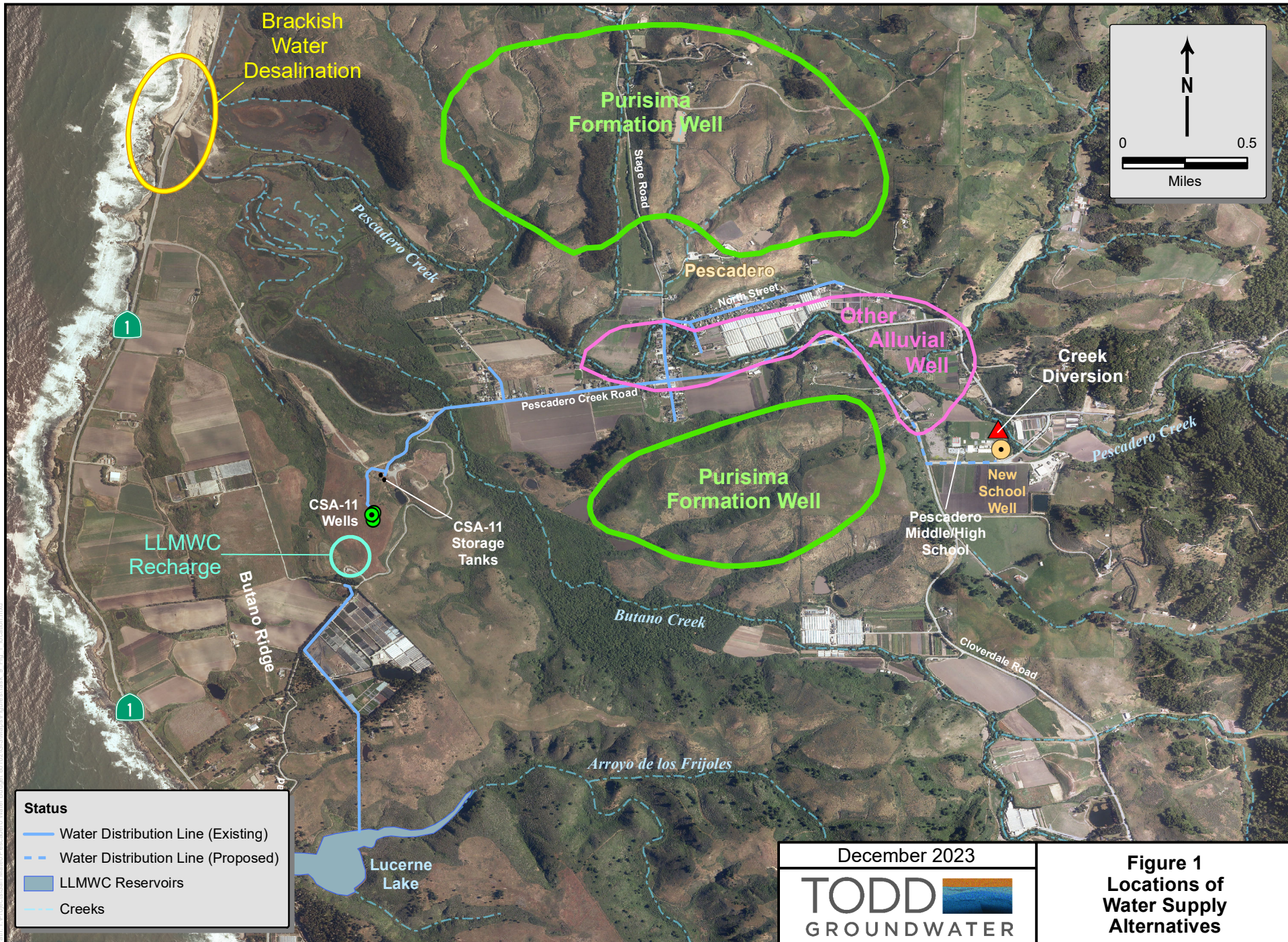
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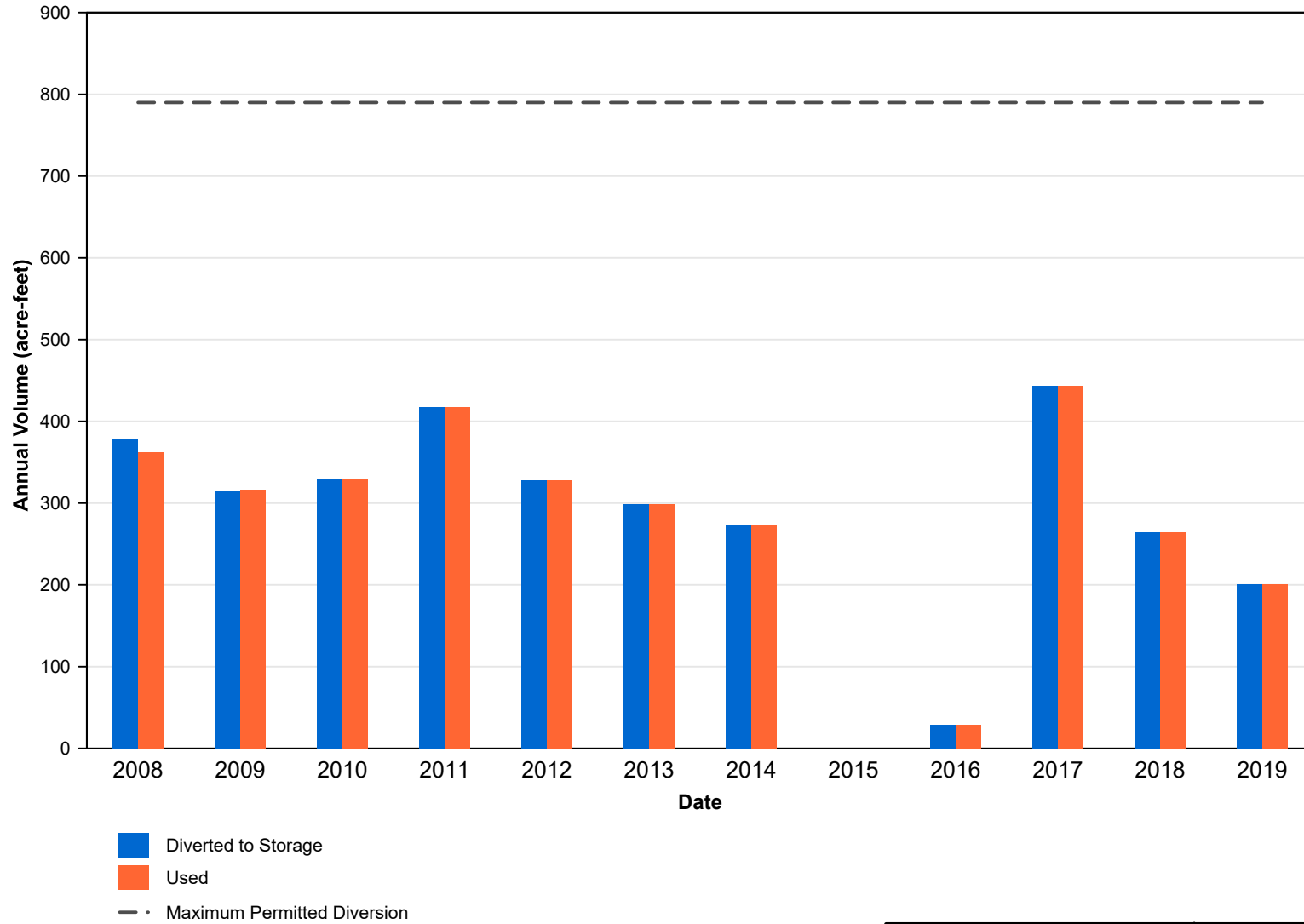
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Lake Lucerne Mutual Water Company Annual Use



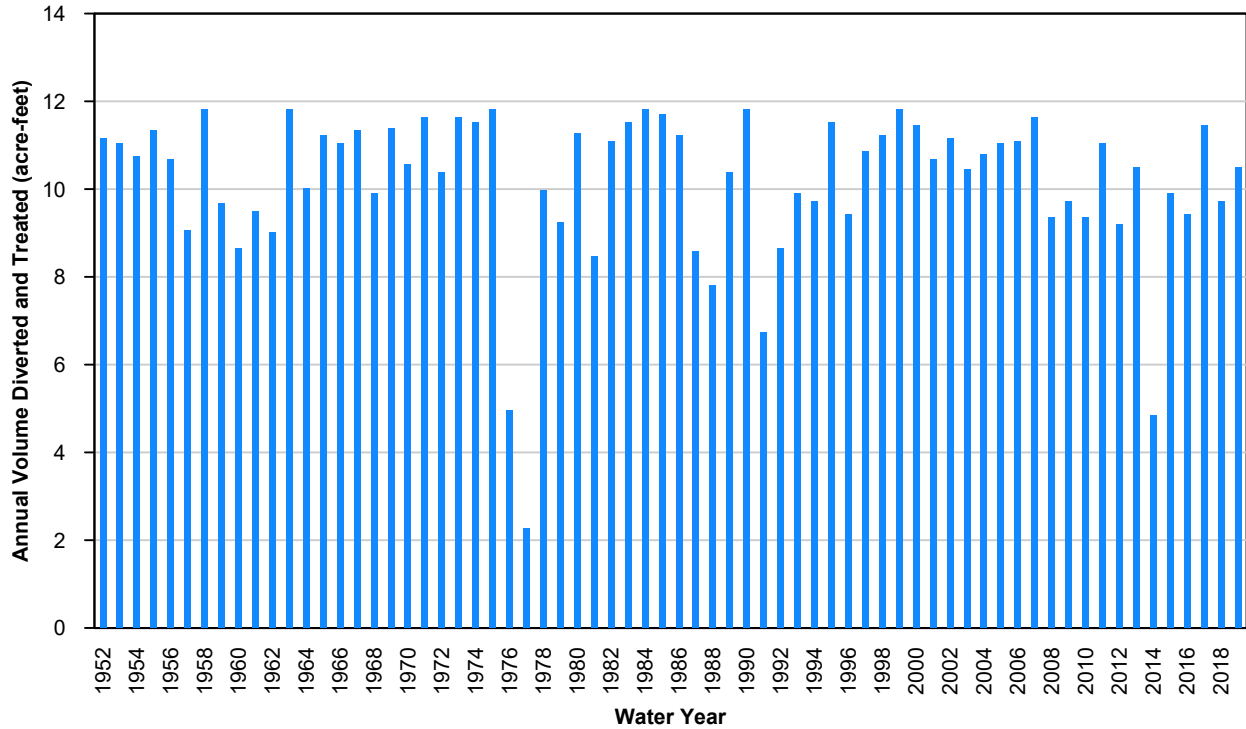
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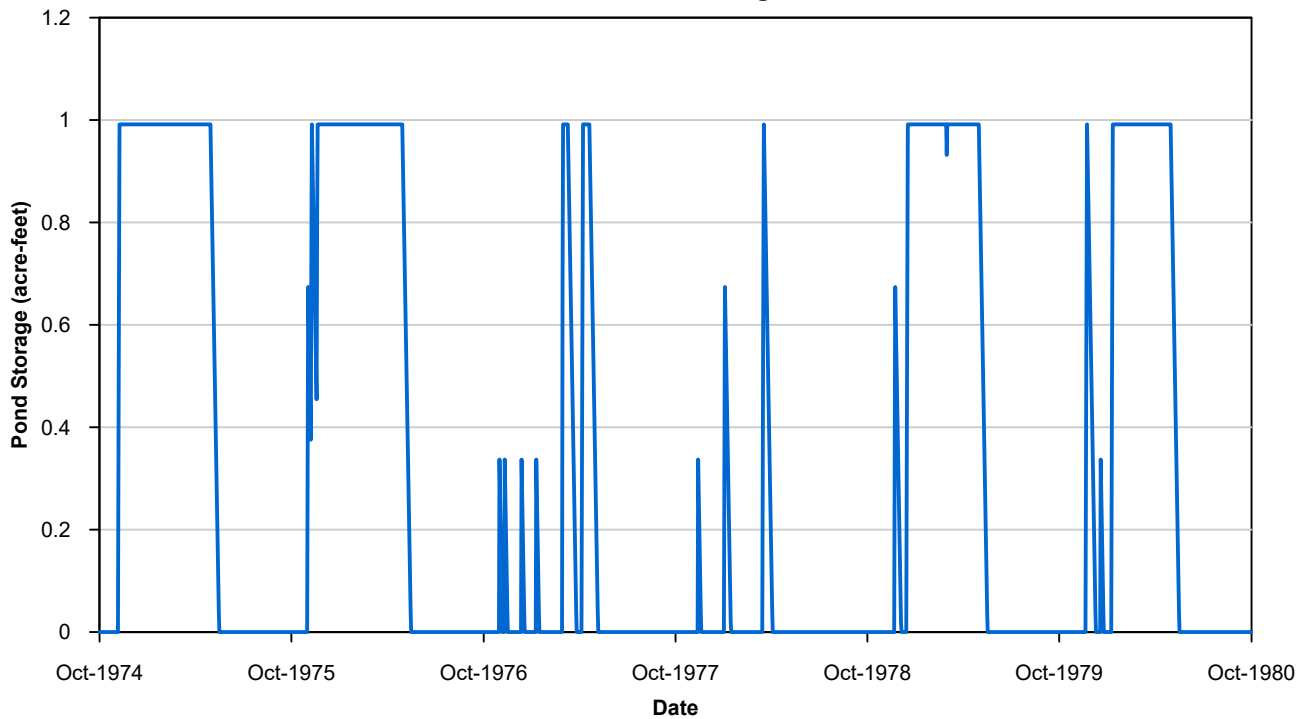
Figure 2
LLMWC Annual
Diversion and Use
2008-2019

Pescadero Creek Diversion Opportunity

Bypass flow = 6.64 cfs; Diversion rate = 0.2 cfs; Pond capacity = 0.99 AF; Treatment capacity = 19,440 gpd



Pond Storage



December 2023



Figure 3
Simulated Diversion
and Pond Storage

Data:
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