MONTGOMERY & ASSOCIATES
Water Resource Consultants

REPORT

July 29, 2024

Updated Inventory of Brackish Groundwater in Arizona

Prepared for:

Arizona Department of Water Resources

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Prepared for:

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1 INTRODUCTION

Montgomery & Associates (M&A) prepared this statewide inventory of brackish groundwater for the Arizona Department of Water Resources (ADWR). This report summarizes the physical and chemical characteristics of brackish groundwater in Arizona based on publicly available information. It includes datasets, methodology, and results of the analysis. In all, 21 individual study areas were identified with brackish groundwater. ADWR selected 4 of these as focus areas for further evaluation within the following groundwater basins: Gila Bend, Ranegras Plain, West Salt River Valley, and the Little Colorado River Plateau. The information in this report provides a foundation for planning for development of brackish groundwater resources. The report does not include policy or regulatory considerations or engineering cost estimates of water treatment and other infrastructure requirements, which would also need to be part of any feasibility evaluation or pilot demonstration project.

1.1 Previous Investigations

Two previous investigations identified and characterized brackish groundwater in Arizona. In 1981, ADWR published a map of areas of known brackish or saline groundwater (Daniel, 1981). The map highlighted the substantial brackish groundwater resources in the Little Colorado River Plateau groundwater basin and along the Gila River corridor. Additional smaller areas with brackish groundwater were identified in northern, western, and southeastern portions of the state.

In 2008, M&A prepared an updated brackish groundwater inventory for the Central Arizona Water Conservation District (CAWCD). Several areas with brackish groundwater were identified throughout the State based on the presence of total dissolved solids (TDS) concentrations above 1,000 milligrams per liter (mg/L). These areas are generally consistent with those mapped by Daniel (1981) with an important exception noted for the Little Colorado River Plateau area, which was determined to have a much greater extent of brackish groundwater than previously mapped (M&A, 2008). Ultimately, 14 areas were identified as feasible for large-scale withdrawals, defined as potentially capable of sustaining a future desalination project of 10,000 acre-feet per year (AF/yr) or greater for at least 30 years. These 14 areas were estimated to have over 600 million AF (MAF) of brackish groundwater in storage, generally at depths of less than 1,200 feet (McGavock and Cullom, 2008). Additional evaluation based on CAWCD priorities, which included the opportunity to augment supply for CAP users, identified the 5 most promising areas: Buckeye, Gila Bend, Picacho, Yuma Mesa, Yuma Valley, and Winslow-Leupp.

1.2 Current Study Motivation

In the past few years, there has been renewed interest in evaluating the use of brackish groundwater to augment Arizona's limited water supplies. Several recent initiatives by Arizona's executive branch and legislature have recognized desalinated brackish groundwater as a potential water supply. In 2018, the Legislature held a "Brackish Groundwater Conference," supported by staff from ADWR. From 2016 to 2018, the Governor's Water Augmentation Council (GWAC) convened both a Desalination Committee and a Long-Term Water Augmentation Committee that recommended further evaluation of brackish groundwater for augmentation. From 2019 to 2022, the Governor's Water Augmentation, Innovation, and Conservation Council (GWAICC) formed a Desalination Committee that included a subcommittee to evaluate the legal and regulatory obstacles to developing brackish groundwater. In 2023, the Legislature appropriated funds for ADWR to prepare an updated inventory of brackish groundwater in Arizona, which is the source of funding for this report. Also in 2023, the state budget included $11M for a brackish groundwater desalination pilot project, although the project had not been initiated and these funds were ultimately taken back for the 2024 budget.

2 STATEWIDE INVENTORY

Public datasets from wells around the state were used to update the statewide inventory of brackish groundwater areas. As with the previous investigation (M&A, 2008), brackish groundwater areas were delineated where TDS concentrations are above 1,000 mg/L.

2.1 Study Areas

The TDS concentration of groundwater is often estimated from the electrical conductivity (EC) of water, which can be easily measured in the field. Because a strong correlation exists between TDS and EC, TDS can be estimated from EC measurements (Driscoll, 1986).

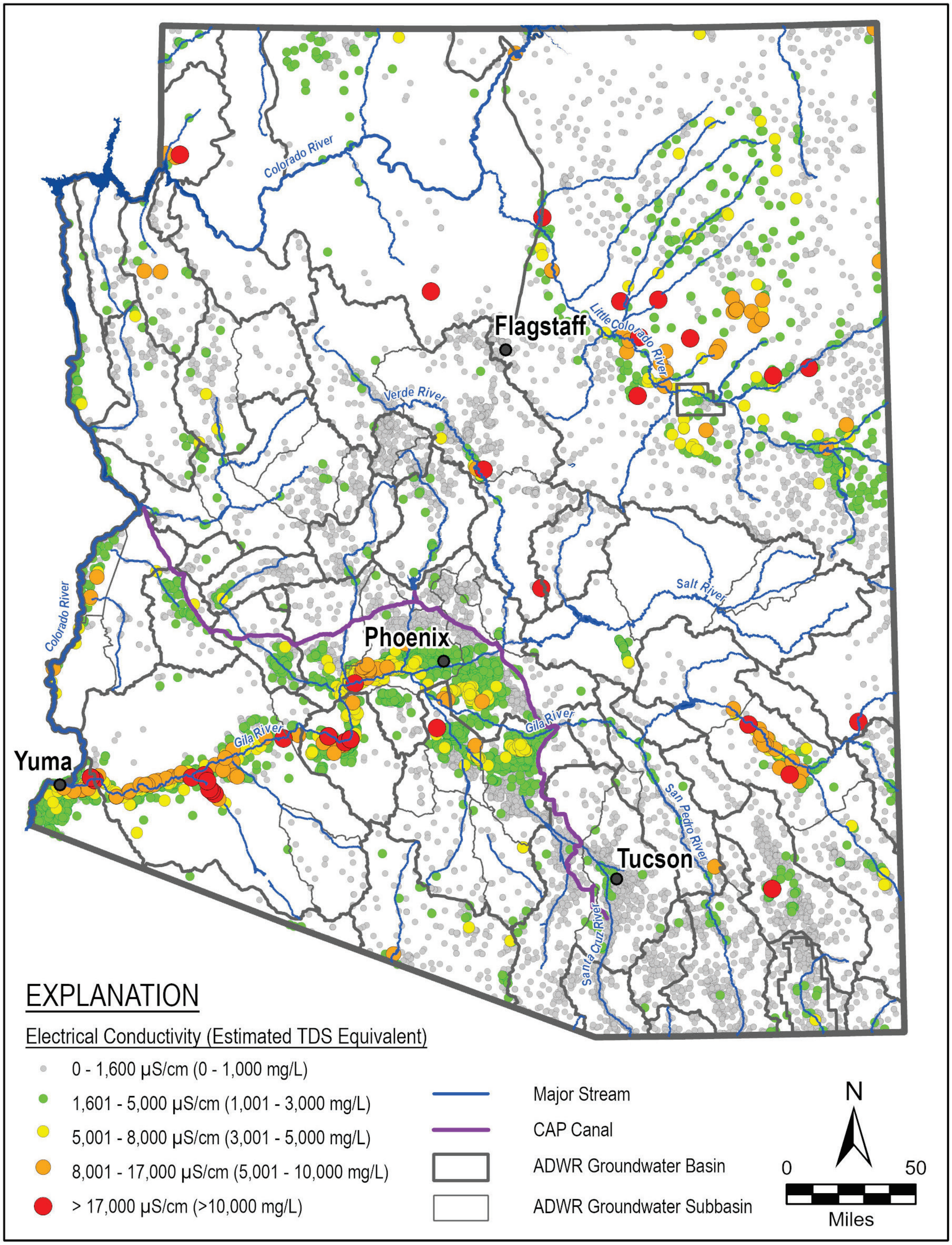
Figure 2-1 shows the most recent measurement of EC for a given well based on groundwater data from the U.S. Geological Survey (USGS) National Water Information System (NWIS) and ADWR Groundwater Site Inventory (GWSI) databases[1]. The brackish groundwater areas stand out with a high density of colored dots and are similar to those in previous investigations. The general distribution of brackish groundwater has not changed significantly since the most recent study in 2008; very little new data have been collected since that time, and some areas of the state lack data.

Figure 2-2 shows the distribution of sampling date for the measurements shown on Figure 2-1. Of the 15,475 measurements, 565 are new data not included in the previous study (McGavock and Cullom, 2008); 70% of the data were collected between the 1970s and 1990s.

Figure 2-3 shows the distribution of known well depth for the measurements shown on Figure 2-1. Depth is reported for 87% of the wells, but there are limited data from deep wells, therefore, relationships between TDS and depth are difficult to characterize with this dataset. Generally, elevated TDS levels at shallow depths are influenced by recent land use and at greater depths are likely attributable to geology.

These data were used to delineate Brackish Groundwater Study Areas (study areas) as shown on Figure 2-4. A total of 21 study areas were delineated and are generally named for the groundwater basin or sub-basin in which they are located. The study area boundaries are based on the wells with TDS greater than 1,000 mg/L (converted from EC) within a particular sub-basin, excluding bedrock areas. Because parts of many basins around the state lack data, particularly in rural areas, additional data are required to more precisely estimate the boundaries of brackish groundwater zones in each study area (Figure 2-1).

[1] Based on data through March 8, 2023



G:\GIS-Tuc\Projects\1751\Reports_and_Deliverables\TM_2024\ArcPro_Projects\EC_NWIS_and_StudyAreas\EC_NWIS_and_StudyAreas.aprx EC_TDS_AZ_NWIS_202331May2024

Figure 2-1. Most Recent EC Data from NWIS and GWSI

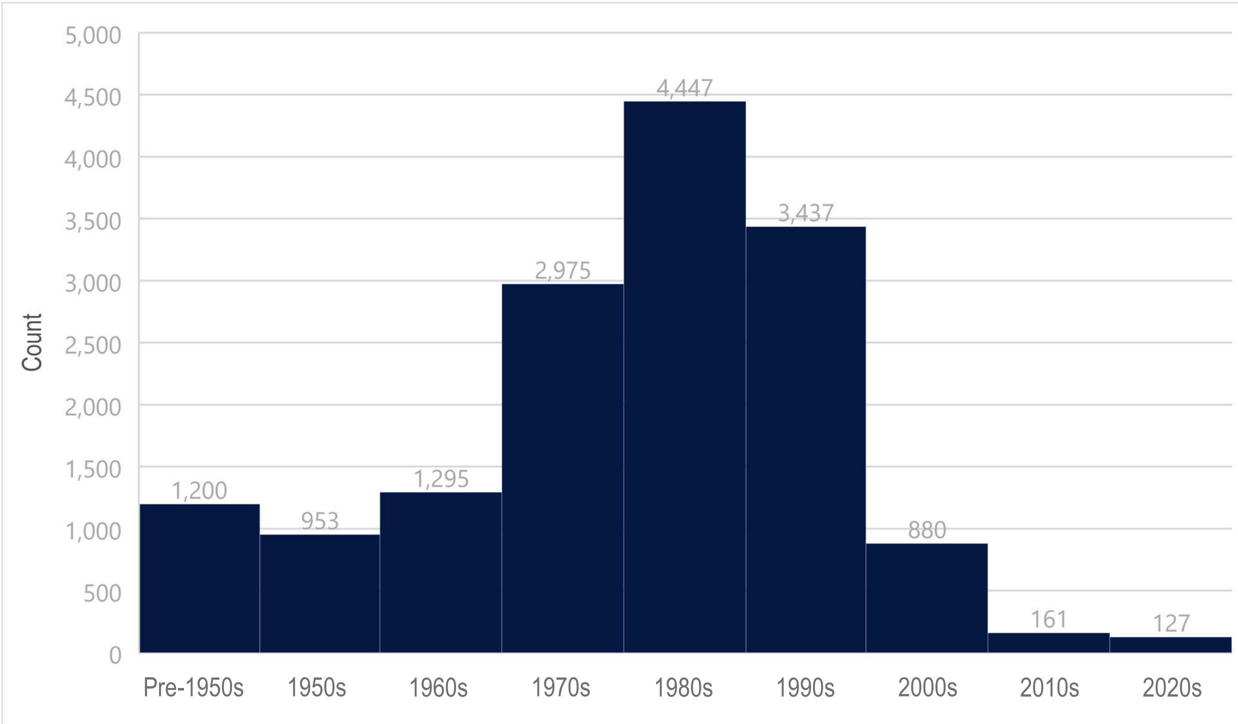


Figure 2-2. Distribution of Most Recent EC Measurement Date of Wells in NWIS and GWSI Datasets

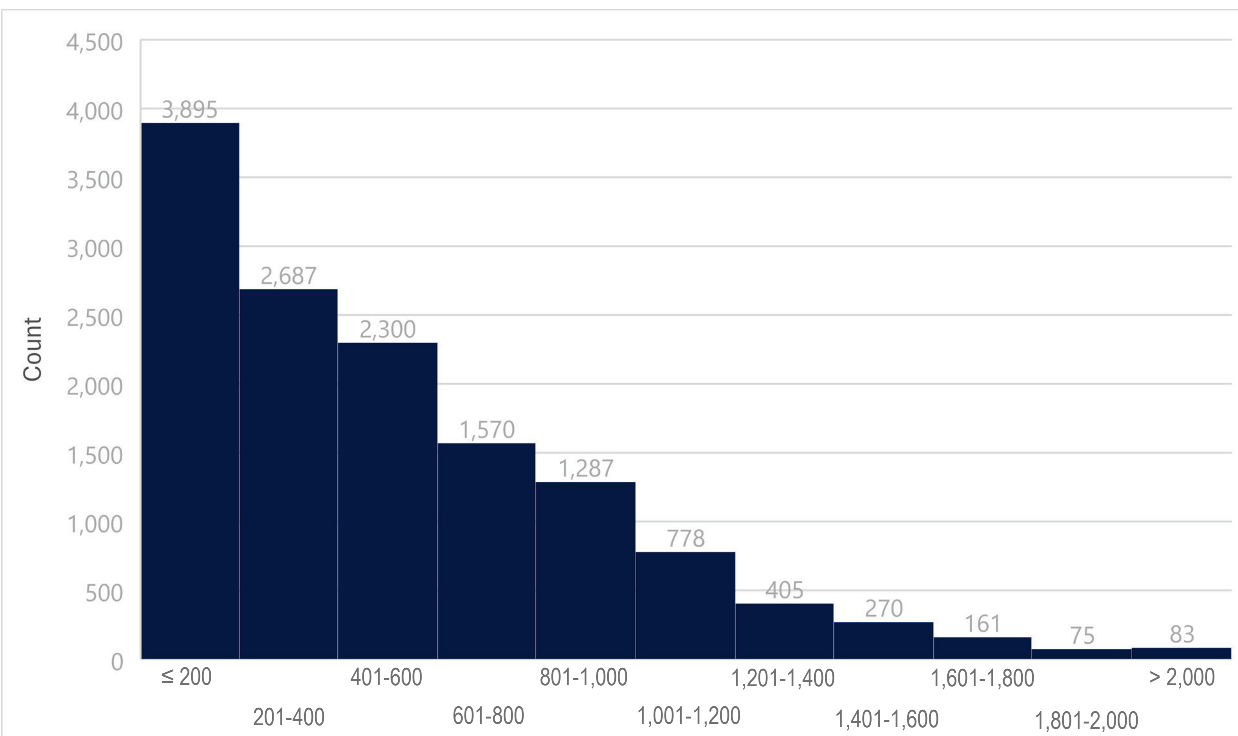


Figure 2-3. Distribution of Known Depths of Wells (in Feet) in NWIS and GWSI Datasets

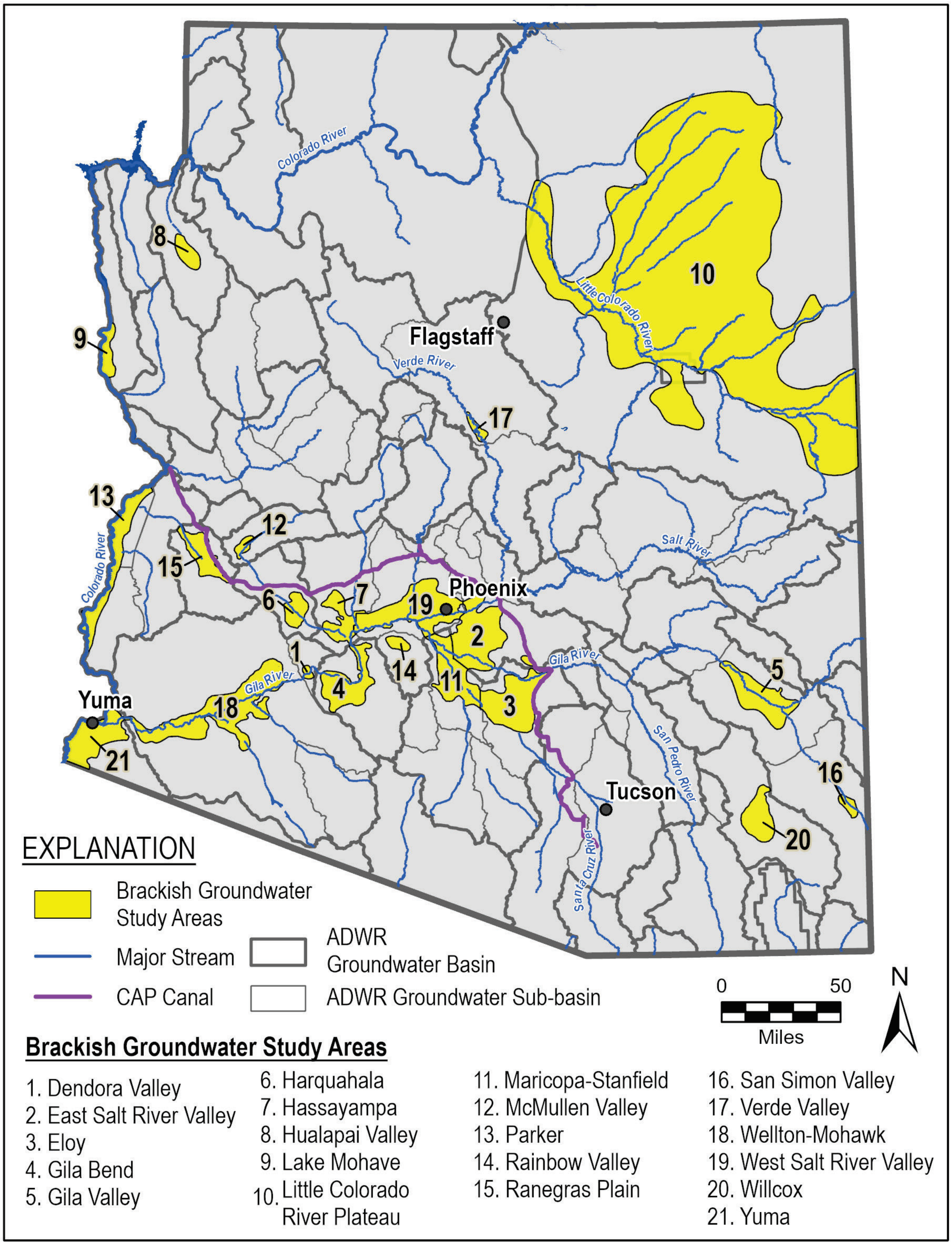


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Figure 2-4. Initial Brackish Groundwater Study Areas

2.2 Study Area Characteristics

Table 2-1 is an inventory of general physical, chemical, and hydrologic characteristics of each of the 21 study areas. The table summarizes characteristics related to development potential of brackish groundwater resources in each study area, which may be useful for future feasibility investigations. Data sources and assumptions are documented in the footnotes.

2.2.1 Groundwater in Storage

Total estimated groundwater in storage in the 21 study areas ranges from 530 MAF to 700 MAF within a specific portion of the aquifer, as discussed below. In many areas these volume estimates include wells with measured TDS data that are non-brackish (fresh) water. Because TDS and depth relationships are not well-characterized, additional data are required to more precisely estimate brackish groundwater in each study area.

The volume estimates represent groundwater in storage within the upper 1,200 to 1,500 feet of the aquifer in the study areas. Maximum depth to the base of the aquifer in many of these areas is several times the 1,200- to 1,500 -foot cutoff depth, and the total groundwater in storage is therefore significantly higher than presented. However, a cutoff depth was implemented to recognize the regulatory, economic, and physical challenges of withdrawing groundwater from greater depths. The 1,200-foot depth is a maximum regulatory drawdown limit for the Adequate Water Supply program. The 1,500-foot depth was selected to represent a maximum economically feasible depth to draw down groundwater levels, although this would need to be evaluated on a site-specific basis. In order to extract all groundwater in the upper 1,500 feet of the aquifer, extraction wells need to be many hundreds of feet deeper. Additionally, productivity of alluvial aquifers generally declines with depth as sediments become more consolidated. Rates of land subsidence in alluvial basins also increase with depth of drawdown. Due to these concerns, the feasibility of extracting groundwater in storage from greater depths needs to be carefully evaluated on a site-specific basis with cost-benefit and sustainability investigations.

With the exception of the Little Colorado River Plateau, all areas are within alluvial basins containing basin-fill aquifers within the basin and range geologic province. For these basins, unconfined conditions were assumed and groundwater in storage was calculated from an average water level depth down to bedrock or a maximum depth of 1,200 and 1,500 feet. A specific yield value of 0.11 was applied, which is the average value in a commonly cited study of basin and range aquifers (Anderson, 1995). Additional details on aquifer storge are provided in Section 3.1.3.

The Little Colorado River Plateau study area is geologically distinct from the alluvial basins of the basin and range province. Its major aquifers are composed of layers of fractured rock rather than unconsolidated alluvial sediments, and conditions range from unconfined to confined. The volume in storage calculation was more complex and is described in Section 3.2.4.

2.2.2 Water Quality

The highest TDS values are measured in the Little Colorado River Plateau and Willcox study areas. Aside from TDS, water quality characteristics summarized in Table 2-1 include hardness, water type, and the presence of trace elements. These factors may indicate which brackish groundwater areas are more suitable for certain types of desalination processes and end uses. High concentrations of certain common or trace constituents may require expensive pre-treatment. The source of the salinity is also characterized as natural or anthropogenic, which highlights areas where TDS may be affected by land use changes compared to areas where TDS is likely to remain elevated and relatively stable due to geologic factors.

2.2.3 Groundwater Production

The summary data on pump capacity, water level change, and depth to water help assess production potential and pumping costs (Table 2-1). The Gila Bend and Wellton Mohawk study areas contain the largest capacity wells, with much lower capacity wells in areas such as the Middle Verde, San Simon Valley, and the Little Colorado River Plateau. Gila Bend and Willcox basins have experienced the greatest rates of water level decline. Depth to water is greatest in the Little Colorado River Plateau area due to the unique geology, with the maximum reported depth over 650 feet in 2022. Depth to water in the other alluvial basins ranges from less than 10 feet to more than 550 feet.

2.2.4 Infrastructure and Subsidence

Subsidence data from ADWR studies show the most severe rates of subsidence in the McMullen Valley, San Simon Valley, and Willcox basins (Table 2-1). Other infrastructure-related information includes proximity to the CAP canal, which could provide opportunities for delivery to central Arizona. Also noted is the presence of significant local infrastructure already in place to move large quantities of water, with extensive infrastructure in the Salt River Valley, Pinal, and Yuma areas.

Table 2-1. Characteristics of Brackish Groundwater Study Areas

Brackish Groundwater Study Area	TDS Range (mg/L) [1]		Hardness Range (mg/L) [2]		Water Type [3]	Trace Elements [5]	Salinity Source [6]	Estimated Available Groundwater in Storage (MAF) [7]		Pump Capacity (gpm) [9]		Median Rate of Water Level Change 2010 to 2020 (feet/year) [10]	Depth to Water (feet, bls) [11]				Subsidence [12]	Infrastructure	
	Low	High	Low	High				Max depth 1,200 feet	Max depth 1,500 feet	Min	Max		Min	Max	Year	Well Count		Within 10 miles of CAP canal [13]	Local Canal Infrastructure [14]
1. Dendora Valley	900	5,400	160	1,400	Sodium Chloride	Arsenic, Fluoride	Natural and anthropogenic	0.8	0.8	< 900	4,000	-1.3	42	120	1992 - 2022	11	Some	No	None
2. East Salt River Valley	<100	5,700	30	3,500	Sodium Bicarbonate [4]	--	--	29	35	< 100	6,100	1.1	22	374	2023	120	Some	Yes	Extensive
3. Eloy	200	12,400	10	3,000	Sodium Bicarbonate and Calcium Sulfate	Arsenic, Boron, Fluoride	Natural	26	31	< 100	10,000	-0.6	56	466	2022	61	Some	Yes	Extensive
4. Gila Bend	700	12,900	60	4,900	Sodium Chloride	Arsenic, Fluoride	Natural and anthropogenic	16 [8]	19 [8]	< 100	30,000	-3.8	10	454	2020	65	Some	No	Some
5. Gila Valley	100	14,300	10	2,900	Calcium Bicarbonate and Sodium Bicarbonate	Arsenic, Boron, Fluoride	Natural and anthropogenic	25	31	< 100	7,000	-1.1	25	174	2022	14	Some	No	Some
6. Harquahala	300	3,000	20	700	Sodium Chloride	Arsenic, Fluoride	Natural and anthropogenic	5.7	7.5	< 100	3,500	-1.1	21	553	2022	41	Some	Yes	Extensive
7. Hassayampa	300	4,800	10	830	--	--	--	8.7	10	< 100	4,000	-0.04	60	305	2023	61	--	Yes	Some
8. Hualapai Valley	300	10,200	90	360	Mixed Bicarbonate	Boron, Fluoride, Selenium, Zinc	Natural	5.8	7.7	--	--	-0.8	269	442	2023	10	--	No	None
9. Lake Mohave	500	3,500	40	1,400	Calcium Sulfate and Sodium Chloride	Boron, Fluoride	--	6.1	7.5	< 100	5,000	-0.2	18	428	1984 - 2000	9	--	No	Some
10. Little Colorado River Plateau	100	65,900	<10	6,100	Sodium Chloride, Sodium Bicarbonate and Calcium Sulfate [4]	--	Natural	236 [8]	347 [8]	100	3,000	-0.1	3	652	2022	28	Some (Holbrook)	No	Some
11. Maricopa-Stanfield	<100	11,200	10	3,000	Sodium Bicarbonate and Calcium Sulfate	Arsenic, Boron, Fluoride	--	20	24	< 100	3,600	2.4	29	561	2022	29	Some	No	Extensive
12. McMullen Valley	<100	3,600	10	710	Sodium Chloride or Mixed Sodium	Arsenic, Boron, Fluoride, Barium, Chromium	--	1.8	2.5	< 600	4,800	-1.1	33	617	2022	27	Substantial	Yes	Some
13. Parker	600	7,700	60	3,600	--	--	--	19	22	< 100	3,000	0.1	10	78	2004 - 2022	3	--	Yes	Extensive
14. Rainbow Valley	700	2,900	50	240	--	--	Anthropogenic	2.5	3.2	< 400	3,200	-0.3	316	384	2023	15	--	No	Some
15. Ranegras Plain	400	4,700	20	1,100	Mixed Sodium (Sodium Chloride or Sodium Sulfate)	Arsenic, Fluoride, Chromium	Natural	9.3 [8]	11 [8]	< 400	4,100	-0.6	35	526	2022	88	Some	Yes	Some
16. San Simon Valley	200	4,400	10	1,120	Calcium Sulfate and Sodium Bicarbonate	Arsenic, Boron, Fluoride, Iron, Zinc	Anthropogenic	3.1	4.1	< 200	2,100	-1.4	52	365	2021	26	Substantial	No	Some
17. Verde Valley	300	16,000	120	2,400	--	--	Natural	2.8	3.2	< 100	1,000	-0.1	7	143	2022	40	--	No	Some

Brackish Groundwater Study Area	TDS Range (mg/L) [1]		Hardness Range (mg/L) [2]		Water Type [3]	Trace Elements [5]	Salinity Source [6]	Estimated Available Groundwater in Storage (MAF) [7]		Pump Capacity (gpm) [9]		Median Rate of Water Level Change 2010 to 2020 (feet/year) [10]	Depth to Water (feet, bls) [11]				Subsidence [12]	Infrastructure	
	Low	High	Low	High				Max depth 1,200 feet	Max depth 1,500 feet	Min	Max		Min	Max	Year	Well Count		Within 10 miles of CAP canal [13]	Local Canal Infrastructure [14]
18. Wellton-Mohawk	500	28,800	<10	3,000	Sodium Chloride	Arsenic, Fluoride	Natural and anthropogenic	47	55	< 100	28,000	-0.2	2	459	2020	162	Some	No	Extensive
19. West Salt River Valley	<100	11,300	10	2,520	Calcium Sulfate [4]	--	Natural and anthropogenic	25 [8]	30 [8]	< 100	6,900	-0.3	8	335	2023	126	Some	Yes	Extensive
20. Willcox	200	74,900	15	2,300	Calcium Bicarbonate and Calcium Sulfate	Arsenic, Fluoride	Natural and anthropogenic	15	18	< 100	3,500	-2.3	21	410	2021	22	Substantial	No	Some
21. Yuma	<100	8,400	30	3,400	Calcium Sulfate and Sodium Chloride	Arsenic, Boron, Selenium, Iron, Fluoride, Boron, Manganese	Anthropogenic	23	28	< 100	7,000	-0.5	13	142	2006 - 2023	12	--	No	Extensive

[1] EC data from USGS NWIS (parameter 00095) within Study Area. TDS calculated as 0.64 * Electrical Conductivity (EC). Conversion factor based on average ratio of EC to TDS data for wells within the GWSI database for which both TDS and EC were available.

[2] Hardness data from USGS NWIS (parameter 00900) within Study Area

[3] Summarized from ADEQ Ambient Groundwater Quality basin reports, except where noted otherwise
https://legacy.azdeq.gov/environ/water/assessment/ambient.html

[4] Determined from water chemistry data from USGS NWIS within Study Area

[5] Summarized from ADEQ Ambient Groundwater Quality basin reports
https://legacy.azdeq.gov/environ/water/assessment/ambient.html

[6] M&A (2008)

[7] Calculated based on area of Study Area, average depth to water based on recent GWSI data, interpolated depth to bedrock based on AZGS contours (Richard *et al.*, 2007), maximum depths of 1,200 and 1,500 feet, and specific yield of 0.11 (Anderson, 1995). Groundwater in storage was calculated using an average water level through the Study Area as an upper surface. The lower surface of the calculation was bedrock, or maximum depths of 1,200 feet and 1,500 feet where bedrock is deeper. Though a constant water level depth value was used for the upper surface, the calculation was performed on a cell-by-cell basis using ArcGIS in order to account for the variation in the bottom surface depth.

[8] For Gila Bend, West Salt River Valley, Ranegras Plain, and Little Colorado River Plateau, the volumes presented in Table 2-1 are the refined estimates developed for the Focus Area Assessments (Section 3). The storage estimates were refined to utilize a contoured water level surface as the upper limit of the volume calculation. For the Little Colorado River Plateau, the volume estimate represents groundwater in the upper 1,200 to 1,500 feet of the C-Aquifer as represented by Layers 1 and 2 of the NARGFM model (Pool *et al.*, 2011). Average specific yield values of 0.14 and 0.1 were applied to volumes in Layers 1 and 2, respectively. Groundwater in storage was calculated using an upper limit of either the top of Layer 1 or water level surface, whichever is lower in a given cell. The lower limit of the calculation was the bottom of Layer 2, or maximum depths of 1,200 and 1,500 feet where Layer 2 is deeper. These calculations were performed on a cell-by-cell basis using ArcGIS.

[9] Pump capacity in gallons per minute (gpm) reported in ADWR Wells 55 Registry for > 16" diameter non-exempt wells within Study Areas

[10] Sub-basin wide median annual rate of water level change for the period 2010 to 2020 reported by ADWR (ADWR, 2023a)

[11] Range of recent water level depths below land surface (bls) reported in ADWR GWSI database within study area. Water levels with measurement remarks were excluded.

[12] Relative assessment based on most recent ADWR Land Subsidence Rate Maps. "Substantial" subsidence is noted where maps document greater than 7 cm/yr of subsidence in some areas. "—" notes areas with no published ADWR subsidence assessment reports.

[13] Any point in study area within 10 miles of CAP aqueduct

[14] Relative assessment of local canal infrastructure within Study Area based on USGS National Hydrography Dataset

3 FOCUS AREA ASSESSMENTS

ADWR selected 4 focus areas from the 21 individual study areas for further evaluation: Gila Bend, Ranegras Plain, West Salt River Valley, and the Little Colorado River Plateau. The focus area assessments present basic hydrogeologic information for each area relevant to evaluation of the brackish resource development potential.

3.1 Approach

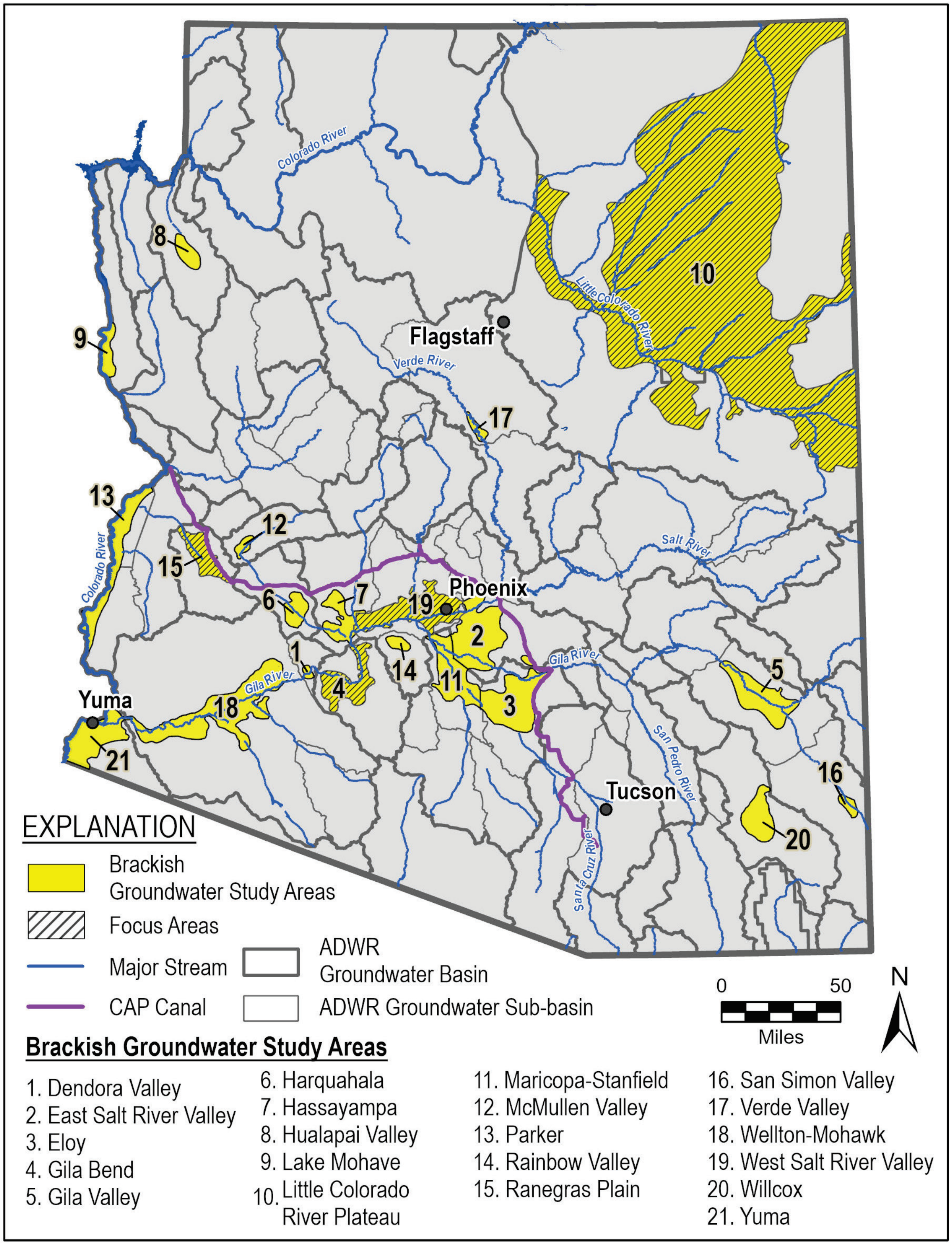
For each focus area, analyses presented in Section 3.2 include revised study area boundaries based on additional groundwater quality data, water level elevation contours, refined groundwater in storage estimates, and summary of a groundwater budget. This section describes the methodologies for each type of analysis.

3.1.1 Groundwater Quality

The general statewide inventory relied on EC data, which was converted to estimated TDS values. For the focus areas, TDS data were used directly when reported and converted EC data were used when TDS measurements were not available for a given well. Additionally, the statewide inventory was based solely on data from NWIS and GWSI. For the focus areas, additional data were compiled for the 4 sub-basins and used to refine the boundaries of the brackish groundwater areas. Additional TDS and EC data sources include the following:

- USEPA's STORET Data Warehouse, which includes data from Arizona Department of Environmental Quality (ADEQ)
- Data compiled for the Arizona Geological Survey study titled "A Summary of Salinities in Arizona's Deep Groundwater" (Gootee *et al.*, 2012), which includes data for some Arizona Oil and Gas Commission wells
- USGS's nationwide Brackish Groundwater Assessment (Qi and Harris, 2017)

Figure 3-1 shows the final statewide inventory with revised boundaries for the 4 focus areas; these revised study areas are shown on the remaining figures throughout Section 3.2.



G:\GIS-Tuc\Projects\1751\Reports_and_Deliverables\AZ_WateReuse_Conf_2024\StatewideInventory.aprx Study_Areas27Jul2024

Figure 3-1. Refined Brackish Groundwater Study Areas

To evaluate whether EC/TDS ratios vary by geography or concentration, these ratios were calculated separately for each of the 4 focus areas for 3 different TDS ranges: fresh water (<1,000 mg/L), brackish water (1,000 to 10,000 mg/L), and saline water (>10,000 mg/L).[2] Table 3-1 summarizes the EC/TDS ratios by focus area and TDS range. Within the same TDS range, the ratios are similar among areas. Generally, the ratio increases with increasing TDS. Therefore, the average ratio for each TDS range was used in each focus area.

Table 3-1. Calculated Ratio of EC:TDS by Focus Area and TDS Range

Focus Area	Fresh TDS <1,000 mg/L	Brackish 1,000-10,000	Saline TDS > 10,000 mg/L
Gila Bend	0.62 (534)	0.65 (250)	0.67 (5)
Ranegras Plain	0.60 (50)	0.66 (43)	N/A
West Salt River Valley	0.61 (286)	0.64 (311)	N/A
Little Colorado River Plateau	0.62 (325)	0.66 (221)	0.69 (6)
Average	**0.61**	**0.65**	**0.68**

Number in parentheses is the number of samples; there may be multiple samples from the same well.

The available TDS dataset does not allow for comprehensive assessment of temporal trends in TDS, especially in recent decades. The most recent TDS and EC data for many wells throughout the state are several decades old. Overall, trends can be observed in select wells in specific basins, but most areas have few wells with repeat TDS or EC measurements in the past 2 decades.

3.1.2 Groundwater Level Elevation

Groundwater level contour maps were prepared for the basin of each focus area. These maps indicate overall groundwater flow direction in the basin relative to the brackish groundwater area. The contours were also used to refine the groundwater in storage calculation, as described in the following section. Water level contours are based on recent groundwater level elevations from ADWR's GWSI database. The year with the most data collected during 2020 to 2023 was used for each focus area. Due to differences in groundwater level monitoring frequency, data from the same year were not used for all focus areas. Groundwater level contours are based on 2020 monitoring data for Gila Bend, 2022 data for Ranegras Plain and Little Colorado River Plateau, and 2023 data for West Salt River Valley. An average annual groundwater level elevation was calculated for wells that had multiple measurements for the selected year. Water levels were not used if ADWR noted the measurement may have been influenced by pumping or other factors such as foreign material in the well, obstructions, cascading water, etc. Wells with anomalous water levels completed in or near bedrock without lithologic logs were also excluded.

[2] Data reported from ADEQ WQARF (Water Quality Assurance Revolving Fund) program and the USEPA Superfund (NPL, National Priorities List) program were excluded.

3.1.3 Groundwater in Storage

Aquifers are porous sediments or rock formations that store or transmit water. Aquifers where the groundwater is found between layers of impermeable rock are referred to as confined aquifers. Water levels in wells completed in confined (artesian) aquifers will rise above the top of the confining layer. If there is no confining layer, the aquifer is referred to as an unconfined aquifer. Figure 3-2 illustrates these concepts.

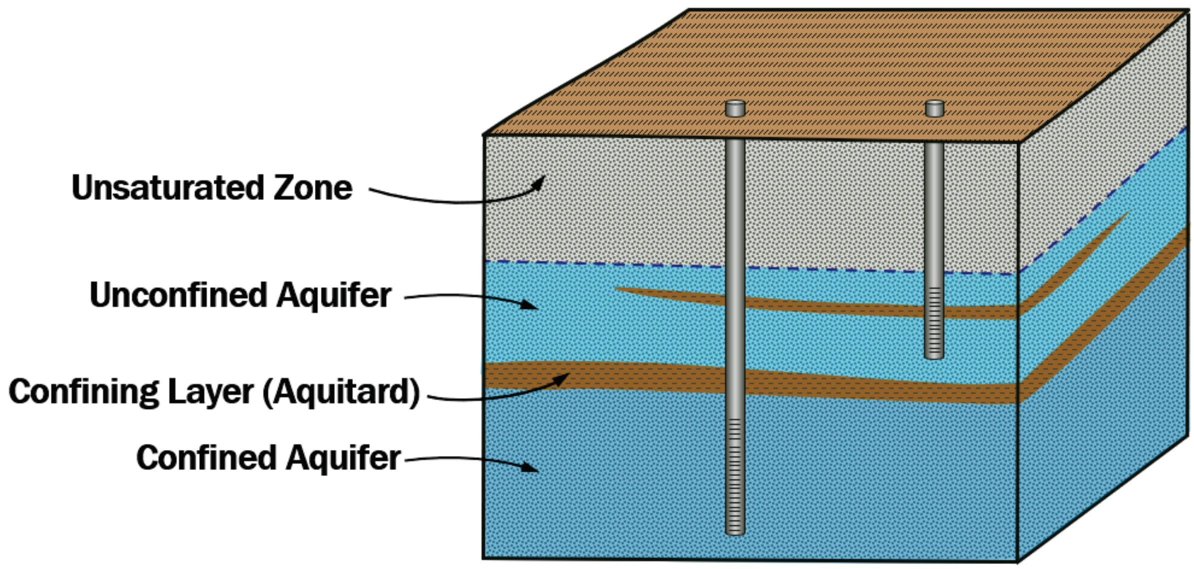


Figure 3-2. Confined and Unconfined Aquifer Schematic Diagram (Source: ADWR, 2023a)

When the water level in an unconfined aquifer is lowered by pumping, water drains from pore spaces due to gravity. The amount of water that can be obtained from an unconfined aquifer is represented by specific yield (Sy), which ranges from 0 to 1. Sy values for unconfined basin-fill sediments in Arizona can range from 0.03 to 0.25 but are commonly on the order of 0.1 to 0.15 overall (Anderson *et al.*, 1992). The volume of groundwater stored in an unconfined aquifer can be estimated by multiplying the saturated volume of the aquifer by the Sy.

When pressure in a confined aquifer is lowered by pumping or artesian flow, water expands slightly and the aquifer framework compresses, releasing water. The amount of water that can be obtained from a confined aquifer is represented by specific storage (Ss). Ss values for confined aquifers are several orders of magnitude lower than Sy values for unconfined aquifers. Since all 4 focus areas contain unconfined aquifers, only unconfined storage (Sy) was considered for the groundwater in storage calculation.

For all study areas aside from the 4 focus areas, the groundwater in storage calculation presented in Table 2-1 applied an average water table depth throughout the entire study area. For the focus areas, calculations were refined by using a variable water level surface throughout each focus area, based on the groundwater level contours previously described. Maximum depth cutoffs and specific yield remain the same. The amount of groundwater in storage in the Little Colorado River Plateau was estimated using a more detailed approach, described in Section 3.2.4.

3.1.4 Groundwater Budgets

Estimated water budgets for each of the 4 basins/sub-basins that contain a focus area were summarized from existing reports. All 4 budgets show a net groundwater overdraft where total groundwater outflows exceed inflows. For the Gila Bend, Ranegras Plain, and West Salt River Valley, groundwater pumping alone exceeds total inflows, which include natural and artificial recharge. When other groundwater outflows such as evapotranspiration, discharge to streams, and underflow to adjacent basins are included, the imbalance is even greater. The Little Colorado River Plateau basin is unique in that groundwater pumping is not the largest component of groundwater outflow. Relative to the other areas, groundwater extraction is minimal. This is due to the rural nature of the area and the difficulty in extracting groundwater from the fractured rock aquifers that are many thousands of feet below land surface in some areas.

3.2 Results

The following sections summarize the results for each of the 4 focus areas.

3.2.1 Gila Bend

The Gila Bend groundwater basin is in Maricopa County, approximately 50 miles southwest of Phoenix. The primary aquifer in the Gila Bend groundwater basin consists of basin-fill sediments, including unconsolidated stream alluvium along the Gila River and its tributaries; unconsolidated to moderately consolidated upper basin fill; and weakly to well-consolidated gravel, sand, slit, and clay in the lower basin fill (Rascona, 1996).

Figure 3-3 shows average 2020 groundwater level contours for the Gila Bend groundwater basin, along with the revised extent of brackish groundwater, which are generally consistent with the groundwater flow directions reported by ADWR (2009). Groundwater pumping in the northern portion of the focus area has created a localized cone of depression. Between 2000 and 2020, the annual rate of groundwater level change in wells in the Gila Bend groundwater basin ranged from -9.3 to -0.8 feet per year (ft/yr) with a median change of -3 ft/yr (ADWR, 2023b).

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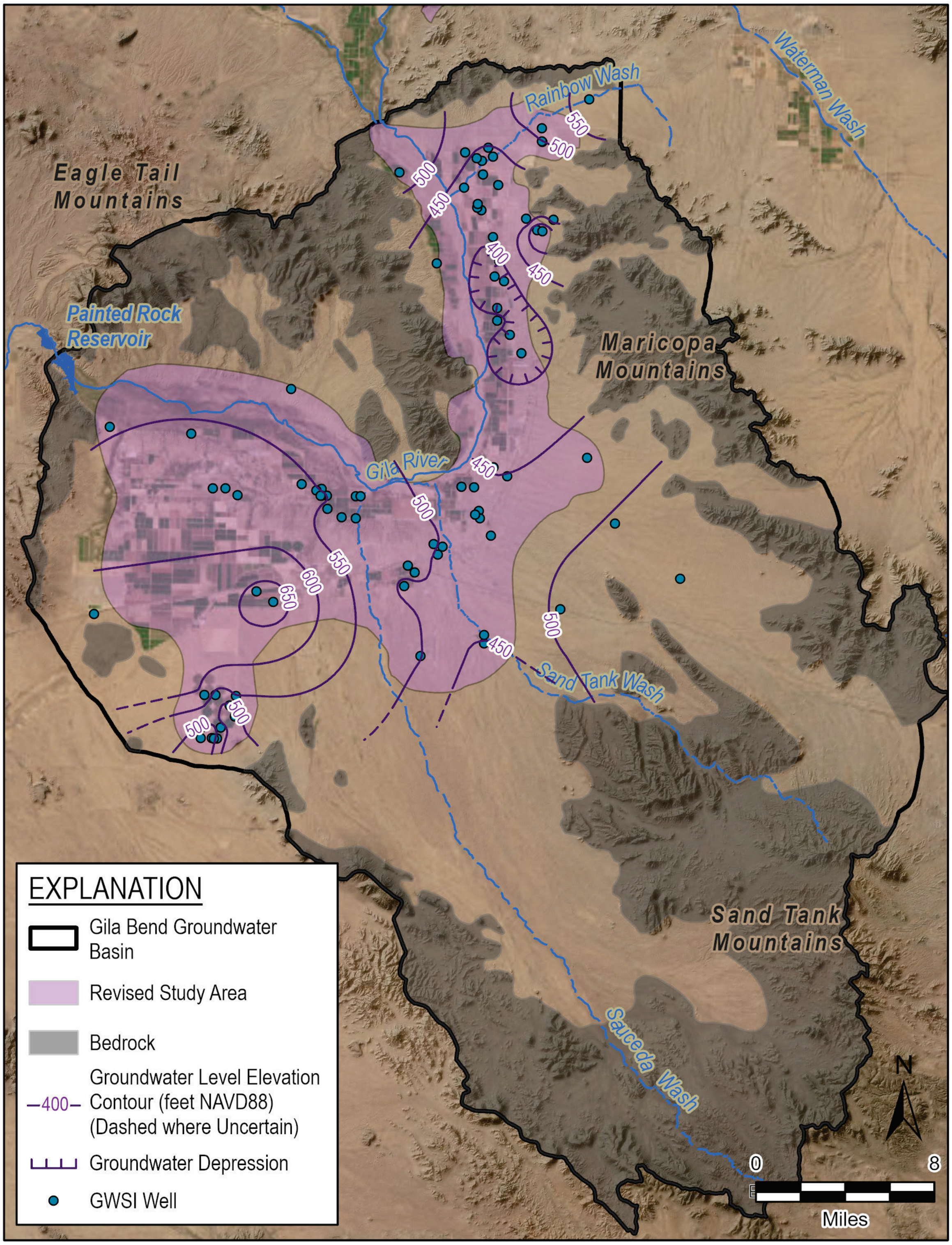

Figure 3-3. Gila Bend Groundwater Basin 2020 Groundwater Level Contours

On Figure 3-4, map panels A – F show the lateral distribution of TDS for various depth ranges. Plots G – I on Figure 3-4 show the distribution of well depth and TDS in the basin for wells with fresh, brackish, and saline water. Based on the most recent EC or TDS measurement for 423 unique wells in the Gila Bend groundwater basin, 91% of the wells have TDS concentrations of 1,000 mg/L or greater, with 5 of those wells in the saline range (>10,000 mg/L).

The source of poor-quality groundwater in the Gila Bend groundwater basin is thought to be mineralized surface flows in the Gila River that have been diverted for irrigation or have seeped into the basin-fill aquifer due to pumping of fresher groundwater (Hem, 1948; Rascona, 1996) and recharge of excess irrigation water applied to crops (Towne, 2015). Evaporites present in the fine-grained units and in the western portion of the basin are also a source of high TDS (M&A, 2008; Sebenik, 1981). Plot I on Figure 3-4 shows that the only wells with saline groundwater are shallower than 20 feet, which may represent especially poor-quality water in perched zones. Most brackish groundwater is found between 400 and 1,200 feet below land surface.

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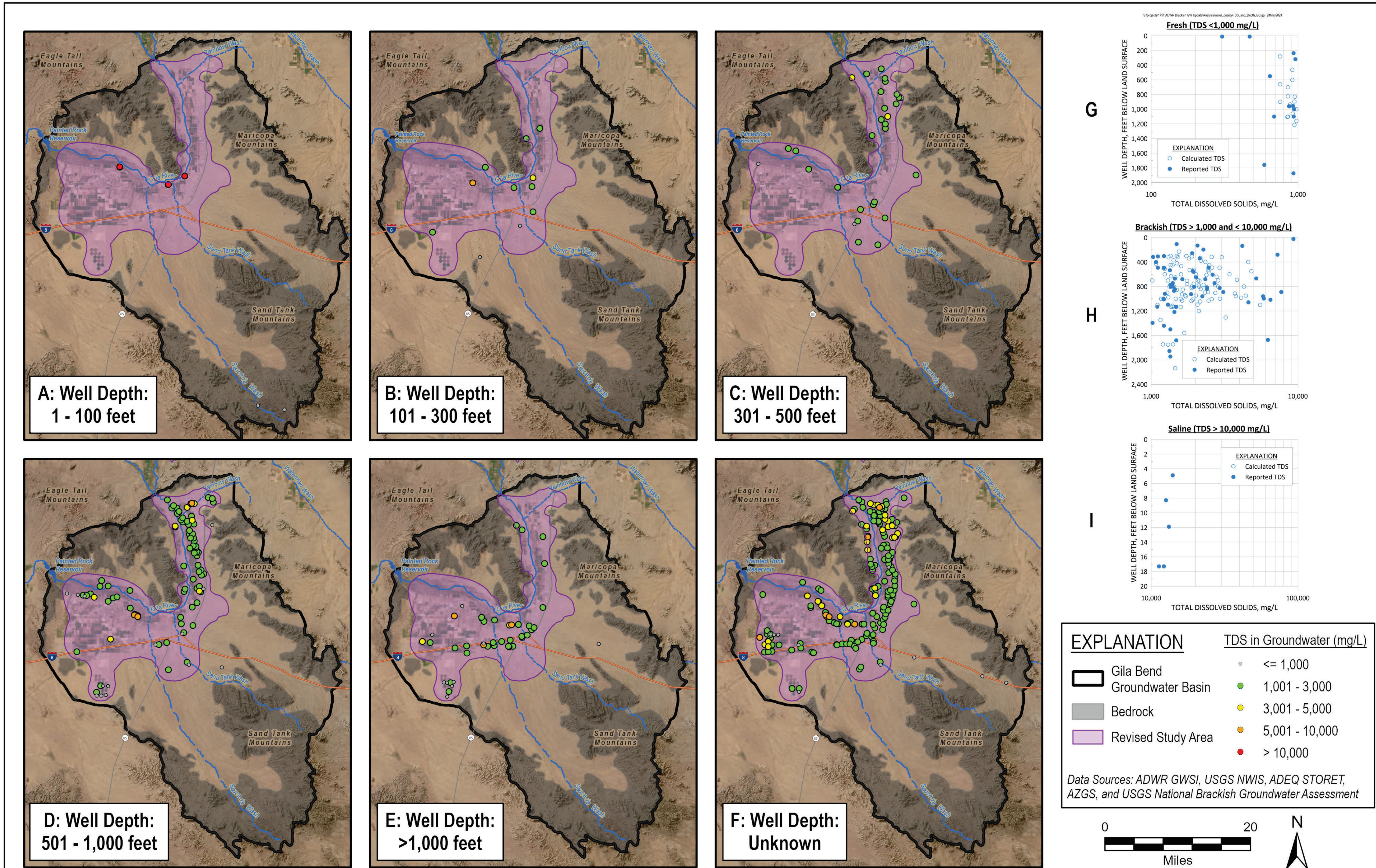

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Figure 3-4. Gila Bend Groundwater Basin Water Quality

Potential yields for wells in the focus area were estimated based on reported pumping capacities (ADWR, 2024) for non-exempt wells with large diameters greater than or equal to 16 inches. Only large-diameter wells were considered in order to provide a representative range of production potential for a large-scale desalination project. Capacities of half the large-diameter wells in the Gila Bend focus area are between 2,200 and 3,300 gpm.

Estimate of groundwater in storage in the upper 1,200 and 1,500 feet of the aquifer based on specific yield of 0.11 is 16 and 19 MAF, respectively.

Table 3-2 presents a conceptual groundwater budget for the Gila Bend groundwater basin based on a USGS study of alluvial basins in southern Arizona (Tillman *et al.*, 2011) and the Arizona Water Atlas (ADWR, 2009). The Gila Bend basin is overdrafted with outflows exceeding inflows by approximately 140,000 AF or more. Median groundwater level declines in wells throughout the basin are the highest in the state. Average annual groundwater pumping exceeds all combined groundwater inflow components. Agricultural pumping and recharge are the largest components of outflows and inflows, respectively, although the stream recharge component from large Gila River flow events is highly variable and can be significant in flood years.

Table 3-2. Gila Bend Groundwater Basin Conceptual Groundwater Budget

Component		Estimated Value, AF/yr	Year / Period	Source
INFLOW	Natural Recharge (including stream recharge)	10,000 – 37,000		ADWR, 2009 (Table 7.2-6)
	Agricultural Incidental Recharge	137,000	2005	Tillman *et al.*, 2011 (Table 27)
	Groundwater Underflow	7,500	2005	Tillman *et al.*, 2011 (Table 18)
	TOTAL INFLOW	154,500 – 181,500		
OUTFLOW	Agricultural Pumping	287,000	2005	Tillman *et al.*, 2011 (Table 24)
	Public Supply Pumping	800	2005	Tillman *et al.*, 2011 (Table 25)
	Industrial Pumping	4,700	2001–2005 Average	ADWR, 2009 (Table 7.2-8)
	Groundwater Evapotranspiration	26,850	2000-2007 Average	Tillman *et al.*, 2011 (Table 17)
	Groundwater Underflow	2,000	2005	Tillman *et al.*, 2011 (Table 18)
	TOTAL OUTFLOW	321,350		
BALANCE: INFLOW-OUTFLOW		**-139,850 to -166,850**		

Overall, the Gila Bend area contains large volumes of brackish groundwater at relatively shallow depths in a productive alluvial aquifer with large well yields. This high TDS groundwater is already being used in large quantities, primarily for agricultural purposes. Land use changes may impact future groundwater quality. Additionally, groundwater levels in the Gila Bend basin have experienced significant rates of decline, which has caused land subsidence. These declines would be worsened by extracting additional large quantities of groundwater for desalination.

3.2.2 West Salt River Valley

The West Salt River Valley groundwater sub-basin is located within the Phoenix Active Management Area in Maricopa County and includes portions of Phoenix and its western suburbs. The primary aquifer in the West Salt River Valley groundwater sub-basin consists of basin-fill sediments divided into upper, middle, and lower units (Brown and Pool, 1989). The lower unit includes playa, alluvial, fluvial, and evaporite deposits that formed when the basin was closed (Anning, 2010). The sediments of the middle unit range from clay to silt to gravel, with some clayey layers forming a locally confining bed near Goodyear and Glendale (Edmonds and Gellenbeck, 2002). The upper unit consists of alluvial deposits of the Agua Fria, Salt, and Gila Rivers (Anning, 2010).

Figure 3-5 shows average 2023 groundwater level contours for the West Salt River Valley groundwater sub-basin along with the revised extent of brackish groundwater. In the northern portion of the sub-basin, groundwater moves toward cones of depression created by groundwater pumping centers. In the southern portion of the sub-basin, groundwater moves from east to west following the Salt and Gila Rivers.

Westwardly thinning basin-fill sediments and a westward gradient resulted in shallow groundwater conditions along the Gila River channel near Buckeye prior to development (ADWR, 2015). Post-development, recharge from excess irrigation water raised water levels further and the Buckeye Water Logged Area (BWLA) was designated in 1988 (ARS §45-411.01).

Between 2000 and 2020, the annual rate of groundwater level change in wells in the West Salt River Valley groundwater sub-basin ranged from -2.0 to +8.4 ft/yr with a median change of -0.2 ft/yr (ADWR, 2023b).

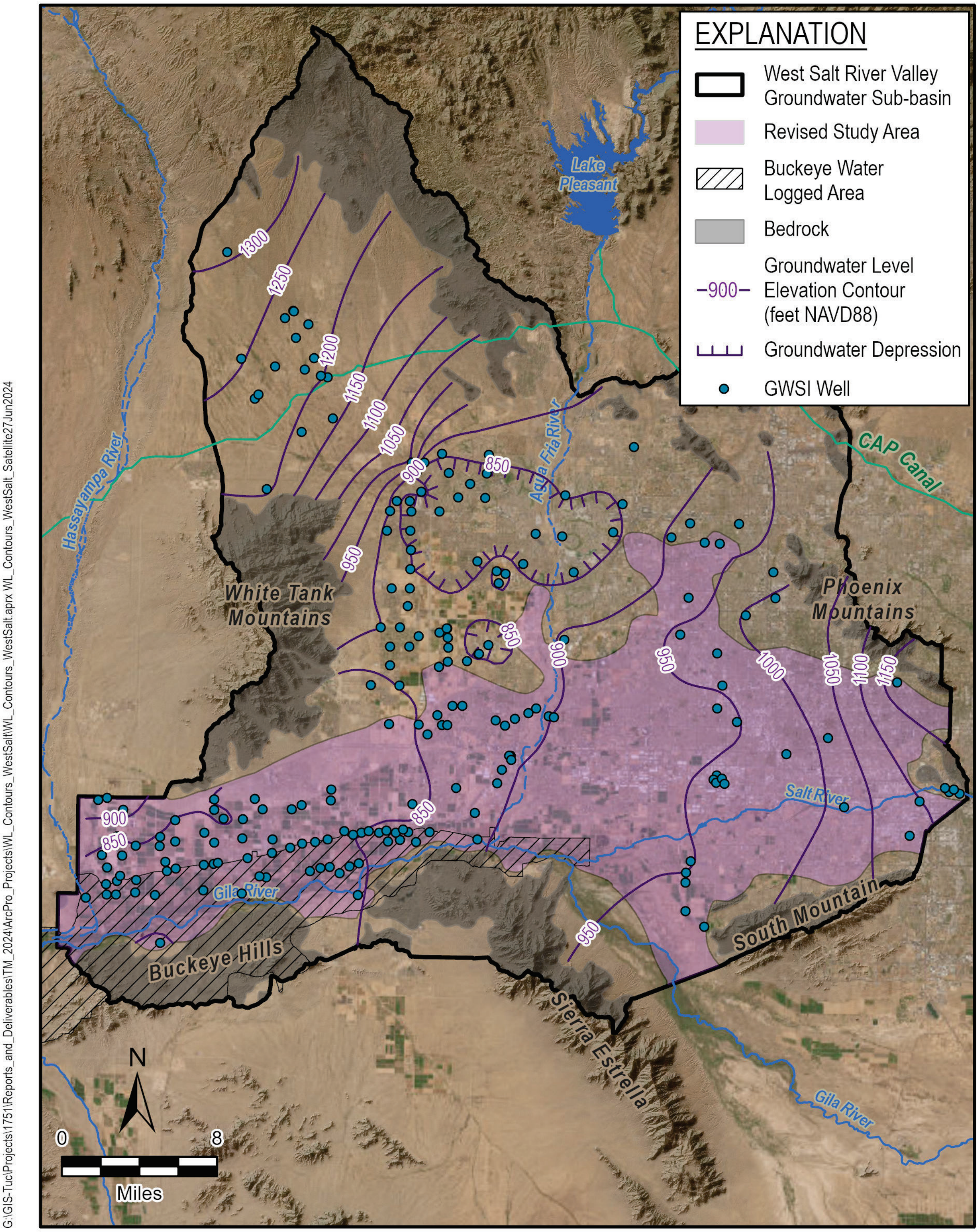

Figure 3-5. West Salt River Valley Groundwater Sub-Basin 2023 Groundwater Level Contours

On Figure 3-6, map panels A – F show the lateral distribution of TDS for various depth ranges in the sub-basin. TDS levels are generally higher in the western half of the focus area. Plots G – I on Figure 3-6 show the distribution of well depth and TDS in the sub-basin for wells with fresh, brackish, and saline water. Based on the most recent EC or TDS measurement for 1,537 unique wells in the West Salt River Valley groundwater sub-basin, 41% have TDS concentrations of 1,000 mg/L or greater, with 10 of those wells in the saline range (> 10,000 mg/L). No clear relationship exists between TDS and depth for fresh and brackish water; however saline water is generally encountered at greater depths.

Prior to development, TDS concentrations in the BWLA were elevated due to phreatophyte evapotranspiration and the inflow of mineralized groundwater and surface water from the Salt River watershed. Post-development agricultural practices resulted in recharge of excess irrigation water, further increasing near-surface TDS concentrations (Brown and Pool, 1989). Evaporite deposits are the source of elevated TDS concentrations in the lower basin fill unit, with values approaching 100,000 mg/L reported near the Luke salt body (Brown and Pool, 1989).

All wells with naturally occurring saline water exceed 500 feet deep. The well shown on Plot A of Figure 3-6with a TDS concentration in excess of 10,000 mg/L is a 90-foot deep monitoring well (55- 564695) that was installed at an industrial waste facility and abandoned in 2006. Saline water is also found near the Luke salt body and in the BWLA.

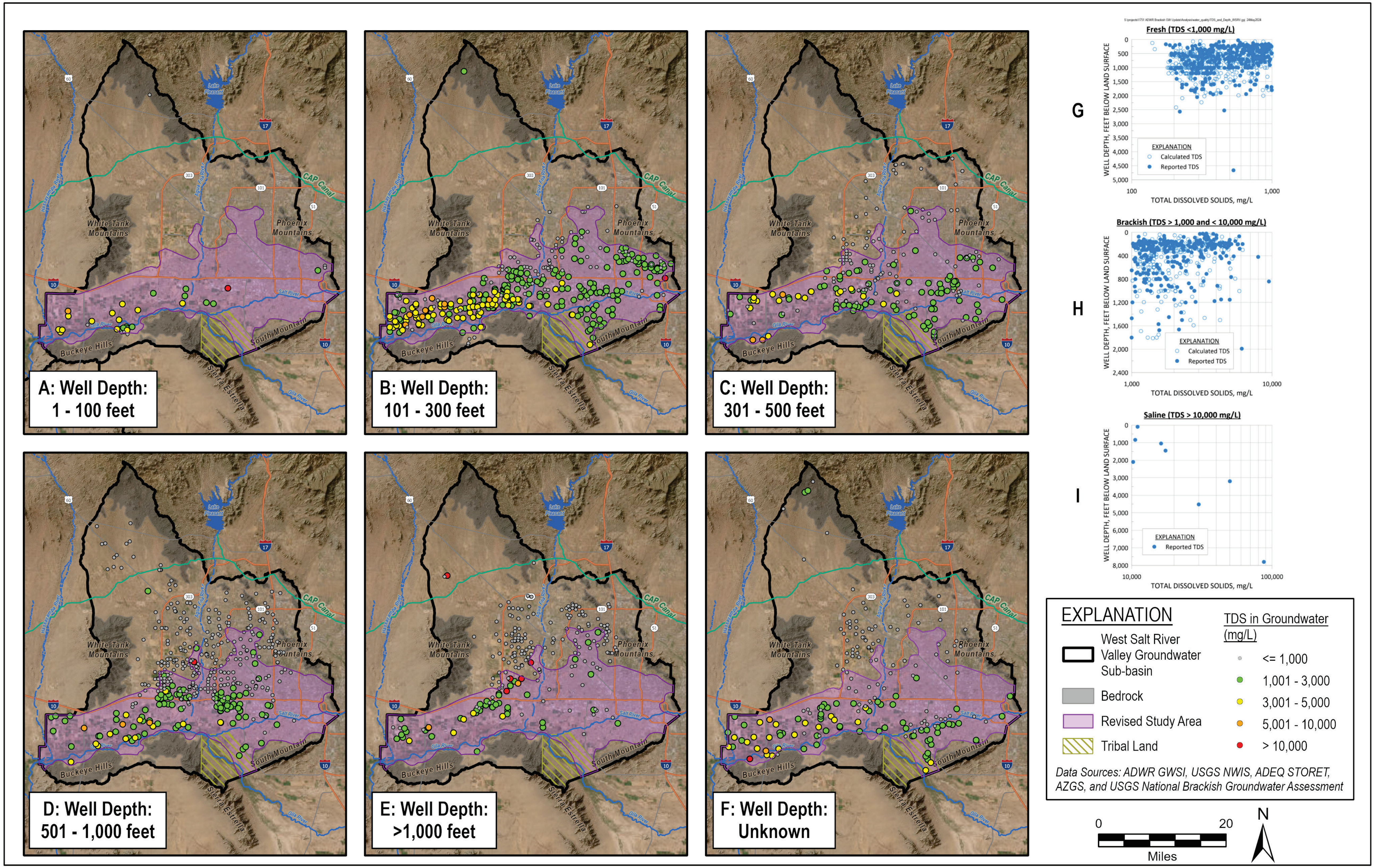

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Figure 3-6. West Salt River Valley Groundwater Sub-Basin Water Quality

Potential yields for wells in the focus area were estimated based on reported pumping capacities (ADWR, 2024) for non-exempt wells with large diameters greater than or equal to 16 inches. Half the large-diameter wells in the West Salt River Valley focus area have capacities between 1,200 and 2,640 gpm.

The estimated groundwater in storage in the upper 1,200 and 1,500 feet of the aquifer, based on specific yield of 0.11, is 25 and 30 MAF, respectively.

Table 3-3 presents a conceptual groundwater budget for the West Salt River Valley groundwater sub-basin from Anning (2010). The sub-basin is overdrafted with outflows exceeding inflows by approximately 67,000 AF/yr. As shown in Table 3-3, agriculture return flows account for nearly two-thirds of groundwater recharge in the West Salt River Valley groundwater sub-basin. Future land-use changes that reduce irrigated acreage would decrease this source of recharge.

Table 3-3. West Salt River Valley Groundwater Sub-Basin Conceptual Groundwater Budget

Component		Estimated Value, AF/yr	Year / Period	Source
INFLOW	Mountain-Front Recharge	6,000	2005	Anning, 2010 (Table 1)
	Streambed Recharge	68,000	2005	Anning, 2010 (Table 1)
	Agricultural Incidental Recharge and Canal Seepage	308,000	2005	Anning, 2010 (Table 1)
	Artificial Recharge	45,000	2005	Anning, 2010 (Table 1)
	Groundwater Underflow	30,000	2005	Anning, 2010 (Table 1)
	TOTAL INFLOW	**457,000**		
OUTFLOW	Groundwater Pumping	497,000	2005	Anning, 2010 (Table 1)
	Groundwater Evapotranspiration	15,000	2005	Anning, 2010 (Table 1)
	Discharge to Streams	5,000	2005	Anning, 2010 (Table 1)
	Groundwater Underflow	7,000	2005	Anning, 2010 (Table 1)
	TOTAL OUTFLOW	**524,000**		
BALANCE: INFLOW-OUTFLOW		**-67,000**		

Overall, similar to the Gila Bend Area, the West Salt River Valley contains large volumes of brackish groundwater at relatively shallow depths in a productive alluvial aquifer with large well yields. Though this high TDS groundwater is already being used for agricultural purposes, desalination of additional brackish groundwater could be used to provide supplies for other end uses in the West Valley, particularly areas that rely on CAP supplies. The waterlogged conditions may benefit from a desalination project. However, future land use changes that reduce irrigated agriculture could significantly impact the area’s groundwater budget and water quality.

3.2.3 Ranegras Plain

The Ranegras Plain groundwater basin is in La Paz and Yuma counties, approximately 100 miles west from Phoenix. The primary aquifer in the Ranegras Plain groundwater basin consists of Tertiary alluvium composed of clay, volcanic rocks, conglomerate, and lesser amounts of sand and gravel (Johnson, 1990).

Figure 3-7 shows average 2022 groundwater level contours for the Ranegras Plain groundwater basin along with the revised extent of brackish groundwater. The groundwater level contours are generally consistent with the generalized groundwater flow directions reported by ADWR (2009). The groundwater mound in the central portion of the basin may be due to recharge from agriculture or enhanced recharge along Bouse Wash in this area.

Between 2000 and 2020, the annual rate of groundwater level change in wells in the Ranegras Plain groundwater basin ranged from -4.3 to -0.2 ft/yr with a median change of -0.6 ft/yr (ADWR, 2023b).

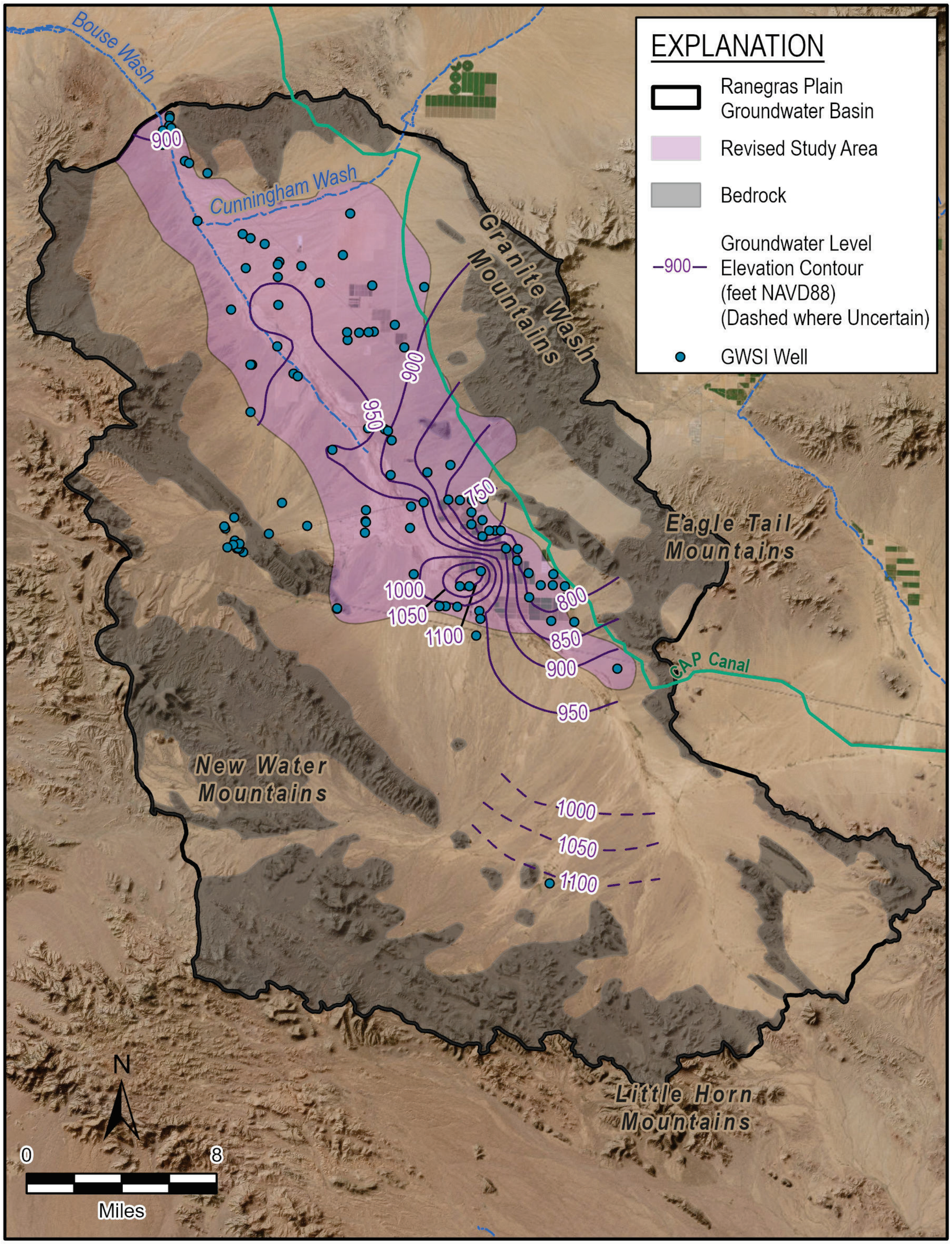

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Figure 3-7. Ranegras Plain Groundwater Basin 2022 Groundwater Level Contours

On Figure 3-8, map panels A – F show the lateral distribution of TDS for various depth ranges. Plots G and H on Figure 3-8 show the distribution of well depth and TDS in the basin for wells with fresh and brackish water. Based on the most recent EC or TDS measurement for 211 unique wells in the Ranegras Plain groundwater basin, 36% have TDS concentrations of 1,000 mg/L or greater. No wells in the Ranegras Plain groundwater basin have saline water; the highest TDS concentration in the basin is approximately 5,000 mg/L. Plots G and H on Figure 3-8 show no clear relationship between TDS concentration and depth. Figure 3-8 shows that brackish water is present between close to land surface and a depth of over 1,000 feet. The source of poor-quality groundwater in the Ranegras Plain groundwater basin is attributed to near-surface evaporites (Robertson, 1991).

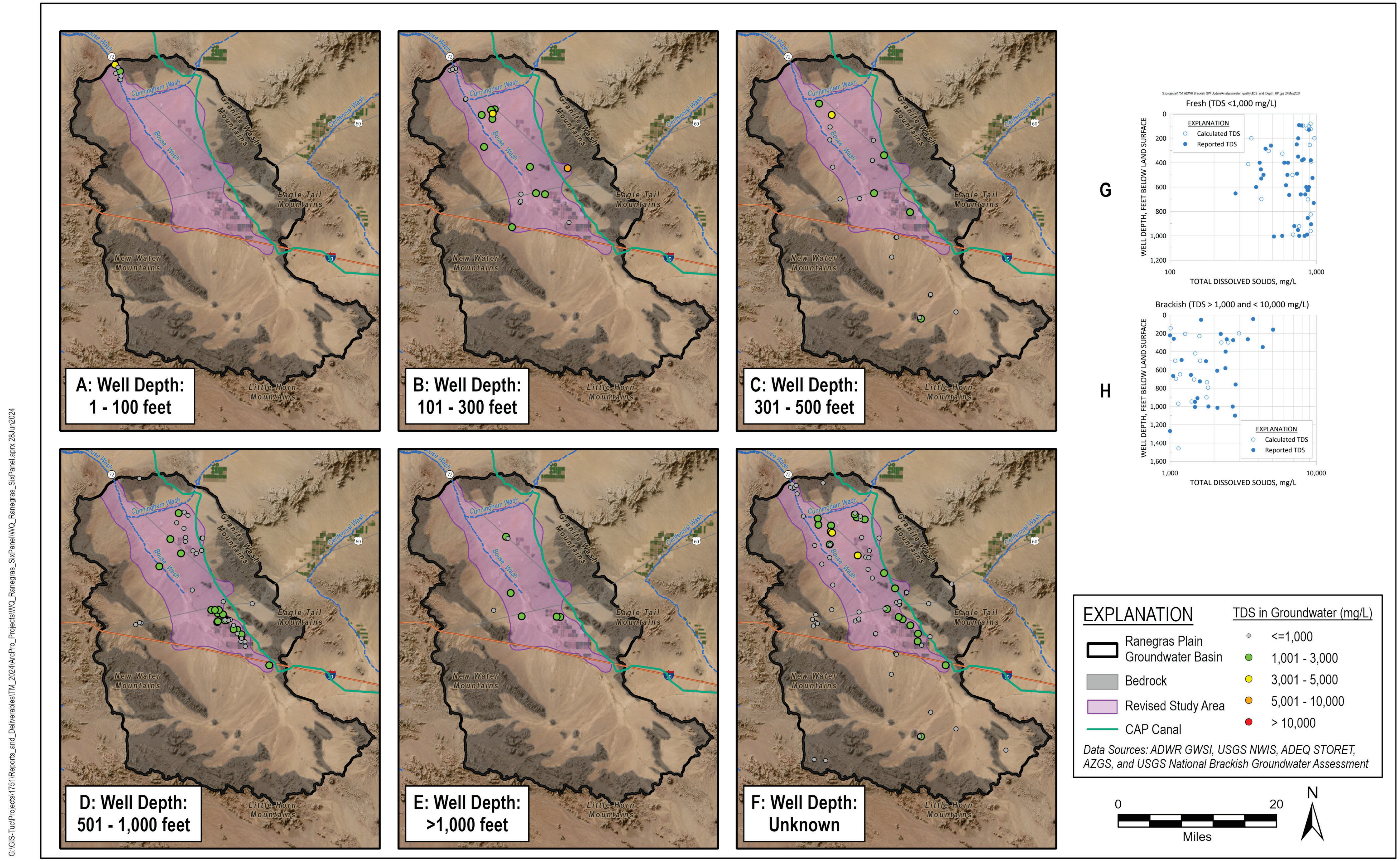

Figure 3-8. Ranegras Plain Groundwater Basin Water Quality

Potential yields for wells in the focus area were estimated based on reported pumping capacities (ADWR, 2024) for non-exempt wells with large diameters greater than or equal to 16 inches. Half the large-diameter wells in the Ranegras Plain focus area have capacities between 1,400 and 3,000 gpm.

The estimated groundwater in storage in the upper 1,200 and 1,500 feet of the aquifer, based on specific yield of 0.11, is 9 and 11 MAF, respectively.

Table 3-4 presents a conceptual groundwater budget for the Ranegras Plain groundwater basin. This budget was compiled in a numerical groundwater model report developed for a proposed solar energy project near Brenda (Quinn *et al.*, 2013). The Ranegras Plain basin is overdrafted, with outflows approximately 4 times greater than inflows.

Table 3-4. Ranegras Plain Groundwater Basin Conceptual Groundwater Budget

Component		Estimated Value, AF/yr	Year / Period	Source
INFLOW	Mountain-Front Recharge	1,000	Post-development	Quinn *et al.*, 2013 (Table 1)
	In-Place Recharge	400	Post-development	Quinn *et al.*, 2013 (Table 1)
	Agricultural Incidental Recharge	2,800	Post-development	Quinn *et al.*, 2013 (Table 1)
	CAP Canal Leakage	2,500	Post-development	Quinn *et al.*, 2013 (Table 1)
	Groundwater Underflow from Butler Valley	300	Post-development	Quinn *et al.*, 2013 (Table 1)
	TOTAL INFLOW	**7,000**		
OUTFLOW	Agricultural Pumping	27,500	Post-development	Quinn *et al.*, 2013 (Table 1)
	Public Supply Pumping	400	Post-development	
	Groundwater Evapotranspiration	Negligible	Post-development	Quinn *et al.*, 2013 (Table 1)
	Groundwater Underflow at Bouse	860	Post-development	Quinn *et al.*, 2013 (Table 1)
	TOTAL OUTFLOW	**28,760**		
BALANCE: INFLOW-OUTFLOW		**-21,760**		

Overall, well data is more limited in this area than for Gila Bend and West Salt River Valley, but available data show TDS concentrations in the lower end of the brackish range. At the current rate of groundwater use, the majority of wells in the area have experienced groundwater level decline over the past 20 years and land subsidence has been documented in some areas. The basin is situated along the CAP canal, which provides opportunity for desalinated groundwater to be delivered to central Arizona.

3.2.4 Little Colorado River Plateau

The Little Colorado River Plateau (LCRP) groundwater basin is located in northeastern Arizona at the southern end of the Colorado Plateau. ADWR delineates the Joseph City Irrigation Non-Expansion Area (INA) as a separate groundwater basin within the LCRP, but the 2 areas are combined for the purpose of this analysis. Unlike the other 3 focus areas described in this study, the LCRP contains fractured rock aquifers. The most extensive aquifers are the Coconino aquifer (C-Aquifer) system and the Redwall-Muav aquifer (R-Aquifer). The Navajo aquifer (N-Aquifer) also overlies the C-Aquifer in the northeastern portion of the LCRP. The C-Aquifer is the primary water source and most productive aquifer across northern Arizona. This analysis therefore focuses on the C-Aquifer, which includes the Kaibab Formation, the Coconino Sandstone, the Schnebly Hill Formation, and the Upper and Middle Supai Formation (Bills *et al.*, 2000; Pool *et al.*, 2011).

Figure 3-9 shows average 2022 groundwater level contours for the LCRP groundwater basin along with the extent of brackish groundwater. The water levels shown on Figure 3-9 are a composite of groundwater levels in all available wells with data, regardless of aquifer unit. Portions of the aquifer are confined so the water levels represent a potentiometric surface. Groundwater generally moves north and east from recharge areas along the Mogollon Rim. In the northeastern portion of the basin, groundwater moves west from a recharge area in the Defiance Uplift near the Arizona – New Mexico border. In the northwestern portion of the basin, groundwater movement is toward the northwest and the Colorado River.

Between 2000 and 2020, the annual rate of groundwater level change in wells in the LCRP groundwater basin has ranged from -2.2 to 1.0 ft/yr with a median change of -0.1 ft/yr (ADWR, 2023b).

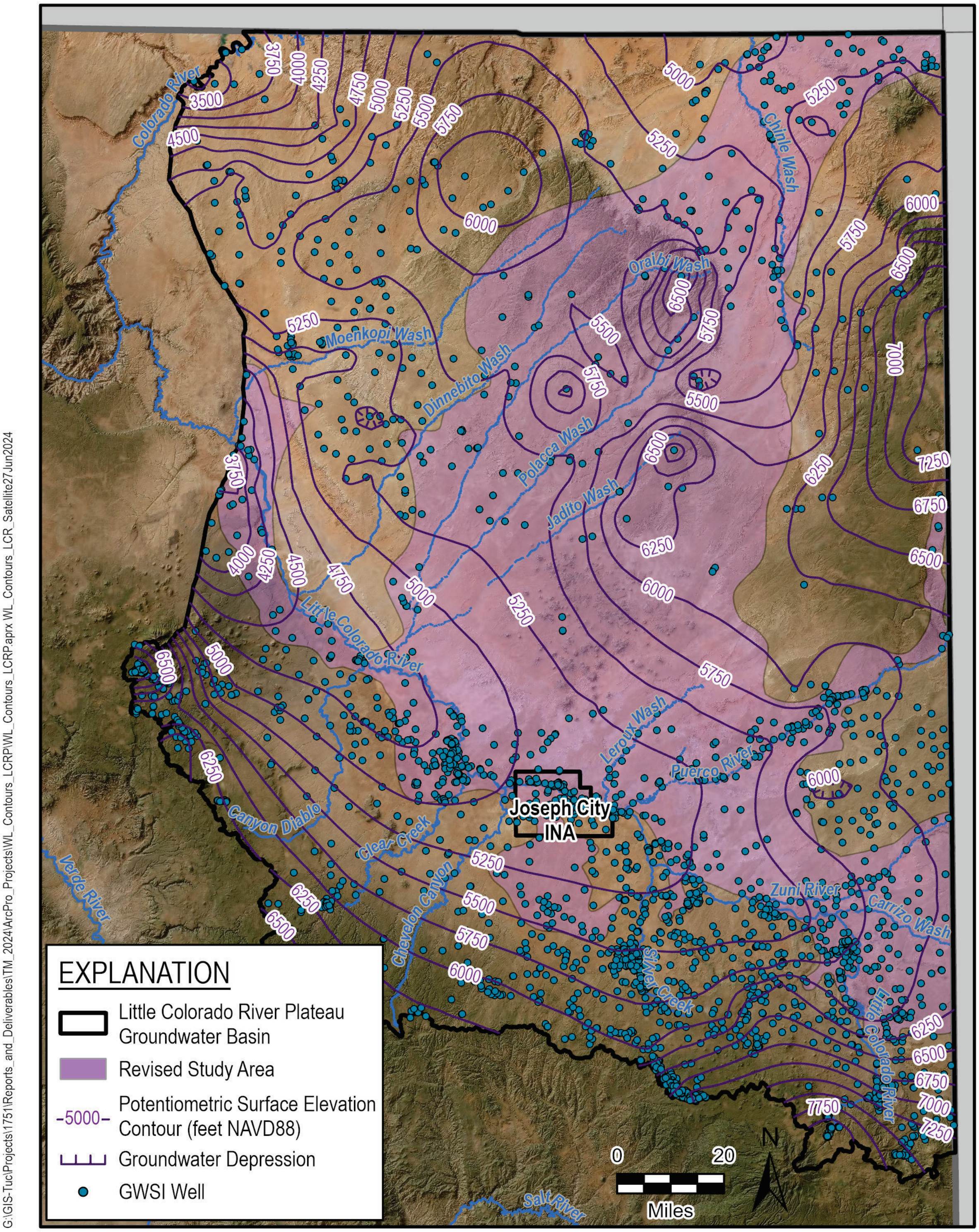

Figure 3-9. Little Colorado River Plateau Groundwater Basin 2022 Groundwater Level Contours

On Figure 3-10, map panels A – E show the lateral distribution of TDS for various geologic formations. Since the bedrock formations generally dip to the north, TDS concentrations on Figure 3-10 are shown by formation rather than depth. The formation contacts were determined from the USGS Northern Arizona Regional Groundwater Flow Model (NARGFM) (Pool *et al.*, 2011). Plots F – J on Figure 3-10 show the distribution of well depth and TDS in the basin for wells with fresh, brackish, and saline water. Based on the most recent EC or TDS measurement for 1,786 unique wells in the Little Colorado River Plateau groundwater basin, 26% have TDS concentrations of 1,000 mg/L or greater, with 44 in the saline range (> 10,000 mg/L).

Halite beds in the Supai Formation are the source of high TDS water in the C-Aquifer. Although increasing TDS concentrations with depth have been reported in localized areas (Daniel, 1981; M&A, 2008), it is difficult to draw conclusions about vertical TDS trends over the entire study area, as discussed in the following paragraphs.

Most wells completed in the Coconino Sandstone are near the Little Colorado River, where the unit is at or near land surface. In these areas, fresh water occurs throughout the Coconino Sandstone (Figure 3-10 B) and shows no correlation with depth (Plot G on Figure 3-10); fresh water was found at depths approaching 4,000 feet bls. Plot G on Figure 3-10 shows that brackish water generally occurs at shallower depths than fresh water in the Coconino Sandstone, however wells drilled for water supply would not likely be drilled deeper if they encountered brackish water at shallow depths, potentially biasing the dataset.

The Supai Formation is generally less permeable than the Coconino Sandstone and fewer wells have been completed in the Supai Formation. The upper and middle portion of the Supai Formation are considered part of the C-Aquifer, while the lower Supai is confining unit (Pool *et al.*, 2011). Panel C Figure 3-10 shows that most wells completed in the Supai Formation are located south of the Little Colorado River, with a zone of brackish water located south of Carrizo Wash in the southeastern portion of the LCRP groundwater basin. There is little correlation between TDS concentration and depth for wells completed in the Supai Formation, as shown on Plot H on Figure 3-10.

Panel D on Figure 3-10 shows that relatively few wells are completed in the Redwall-Muav Limestone, and most are located in the southeastern portion of the LCRP groundwater basin where there is an area of brackish water. Wells completed in the Redwall-Muav Limestone show little correlation between TDS and depth (Plot I on Figure 3-10). The saline wells in the Redwall-Muav formation may be partially screened in the Supai Formation where halite beds provide a source of high TDS.

Panel E on Figure 3-10 shows the distribution of TDS for wells completed in an unknown formation; either no well depth was reported or the wells are located outside the NARGFM model boundary. There is no correlation between depth and TDS concentration for fresh or brackish water (Plot H on Figure 3-10).

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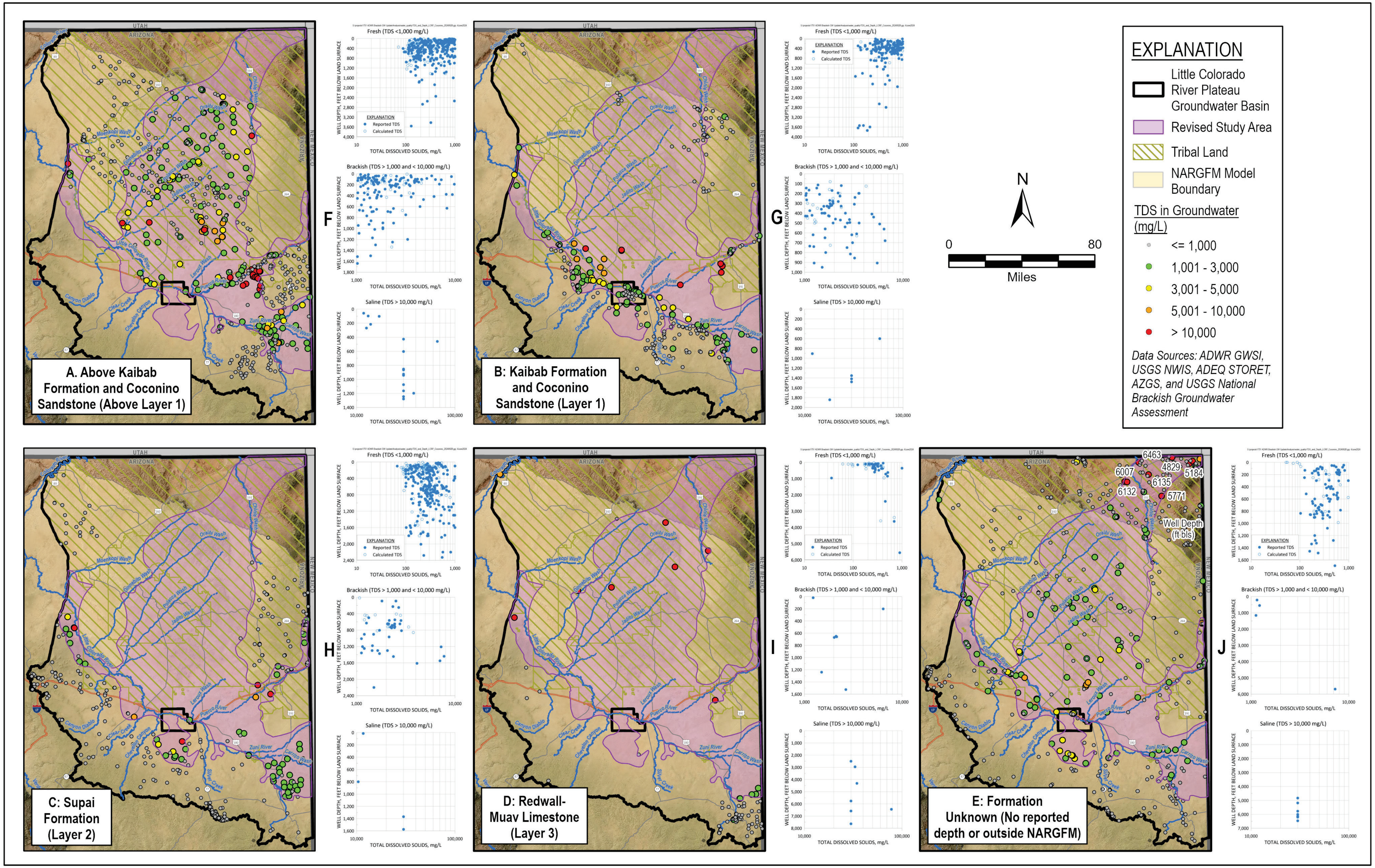

Figure 3-10. Little Colorado River Plateau Groundwater Basin Water Quality

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Table 3-5 summarizes results of the groundwater in storage calculation, which was developed based on parameters in the NARGFM model (Pool *et al.*, 2011). The groundwater in storage calculation was limited to water in the C-Aquifer as represented by Layer 1 and Layer 2 of the NARGFM. Layer 1 represents the Kaibab Formation and Coconino Sandstone, and Layer 2 represents the Supai Formation. Although only the upper and middle Supai and considered part of the C-Aquifer, the entirety of Layer 2 was included in the calculation. Layer 3 represents the Redwall-Muav Limestone (R-Aquifer), which was not included in the groundwater in storage calculation. The northeastern most portion of the focus area contains brackish and saline groundwater but is not included in the groundwater in storage calculation because the NARFGM model grid does not extend this far, as shown on Figure 3-9 through Figure 3-11.

Figure 3-11 shows the depths of the Kaibab/Coconino and Supai Formation below land surface. Groundwater in storage in the Kaibab/Coconino (Layer 1) and Supai (Layer 2) was calculated only to a maximum depth of 1,200 and 1,500 feet, as in the other areas. Because the geologic formations of the C-Aquifer dip to the north and become deeply buried, groundwater in much of the northern portion of the brackish groundwater extent is not quantified in the volume calculation. The boundaries of the 1,200 and 1,500 depths on Figure 3-11 indicate the portion of the aquifer included in the volume estimate. These areas are shown in shades of blue and indicate where the C-Aquifer is at or near land surface.

The C-Aquifer is confined and fully saturated in some areas and unconfined and partially saturated in other areas. To account for this, the top surface for the storage volume calculation was limited to the top of Layer 1 in areas where the C-Aquifer is confined. The lower limit for the storage volume calculation was the bottom of Layer 2, or 1,200 and 1,500 feet in areas where Layer 2 is deeper. Specific yield was calculated as the average specific yield of NARGFM model cells that fall within the depth cutoffs. As discussed in Section 3.1.3, only unconfined storage (Sy) was considered for this study.

Table 3-5. Range of Estimated Volume of Brackish Water in the Little Colorado River Plateau Focus Area

NARGFM Layer	Average Sy	Estimated Volume of Groundwater in Storage
Maximum Depth 1,200 feet		
Kaibab and Coconino (Layer 1)	0.14	160 AMF
Supai (Layer 2)	0.10	76 MAF
TOTAL		**236 MAF**
Maximum Depth 1,500 feet		
Kaibab and Coconino (Layer 1)	0.14	202 MAF
Supai (Layer 2)	0.10	145 MAF
TOTAL		**347 MAF**

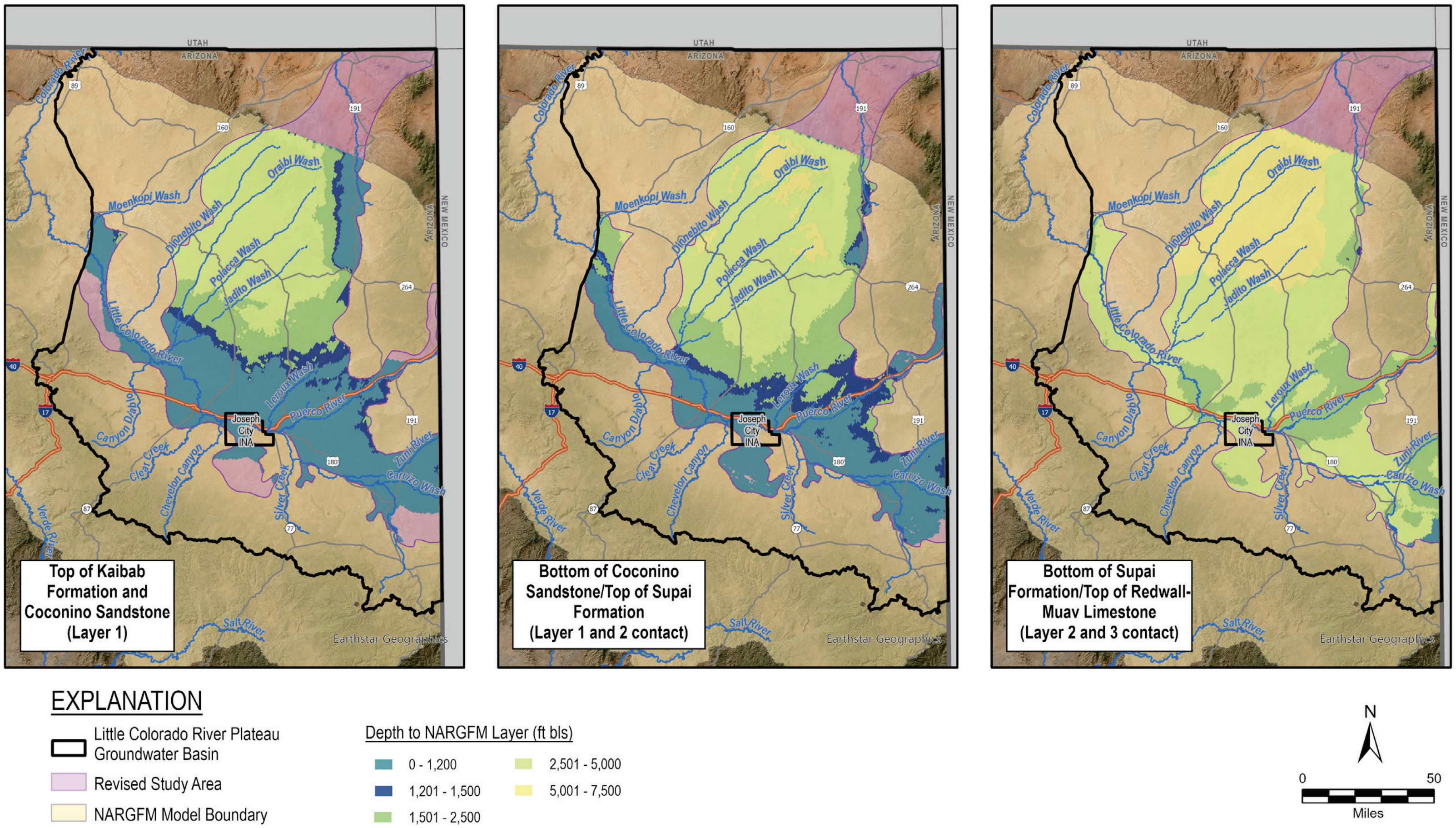

Figure 3-11. Depth to NARGFM Model Layers

Potential yields for wells in the refined study area were estimated based on reported pumping capacities (ADWR, 2024) for non-exempt wells with large diameters greater than or equal to 16 inches. Approximately half the large-diameter wells in the Little Colorado River groundwater basin focus area have capacities between 400 and 2,000 gpm.

Pool *et al*., 2011, developed a water budget for the Little Colorado River Plateau groundwater basin, which is summarized in Table 3-6. Groundwater outflows exceed inflows by approximately 85,000 AF/yr. Unlike the other focus areas, groundwater pumping is not the largest component of outflows.

Table 3-6. Little Colorado River Plateau Groundwater Basin Conceptual Groundwater Budget

Component		Estimated Value, AF/yr	Year / Period	Source
INFLOW	Recharge from Precipitation	154,900	2005	Pool *et al.*, 2011
	Streambed Recharge	13,100		
	Incidental Recharge	49,800		
	Groundwater Underflow	2,600		
	TOTAL INFLOW	**220,300**		
OUTFLOW	Groundwater Pumping	81,700	2005	Pool *et al.*, 2011
	Groundwater Discharge to Springs	300		
	Groundwater Discharge to Streams	13,100		
	Groundwater Underflow	210,400		
	TOTAL OUTFLOW	**305,600**		
BALANCE: INFLOW-OUTFLOW		**-85,300**		

Overall, the high TDS groundwater in the Little Colorado River Plateau basin represents the largest brackish groundwater area in the state. The C-Aquifer contains substantial amounts of both fresh and brackish groundwater. Groundwater development to date is relatively limited compared to the other focus areas, but the geologic setting poses significant challenges for large-scale desalination. The depth of the C-Aquifer increases to the north so the primary opportunities for large-scale desalination are likely in locations where the aquifer is near surface such as the Winslow-Leupp area (M&A, 2008).

4 CONCLUSIONS

ADWR commissioned this updated statewide inventory of brackish groundwater in Arizona as required by the state legislature in 2023. Based on public water quality data, areas of brackish groundwater were delineated where clusters of wells measured TDS concentrations above 1,000 mg/L. In general, the occurrence of brackish groundwater has not changed significantly from previous investigations, although the specific areas have been revised. In this updated inventory, brackish groundwater study areas were identified in 21 individual groundwater sub-basins.

Total estimated groundwater in storage in the 21 study areas ranges from 530 MAF to 700 MAF at depths of 1,200 and 1,500 feet, respectively. Approximately half this volume is in the Lower Colorado River Plateau basin. In many areas, these volume estimates include wells with measured TDS concentrations in both the fresh and brackish range. Because of limited data from deep wells, relationships between TDS and depth are difficult to characterize with this dataset. Generally, elevated TDS levels at shallow depths are influenced by recent land use and at greater depths are likely attributable to geology. Because parts of many basins around the state lack data, particularly in rural areas, and TDS and depth relationships are not well-characterized in any basin, additional data are required to more precisely estimate the extent and volume of brackish groundwater in each study area.

ADWR selected 4 focus areas for further evaluation within the following groundwater basins: Gila Bend, Ranegras Plain, West Salt River Valley, and the Little Colorado River Plateau. For each focus area, analyses and maps include revised study area boundaries based on additional groundwater quality data, water level elevation contours, refined groundwater in storage estimates, and a groundwater budget. With the exception of the Little Colorado River Plateau, all areas are within alluvial basins containing basin-fill aquifers within the basin and range geologic province.

The Little Colorado River Plateau study area is geologically distinct from the alluvial basins; its major aquifers are composed of layers of fractured rock as opposed to unconsolidated alluvial sediments. Overall, the high TDS groundwater in the Little Colorado River Plateau basin represents the largest brackish groundwater area in the state and the C-Aquifer contains substantial amounts of both fresh and brackish groundwater. Groundwater development to date is relatively limited and the basin is not as severely overdrafted as the other focus areas, but the geologic setting poses significant challenges for large-scale desalination. The depth of the C-Aquifer increases to the north so the primary opportunities for large-scale desalination are likely in locations where the C-aquifer is near surface, such as the Winslow-Leupp area.

The information in this report provides a foundation for planning for development of brackish groundwater resources. The report does not include policy or regulatory considerations or engineering cost estimates of water treatment and other infrastructure requirements, which would also need to be part of any feasibility evaluation or pilot demonstration project.

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