Technical Memorandum

Northwest County Recycled Water Strategic Plan

Subject: **Task 6.4 – Using Groundwater to Irrigate City Parks**

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Date: December 23, 2020

Reference: 0038-032

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1 Background

The City of Palo Alto (City) relies on potable water from the San Francisco Public Utilities Commission (SFPUC) to irrigate City parks. This high-quality water supply consists of about 85% Sierra Nevada snowmelt delivered through the Hetch Hetchy water distribution system. Local groundwater provides a backup to the Hetch Hetchy supply through the City's Emergency Water Supply and Storage Project. The emergency groundwater supply is provided by wells located in parks throughout the City.

To actively manage the City's water resources, this study explores using local groundwater to irrigate City parks. Using groundwater as an alternative irrigation supply would provide a benefit of offsetting demand for the Hetch Hetchy supply and likely reduce the need for dewatering in the surrounding area by a small amount. Five City parks and five out of eight emergency wells with usable groundwater supplies were considered: Main Library, Rinconada Park, El Camino Park, Eleanor Pardee Park, and Peers Park. Three alternatives are evaluated to supply groundwater for irrigation:

1. Using existing emergency wells for irrigation and backup potable supply;
2. Converting existing emergency potable wells to irrigation wells;
3. Installing new irrigation wells.

Alternatives are evaluated for water resource benefits and institutional complexity. Key items reviewed include pressure and flow requirements for the irrigation systems and necessary upgrades required to meet those requirements with groundwater wells. Budgetary costs are provided for the alternative that provides a groundwater supply for park irrigation without sacrificing the emergency water supply.

2 Emergency Water Supply and Storage Project

In the event of a catastrophic emergency, the Emergency Water Supply and Storage Project[1,2,3] can provide a backup supply of groundwater to the City using local wells, pumps, and storage facilities. The emergency infrastructure can support the City's water demand for eight hours of normal water use at the maximum day demand level and four hours of fire suppression at the design fire duration level. The groundwater system may also be used to a limited extent for water supply during drought conditions and provide normal wintertime supply needs during extended shutdowns of the SFPUC system. (City of Palo Alto Utilities, 2016). As indicated by the yellow shaded area on Figure 1, the emergency groundwater wells are generally located in the northwest portion of the City.

The City emergency supply wells are currently permitted and designated by the California Division of Drinking Water (DDW) as "Standby" and, as such, can only be used for five consecutive days up to 15 days per year (City of Palo Alto Utilities, 2017). The wells may collectively supply up to 1,500 AF per year during a drought, with restrictions on when the wells can resume pumping following that level of groundwater extraction. The pumping restrictions for the emergency well system are mitigation measures in the Environmental Impact Report (EIR)[4] prepared for the Emergency Water Supply and Storage Project. Supplemental environmental review would be needed if an increase in pumping is needed.

There are eight emergency supply wells that supply groundwater to the City's Emergency Water Supply and Storage Project. Table 1 provides the well construction and performance information for the eight

[1] https://www.cityofpaloalto.org/civicax/filebank/documents/27935

[2] https://www.cityofpaloalto.org/faqs/categoryqna.asp?id=83

[3] https://www.cityofpaloalto.org/civicax/filebank/documents/33271

[4] https://www.cityofpaloalto.org/civicax/filebank/documents/8372/

emergency supply wells. All wells are screened in both the shallow aquifer (less than 200 feet below ground surface [bgs]) and deep aquifer (greater than 200 feet bgs). The well capacities vary from 600 to 3,300 gallons per minute (gpm). Up to 11,300 gallons per minute (gpm) of reliable well capacity is available for emergency (Todd Groundwater, 2018). Depth to groundwater at the well sites is mapped between 10 and 30 feet bgs (URS, 2009).

If the wells were to be used to supply water during a drought, coordination with DDW would be needed to coordinate the treatment necessary to meet regulatory standards in addition to other issues, such as water quality, customer acceptance, and cost of treatment facilities.

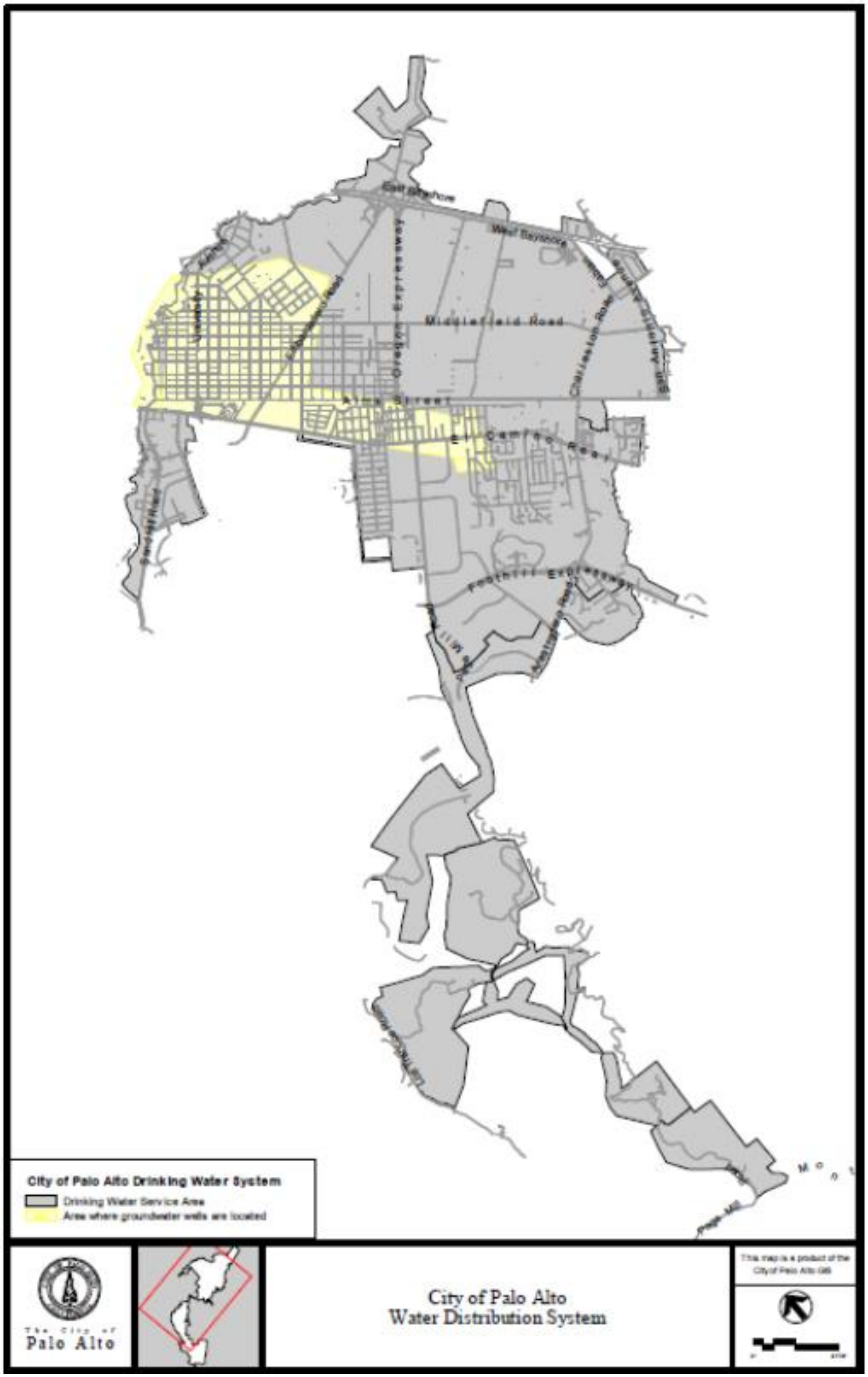


Figure 1: Drinking Water Service and Groundwater Areas

Table 1: Emergency Water Supply Wells

Well Data	Hale	Rinconada Park	Peers Park	Fernando	Matadero	El Camino Park	Eleanor Pardee Park	Main Library
Installation Date	1958	1954	1958	1954	1956	2013	2009	2010
Casing Diameter (in)	14	14	14	14	14	16	18	18
Total Depth Drilled (ft-bgs)	935	1,080	950	1,179	1,186	500	460	545
Bedrock Encountered (ft-bgs)	927	895	NE	1,178	1,066	NE	NE	NE
Casing Depth (ft)	840	540	850	1,020	1,066	290	440	525
Seal Depth (ft-bgs)	100	140	102	91	60	145	150	150
Filter Pack Interval (ft-bgs)	100-840	140-540	102-850	91-1,020	60-1,066	145-290	150-440	150-525
Screen Intervals (ft-bgs)	Multiple btw 108 and 828	Multiple btw 150 and 540	150-320 350-845	N/A presumed to be 100-1,020	142-1,066	152-174 204-280	160-280 300-340 360-440	165-285 305-525
Specific Capacity (gpm/ft)	10.5	24.4	12.0	2.8	3.2	51.1	5.9	2.1
Well Capacity (gpm)	1,450	3,300	1,700	700	700	1,850	1,000	600
Aquifer Screened	Shallow/ deep	Shallow/ deep	Shallow/ deep	Shallow/ deep	Shallow/ deep	Shallow/ deep	Shallow/ deep	Shallow/ deep

Note: NE = Not encountered

3 Groundwater Quality

The City overlies a groundwater aquifer called the Santa Clara Subbasin (DWR Bulletin 118 Basin 2-009.02), which consists of a shallow "unconfined" aquifer and a deep "confined" aquifer. The shallow and deep aquifers are separated by extensive clay deposits that form a confining layer or "aquitard" which prevents groundwater from moving between the shallow and deep aquifers (Todd Groundwater, 2018).

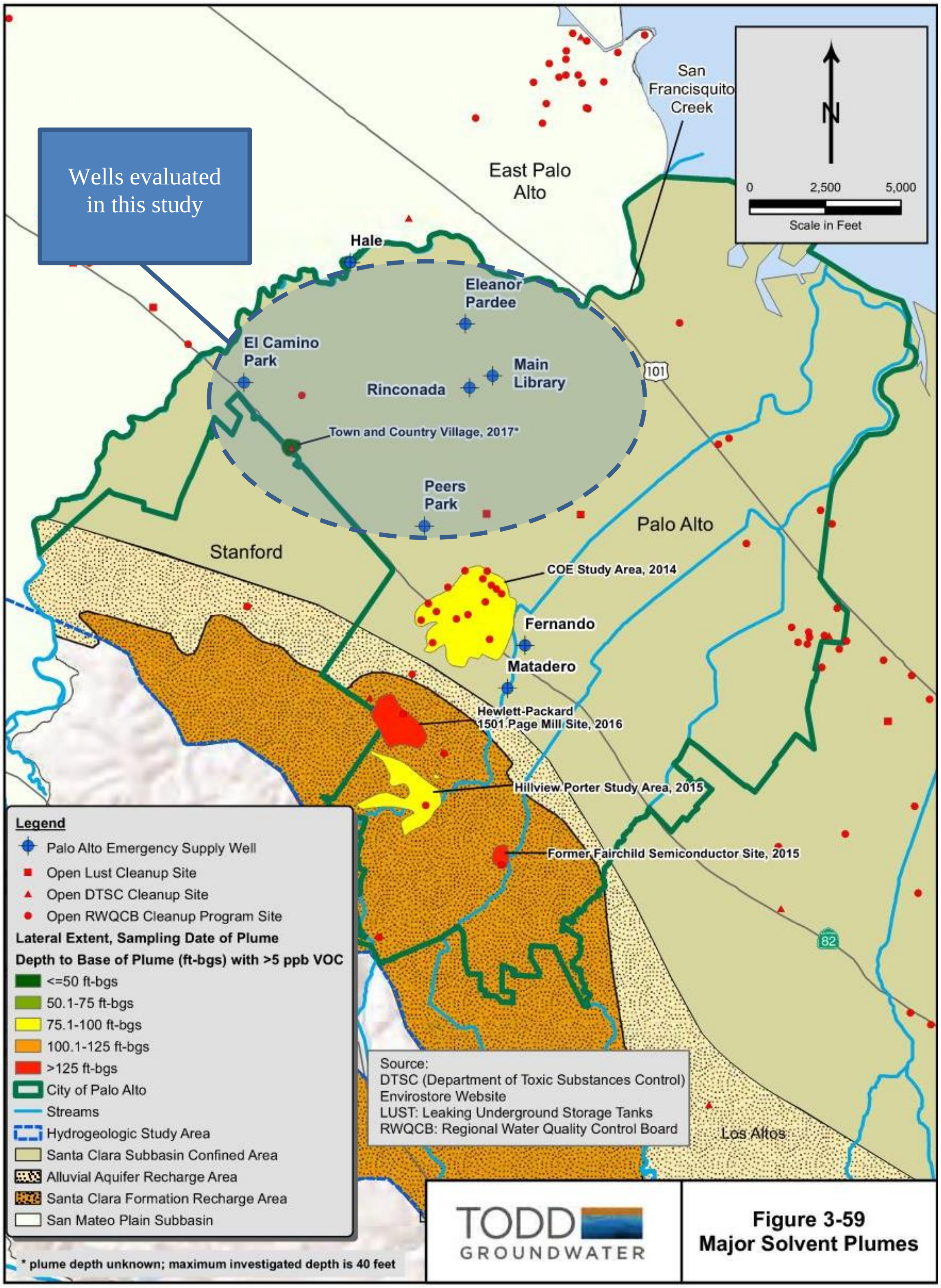
In 2010 and 2014, DDW approved a permit amendment to add the Main Library, Eleanor Pardee, and El Camino Park wells to the City's existing water supply permit. As part of the permit process, all three wells were tested for primary and secondary drinking water quality standards. The results indicated the wells meet primary and secondary water quality standards, but there is a potential for exceedance of secondary standards for manganese, iron, and total dissolved solids (TDS).

Secondary standards are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. Groundwater is approximately six times higher in total dissolved solids (TDS) and hardness than SFPUC's supplies. Local groundwater quality would be generally suitable for irrigation of park turfgrass (Woodard & Curran, 2020) based on data from shallow groundwater quality from dewatering operations. Before using groundwater on other plant species, an assessment of the quality of groundwater at a specific site will be undertaken to ensure the water will not cause any adverse impacts.

Groundwater contamination has been identified in Palo Alto based on reports of releases and site investigations required by State and Federal environmental policies and regulations, or during due diligence investigations for real estate property transactions. Many of these sites have been investigated through installation and sampling of monitoring wells, and some sites have been partially or completely remediated, while others remain contaminated. Investigation and remediation are typically conducted by the responsible party or property owner under the supervision of the regulating agency or agencies.

At sites with groundwater contamination, downward gravity-driven migration through the vadose (unsaturated) zone causes contaminants to enter the saturated groundwater zone, where they flow via advection in groundwater, spread laterally and vertically due to dispersion and molecular diffusion, and depending on chemical type, can adsorb onto the solid aquifer matrix and/or degrade into other compounds. The extents of chemical plumes in groundwater are controlled by chemical properties and site-specific hydrogeologic conditions (e.g., groundwater flow rates and directions, both laterally and vertically, and the presence of fine- and coarse-grained layers that could impede or allow migration), as well as the size, duration, and timing of the release.

Figure 2 shows the locations of the emergency supply wells in relation to known contaminant sites within the City, including leaking underground storage tank (LUST) locations. Two emergency supply wells (Fernando and Matadero) are near a significant solvent contamination plume with low level contamination detected to a depth of about 100 feet bgs (Todd Groundwater, 2018). As such, these wells were excluded from further evaluation in this study. The five remaining wells considered in this study (El Camino Park, Eleanor Pardee Park, Rinconada Park, Main Library, and Peers Park) are north of the contaminant plume and not expected to mobilize the plume if used.



Source: Todd Groundwater, 2018

Figure 2: Emergency Supply Wells

4 Irrigation Demand

The five parks considered in this study (El Camino Park, Eleanor Pardee Park, Rinconada Park, Main Library, and Peers Park) are located east of El Camino Real and north of the Oregon Expressway as indicated on Figure 3. Although there is an emergency supply well located in each park, the wells are not currently used for irrigation. The park irrigation systems are connected by meters to the City's potable water system. The City's potable water system supplies the parks with an average supply pressure ranging between 60 and 65 pounds per square inch (psi). The pressure at Peers Park is boosted to 65 - 70 psi. The El Camino well is directly plumbed to a 2.5 MG reservoir, not tied into the distribution system, with booster pumps pumping reservoir water into the distribution system after filled.

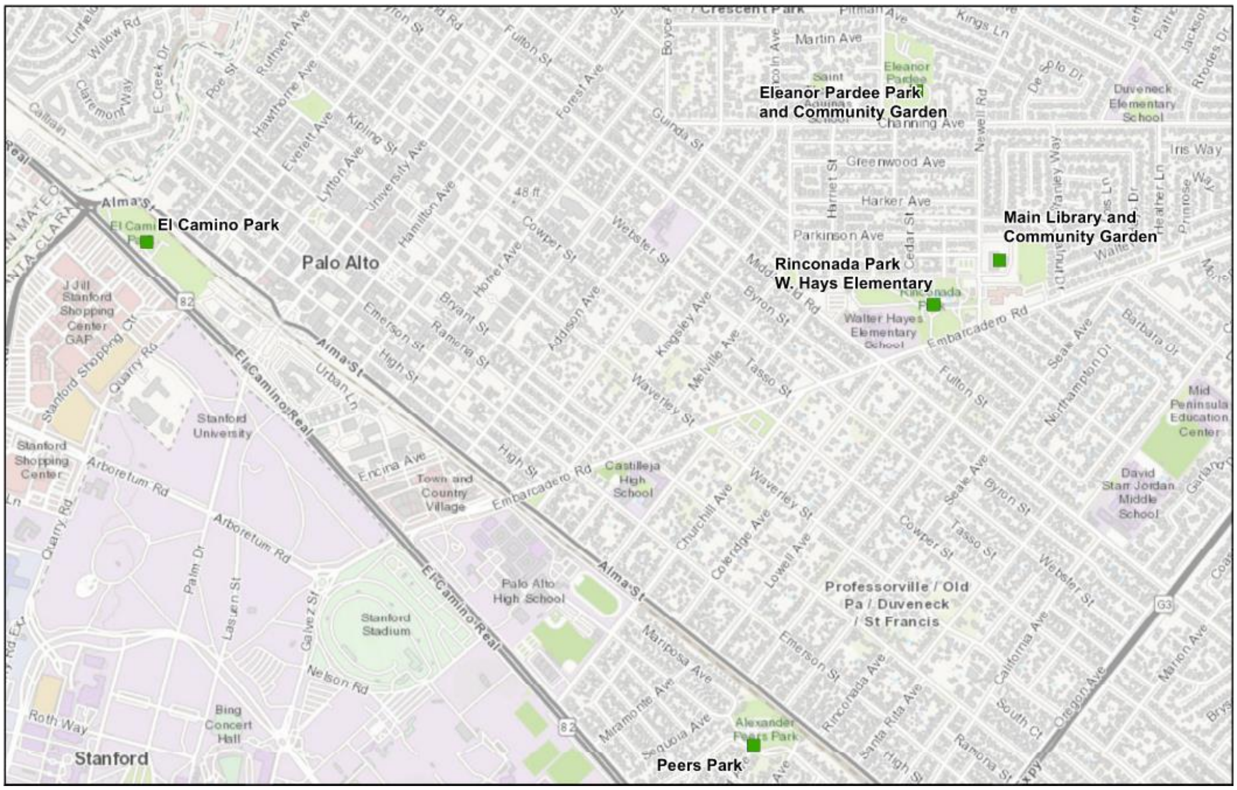


Figure 3: Parks Considered for Groundwater Irrigation

Irrigation demand for each of the parks and adjacent public land such a community gardens and schools was obtained from the 2019 Northwest County Recycled Water Strategic Plan prepared to assess drought-proof recycled water expansion opportunities throughout the Palo Alto Regional Water Quality Control Plant service area[5,6]. The Strategic Plan evaluated landscape irrigation demands as summarized in Table 2. Additionally, Rinconada Park water meter data was provided for the period January 2019 to December 2019, which showed an annual demand of 12.4 AFY in 2019 and a peak summer demand of 100 to 125 gallons per minute (gpm).

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5 https://www.cityofpaloalto.org/gov/depts/pwd/pollution/recycled_n_other_non_potable_water.asp

6 https://www.cityofpaloalto.org/news/displaynews.asp?Newsid=2101&targetid=65

Table 2: Park Irrigation Demands

Park	Irrigation Demand	
Main Library and Garden	9.6 AFY	--
Rinconada Park/W. Hays Elementary	9.1 to 12.4* AFY	100 to 125 gpm*
El Camino Park	6.8 AFY	--
Eleanor Pardee Park and Garden	10.9 AFY	--
Peers Park	14.7 AFY	--
Total	**51 to 54 AFY**	**--**

*Note: Based on 2019 meter data

Although data is not available for all the parks, it is reasonable to assume based on data available that the maximum irrigation demand is 200 gpm or less for all the parks.

The existing emergency supply wells are equipped with pumps designed to supply water to large diameter pipes that supply the Emergency Water Supply and Storage Project. Well capacities range from 600 gpm at the Main Library to 3,300 gpm at Rinconada Park. The comparison in Table 3 shows that well capacities significantly exceed irrigation demands at all the parks.

Table 3: Comparison of Emergency Water Supply Well Capacity and Irrigation Demand

Capacity/Demand (gpm)	El Camino Park	Eleanor Pardee Park and Garden	Rinconada Park/W.Hays Elementary	Main Library and Garden	Peers Park
Well Capacity (gpm)	1,850	1,000	3,300	600	1,700
Irrigation Demand (gpm)	<200	<200	<200	<200	<200

5 Irrigation Alternatives

Converting the park irrigation systems to a local groundwater supply would offset demand of high-quality potable water from the SFPUC/Hetch Hetchy system. The park irrigation systems are currently supplied from a metered connection to the City’s potable water system with an average supply pressure of 60 to 65 pounds per square inch (psi). As shown in Table 3, the emergency wells have sufficient capacity to supply irrigation demands for each of the parks.

The following three options were considered to convert the existing park irrigation systems to a local groundwater supply:

1. Using existing emergency wells for irrigation and backup potable supply;
2. Converting existing emergency potable wells to irrigation wells;
3. Install new irrigation wells.

Each of the options are discussed in the following sections.

5.1 Use Existing Emergency Wells for Irrigation and Potable Backup

The emergency supply wells are equipped with pumps designed to pump high volumes of water into large diameter pipes that feed the Emergency Water Supply and Storage Project. Existing emergency well pumps range between 220 and 350 horsepower each. The volume and pressure of the emergency supply system far exceed the volume and pressure requirements for the park irrigation systems. Groundwater well capacities range between 600 and 3,300 gpm and irrigation demands are estimated to be less than 200 gpm.

Even if hydropneumatic storage tanks were installed at each of the parks, the existing high-powered well pumps would be oversized to supply water to the existing irrigation systems and would lead to broken/burst pipelines and damaged irrigation systems from high pressure caused by the oversized pumps. Overall, connecting the existing wells, as they are currently equipped, to supply the park irrigation systems is not technically feasible.

5.2 Convert Existing Emergency Potable Wells to Irrigation Wells

To utilize the emergency supply wells for irrigation, the existing well pumps could be replaced with smaller pumps. The high-powered pumps would be pulled from the well and replaced with smaller pumps sized to better supply the park irrigation demand. The wells would have to be disconnected from the Emergency Water Supply and Storage Project Supply because the pumps would not have the power to supply water into the potable water system any longer.

Table 4 shows the contribution that each of the wells makes up of the total Emergency Water Supply and Storage Project capacity of 11,300 gpm. If all five of the wells were converted to irrigation wells, the City would give up 8,450 gpm, or about 75% of the total Emergency Water Supply and Storage Project capacity. This would result in the undesirable consequence of losing a source of emergency water.

Table 4: Contribution of Each Well to the Total Emergency Water Supply

Capacity/Demand (gpm)	El Camino Park	Eleanor Pardee Park	Rinconada Park	Main Library	Peers Park
Well Capacity (gpm)	1,850	1,000	3,300	600	1,700
% of Total Emergency Water Supply that would be lost if converted to irrigation (11,300 gpm)	16%	9%	29%	5%	15%

5.3 Install New Irrigation Wells

A third groundwater alternative for park irrigation is to drill new irrigation wells at the parks[7]. Since the demand for the wells would be for irrigation purposes only, the new wells would be permitted as non-potable supplies, and the wells would be shallower and smaller diameter than the existing City wells. The new irrigation wells would not be limited to the current locations of the existing emergency supply wells and could be expanded to other park irrigation systems such as Greer Park. For the purposes of this study, additional well sites were not evaluated.

[7] https://www.waterboards.ca.gov/gama/docs/wellowner_guide.pdf

The non-potable wells would rely on the shallow unconfined aquifer and the existing wells would remain part of the Emergency Water Supply and Storage Project. Installing new irrigation wells in the shallow aquifer will not have a significant effect on the emergency water supply and would add to the City's water supply diversity and resiliency.

The budgetary cost for constructing a new non-potable well drilled to a maximum depth of 200 feet with 4- to 6-inch diameter casing is $75,000 per well as summarized in Table 5. If a well is constructed in each of the five parks, the total budgetary cost would be $375,000. Well construction permit fees are typically less than $1,000 per well[8].

Table 5: New Irrigation Well Planning Level Capital Cost Estimate

Item	Planning Level Cost	Description
Well Construction (200-foot depth; 4-6-inch diameter)	$50,000	Well drilling, disposal of well cuttings, permit fee, well development, pump testing
Well Equipping	$15,000	Electrical supply, pump, flow totalizer, surface improvements (i.e. mesh cage)
Conversion of Existing Irrigation System to Non-potable	$10,000	Excavation, valves, piping, signage
Total Budgetary Allowance*	**$75,000**	**Cost per well**

*Excludes CEQA review and additional study to site new wells.

The annual operations and maintenance costs for five new shallow irrigation wells with an irrigation demand of 54 AFY is estimated to be $119,800 or approximately $24,000 per well. Table 6 summarizes the estimated O&M costs associated with five new 4 to 6-inch diameter, 200-foot deep irrigation wells. O&M costs include groundwater pumping charges, electrical power, specific capacity testing, and routine maintenance. Costs for airlifting the five wells every 10 years have been annualized to $1,200 per year. These are high level planning costs as the annual costs for each well may be higher or lower depending on the actual depth of the well and system operation.

Table 6: Annual Operations and Maintenance Budget (5 New Wells)

Item	Annual Budget	Assumptions
Groundwater Pumping Charge	$105,000	Valley Water groundwater pumping charge 54 AFY @ $1,940/AF
Pumping Power	$9,000	Irrigating 4 hrs / day for 8 months, $0.20 / kWh, 65 psi delivery pressure
Annual Specific Capacity Tests	$2,500	Palo Alto Staff labor $100 / hour, 5 hours per well
Pump Servicing and Well Airlifting (Annualized)	$3,300	Service pumps twice per year: 2 hours @ $105 / hour Airlifting: $2,400 / well every 10 years
Total	**$119,800/year**	**For 5 new irrigation wells**

[8] https://www.valleywater.org/contractors/doing-businesses-with-the-district/wells-and-well-owners

6 Summary and Conclusions

This study considered three alternatives for irrigating City parks with local groundwater to offset demand for potable water from the SFPUC/Hetch Hetchy supply. Existing emergency supply wells at each of the parks were considered as an irrigation source, but technical considerations due to differences between the emergency supply system and the park's irrigation system would require the wells to be removed from the emergency supply system to supply the smaller demands of the irrigation system. This would result in the undesirable consequence of losing a source of emergency water.

To preserve existing wells for emergency supply, new wells could be constructed solely for non-potable irrigation use. This alternative would utilize the shallow groundwater beneath each of the parks and offset demand for the potable water from the SFPUC/Hetch Hetchy supply while preserving emergency groundwater supply from the existing wells. There should be no impact on groundwater-dependent ecosystems due to the small irrigation demand (54 AFY), although no analysis is presented. It is recommended that if any of these options are pursued in the future, environmental impacts will have to be fully evaluated prior to construction. Table 7 compares the advantages and disadvantages for each of the alternatives analyzed in this study.

Table 7: Comparison of Alternatives

Alternative	Conclusions
Use Existing Emergency Supply Wells for Irrigation	Not technically feasible due to differences in system pressure and flow requirements
Convert Existing Emergency Supply Wells to Irrigation Wells	Technically feasible, lowest capital cost, but emergency water supply would be lost
Install New Irrigation Wells	Technically feasible, highest capital cost, preserves emergency groundwater supply, adds operations and maintenance costs for City

It is estimated that each new well would cost approximately $75,000 to construct and could completely offset the irrigation demand for the park. Depending on the park, it is estimated that each new well could offset between 7 and 15 AF per year of potable water. The annual cost for O&M is estimated at approximately $24,000 per well.

7 References

City of Palo Alto Utilities. 2016. 2015 Urban Water Management Plan. June.

City of Palo Alto Utilities. 2017. Water Integrated Resources Plan. January.

Todd Groundwater, Woodard & Curran. 2018. Groundwater Assessment and Indirect Potable Reuse Feasibility Evaluation and Implementation Strategy Northwest County Recycled Water Strategic Plan. November.

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