STATE WATER RESOURCES CONTROL BOARD
WATER SUPPLY STRATEGY IMPLEMENTATION
WATER AVAILABLE FOR BRACKISH GROUNDWATER DESALINATION

Background

The Water Supply Strategy requires the State Water Board, by January 1, 2024, to review groundwater basins impaired by salts and nutrients and determine the volume of water available for brackish groundwater desalination. State Water Board staff (staff) coordinated with Department of Water Resources staff to identify nine planned brackish groundwater desalination facilities that could provide an estimated 20,000 acre-feet of potable water by 2040. Staff completed a review of salt and nutrient management plans (SNMPs) and coordinated with the United States Geologic Survey (USGS) to identify existing data sources and data gaps to evaluate the additional volume of water available for brackish groundwater desalination. Additionally, staff identified areas in California with the highest potential for brackish groundwater desalination projects, potential impediments to bringing brackish groundwater desalination online, and recommendations for next steps.

Deliverable: Groundwater basins with the highest potential for brackish groundwater desalination projects.

Attachment 1 shows a map of existing brackish groundwater desalination projects, projects scheduled to be operational by 2040, and groundwater basins identified as having potential for brackish groundwater desalination. **Attachment 2** includes a table of groundwater basins in each region with at least ten percent of their extraction wells having salinity over 1,000 mg/L total dissolved solids (TDS), which was used as an initial indication of potential for a brackish groundwater desalination project.

The highest potential for brackish groundwater desalination exists in coastal groundwater basins with access to existing infrastructure for brine disposal and where the extraction is consistent with the local Groundwater Sustainability Plan. Groundwater Sustainability Plans may preclude brackish groundwater desalination where the extraction causes undesirable results such as exacerbating aquifer draw-down or seawater intrusion. Basins or subbasins already impacted by seawater intrusion may be strong candidates for brackish groundwater desalination and warrant further evaluation. Staff was not able to estimate the total volume available for brackish groundwater desalination in California because of limitations of information in available datasets, like pumping rates, aquifer sources, etc. However, this analysis can serve as a starting point to locate areas for further site-specific analyses such as feasibility evaluations, groundwater quality assessments, and modeling, to evaluate volumetric potential for brackish groundwater desalination projects.

Methodology

State Water Board staff analyzed data from the SNMPs and the Groundwater Ambient Monitoring and Assessment Program's Groundwater Information System (GAMA GIS) to identify basins and sub-basins with salinity concentrations above a brackish water threshold of 1,000 mg/L TDS. Staff excluded data from wells identified for regulatory

cleanup and monitoring purposes because these wells are often very shallow and do not reflect the conditions of the groundwater aquifers used for drinking, irrigation, industrial, or other beneficial uses. Staff also verified the data with the regional water quality control boards (regional water boards) and used airborne electromagnetic survey data collected by the Department of Water Resources.

These data were used to develop a map of groundwater basins and sub-basins that may hold the potential for future brackish groundwater desalination projects (Attachment 1). Attachment 1 also includes the existing brackish groundwater desalination projects and projects planned to be operational by 2040, as well as the locations of known seawater intrusion barrier projects. The table in Attachment 2 lists these eighty-four basins and subbasins including number of wells available, the number of wells above 1,000 mg/L TDS, and the percentage of wells above this threshold. Although the data that are currently available were insufficient to estimate the volume of brackish groundwater available for desalination, staff identified research needs and next steps provided in the recommendations below. These recommendations also include considerations and challenges to the desalination of groundwater.

Opportunities for Brackish Groundwater Desalination in Coastal Basins

- Brackish groundwater is less saline than seawater, ranging from 1,000 to 10,000 mg/L in TDS compared with 35,000 mg/L for seawater. Consequently, when compared to seawater desalination, brackish water desalination requires less treatment, reducing energy requirements, costs, construction impacts, and brine concentration and volume to treat the water to drinking water standards.
- In addition to augmenting drinking water, brackish groundwater can be desalinated for other purposes that may require less treatment, including for cooling during power generation, irrigation, livestock watering, aquaculture, and in the oil and gas industry for drilling, enhanced recovery, and hydraulic fracturing to reduce the use of conventional water supplies in situations for which it is not required (https://pubs.usgs.gov/fs/2018/3010/fs20183010_.pdf).
- Shallow brackish groundwater can be extracted using conventional vertical well drilling technologies, which are more feasible and less expensive to implement than some seawater desalination intake technologies. .
- Optimizing existing water infrastructure for brine management can further reduce costs to be more competitive with other potential water supply sources, although costs remain high relative to some water supplies. The Pacific Institute estimates brackish groundwater desalination facilities cost between $840-$1,700 per acre foot, relative to $1,900-$4,100 for seawater desalination facilities or $550-$2,200 for recycled water facilities.

Challenges to Developing Brackish Groundwater Desalination

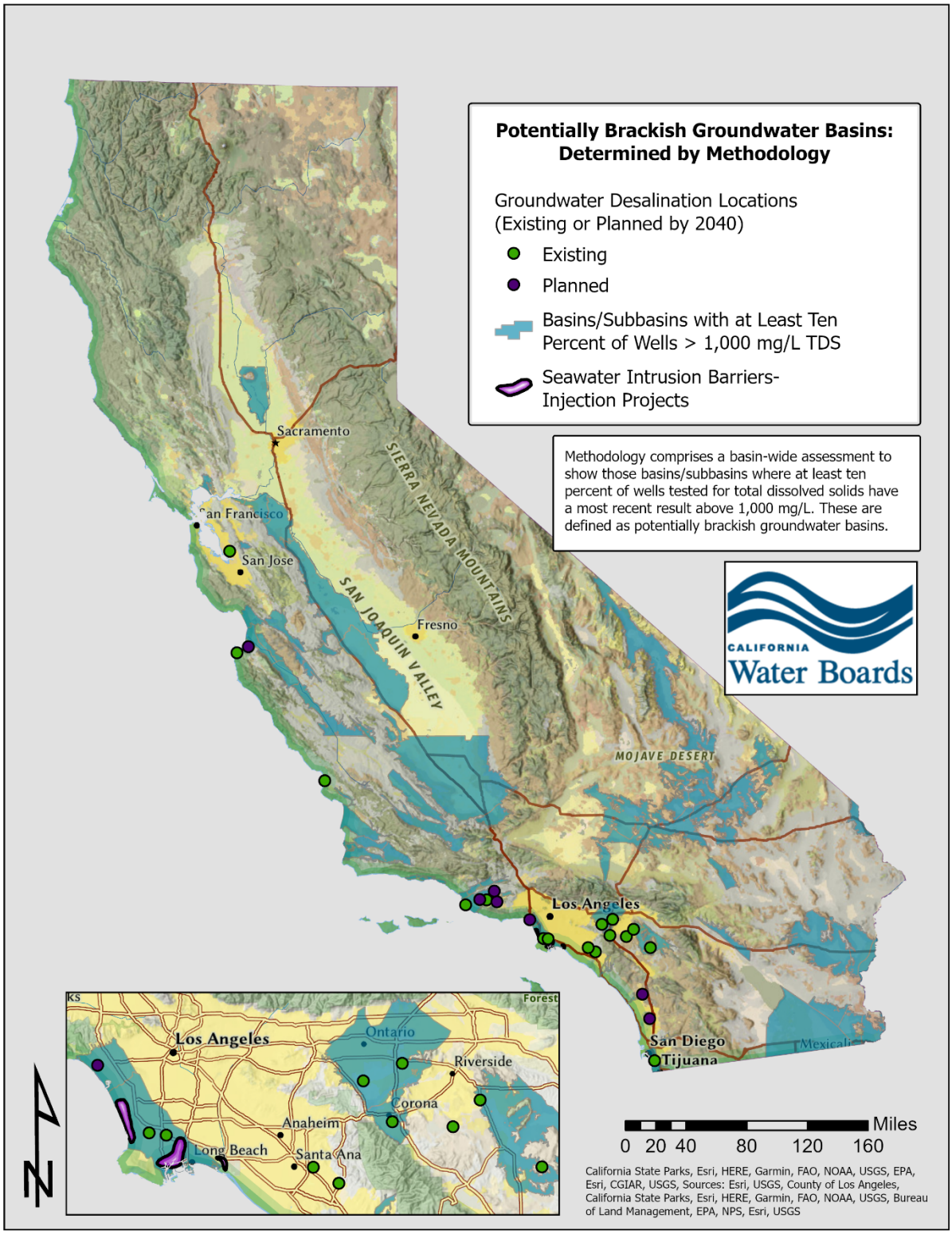
- Project-specific modeling of local or regional aquifer impacts from extraction is needed to ensure projects do not degrade water quality due to mobilization of potential contaminants or exacerbate seawater intrusion or subsidence in vulnerable basins.

- Projects must be sized for the amount of groundwater that a particular aquifer can provide. Porous aquifers, such as those in a sand or gravel matrix, may allow more water to flow more freely than those aquifers comprising hard rock. Site-specific evaluations will be needed to assess the extractive potential for each basin.
- Brackish groundwater in adjudicated basins and basins with Groundwater Sustainability Plans under the Sustainable Groundwater Management Act (SGMA) must be extracted consistent with the adjudication or Plan, which may limit the volumes of brackish groundwater potentially available for desalination.
- Some chemical constituents may be found in brackish groundwater at high concentrations requiring additional treatment depending on use. Even naturally occurring compounds may render the groundwater unsuitable for certain uses. Project-specific groundwater quality assessments can ensure the extracted brackish groundwater is appropriate for a particular use.
- Appropriate brine management options and proximity to distribution systems are often limiting factors for otherwise feasible projects, particularly for inland areas. Projects closer to the coast with access to existing brine disposal mechanisms and existing distribution systems have a higher likelihood of success.

Recommendations

1. **Conduct Site Specific Evaluations:** Water purveyors considering brackish groundwater desalination should conduct local basin feasibility assessments to assess potential for desalinating brackish groundwater. Local evaluations should consider factors that affect the implementation of brackish groundwater desalination including availability of lower cost alternatives, funding need, affordability, environmental justice issues, local hydrogeologic conditions, extractive potential, proximate water users, treatment requirements, permitting considerations, energy use, and brine disposal options.
2. **Improve Coordination:** Continued coordination among groundwater sustainability agencies (under SGMA), SNMP groups, drinking water purveyors, urban water management plan developers, and other relevant programs is needed to (1) identify areas where there is overlap between the need for potable water and opportunities to meet the need through brackish groundwater desalination, and (2) identify potential impediments and solutions to bring projects online in an environmentally responsible manner.
3. **Increase Groundwater Quality Data:** Augment the collection and submission of groundwater quality information to the GAMA GIS to expand the knowledge of areas where brackish groundwater can be suitable to augment water supplies (most current data are collected to monitor groundwater for safe drinking water purposes, so data gaps exist in areas where groundwater is brackish and not suitable for drinking). Filling data gaps could be accomplished by expanding studies within the GAMA Program to analyze and identify areas of brackish groundwater statewide and/or enhance understanding of aquifer volume in these areas, if funds become available in future.

Attachment 1: Existing and Planned Brackish Desalination Facilities and Groundwater Basins/Subbasins with Brackish Groundwater to Further Investigate for Future Brackish Desalination Facilities



Attachment 2: Groundwater Basins/Subbasins with Brackish Groundwater by Regional Water Board to Further Investigate for Future Brackish Desalination Facilities

North Coast Region

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
1-061	1-061	Fort Ross Terrace Deposits	Fort Ross Terrace Deposits	1	5	20%

San Fransico Bay Region

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
2-011	2-011	Sunol Valley	Sunol Valley	1	1	100%
2-004	2-004	Pittsburg Plain	Pittsburg Plain	3	9	33.3%
2-002	2-002.03	Napa-Sonoma Valley	Napa-Sonoma Valley - Napa-Sonoma Lowlands	2	12	16.7%

Central Coast Region

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
3-013	3-013	Cuyama Valley	Cuyama Valley	89	103	86.4%
3-030	3-030	Bitter Water Valley	Bitter Water Valley	1	2	50%
3-005	3-005	Cholame Valley	Cholame Valley	4	8	50%
3-003	3-003.05	Gilroy-Hollister Valley	Gilroy-Hollister Valley - North San Benito	258	617	41.8%
3-015	3-015	Santa Ynez River Valley	Santa Ynez River Valley	227	563	40.3%
3-012	3-012.02	Santa Maria River Valley	Santa Maria River Valley - Arroyo Grande	26	66	39.4%
3-012	3-012.01	Santa Maria River Valley	Santa Maria River Valley - Santa Maria	390	1045	37.3%
3-049	3-049	Montecito	Montecito	7	19	36.8%
3-053	3-053	Foothill	Foothill	4	11	36.4%

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
3-004	3-004.05	Salinas Valley	Salinas Valley - Upper Valley Aquifer	108	311	34.7%
3-016	3-016	Goleta	Goleta	10	30	33.3%
3-017	3-017	Santa Barbara	Santa Barbara	14	46	30.4%
3-004	3-004.04	Salinas Valley	Salinas Valley - Forebay Aquifer	172	649	26.5%
3-019	3-019	Carrizo Plain	Carrizo Plain	2	8	25%
3-052	3-052	Needle Rock Point	Needle Rock Point	1	4	25%
3-041	3-041	Morro Valley	Morro Valley	6	28	21.4%
3-044	3-044	Pozo Valley	Pozo Valley	1	5	20%
3-004	3-004.01	Salinas Valley	Salinas Valley - 180/400 Foot Aquifer	127	698	18.2%
3-028	3-028	San Benito River Valley	San Benito River Valley	3	17	17.6%
3-004	3-004.08	Salinas Valley	Salinas Valley - Seaside	5	35	14.3%
3-009	3-009	San Luis Obispo Valley	San Luis Obispo Valley	20	142	14.1%
3-014	3-014	San Antonio Creek Valley	San Antonio Creek Valley	21	166	12.7%
3-002	3-002.01	Corralitos	Corralitos - Pajaro Valley	123	1055	11.7%
3-018	3-018	Carpinteria	Carpinteria	10	89	11.2%
3-004	3-004.02	Salinas Valley	Salinas Valley - East Side Aquifer	50	464	10.8%
3-042	3-042	Chorro Valley	Chorro Valley	1	10	10%

Los Angeles Region

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
4-016	4-016	Hidden Valley	Hidden Valley	2	2	100%
4-009	4-009	Simi Valley	Simi Valley	4	4	100%
4-004	4-004.03	Santa Clara River Valley	Santa Clara River Valley - Mound	2	3	66.7%
4-004	4-004.04	Santa Clara River Valley	Santa Clara River Valley - Santa Paula	9	16	56.3%
4-004	4-004.05	Santa Clara River Valley	Santa Clara River Valley - Fillmore	9	18	50%

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
4-004	4-004.06	Santa Clara River Valley	Santa Clara River Valley - Piru	2	4	50%
4-004	4-004.02	Santa Clara River Valley	Santa Clara River Valley - Oxnard	41	83	49.4%
4-006	4-006	Pleasant Valley	Pleasant Valley	7	17	41.2%
5-022	5-022.07	San Joaquin Valley	San Joaquin Valley - Delta-Mendota	47	138	34.1%
4-011	4-011.03	Coastal Plain of Los Angeles	Coastal Plain of Los Angeles - West Coast	70	222	31.5%
4-011	4-011.01	Coastal Plain of Los Angeles	Coastal Plain of Los Angeles - Santa Monica	8	27	29.6%

Central Valley Region

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
5-021	5-021.62	Sacramento Valley	Sacramento Valley - Sutter	8	44	18.2%
4-008	4-008	Las Posas Valley	Las Posas Valley	5	36	13.9%
5-023	5-023	Panoche Valley	Panoche Valley	1	1	100%
5-022	5-022.17	San Joaquin Valley	San Joaquin Valley - Kettleman Plain	2	2	100%
5-083	5-083	Cuddy Ranch Area	Cuddy Ranch Area	5	8	62.5%
5-022	5-022.09	San Joaquin Valley	San Joaquin Valley - Westside	17	30	56.7%
5-022	5-022.14	San Joaquin Valley	San Joaquin Valley - Kern County	280	851	32.9%
5-022	5-022.15	San Joaquin Valley	San Joaquin Valley - Tracy	11	61	18%
5-022	5-022.19	San Joaquin Valley	San Joaquin Valley - East Contra Costa	10	58	17.2%
5-022	5-022.18	San Joaquin Valley	San Joaquin Valley - White Wolf	1	8	12.5%

Lahontan Region

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
6-037	6-037	Coyote Lake Valley	Coyote Lake Valley	1	1	100%
6-035	6-035	Cronise Valley	Cronise Valley	5	6	83.3%
6-032	6-032	Broadwell Valley	Broadwell Valley	1	2	50%
6-018	6-018	Death Valley	Death Valley	2	4	50%
6-048	6-048	Goldstone Valley	Goldstone Valley	4	9	44.4%
6-038	6-038	Caves Canyon Valley	Caves Canyon Valley	2	5	40%
6-036	6-036.02	Langford Valley	Langford Valley - Irwin	7	23	30.4%
6-047	6-047	Harper Valley	Harper Valley	28	114	24.6%
6-036	6-036.01	Langford Valley	Langford Valley - Langford Well Lake	4	19	21.1%
6-024	6-024	Red Pass Valley	Red Pass Valley	1	5	20%
6-040	6-040	Lower Mojave River Valley	Lower Mojave River Valley	21	118	17.8%
6-022	6-022	Upper Kingston Valley	Upper Kingston Valley	1	6	16.7%
6-041	6-041	Middle Mojave River Valley	Middle Mojave River Valley	6	38	15.8%
6-033	6-033	Soda Lake Valley	Soda Lake Valley	1	7	14.3%
6-043	6-043	El Mirage Valley	El Mirage Valley	6	47	12.8%
6-025	6-025	Bicycle Valley	Bicycle Valley	3	28	10.7%

Colorado River basin

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
7-034	7-034	Amos Valley	Amos Valley	3	3	100%
7-038	7-038	Palo Verde Valley	Palo Verde Valley	10	13	76.9%
7-044	7-044	Needles Valley	Needles Valley	6	11	54.5%
7-036	7-036	Yuma Valley	Yuma Valley	3	6	50%
7-035	7-035	Ogilby Valley	Ogilby Valley	6	13	46.1%
7-039	7-039	Palo Verde Mesa	Palo Verde Mesa	5	12	41.7%
7-030	7-030	Imperial Valley	Imperial Valley	3	14	21.4%
7-021	7-021.03	Coachella Valley	Coachella Valley - Desert Hot Springs	2	10	20%
7-005	7-005	Chuckwalla Valley	Chuckwalla Valley	1	6	16.7%
7-013	7-013.01	Deadman Valley	Deadman Valley - Deadman Lake	1	10	10%

Santa Ana Region

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
8-005	8-005	San Jacinto	San Jacinto	27	111	24.3%
8-002	8-002.01	Upper Santa Ana Valley	Upper Santa Ana Valley - Chino	31	238	13%
8-002	8-002.09	Upper Santa Ana Valley	Upper Santa Ana Valley - Temescal	3	27	11.1%

San Diego Region

Basin Number	Subbasin Number	Basin Name	Subbasin Name	Wells with TDS >1,000 mg/L	Total Wells	Percent Brackish Wells
9-007	9-007.02	San Luis Rey Valley	San Luis Rey Valley - Lower San Luis Rey Valley	10	10	100%
9-033	9-033	Coastal Plain of San Diego	Coastal Plain of San Diego	39	50	78%
9-001	9-001	San Juan Valley	San Juan Valley	7	10	70%
9-015	9-015	San Diego River Valley	San Diego River Valley	4	8	50%