Docket	:	A.23-08-010
Exhibit Number	:	Cal Adv - #
Commissioner	:	Shiroma Genevieve
Administrative Law Judge	:	Amin Nojan
Public Advocates Office Witness	:	Cortney Sorensen

PUBLIC ADVOCATES OFFICE
CALIFORNIA PUBLIC UTILITIES COMMISSION

Report On Region II Capital Projects Forecast

Los Angeles, California
February 27, 2024

TABLE OF CONTENTS

MEMORANDUM

The Public Advocates Office at the California Public Utilities Commission ("Cal Advocates") examined application material, data request responses, and other information presented by Golden State Water Company ("GSWC") in Application ("A.") 23-08-010 to provide the California Public Utilities Commission ("Commission" or "CPUC") with recommendations in the interests of ratepayers for safe and reliable service at the lowest cost. Mr. Mehboob Aslam is Cal Advocates project lead for this proceeding. Mr. Victor Chan is the oversight supervisor, and Ms. Crystal Yu and Mr. Brett Palmer are the legal counsel.

Although every effort was made to comprehensively review, analyze, and provide the Commission with recommendations on each ratemaking and policy aspect presented in the Application, the absence from Cal Advocates' testimony of any particular issue connotes neither agreement nor disagreement of the underlying request, methodology, or policy position related to that issue.

CHAPTER 1 Central Basin – Capital Project

I. INTRODUCTION

This Chapter discusses Cal Advocates' review and recommendations pertaining to GSWC's capital projects in the Central Basin. GSWC's Artesia, Norwalk, Bell-Bell Gardens, Florence-Graham, Hollydale, and Willowbrook systems are located in the Central Basin.

II. SUMMARY OF RECOMMENDATIONS

The Commission should adopt the following changes to GSWC's proposed capital budget for GSWC's Artesia, Norwalk, Bell-Bell Gardens, Florence-Graham, Hollydale, and Willowbrook systems:

- Remove $555,150 from 2025 customer rates to avoid GSWC's proposal to prematurely replace filter media at Centralia Plant.
- Remove $1,116,300 from 2025 customer rates to avoid GSWC's proposal to prematurely replace filter media at Bissell Plant.
- Remove $555,100 from 2025 customer rates to avoid GSWC's proposal to prematurely replace filter media at Century Plant.
- Approve only $53,350 in 2026 for Hawaiian backwash tank improvements.
- Approve only $85,250 in 2026 for Roseton backwash tank Improvements.
- Deny GSWC's requested budget of $757,100 in 2024 and $6,691,100 in 2026 to replace Roseton Well No. 1.
- Deny GSWC's requested budget of $2,265,600 in 2024 to replace Converse Well No. 1.
- Deny GSWC's requested budget of $428,200 in 2025 and $3,642,400 in 2026 to purchase land for the purpose of replacing Goodyear Well 4
- Adjust the budget for the Miramonte Plant, Chromium Removal and Treatment project to $1,639, 262.

- Deny GSWC's request of $1,001,300 to replace the plastic backwash tank at Century Plant.

III. ANALYSIS

A. Replace Filter Media – Artesia, Bell-Bell Gardens, and Hollydale Systems

GSWC requests $2,220,600 in 2024 to replace filter media at four treatment facilities in the Artesia system: Juan Plant Site, Hawaiian Plant Site, Roseton Plant Site, and Centralia Plant Site.[1] Also, GSWC requests $1,116,300 in 2024 to replace filter media at Bissell Plant Site in the Bell-Bell Gardens system and $555,100 in 2024 to replace filter media at Century Plant Site in the Hollydale system. The Commission should not approve GSWC's request to change the filter media at Centralia Plant, Bissell Plant, and Century Plant because the filter media is less than 15 years old at these plant sites.

1. The industry standard for changing filter media is 15-20 years.

Typical media life is 15 – 20 years if it is properly maintained.2 The Commission should not approve any filter media replacements at any treatment facility with filter media less than 15 years old. GSWC claims that filter media needs to be changed every 7-10 years.3 This is not consistent with GSWC's current and past operational practices. Below is a list of GSWC treatment facilities that have had filter media in place for 15 or more years:

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[1] Gisler Testimony at p. 103, lines 3 – 7

[2] 11 at p. A-58

[3] Gisler Testimony at p. 103, lines 11 -12

Table: 1-1

Treatment Facility	Age of Filter Media (years)
Juan Plant Site	18[4]
Hawaiian Plant Site	23[5]
Roseton Plant Site	17[6]
Heath Creek Plant	20[7]

The fact that the above four treatment facilities have operated with filter media over 15 years old supports Cal Advocates' recommendation of not changing filter media less than 15 years old. GSWC did not provide any support, such as water quality results or filter bed depths, to substantiate its claim that filter media needs to be replaced every 7 – 10 years.

The existing filter media at Centralia, Bissell and Century plants have been in service for approximately 7, 10, and 10 years, respectively.[8,9,10] Therefore, the filter media at these plants does not need to be replaced during this GRC cycle.

The Commission should adopt Cal Advocates' recommendation regarding GSWC's request to prematurely replace filter media at Centralia

[4] Gisler Testimony at p. 103, lines 12 -13

[5] Gisler Testimony at p. 103, lines 12 -13

[6] Gisler Testimony at p. 103, lines 12 -13

[7] Gisler Testimony at p. 281, lines 12 -13

[8] Gisler Testimony at p. 103, line 13

[9] Gisler Testimony at p. 118, line 5

[10] Gisler Testimony at p. 134, line 2

Plant, Bissell Plant, and Century Plant in GSWC's Artesia, Bell – Bell Gardens, and Hollydale systems.

B. Backwash Tank Improvements – Artesia System

GSWC requests $277,700 in 2026 to recoat and make improvements to the Hawaiian backwash tank[11] and $260,100 in 2026 to recoat and make improvements to the Roseton backwash tank in GSWC's Artesia system.[12] Based on the cost estimates provided by GSWC's consultant, Harper and Associates Engineering, the Commission should approve $53,350 for the Hawaiian backwash tank improvements and $82,250 for the Roseton backwash tank improvements.

1. GSWC has Unnecessarily Increased Construction Cost for the Hawaiian Backwash Tank Project.

The Harper and Associates Engineering Inc. Corrosion Engineering Evaluation of Hawaiian Backwash Tank, dated December 2022, gives a cost estimate for this project.[13] Using the midpoint of each range, the total construction cost for this project should be $53,350.[14] However, GSWC includes direct construction costs of $145,436 in its workpapers. GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[15] The Commission should reject GSWC's direct construction cost estimate of $145,436 and only approve $53,350, which is

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[11] Gisler Testimony at p. 104, line5

[12] Gisler Testimony at p. 105, line 11

[13] Gisler Testimony, Attachment CBE01 at p. 10 – 11

[14] $21,000+$4,500+$2,400+$11,000+$2,200+$9,000+3,250=$53,350

[15] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

the cost estimate provided by GSWC's own consultant, Harper and Associates Engineering Inc.

2. GSWC has Unnecessarily Increased Construction Cost for the Roseton Backwash Tank Project.

The Harper and Associates Engineering Inc.'s Corrosion Engineering Evaluation of Hawaiian Backwash Tank, dated December 2022, gives a cost estimate for this project.[16] Using the midpoint of each range, the total construction cost for this project should be $82,250.[17] However, GSWC included direct construction costs of $136,217.50 in its workpapers. GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[18] The Commission should reject GSWC's direct construction cost estimate of $136,217.50 and only approve $82,250, which is the cost estimate provided by GSWC's own consultant, Harper and Associates Engineering Inc.

3. GSWC's Cost Estimates are Inaccurate.

GSWC used inspection reports for different tanks/reservoirs as its basis for Hawaiian and Roseton backwash tank projects, rather than using reports that The Harper and Associates Engineering Inc. wrote for specifically for Hawaiian and Roseton backwash tanks. GSWC used the "2022 Pineview Plant, Reservoir Improvements Replace damaged elements and recoat Pineview Reservoir" inspection to estimate an inspection cost of $50,000 then added a location of 3% on top of the $50,000. It is

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[16] Gisler Testimony, Attachment CBE02 at p. 9

[17] $50,000+$4,500+$5,300+$2,250+$2,200+$9,000+$9,000=$82,250

[18] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

unnecessary to use another report to estimate the inspection performed by Harper and Associates Engineering Inc for these projects because the inspection/report was completed in December of 2022. GSWC filed its application in August of 2023, therefore, GSWC knew the exact cost for Harper and Associates Engineering Inc to perform the inspections of Hawaiian and Roseton backwash tanks. Also, the Hawaiian and Roseton backwash tanks are not reservoirs. GSWC then used another report on another tank, "HAE 2022 Report - Centralia North Backwash Tank. Average cost" to estimate the remaining items in the cost estimate, rather than using the cost estimate provide by Harper and Associates Engineering Inc for the Hawaiian and Roseton backwash tanks. Since GSWC used other reports for other tanks/reservoirs instead the cost estimates made by Harper and Associates Engineering Inc specifically for Hawaiian and Roseton backwash tanks, the Commission should disregard GSWC's cost estimate.

C. Artesia System, Roseton Plant, Replace Roseton Well No. 1

GSWC requests $757,100 in 2024 and $6,691,100 in 2026 for a total of $7,448,200 to replace the current, active Roseton Well No. 1 with a new well.[19] The Commission should not approve this project.

1. Existing Roseton Well No. 1 is in good condition and does not need to be replaced because of its age.

Roseton Well No. 1, located in the Central Basin, was drilled in 1954, which makes the well approximately 69 years old. GSWC incorrectly states that Roseton Well No. 1 was rehabilitated only twice, in

[19] Gisler Testimony at p. 106, lines 18 – 20 and p. 107, line 1

1976 and 2010.[20] Wood Rodgers, Inc. performed a well assessment on Roseton Well No. 1.[21] According to the Wood Rodgers Well Assessment and Recommendations, dated March 2020 "At least five well rehabilitation events have been reported for Roseton Well No. 1 between 1976 and 2010."[22] Also, The Wood Rodgers Well Assessment and Recommendations, dated March 2020, states that the inspection did not reveal any structural anomalies, the water quality produced from this well is generally good, and the monthly production from this well has increased over time.[23]

GSWC claims, "continuing the use of the well will increase sand production over time."[24] However, the Wood Rodgers Reports states, "It is currently unknown if the Roseton Well No. 1 produces sand during operation; however, cable tool wells do not have a gravel envelope to provide stabilization of the formation, and sand production *may* increase over time with continued use of this well. (emphasis added)"[25] Furthermore, Roseton Well No. 1 has no documented issue with sand, and it is unknown if the well will ever have an issue with sand in the future.

GSWC's only reason for spending $7,448,200 to replace an active well with good water quality and increasing monthly production is its age. However, GSWC has not provided support to demonstrate that Roseton Well No.1's age necessitates replacement. For example, GSWC operates

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[20] Gisler Testimony at p. 107, line 8

[21] Gisler Testimony, Attachment CBE03

[22] Gisler Testimony, Attachment CBE03 at p. 6

[23] Gisler Testimony, Attachment CBE03 at p. 6

[24] Gisler Testimony, at p. 107, lines 13 -14

[25] Gisler Testimony, Attachment CBE03 at p. 6

Converse Well 1 and Goodyear Well 4, which are also in the Central Basin in the Florence-Graham system. These wells are more than 20 years older than Roseton and are still active. Converse Well No. 1 produced 350 acre-feet during the most recent water year, July 2022 – June 2023. GSWC has not provided any compelling evidence that Roseton Well No. 1 cannot continue to operate at its age, similar to Converse Well No. 1 and Goodyear Well 4. Therefore, the Commission should deny this project.

2. GSWC is not fully utilizing its existing sources in the Artesia System

GSWC has six active wells in the Artesia system. The following table lists the production of these wells over the past two water years (July 2021 – June 2022 and July 2022 – June 2023):

Table 1-2

Well Name	Capacity (gpm)	Capacity (acre-feet per year)	Production Yr 1 (acre-feet)	% Used Yr 1	Production Yr 2 (acre-feet)	% Used Yr 2
Roseton Well 2	1,100	1,774.3	1,228.18	69.2%	931.52	52.5%
Roseton Well 1	720	1,161.4	757.27	65.2%	844.23	72.6%
Hawaiian Well 1	600	967.8	35.87	3.71%	16.92	1.7%
Centralia Well 6	2,000	3,226.0	1,316.23	40.8%	404.55	12.5%
Centralia Well 7	2,000	3,226.0	1,061.07	32.9%	1707.54	52.9%
Juan Well 4	840	1,354.93	77.64	5.73%	23.69	1.7%
Total:	7,260	11,710.4	4,476.26	38.2%	3,928.45	33.5%

Yr. 1: July 2021 – June 2022

Yr. 2: July 2022 – June 2023

Based on the information above, Hawaiian Well 1 and Juan Well 4 are used at less than fifty percent of full capacity. Also, Centralia Well 6 well production decreased 69.3%. GSWC should fully utilize its existing sources before spending funds on an additional source. If GSWC needs to perform maintenance/rehabilitation on Hawaiian Well 1, Juan Well 4, or Centralia Well 6, then it should spend funds on getting these wells back to running at full capacity rather than spending a large amount of money on a new source.

3. GSWC does not have enough water rights to operate an additional wells in the Central Basin

According to the most recent Central Basin Watermaster Report for water year 2022-2023 (Attachment 12), GSWC's allowed pumping allocation (APA) is 16,439.20 acre-feet per year. In that same water year, GSWC pumped 17,916.43 acre-feet of water, which is 1477.23 in excess of GSWC's APA. This excess production occurred with at least 18 Central Basin wells not running at full capacity.[26] Additional Central Basin wells were offline during this time while GSWC built treatment facilities for these wells.[27,28] Finally, GSWC is already drilling 3 new wells in the Central Basin.[29]

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[26] Gage Well 2, Goodyear Well 4, Converse Well 1, Bissel Well 2, Bissel Well 3, Miramonte Well 2, Pioneer Well 1, Dace Well 2, Century Well 1, Pioneer Well 3, Imperial Well 2, Imperial Well 3 Mckinley Well No. 3, Willowbrook Well 1, Willowbrook Well 3, Centralia Well 6, Hawaiian Well 1, and Juan Well 4 all ran at less than 50% of full capacity. (Table 1-X)

[27] Dace Well No. 2 and Clara Well No. 2 were offline to build treatment (D.6 Capital Built Not Authorized – APP – Revised, lines 57 and 65)

[28] Cal Advocates' recommendations regarding these treatment projects are discussed in Chapter 3 of this report.

[29] Replacement wells for Miramonte Well 1, Gage Well 2, and Willowbrook Well (Y-SEC-50_RB_CWIP, Tab IN_CWIP, Cells J749, J750, and J751)

Once the above wells are online and all wells are running at full capacity, the difference between the capacity of GSWC's existing sources and GSWC's APA in the Central Basin will be even greater. GSWC would have to purchase or lease additional water rights to run a new well at full capacity in the Central Basin. It is uncertain that GSWC will be able to purchase or lease the additional water rights needed to run a new source at full capacity over the next 70 plus years, which for planning purposes is the estimated useful life of well.

GSWC has 31 active wells in the Central Basin. The following table lists the production of these wells over the past two water years (July 2021 – June 2022 and July 2022 – June 2023):

Table 1-3

Well Name	Capacity (gpm)	Capacity (acre-feet per year)	Production Yr 1 (acre-feet)	% Used Yr 1	Production Yr 2 (acre-feet)	% Used Yr 2
Clara 2	1,000	1,613.01	0.30	0.02%	2.34	0.15%
Gage 2	1,000	1,613.01	998.88	61.9%	682.93	42.3%
Watson 1	660	1,064.58	706.1	66.3%	727.24	68.3%
Goodyear 4	850	1,371.06	868.97	63.4%	494.83	36.0%
Converse 1	450	725.85	302.75	41.7%	257.16	35.4%
Converse 2	550	887.15	778.63	87.8%	848.66	95.6%
Bissel 2	500	806.5	535.86	66.4%	2.25	0.2%
Bissel 3	2,000	3226.015	544.36	16.9%	1,580.52	48.9%
Otis 3	1,000	1,613.01	561.27	34.8%	818.19	50.7%
Nadeau 3	500	806.5	535.74	66.4%	626.54	77.6%
Miramonte 3	800	1,290.41	805.08	62.4%	859.96	66.6%
Miramonte 1	650	1,048.45	199.58	19.0%	0	0.0%
Miramonte 2	800	1,290.41	885.18	68.6%	459.36	35.6%
Pioneer 1	600	967.804	809.24	83.6%	320.20	33.0%

Dace 2	2,000	3226.015	174.40	5.4%	0.52	0.0%
Studebaker 3	1,000	1,613.01	381.27	23.6%	868.71	53.8%
Century 1	400	645.203	49.73	7.71%	10.14	1.5%
Pioneer 3	600	967.804	659.08	68.1%	445.84	46.0%
Imperial 2	550	887.15	0.32	0.04%	182.0	20.5%
Imperial 3	550	887.15	0.26	0.03%	421.61	47.5%
McKinley 3	800	1,290.41	660.54	51.2%	631.22	48.9%
Roseton 2	1,100	1,774.3	1,228.18	69.2%	931.52	52.5%
Roseton 1	720	1,161.4	757.27	65.2%	844.23	72.6%
Bellhaven 3	950	1,532.36	1,179.06	76.9%	1,275.68	83.2%
Bellhaven 4	1,200	1935.61	1,336.09	69.0%	1,613.66	83.3%
Willowbrook 1	1,000	1,613.01	234.02	14.5%	428.01	26.5%
Willowbrook 3	925	1,492.03	704.52	47.2%	430.32	28.8%
Hawaiian 1	600	967.804	35.87	3.71%	16.92	1.7%
Centralia 6	2,000	3,226.0	1,316.23	40.8%	404.55	12.5%
Centralia 7	2,000	3,226.0	1,061.07	32.9%	1707.54	52.9%
Juan 4	840	1,354.93	77.64	5.73%	23.69	1.7%
Total:	28,595	46,123.95	18,387.49	39.7%	17,916.34	38.8%

4. GSWC's cost benefit analysis is inaccurate.

GSWC provides a cost benefit analysis comparing replacing Roseton Well No. 1 with the cost of purchasing water.[30] There are numerous inaccuracies with this analysis; therefore, the Commission should disregard it.

[30] Gisler Testimony, Attachment CBE04

As stated in the previous section, GSWC would have to purchase or lease additional water rights to run its wells at full capacity in the Central Basin. GSWC did not include the cost associated with leasing or purchasing additional water rights in its cost benefit analysis.

GSWC assumes that the replacement well will run at 75% of full capacity. This is a gross overestimate. In this GRC, GSWC estimates that 8,500,348 ccf of water will be pumped from Region II wells.[31] This is equivalent to 19,514 acre-feet of water. The capacity of Region II wells is 64,431 acre-feet per year. Therefore, GSWC plans on running its wells, on average, at 30.3%[32] of full capacity. Therefore, GSWC should have assumed that a new well would run at 30.3% of full capacity, not 75% of full capacity.

GSWC's cost-benefit analysis includes the minimum amount of capital that will be spent on a new well. For example, GSWC could install a generator at the new well in the future claiming that a permanent generator is needed to run the new well during an emergency. Also, if the new well becomes contaminated in the future, GSWC would need to install expensive treatment systems. None of these costs were included in the cost benefit analysis. Therefore, GSWC underestimated the potential capital required for a new well.

Because of these major errors in GSWC's cost benefit analysis, the Commission should disregard the analysis.

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[31] SEC-30_REV_Water Production, Sheet Rec Proj Wtr Prod WS-04, cell Q61

[32] 19,514/64,431 = 0.303

D. Florence – Graham, Drill and Equip New Well (Phase II of Replace Converse Well 1)

GSWC requests $2,265,600 in 2024 to replace Converse Well No. 1 with a new well. The Commission should not authorize this project because GSWC has existing underutilized sources. Additionally, GSWC does not have enough water rights for an additional well in the Central Basin.

1. GSWC is not fully utilizing its existing sources in its Florence – Graham System.

GSWC has six active wells in the Florence-Graham system. The following table lists the production of these wells over the past two water years (July 2021 – June 2022 and July 2022 – June 2023):

Table 1-4

Well Name	Capacity (gpm)	Capacity (acre-feet per year)	Production Yr 1 (acre-feet)	% Used Yr 1	Production Yr 2 (acre-feet)	% Used Yr 2
Goodyear 4	850	1,371.06	868.97	63.4%	494.83	36.0%
Converse 1	450	725.85	302.75	41.7%	257.16	35.4%
Converse 2	550	887.15	778.63	87.8%	848.66	95.6%
Nadeau 3	500	806.5	535.74	66.4%	626.54	77.6%
Miramonte 3	800	1,290.41	805.08	62.4%	859.96	66.6%
Miramonte 1	650	1,048.45	199.58	19.0%	0	0.0%
Miramonte 2	800	1,290.41	885.18	68.6%	459.36	35.6%
Total:	4,600	7,419.8	4,375.93	59.0%	3,546.51	47.8%

Yr. 1: July 2021 – June 2022

Yr. 2: July 2022 – June 2023

Based on the information above, Goodyear 4, Converse 1, and Miramonte Well 2 were used less than fifty percent of full capacity during the most recent water year. If GSWC needs to perform maintenance/rehabilitation on these, then it should spend funds on getting these wells back to running at full capacity rather than spending a large amount of money on a new source. Also, GSWC is drilling a new well in the Florence – Graham system, which is a replacement well for Miramonte Well 1.

2. GSWC does not have enough water rights to run an additional well in the Central Basin

As discussed in Section C.3. above, GSWC should fully utilize its existing sources before spending funds on an additional source. According to the most recent Central Basin Watermaster Report for water year 2022-2023 (Attachment 12), GSWC's allowed pumping allocation (APA) is 16,439.20 acre-feet per year. In that same water year, GSWC pumped 17,916.43 acre-feet of water, which is 1477.23 in excess of GSWC's APA. This excess production occurred with at least 18 Central Basin wells not running at full capacity.[33] Additional Central Basin wells were offline during this time while GSWC built treatment facilities for these wells.[34, 35] Finally, GSWC is already drilling 3 new wells in the Central Basin.[36]

Once the above wells are online and all wells are running at full capacity, the difference between the capacity of GSWC's existing sources and GSWC's APA in the Central Basin will be even greater. GSWC would have to purchase or lease additional water rights to run a new well at full

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[33] Gage Well 2, Goodyear Well 4, Converse Well 1, Bissel Well 2, Bissel Well 3, Miramonte Well 2, Pioneer Well 1, Dace Well 2, Century Well 1, Pioneer Well 3, Imperial Well 2, Imperial Well 3 Mckinley Well No. 3, Willowbrook Well 1, Willowbrook Well 3, Centralia Well 6, Hawaiian Well 1, and Juan Well 4 all ran at less than 50% of full capacity. (Table 1-X)

[34] Dace Well No. 2 and Clara Well No. 2 were offline to build treatment (D.6 Capital Built Not Authorized – APP – Revised, lines 57 and 65)

[35] Cal Advocates' recommendations regarding these treatment projects are discussed in Chapter 3 of this report.

[36] Replacement wells for Miramonte Well 1, Gage Well 2, and Willowbrook Well (Y-SEC-50_RB_CWIP, Tab IN_CWIP, Cells J749, J750, and J751)

capacity in the Central Basin. It is uncertain that GSWC will be able to purchase or lease the additional water rights needed to operate a new source over the next 70 plus years, which for planning purposes is the estimated useful life of well.

3. GSWC's Cost Benefit Analysis is Inaccurate

GSWC provides a cost benefit analysis comparing replacing Converse Well No. 1 with the cost of purchasing water.[37] There are numerous inaccuracies with this analysis; therefore, the Commission should disregard it.

As stated in the previous section, GSWC would have to purchase or lease additional water rights to run its wells at full capacity in the Central Basin. GSWC did not include the cost associated with leasing or purchasing additional water rights in its cost benefit analysis.

GSWC assumes that the replacement well will run at 75% of full capacity. This is a gross overestimate. In this GRC, GSWC estimates that 8,500,348 ccf of water will be pumped from Region II wells.[38] This is equivalent to 19,514 acre-feet of water. The capacity of Region II wells is 64,431 acre-feet per year. Therefore, GSWC plans on running its wells, on average, 30.3%[39] of full capacity. Therefore, GSWC should have assumed that a new well would run at 30.3% of full capacity, not 75% of full capacity.

GSWC's cost-benefit analysis includes the minimum amount of capital that will be spent on a new well. For example, GSWC could install a generator at the new well in the future claiming that a permanent

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[37] Gisler Testimony, Attachment CBW04

[38] SEC-30_REV_Water Production, Sheet Rec Proj Wtr Prod WS-04, cell Q61

[39] 19,514/64,431 = 0.303

generator is needed to run the new well during an emergency. Also, if the new well becomes contaminated in the future, GSWC would need to install expensive treatment systems. None of these costs were included in the cost benefit analysis. Therefore, GSWC underestimated the potential capital required for a new well.

Because of these major errors in GSWC's cost benefit analysis, the Commission should disregard the analysis.

E. Florence – Graham, Land Acquisition to Replace Goodyear Well 4

GSWC requests $428,200 in 2025 and $3,642,400 in 2026 for a total of $4,070,600 to purchase land for a new water supply well to replace Goodyear Well No. 4. The Commission should remove the capital budget associated with this project because GSWC is not fully utilizing its existing sources, GSWC does not own enough water rights for a new source in the Central Basin, and this project will provide no benefits to ratepayers during this GRC cycle.

1. GSWC is not fully utilizing its existing sources and does not have enough water rights for new sources in the Central Basin.

As discussed in Section C.3. above, GSWC should fully utilize its existing sources before spending funds on an additional source. Also, GSWC would have to purchase or lease additional water rights to run a new well in the Central Basin. It is uncertain that GSWC would be able to acquire additional water rights, either by leasing or purchasing, in the future to fully utilize an additional well in the Central Basin. Finally, if GSWC were to propose purchasing additional water rights to operate a new well in the Central Basin, GSWC would need to perform a cost benefit analysis showing that the costs of drilling a new well and purchasing additional water rights is more cost effective than purchasing water.

2. A vacant plot of land will provide no benefits to ratepayers in this GRC cycle.

The Commission should not allow the budget for a land purchase that would provide no benefit to ratepayers in this GRC cycle.

If GSWC is allowed to complete the Goodyear Well 4 replacement project in multiple GRCs, the project would not become used and useful until a future GRC after the replacement well is actually drilled and producing water. Ratepayers should not fund projects that provide no benefits to them. Splitting the project onto multiple GRCs would only benefit shareholders by allowing them to earn GSWC's full rate of return on a vacant piece of land that is not used and useful. GSWC's request of $4,070,600 to purchase land would provide no benefit to ratepayers in the current GRC cycle and should not be included in rate base.

F. Florence-Graham, Miramonte Plant, Chromium Removal and Treatment

GSWC estimates a total budget of $3,785,100 for this project. However, GSWC's estimate is inaccurate and unreasonably inflated. The Commission should adjust GSWC's proposed budgeted amounts of $395,100 in 2024 to design and permit a Chromium removal treatment system and $3,390,000 to construct the treatment system in 2025 at the Miramonte Plant to a total of $1,639,262 in 2025. Cal Advocates' recommended budget for this treatment system is based on the United States Environmental Protection Agency's (USEPA) cost model for anion exchange for chromium removal treatment.

1. GSWC's Cost Estimate for the Chromium removal treatment system is inflated and inaccurate.

GSWC's estimated total budget of $3,785,100 for this project is inflated and inaccurate, because GSWC added a location markup of 3% to cost items with cost sources located in the same region as Miramonte Plant and used the wrong year (2023) when estimating the cost of the treatment system.

GSWC uses a 3% location markup for all items in the cost estimate for this project except the treatment system. This includes the following items: Electrical Conduits/Wiring/Plugs/Switches/Connections, Instrumentation & Control Devices, and PLC Modifications & Programming. The cost source for these items is "Bissell Plant, Expansion of Manganese Treatment Expand manganese for wells #2 & #3." Bissell Plant is located in the same region, GSWC's Region II, which includes systems in the greater Los Angeles area. It is unnecessary to add a location markup of 3% to these items because both Miramonte Plant and Bissell Plant are located in the same geographical region (i.e., Region II). Thus, adding this 3% location markup unnecessarily inflates the cost estimate for this project. GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[40]

The Ion Exchange system is the highest cost included in the budget for this system. GSWC's estimated cost of $1,644,000 for the Ion Exchange System uses a cost source of "Estimate used. From AqueoUSvets in 2023." GSWC's RO model uses 2022 as the year in which construction estimates are based. Because GSWC used an estimated based in 2023 dollars instead of the correct year of 2022, GWC's cost estimate for this project is inaccurate.

Accordingly, the Commission should reject GSWC's cost estimate for this project because it is inflated and inaccurate.

[40] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

2. Cal Advocates' Cost Estimate

Cal Advocates uses USEPA's cost model for anion exchange, which is available on USEPA's website,[41] to estimate the budget for GSWC to install chromium removal treatment at Miramonte Plant. USEPA's cost models were developed to estimate compliance costs for drinking water standards. USEPA's cost models use a bottom-up approach known as work breakdown structure (WBS). The WBS models derive system-level costs and provide USEPA comprehensive, flexible, transparent tools to help estimate treatment costs.[42]

Cal Advocates uses the information (target contaminant, raw water quality, and design flow) provided by GSWC[43] as inputs into USEPA's WBS cost model for anion exchange. For the information not provided by GSWC, the WBS cost model has default settings and critical design assumptions, which generally reflect engineering practices. USEPA's WBS cost model calculated that one treatment system with two vessels in parallel and one standby vessel, for a total of three vessels, is needed at the Miramonte Plant for the removal of chromium.[44] The model calculated the size of the vessels should be 11 feet in diameter and 7 feet in height.[45] The WBS cost model estimates total capital costs of $1,463,626, which is in 2021 dollars, for this project. This amount is based on the national average for materials and construction costs. Cal Advocates makes two adjustments to this amount to reflect costs in the greater Los Angeles area,

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[41] https://www.epa.gov/sdwa/drinking-water-treatment-technology-unit-cost-models

[42] https://www.epa.gov/sdwa/drinking-water-treatment-technology-unit-cost-models

[43] Gisler Testimony at pp. 128 – 129

[44] Attachment 17 at pp. A116 – A120

[45] Attachment 17 at pp. A116 – A120

where Miramonte Plant is located, and expresses the cost estimate in 2022 dollars, which is what GSWC uses in its RO model. For the location adjustment, USEPA recommends using location-specific cost indices published by RSMeans. Since the WBS cost model estimates are in 2021 dollars, Cal Advocates uses the 2021 Los Angeles cost index of 1.12,[46] which increases the estimated capital costs to $1,639,262.[47] Since GSWC uses year 2022 as its cost basis in its RO Model, Cal Advocates uses GSWC's construction escalation factor of 3% to get a total budget, in 2022 dollars, of $1,688,440. The Commission should approve a budget of $1,688,440 for this project. Once the project is completed, GSWC may request any additional amounts in excess of Cal Advocates' cost estimate for prudency review in its future GRC.

G. Century Plant, Replace Plastic Backwash Tank

GSWC requests $104,500 in 2024 and $896,800 in 2025 to replace the plastic backwash tank with a bolted steel tank at the Century Plant Site. The Commission should not approve GSWC's request.

GSWC did not provide a condition assessment of the plastic backwash tank at Century Plant. For GSWC's other backwash tank projects, GSWC provided detailed condition assessments, which included cost estimates to fix any deficiencies. For example, in GSWC's Artesia system, GSWC hired Harper and Associates Engineering Inc. Corrosion Engineering to perform an evaluation of Hawaiian Backwash Tank. GSWC provided the detailed report, dated December 2022, prepared by Harper and Associates Engineering Inc. Corrosion Engineering.[48] The Commission should require GSWC to perform a similar

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[46] Attachment 17 at pp. A121

[47] $1,463,626 x 1.12 = $1,639,262

[48] Gisler Testimony, Attachment CBE01

assessment before approving the replacement of the backwash tank at Century Plant.

Also, during the field visit to the Hollydale system, Cal Advocates did not observe any deficiencies with the backwash tank at Century Plant.

GSWC's request to replace the backwash tank at Century Plant is not justified and is unnecessary. The Commission should deny GSWC's requests for $104,500 in 2024 and $896,800 in 2025 to replace the backwash tank at Century Plant.

IV. CONCLUSION

The Commission should adopt Cal Advocates' recommendations regarding filter media replacement, Hawaiian backwash tank improvements, Roseton backwash tank improvements, replacement of Roseton Well no. 1, replacement of Converse Well 1, the purchase land for a future replacement of Goodyear Well 4, Miramonte Plant chromium removal treatment, and Century Plant backwash tank replacement in GSWC's Central Basin systems.

CHAPTER 2 Southwest System – Capital Projects

I. INTRODUCTION

This Chapter discusses Cal Advocates' review of GSWC's capital projects in the Southwest System of Region II.

II. SUMMARY OF RECOMMENDATIONS

The Commission should adopt the following changes to GSWC's proposed capital budget for GSWC's Southwest System:

- Deny GSWC's requested budget of $1,105,100 in 2024 to perform maintenance on Budlong North Reservoir.
- Deny GSWC's requested budget of $123,100 in 2025 and $1,046,700 in 2026 to perform maintenance on Budlong South Reservoir.
- Deny GSWC's requested budget of $453,200 in 2024 and $3,888,900 in 2025 to replace Chadron Reservoir with a new 1.5 MG reservoir and approve $1,110,169 to perform recommended improvements at Chadron Reservoir.
- Remove $5,133,193.09 from rate base and deny GSWC's proposed capital budget of $792,000 in this GRC for Chadron Plant site soil remediation because Chadron Plant soil remediation is not the responsibility of ratepayers.
- Approve only $550,700 to perform improvements at Gardena Heights Reservoir.
- Approve only $29,500 in 2024 to recoat Doty Plant Backwash Tank A.
- Approve only $29,500 in 2025 to recoat Doty Plant Backwash Tank B.
- Approve only $29,500 in 2025 to recoat Goldmedal Plant Backwash Tank.
- Approve only $29,500 in 2026 to recoat Southern Plant Backwash Tank.

- Deny GSWC's requested budget of $757,100 in 2024 and $6,496,200 in 2025 to replace Compton-Doty Well No. 1.
- Deny GSWC's requested budget of $369,900 in 2024 and $3,173,800 in 2025 to expand treatment capacity at Doty Plant.
- Deny GSWC's requested budget of $817,300 to design and permit a replacement well for Dalton Well No. 1.
- Deny GSWC's requested budget of $1,191,200 in 2024 to prematurely replace filter media at Southern Plant.
- Deny GSWC's requested budget of $1,672,100 in 2024 to install distribution system valves for NO-DES flushing.
- Deny GSWC's requested budget of $654,700 in 2024 to perform a disinfection alternatives study.

III. ANALYSIS

A. Budlong Plant, Recoat North Reservoir

GSWC requests $1,105,100 in 2024 to perform maintenance on Budlong North Reservoir. This request is based on an inspection of Budlong North Reservoir performed by Albert A. Webb Associates. GSWC contracted Albert A. Webb Associates to perform corrosion inspections and a seismic evaluation of the Budlong North Reservoir. The Commission should deny the capital budget associated with this project because the reservoir is in overall good condition and does not need maintenance performed on it at this time.

1. The Tank Evaluation Performed by Albert A. Webb Associates is Inaccurate

Budlong North Reservoir was built in 2009.[49, 50] However, The Tank Evaluation Performed by Albert A. Webb Associates, dated December 2022, inaccurately states that the Budlong North Reservoir was built in 2003.[51] Therefore, all recommendations in the tank evaluation report based on a timeframe need to be adjusted by adding 6 years to account for the inaccuracy regarding the age of the tank. For example, the tank evaluation states that the interior lining is approximately 21 years old,[52] the lining is nearing the end of its expected service life,[53] and the tank should be relined in approximately 5 years.[54] Given this information stated in the tank evaluation, Cal Advocates reasonably concludes that the useful life of the tank's interior lining is approximately 25 years. However, the tank was built in 2009, so the lining is approximately 15 years old, not 21 years old as inaccurately stated in the tank evaluation. Therefore, the interior lining needs to be replaced in 2034, which is well outside the scope of this GRC. The Commission should not approve this project.

2. GSWC has Unnecessarily Increased the Project Construction Cost

The Tank Evaluation Performed by Albert A. Webb Associates, dated December 2022, states that the total construction cost for the project

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[49] Gisler Testimony at p. 144, lines 3 - 4

[50] 2017 Annual Report to the Drinking Water Program at p. 16

[51] Gisler Testimony, Attachment SW01 at p. 7

[52] Gisler Testimony, Attachment SW01 at p. 19

[53] Gisler Testimony, Attachment SW01 at p. 20

[54] Gisler Testimony, Attachment SW01 at p. 20

is $484,728. However, GSWC included direct construction costs of $615,118 in its workpapers. GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[55] If the Commission approves this project, which it should not, only $484,728 in direct construction costs should be approved, which is the amount stated in the Tank Evaluation Performed by Albert A. Webb Associates.

GSWC used a different inspection report as its cost source for the inspection performed by Albert A. Webb Associates. GSWC used the "2022 Pineview Plant, Reservoir Improvements Replace damaged elements and recoat Pineview Reservoir" inspection to estimate an inspection cost of $75,000 then added a location of 11% on top of the $75,000. It is unnecessary to use another report to estimate the inspection performed by Albert A. Webb Associates because the inspection report was completed in December of 2022. GSWC filed its application in August of 2023, therefore, GSWC knew the exact cost for Albert A. Webb Associates to perform the inspection of Budlong Plant reservoirs. Since GSWC used another report for other another reservoir instead of the actual cost for Albert A. Webb Associates to perform the inspection, the Commission should disregard GSWC's cost estimate.

3. Tank is in Good Condition

The Tank Evaluation Performed by Albert A. Webb Associates states, "The tank is in overall good condition."[56] Also, "The paint system on the exterior was found to be relatively thin and in excellent condition. The exterior surfaces have only isolated spot rust and minimal chalking.

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[55] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

[56] Gisler Testimony, Attachment SW01 at p. 7

The condition of the paint system poses no immediate threat to the structure and the system is performing as intended."[57]

B. Budlong Plant, Recoat South Reservoir

GSWC requests $123,100 in 2025 and $1,046,700 in 2026 for a total of $1,169,800 to perform maintenance on Budlong South Reservoir. This request is based on corrosion inspections and a seismic evaluation of Budlong North Reservoir performed by Albert A. Webb Associates in 2022. The Commission should remove the capital budget associated with this project because the reservoir is in overall good condition and does not need maintenance performed on it at this time.

1. The Tank Evaluation Performed by Albert A. Webb Associates is Inaccurate

Budlong North Reservoir was built in 2009.[58,59] However, the Tank Evaluation Performed by Albert A. Webb Associates, dated December 2022, inaccurately states that the Budlong North Reservoir was built in 2006.[60] Therefore, all recommendations in the tank evaluation report based on a timeframe need to be adjusted by adding 3 years to account for the inaccuracy regarding the age of the tank. For example, the tank evaluation states that the interior lining is approximately 20 years old,[61] the lining is nearing the end of its expected service life,[62] and the tank should be relined

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[57] Gisler Testimony, Attachment SW01 at p. 7

[58] Gisler Testimony at p. 144, lines 3 - 4

[59] 2017 Annual Report to the Drinking Water Program at p. 16

[60] Gisler Testimony, Attachment SW02 at p. 7

[61] Gisler Testimony, Attachment SW02 at p. 19

[62] Gisler Testimony, Attachment SW01 at p. 20

in approximately 5 years.[63] Given this information stated in the tank evaluation, Cal Advocates reasonably concludes that the useful life of the tank's interior lining is approximately 25 years. However, the tank was built in 2009, so the lining is approximately 15 years old, not 20 years old as inaccurately stated in the tank evaluation. Therefore, the interior lining needs to be replaced in 2034, which is well outside the scope of this GRC. The Commission should not approve this project.

2. GSWC has Unnecessarily Increased the Project Construction Cost

The Tank Evaluation Performed by Albert A. Webb Associates, dated December 2022, states that the total construction cost for the project is $484,728. However, GSWC included direct construction costs of $615,118 in its workpapers. GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[64] If the Commission approves this project, which it should not, only $484,728 in direct construction costs should be approved, which is the amount stated in the Tank Evaluation Performed by Albert A. Webb Associates.

3. Tank is in Good Condition

The Tank Evaluation Performed by Albert A. Webb Associates states, "The tank is in overall good condition."[65] Also, "The paint system on the exterior was found to be relatively thin and in excellent condition. The exterior surfaces have only isolated spot rust and minimal chalking.

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[63] Gisler Testimony, Attachment SW01 at p. 20

[64] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

[65] Gisler Testimony, Attachment SW03 at p. 7

> The condition of the paint system poses no immediate threat to the structure and the system is performing as intended."[66]

C. Chadron Plant, Replace Reservoir

GSWC requests $453,200 in 2024 and $3,888,900 in 2025 for a total of $4,342,100 to replace Chadron Reservoir with a new 1.5 MG reservoir. The Commission should remove the capital budget associated with replacing Chadron Reservoir because the reservoir is in overall good condition. The Commission should instead approve direct construction costs of $1,110,169, which is the cost recommended in the Tank Evaluation Performed by Albert A. Webb Associates to perform recommended improvements.

1. Chadron Reservoir is in Overall Good Condition

The Tank Evaluation Performed by Albert A. Webb Associates states, "The tank is in overall good condition."[67] Also, "The paint system on the exterior shell and tank accessories was found to be relatively thin and in overall good condition." Furthermore, "The exterior surfaces have only isolated spot rust and minimal chalking. The condition of the paint system poses no immediate threat to the structure."[68]

2. Chadron Reservoir does not need to be replaced.

Since Chadron Reservoir is in good condition overall, it does not need to be replaced. Chadron Reservoir was constructed in 1963. GSWC's reasons for replacing this reservoir are based entirely on the age of the

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[66] Gisler Testimony, Attachment SW03 at p. 7

[67] Gisler Testimony, Attachment SW03 at p. 7

[68] Gisler Testimony, Attachment SW03 at p. 7

reservoir and not its current condition. GSWC cites the following statements from the Tank Evaluation for Chadron Tank, Performed by Albert A. Webb Associates, dated December 2022, "Consider replacing the existing Chadron Tank with a new portable water storage tank that meets other requirements of AWWA D-100-21 standard. The existing Chadron tank is 59 years old, and the recommended modifications will cost a significant percentage of the cost of a new water storage tank and may not extend the tank beyond the following coating replacement cycle."[69]

GSWC's Gardena Heights Reservoir is approximately the same age as Chadron Reservoir, and Albert A. Webb Associates made identical recommendations to replace this reservoir.[70] Yet, as described in the next section, GSWC is proposing a capital budget of $1,184,000 to perform spot repair on the exterior and interior of the Gardena Heights Reservoir, as well as perform structural and safety, health and code modifications."[71] The Commission should approve direct construction costs of $1,110,169 to make similar repairs at Chadron Reservoir.

D. Chadron Plant, Soil Remediation

The Chadron Plant Site consists of a 1.5 MG reservoir and three booster pumps with a capacity of 3,200 gpm. Previously, groundwater was pumped from two water supply wells to the reservoir. The two wells were abandoned in May of 1988. The site is still used for water storage and as a maintenance yard.

The site previously operated two 6,000 gallon gasoline fuel underground storage tanks and associated piping and dispenser to fuel GSWC vehicles. The first underground gasoline storage tank was installed in 1969 and removed and

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[69] Gisler Testimony, at p. 146, lines 11 – 15

[70] Gisler Testimony, Attachment SW06 at p. 10

[71] Gisler Testimony, at p. 149, lines 8 – 12

replaced by another underground gasoline storage tank in 1978, which was connected to the existing piping and dispenser. The second underground gasoline storage tank, along with associated piping and fuel dispenser, was removed in 1990 and not replaced.

Over time, these underground gasoline storage tanks leaked, which resulted in soil and groundwater contamination. Several site assessments were conducted between 1994 and 2003 at the Chadron Plant site. The primary constituents of concern are benzene and methyl tertiary butyl ether (MTBE).

1. GSWC is responsible for soil contamination at Chardon Plant

GSWC owned and operated the underground storage tanks that leaked gasoline and contaminated the soil and groundwater. GSWC's most recent Securities and Exchange Commission (SEC) Form 10-K, dated February 21, 2024, states, "GSWC is also responsible for clean-up and remediation at a plant site that contained an underground storage tank."72

2. GSWC has soil remediation projects in rate base.

GSWC's most recent Securities and Exchange Commission (SEC) Form 10-K, dated February 21, 2024, states:73

> As of December 31, 2023, the total amount spent to clean up and remediate GSWC's plant facility was approximately \$6.3 million, of which \$1.5 million has been paid by the State of California Underground Storage Tank Fund. Amounts paid by GSWC have been included in rate base and approved by the CPUC for recovery. As of December 31, 2023, GSWC has a regulatory asset and an accrued liability for the estimated remaining cost of \$1.3 million to complete

[72] Securities and Exchange Commission Form 10-K at p. 8 (Attachment 24 at p. A-297)

[73] Securities and Exchange Commission Form 10-K at p. 61 (Attachment 24 at p. A-350)

> the cleanup at the site. The estimate includes costs for continued activities of groundwater cleanup and monitoring, future soil treatment, and site closure related activities. The ultimate cost may vary as there are many unknowns in remediation of underground gasoline spills and this is an estimate based on currently available information. Management also believes it is probable that the estimated additional costs will continue to be approved in rate base by the CPUC.

The Commission should not continue to approve projects for Chadron Plant site soil remediation, because it is GSWC's responsibility. Ratepayers should not pay for such expenditure caused by GSWC.

3. Ratepayers should not have to fund soil remediation projects.

GSWC has spent a substantial amount on pilot studies, groundwater cleanup, monitoring, soil treatment, and investigations to determine the extent of contamination. GSWC has hired multiple consultants, such as Aquilogic, and Worley Parsons Komex, to perform these activities. Cal Advocates learned through discovery the exact amounts in rate base for projects to remediate the soil at the Chadron Plant Site. In response to Cal Advocates data request, GSWC states:

> The total capital expenditures through December 2023 are $6,627,604.09. We received funding from the State Water Resource Control Board Underground Storage Tank Clean Up Fund in the amount of $1,494,411 that offset the project costs, so the final capital expenditures through December 2023 are $5,133,193.09.[74]

[74] GSWC's response to Cal Advocates' Data Request CSN-003, Southwest System Capital Projects Response, p.3 Question 3.b. (Attachment 3 at pp. A-11 – A-12).

Also, GSWC proposes a capital budget of $792,000 in this GRC (years 2024 to 2026) for Chadron Plant soil remediation.75 The soil contamination is caused by the leak from the storage tank owned by GSWC. Soil remediation at the Chadron Plant site is the responsibility of GSWC shareholders, not its ratepayers. Therefore, ratepayers should not have paid the costs associated with soil remediation at Chadron Pant site and should not continue to pay any future costs. The Commission should remove the total amount of $5,133,193.09 from rate base for setting rates in this GRC cycle and deny GSWC's proposed capital budget of $792,000 in this GRC (Cal Advocates' recommended revenue requirement for Region II does not include the removal of $792,000 from the rate base). The Commission should hold GSWC responsible for the cost of contamination clean-up caused by leak from its own fuel tanks.

E. Gardena Heights Plant, Reservoir Improvements

GSWC requests $1,184,000 in 2025 to perform spot repair on the exterior and interior of Gardena Heights Reservoir, as well as to perform structural and safety, health and code modifications. The Commission should approve direct construction costs of $550,700, which is the cost recommended in the Tank Evaluation Performed by Albert A. Webb Associates to perform recommended improvements.

1. GSWC has Unnecessarily Increased the Project Construction Cost

The Tank Evaluation Performed by Albert A. Webb Associates, dated December 2022, states that the total construction cost for the project is $550,700.[76] However, GSWC included a construction cost of $639,225 in its workpapers. GSWC then adds additional markups, such as

[75] GSWC's response to Cal Advocates' Data Request CSN-003, Southwest System Capital Projects Response, p.3, Question 3.b. (Attachment 3 at p. A-11).

[76] Gisler Testimony, Attachment SW06 at p. 11

mobilization, on top of the inflated direct construction costs.[77] The Commission should only approve $550,700, which is the amount stated in the Tank Evaluation Performed by Albert A. Webb Associates.

F. Recoat Backwash Tanks

GSWC requests to recoat and make improvements to the Doty Plant Backwash Tank A, Doty Plant Backwash Tank B, Goldmedal Plant Backwash Tank, and Southern Plant Backwash Tank. GSWC requests the following amounts for these projects: $242,700 in 2024 for Doty Plant Backwash Tank A, $250,200 in 2025 for Doty Plant Backwash Tank B, $250,200 in 2025 for Goldmedal Plant Backwash Tank, and $258,000 in 2026 for Southern Plant Backwash Tank. Based on the direct cost estimates provided by Albert A. Webb Associates, the Commission should approve $29,500 for each of these projects.

1. GSWC has Unnecessarily Increased Construction Cost for the Doty Plant Backwash Tank A Project.

The Albert A. Webb Associates Tank Evaluation for Doty Plant Backwash Tank A, dated December 2022, gives a construction cost estimate of $25,000 for this project.[78] However, GSWC included direct construction costs of $135,112.50 in its workpapers. GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[79] The Commission should reject GSWC's direct construction cost estimate of $135,112.50 and only approve $29,500, which

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[77] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

[78] Gisler Testimony, Attachment SW04 at p. 9

[79] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

is the cost estimate provided by Albert A. Webb Associates and includes $4,500 for the tank evaluation.

2. GSWC has Unnecessarily Increased Construction Cost for the Doty Plant Backwash Tank B Project.

The Albert A. Webb Associates Tank Evaluation for Doty Plant Backwash Tank B, dated December 2022, gives a construction cost estimate of $25,000 for this project.[80] However, GSWC included a construction cost of $135,112.50 in its workpapers. This is an unnecessary increase of 440%.[81] GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[82] The Commission should reject GSWC's direct construction cost estimate of $135,112.50 and only approve $29,500, which is the cost estimate provided by Albert A. Webb Associates and includes $4,500 for the tank evaluation.

3. GSWC has Unnecessarily Increased Construction Cost for the Goldmedal Plant Backwash Tank.

The Albert A. Webb Associates Tank Evaluation for Goldmedal Plant Backwash Tank, dated December 2022, gives a construction cost estimate of $25,000 for this project.[83] However, GSWC included a construction cost of $135,112.50 in its workpapers. This is an unnecessary

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[80] Gisler Testimony, Attachment SW04 at p. 9

[81] ($135,112 - $25,000)/ $25,000 = 4.40

[82] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

[83] Gisler Testimony, Attachment SW07 at p. 9

increase of 440%.[84] GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[85] The Commission should reject GSWC's direct construction cost estimate of $135,112.50 and only approve $29,500, which is the cost estimate provided by Albert A. Webb Associates and includes $4,500 for the tank evaluation.

4. GSWC has Unnecessarily Increased Construction Cost for the Southern Plant Backwash Tank.

The Albert A. Webb Associates Tank Evaluation for Southern Plant Backwash Tank, dated December 2022, gives a construction cost estimate of $25,000 for this project.[86] However, GSWC included a construction cost of $135,112.50 in its workpapers. This is an unnecessary increase of 440%.[87] GSWC then adds additional markups, such as mobilization, on top of the inflated direct construction costs.[88] The Commission should reject GSWC's direct construction cost estimate of $135,112.50 and only approve $29,500, which is the cost estimate provided in Albert A. Webb Associates and includes $4,500 for the tank evaluation.

G. Compton-Doty Plant, Replace Well No. 1

GSWC requests $757,000 in 2024 and $6,496,200 in 2025 to replace Compton-Doty Well No. 1 with a new well. Also, GSWC requests $369,900 in

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[84] ($135,112 - $25,000)/ $25,000 = 4.40

[85] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

[86] Gisler Testimony, Attachment SW08 at p. 9

[87] ($135,112 - $25,000)/ $25,000 = 4.40

[88] *See* Chapter 1 of the Direct Testimony of Sari Ibrahim for cost adders: Location Markup, Mobilization, Payment and Performance Bond, and Sales Tax. *See also* Justin Menda's testimony for cost adders: Contingency, Escalation and Overhead.

2024 and $3,173,800 in 2025 for treatment at the new, replacement well. This totals $10,797,000 for one source of water. The Commission should not approve these projects because GSWC has underutilized existing sources of water. Additionally, GSWC does not have enough water rights for an additional well in the West Coast Basin.

1. GSWC is not fully utilizing its existing sources in the Southwest system.

GSWC has 11 active wells in the Southwest system. The following table lists the production of these wells over the past two water years (July 2021 – June 2022 and July 2022 – June 2023):

Table 2-1

Well Name	Capacity (gpm)	Capacity (acre-feet per year)	Production Yr 1 (acre-feet)	% Used Yr 1	Production Yr 2 (acre-feet)	% Used Yr 2
129th St Well 2	1,250	2,016	421.56	20.9%	1,053.83	52.3%
Compton-Doty Well 1	600	968	1.51	0.156%	0.88	0.09%
Dalton Well 1	800	1,290	677.35	52.5%	4.26	0.33%
Dalton Well 2	2,500	4,033	3,460.64	85.8%	3,253.08	80.7%
Doty Well 1	700	1,129	13.28	1.18%	562.14	49.8%
Doty Well 2	1,000	1,613	15.18	0.94%	850.81	52.7%
Goldmedal Well 1	1,000	1,613	6.53	0.405%	129.40	8.02%

Southern Well 5	900	1,452	1.44	0.099%	186.44	12.8%
Southern Well 6	1,100	1,774	6.49	0.366%	211.59	11.9%
Ballona Well 4	700	1,129	3.85	0.341%	8.35	0.74%
Ballona Well 5	800	1,290	2.09	0.162%	13.77	1.07%
Total:	11,350	18,307	4,609.92	25.18%	6,274.55	34.3%

Based on the information above the only well in the West Coast Basin that GSWC is using close to full capacity is Dalton Well 2, which was used 85.8% of its full capacity in water year July 2021 – June 2022 and 80.7% of its full capacity in water year July 2022 – June 2023. All the other wells are used at approximately 50% or less of their full capacities with the majority of the wells being used far less than 50% of their full capacities. Prior to requesting over $10M for a new water source, GSWC should demonstrate that it is fully utilizing its existing sources. If GSWC needs to perform maintenance/rehabilitation on its wells, then it should spend funds on getting these wells back to running at full capacity rather than spending large sums of money on new sources.

2. GSWC does not have enough water rights to run an additional well in the West Coast Basin

According to the most recent West Coast Basin Watermaster Report for water year 2022-2023 (Attachment 19), GSWC's adjudicated rights are 7,502 acre-feet per year. GSWC currently has wells with a total annual capacity of 18,307 acre-feet per year. In other words, GSWC would need to more than double its existing water rights in the West Coast Basin just to run its current active wells at full capacity. GSWC would have to purchase or lease even more water rights to run a new well in the Central Basin. It is uncertain that GSWC will be able to purchase or lease the large amount of additional water rights needed to run new sources at full capacity over the next 70 plus years, which for planning purposes is the estimated useful life of a well.

GSWC claims that Compton-Doty Well No. 1 and Dalton Well No. 1 have reached the end of their useful service lives. Removing the capacity of these wells from the total capacity of GSWC's active wells in the West Coast Basin leaves a total of 16,049 acre-feet per year. This is still more than double GSWC's adjudicated rights, which are 7,502.24 acre-feet per year. Therefore, GSWC does not have enough water rights in the West Coast Basin to replace Compton-Doty Well No. 1 and Dalton Well No. 1.

3. GSWC's Cost Benefit Analysis is Inaccurate

GSWC provides a cost benefit analysis comparing replacing Compton-Doty Well No. 1 with the cost of purchasing water.[89] There are numerous inaccuracies with this analysis; therefore, the Commission should disregard it.

As stated in the previous section, GSWC would have to purchase or lease additional water rights to run its wells at full capacity in the West Coast Basin. GSWC did not include the cost associated with leasing or purchasing additional water rights in its cost benefit analysis.

GSWC assumes that the replacement well will run at 75% of full capacity. This is a gross overestimate. In this GRC, GSWC estimates that 8,500,348 ccf of water will be pumped from Region II wells.[90] This is equivalent to 19,514 acre-feet of water. The capacity of Region II wells is

[89] Gisler Testimony, Attachment SW13

[90] SEC-30_REV_Water Production, Sheet Rec Proj Wtr Prod WS-04, cell Q61

64,431 acre-feet per year. Therefore, GSWC plans on running its wells, on average, 30.3%[91] of full capacity. Therefore, GSWC should have assumed that a new well would run at 30.3% of full capacity, not 75% of full capacity.

Because of these major errors in GSWC's cost benefit analysis, the Commission should disregard the analysis.

H. Doty Plant, Expand Treatment Capacity for Compton-Doty

GSWC requests $757,000 in 2024 and $6,496,200 in 2025 to replace Compton-Doty Well No. 1 with a new well. Also, GSWC requests $369,900 in 2024 and $3,173,800 in 2025 for treatment at the new, replacement well. This totals $10,797,000 for one source of water. The Commission should deny GSWC's request because the well has not yet been drilled and, therefore, GSWC does not have any water quality results to support the need for treatment.

1. The water quality produced from existing Compton-Doty Well No. 1 meets all state and federal standards.

Wood Rodgers, Inc. performed a water quality analysis as part of the assessment of Compton-Doty Well No. 1.[92] The water quality analysis shows that sulfate, chloride, manganese, specific conductance, total dissolved solids (TDS), and fluoride are all significantly below their respective Maximum Contaminant Levels[93] (MCLs) or secondary MCLs.

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[91] 19,514/64,431 = 0.303

[92] Gisler Testimony, Attachment SW11 at p. 6 and at pp. 17 - 19

[93] MCLs are adopted as regulations. They are health protective drinking water standards to be met by public water systems. MCLs take into account not only chemicals' health risks but also factors such as their detectability and treatability, as well as costs of treatment. Health & Safety Code §116365(a) requires a contaminant's MCL to be established at a level as close to its PHG as is technologically and economically feasible, placing primary emphasis on the protection of public health.

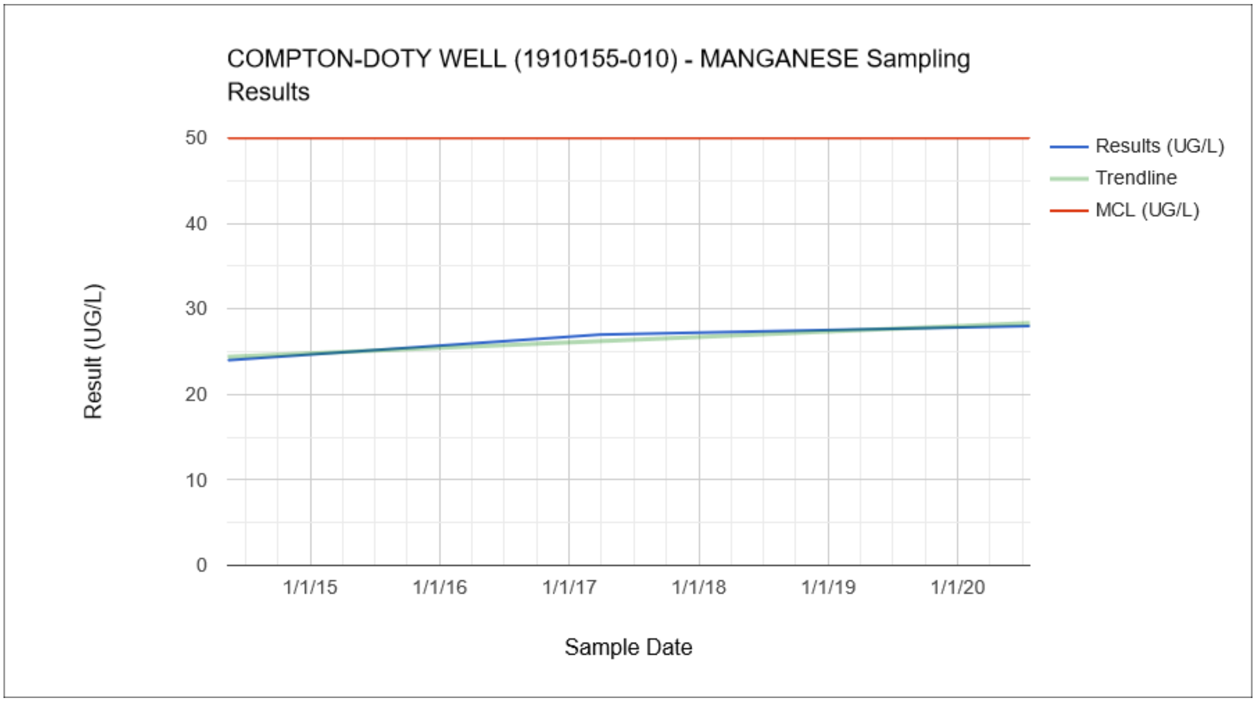
The 2022 Wood Rodgers Well Assessment did not mention any other contaminants of concern and did not state that treatment was needed at Compton-Doty Well No. 1. However, GSWC states, “The existing well is offline due to high manganese concentration and had a history of sediment fill accumulation.”[94] Although, GSWC did not provide any water quality sample results from Compton-Doty Well No. 1., Cal Advocates obtained Manganese levels in Compton-Doty Well No. 1 directly from DDW Drinking Water Watch.[95] All manganese water quality results show that the level of manganese is significantly below the manganese MCL. GSWC has not demonstrated a need to remove Compton-Doty Well No. 1 from service due to manganese concentration. The following graph shows the water quality monitoring results from DDW’s Drinking Water Watch for manganese in the water pumped from Compton-Doty Well No. 1.

(https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html)

[94] Gisler Testimony, at p. 157, lines 20 - 21

[95] https://sdwis.waterboards.ca.gov/PDWW. Drinking Water Watch is a public web portal containing information about public water systems such as location, facilities, sources, and water quality. The data on Drinking Water Watch is sourced from the US EPA database Safe Drinking Water Information System as well as drinking water quality results hosted on the Electron Data Transfer Library dataset.

Figure 2-1



2. Treatment is not needed at Compton-Doty Well No. 1 or at a future replacement well.

The 2022 Wood Rodgers Well Assessment does not state that any treatment is needed at the existing Compton-Doty Well No. 1. Since the replacement well would be at the same site as the existing Compton-Doty Well No. 1, it is reasonable to assume that the replacement well would have similar water quality and would also not require any treatment. GSWC did not provide any water quality results that support GSWC's request to expand the treatment capacity at the Doty Plant site to treat well water from the yet-to-be-drilled Compton-Doty Replacement Well and construct 3,500 feet of 8-inch transmission main to transfer the water from the Compton-Doty replacement well to the Doty Plant site. Therefore, the Commission should not require ratepayers to pay for this project.

I. Dalton Plant, Replace Well No. 1

GSWC requests $817,300 in 2026 and $4,800,000 in the next GRC timeframe (2027-2029) to replace Dalton Well No. 1 with a new well. The Commission should not approve this project because GSWC should fully utilize its existing sources and GSWC does not have enough water rights for an additional well in the West Coast Basin.

1. GSWC is not fully utilizing its existing sources in the Southwest system.

GSWC has 11 active wells in the Southwest system. The following table lists the production of these wells over the past two water years (July 2021 – June 2022 and July 2022 – June 2023):

Table 2-2

Well Name	Capacity (gpm)	Capacity (acre-feet per year)	Production Yr 1 (acre-feet)	% Used Yr 1	Production Yr 2 (acre-feet)	% Used Yr 2
129th St Well 2	1,250	2,016	421.56	20.9%	1,053.83	52.3%
Compton-Doty Well 1	600	968	1.51	0.156%	0.88	0.09%
Dalton Well 1	800	1,290	677.35	52.5%	4.26	0.33%
Dalton Well 2	2,500	4,033	3,460.64	85.8%	3,253.08	80.7%
Doty Well 1	700	1,129	13.28	1.18%	562.14	49.8%
Doty Well 2	1,000	1,613	15.18	0.94%	850.81	52.7%
Goldmedal Well 1	1,000	1,613	6.53	0.405%	129.40	8.02%
Southern Well 5	900	1,452	1.44	0.099%	186.44	12.8%
Southern Well 6	1,100	1,774	6.49	0.366%	211.59	11.9%
Ballona Well 4	700	1,129	3.85	0.341%	8.35	0.74%
Ballona Well 5	800	1,290	2.09	0.162%	13.77	1.07%
Total:	11,350	18,307	4,609.92	25.18%	6,274.55	34.3%

Based on the information above the only well in the West Coast Basin that GSWC is using close to full capacity is Dalton Well 2, which was used at 85.8% of its full capacity in water year July 2021 – June 2022 and 80.7% of its full capacity in the most recent water year, July 2022 – June 2023. All other wells are used at approximately 50% or less of their full capacities with the majority of the wells being used far less than 50% of their full capacities. Prior to requesting ratepayer funding for new water sources, GSWC should demonstrate that it is fully utilizing its existing sources. If GSWC needs to perform maintenance/rehabilitation on its wells, then it should spend funds on getting these wells back to running at full capacity rather than spending large sums of money on new sources.

2. GSWC does not have enough water rights to run an additional well in the West Coast Central Basin

According to the most recent West Coast Basin Watermaster Report for water year 2022-2023 (Attachment 19), GSWC's adjudicated rights are 7,502 acre-feet per year. GSWC currently has wells with a total annual capacity of 18,307 acre-feet per year. In other words, GSWC would need to more than double its existing water rights in the West Coast Basin just to run its current active wells at full capacity. GSWC would have to purchase or lease even more water rights to run a new well in the West Coast Basin. It is uncertain that GSWC will be able to purchase or lease the large amount of additional water rights needed to run new sources at full capacity over the next 70 plus years, which for planning purposes is the estimated useful life of a well.

GSWC claims that Compton-Doty Well No. 1 and Dalton Well No. 1 have reached the end of their useful service lives. Removing the capacity of these wells from the total capacity of GSWC's active wells in the West Coast Basin leaves 16,049 acre-feet per year. This is still more than double

GSWC's adjudicated rights, which are 7,502 acre-feet per year. Therefore, GSWC does not have enough water rights in the West Coast Basin to replace Compton-Doty Well No. 1 and Dalton Well No. 1.

3. GSWC's Cost Benefit Analysis is Inaccurate

GSWC provides a cost benefit analysis comparing replacing Dalton Well No. 1 with the cost of purchasing water.[96] There are numerous inaccuracies with this analysis; therefore, the Commission should disregard it.

As stated in the previous section, GSWC would have to purchase or lease additional water rights to run its wells at full capacity in the West Coast Basin. GSWC did not include the cost associated with leasing or purchasing additional water rights in its cost benefit analysis.

GSWC assumes that the replacement well will run at 75% of full capacity. This is a gross overestimate. In this GRC, GSWC estimates that 8,500,348 ccf of water will be pumped from Region II wells.[97] This is equivalent to 19,514 acre-feet of water. The capacity of Region II wells is 64,431 acre-feet per year. Therefore, GSWC plans on running its wells, on average, 30.3%[98] of full capacity. Therefore, GSWC should have assumed that a new well would run at 30.3% of full capacity, not 75% of full capacity.

GSWC's cost-benefit analysis includes the minimum amount of capital that will be spent on a new well. For example, GSWC could install a generator at the new well in the future claiming that a permanent generator is needed to run the new well during an emergency. Also, if the

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[96] Gisler Testimony, Attachment SW14

[97] SEC-30_REV_Water Production, Sheet Rec Proj Wtr Prod WS-04, cell Q61

[98] 19,514/64,431 = 0.303

new well becomes contaminated in the future, GSWC would need to install expensive treatment systems. None of these costs were included in the cost benefit analysis. Therefore, GSWC underestimated the potential capital required for a new well.

Because of these major errors in GSWC's cost benefit analysis, the Commission should disregard the analysis.

J. Southwest System, Replace Filter Media

GSWC requests $1,191,200 in 2024 to replace filter media at Southern Plant Site and Doty Plant Site. The Commission should not approve GSWC's request to change the filter media at these sites because the filter media is less than 15 years old.

1. The industry standard for changing filter media is 15-20 years.

Typical media life is 15 – 20 years as long as it is properly maintained.[99] The Commission should not approve any filter media replacements at any treatment facility with filter media less than 15 years old. GSWC claims that filter media needs to be changed every 7-10 years.[100] This is not consistent GSWC current and past operations. Below is a list of GSWC treatment facilities that have had filter media in place for 15 or more years:

[99] Attachment 11 at p. A-58

[100] Gisler Testimony at p. 103, lines 11 -12

Table: 2-3

Treatment Facility	Age of Filter Media (years)
Juan Plant Site	18[101]
Hawaiian Plant Site	23[102]
Roseton Plant Site	17[103]
Heath Creek Plant	20[104]

The fact that the above four treatment facilities have operated with filter media over 15 years old supports Cal Advocates' recommendation of not changing filter media less than 15 years old. GSWC did not provide any support, such as water quality results or filter bed depths, for its claim that filter media needs to be replaced every 7 – 10 years.

The existing filter media at Southern Plant Site and Doty Plant Site have been in service for approximately 10 years.[105] Therefore, the filter media at these plants does not need to be replaced during this GRC cycle.

The Commission should adopt Cal Advocates' recommendation regarding GSWC's request to prematurely replace filter media at Southern Plant Site and Doty Plant Site.

K. Systemwide, Install Distribution Valves for NO-DES Flushing

GSWC requests $1,672,100 to install 54 distribution system valves and 18 fire hydrants to increase the utilization of the Neutral Output Discharge

[101] Gisler Testimony at p. 103, lines 12 -13

[102] Gisler Testimony at p. 103, lines 12 -13

[103] Gisler Testimony at p. 103, lines 12 -13

[104] Gisler Testimony at p. 281, lines 12 -13

[105] Gisler Testimony at p. 162, line 8

Elimination System (NO-DES). The Commission should not approve this project because this project is not needed to meet DDW flushing recommendations.

1. GSWC can meet flushing standards without additional spending.

In order to properly maintain the distribution system, DDW recommends flushing dead ends at least annually. DDW does not require water systems to utilize NO-DES flushing. DDW does not prohibit discharging water to the storm drain in order to properly maintain the distribution system. Therefore, GSWC can currently meet this standard without spending additional capital. GSWC can use NO-DES in areas where it is currently feasible and flush the remaining areas using traditional flushing techniques by discharging water to the storm drain.

L. Southwest System, Disinfection Alternative Study

GSWC requests $654,700 to retain an engineering consultant to perform a district-wide water disinfection alternatives study in response to supply chain issues and increasing costs associated with procuring sodium-hypochlorite. The Commission should not approve this request because GSWC has not demonstrated why it is not reasonable to follow the USEPA's recommendations regarding this issue. More importantly, this project would provide no benefit to ratepayers during this GRC cycle.

1. GSWC Should follow the recommendations from the USEPA.

GSWC proposes to perform a disinfectant alternatives study because GSWC claims to have procurement issues with their current disinfectant, sodium hypochlorite. Based on the results of the study, GSWC *might* change to another form of disinfectant. However, the USEPA issued recommendations on this sodium-hypochlorite supply chain issue, and these recommendations do not include changing to another form of disinfectant. USEPA recommends the following:[106]

1) Establish a contract with your primary supplier.
2) Establish a contract with alternate suppliers.
3) Identify mutual aid and assistance contacts.
4) Identify response partners that could provide technical assistance.
5) Consult your state primacy agency.

GSWC should demonstrate that it has explored and is unable to follow USEPA recommendations before incurring additional costs.

2. Multi GRC Project

The Commission should not approve design-only projects that provide no benefit to ratepayers in the current GRC.

This project might benefit ratepayers in a future GRC after GSWC conducts the study and actually builds disinfection facilities based on the results of the study. Ratepayers should not fund projects that provide no benefits in the current GRC cycle. Splitting the "design" portion of a project onto multiple GRCs diverts the engineering risk from the utility onto ratepayers. Engineering expertise in planning and making prudent investments is what GSWC is compensated for through its authorized rate of return.

The Commission should not allow this design-only project because it will provide no benefit to ratepayers in the current GRC cycle. If the GSWC pursues this study and it results in a prudent project that provides benefit to ratepayers, all project costs (including the cost of the study) can be added to rate base in a subsequent GRC.

[106] https://www.epa.gov/waterutilityresponse/status-chlorine-product-availability-and-pricing

IV. CONCLUSION

The Commission should adopt Cal Advocates' recommendations regarding Budlong Plant North Reservoir, Budlong Plant South Reservoir, Chadron Reservoir, Chadron Plant soil remediation, Gardena Heights Reservoir, Doty Plant Backwash Tanks, Goldmedal Backwash Tank, Southern Backwash Tank, replacement of Compton-Doty Well No. 1, expansion of Doty Treatment Plant, filter media replacement, NO-DES flushing, replacement of Dalton Well No. 1, and disinfection study in GSWC's Southwest System.

CHAPTER 3 Region II Treatment Plants Built without Commission Authorization

I. INTRODUCTION

This Chapter discusses Cal Advocates' review of GSWC's treatment plants that were built without Commission authorization in the Norwalk, Bell-Bell Gardens, and Hollydale systems of Region II.

II. SUMMARY OF RECOMMENDATIONS

The Commission should adopt the following changes to GSWC's treatment plants that were built without authorization:

- Disallow $4,624,000 for the construction of treatment for benzene at Dace Well No. 2 in GSWC's Norwalk system.
- Disallow $3,110,500 for the construction of PFAS treatment facilities in GSWC's Norwalk system.
- Disallow $1,411,500 for the construction of PFAS treatment facilities in GSWC's Hollydale system.
- Disallow $3,045,000 for the construction of PFAS treatment facilities in GSWC's Bell – Bell Gardens system.

III. ANALYSIS

A. Dace Plant Benzene Treatment – Norwalk System

GSWC has spent $4,624,000 to construct treatment for benzene at Dace Well No. 2. GSWC constructed this project without Commission authorization. The Commission should not approve this project because water quality results do not support the construction of this treatment facility.

1. Primary Standards for Benzene

Benzene is a volatile organic compound (VOC). The California Code of Regulations (CCR), Title 22, section 64444 states that the MCL for benzene is 0.001 mg/L (1 µg/L). Compliance with VOC MCLs is based on 1) the running annual average or 2) the average concentration of the initial finding, confirmation sample(s), and six subsequent monthly samples.[107]

2. Significant Digits

EPA guidance (Attachment 25) on rounding data for compliance purposes states:

> Data reported to the State or EPA should be in a form containing the same number of significant digits as the MCL. In calculating data for compliance purposes, it is necessary to round-off by dropping the digits that are not significant. The last digit should be increased by one unit if the digit dropped is 5, 6, 7, 8, or 9. If the digit is 0, 1, 2, 3, or 4 do not alter the preceding number.

For example, the Arsenic MCL is 0.010 mg/L, which has two significant digits. Analytical results for arsenic of 0.0105 mg/L would round off to 0.011 mg/L while a result of 0.0104 mg/L would round off to 0.010mg/L.[108]

The Benzene MCL is 1 µg/L, which has 1 significant digit.

3. Benzene Sample Results for Dace Well No. 2

Although GSWC did not provide benzene sample results from Dace Well No. 2., Cal Advocates obtained Benzene levels in Dace Well No. 2 from DDW Drinking Water Watch.[109] Table 1-1 below shows the water

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[107] CCR, Title 22, section 64445.1 (c) (5) (A)

[108] Arsenic Guidance, August 2002, Appendix B at p. B-107 – B-108 (https://www.epa.gov/sites/default/files/2015-09/documents/2005_11_10_arsenic_ars_final_app_b.pdf)

[109] https://sdwis.waterboards.ca.gov/PDWW. Drinking Water Watch is a public web portal containing information about public water systems such as location, facilities, sources, and water quality. The data on Drinking Water Watch is sourced from the US EPA database Safe Drinking Water Information System as well as drinking water quality results hosted on the Electron Data Transfer Library dataset.

quality monitoring results from DDW's Drinking Water Watch for Benzene in the water pumped from Dace Well No. 2. As discussed in the preceding section, the benzene MCL has one significant digit. Therefore, the benzene water quality data in Table 1-1 is reported using one significant digit.

Table 3-1: Dace Well No. 2 Benzene Sample Results

Analyte Name	Sampling Date	Detected Level	MCL	DLR	Unit
BENZENE	04-26-2023	ND	1	.5	UG/L
BENZENE	02-23-2022	ND	1	.5	UG/L
BENZENE	12-08-2021	ND	1	.5	UG/L
BENZENE	10-13-2021	ND	1	.5	UG/L
BENZENE	09-07-2021	1	1	.5	UG/L
BENZENE	08-30-2021	1	1	.5	UG/L
BENZENE	08-23-2021	0.7	1	.5	UG/L
BENZENE	08-16-2021	ND	1	.5	UG/L
BENZENE	08-10-2021	ND	1	.5	UG/L
BENZENE	08-03-2021	ND	1	.5	UG/L
BENZENE	06-30-2021	ND	1	.5	UG/L
BENZENE	05-24-2021	ND	1	.5	UG/L
BENZENE	02-09-2021	1	1	.5	UG/L
BENZENE	02-09-2021	0.9	1	.5	UG/L
BENZENE	02-01-2021	0.9	1	.5	UG/L
BENZENE	02-03-2020	ND	1	.5	UG/L
BENZENE	02-13-2019	ND	1	.5	UG/L
BENZENE	02-13-2018	ND	1	.5	UG/L
BENZENE	06-09-2016	ND	1	.5	UG/L
BENZENE	02-03-2016	ND	1	.5	UG/L
BENZENE	12-03-2015	ND	1	.5	UG/L
BENZENE	09-28-2015	ND	1	.5	UG/L

GSWC inaccurately claims that "In 2021, benzene contamination was detected during routine water quality sampling. Since that time, the level of benzene contamination has increased to above the MCL of 1 ppb."[110] The water quality sample results in Table 1-1 show that the level

[110] Workbook D.6 Built but not Authorized Revised, Tab MDR D.6, Cell H57

of benzene has never been above the MCL of 1 ppb. There were 6 results in 2021 at the MCL of 1 ppb. A sample result at the same level as the MCL is not an exceedance of the MCL, and therefore, not a violation.

As stated above, compliance with the benzene MCL is based on 1) the running annual average, or 2) the average concentration of the initial finding, confirmation sample(s), and six subsequent monthly samples. GSWC has never taken six consecutive monthly samples. Twice, GSWC has taken four consecutive quarterly samples. Both times, the annual average was non-detect (ND) for benzene. The most recent sample, taken in April of 2023, was non-detect for benzene as well.

4. No Treatment is Needed because Water Pumped from Dace Well No. 2 Meets All State Standards

The level of benzene in Dace Well No. 2 has never exceeded the benzene MCL, which is based on an annual average. Twice since 2015, GSWC took four consecutive quarterly samples, and the annual average was non-detect. The most recent sample, taken in April of 2023, was non-detect as well. Therefore, treatment for benzene is not needed at Dace Well No. 2.

B. PFOA-PFOS Treatment

GSWC has spent $3,110,500 in the Norwalk system, $1,411,500 in the Hollydale system, and $3,045,000 in the Bell – Bell Gardens system to construct treatment for both perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). GSWC completed these projects without Commission authorization. The Commission should not approve these projects because they are premature and recent water quality results do not support the construction of this treatment.

1. PFOA and PFOS Standards and Guidance

USEPA

USEPA issued draft MCLs for PFOA and PFOS. The draft MCL is 4 ppt for both PFOA and PFOS. EPA guidance (Attachment 26) states:

> This is a proposed rule for public comment. It does not require any actions for drinking water systems until the rule is finalized. Once the rule is finalized, water systems would have three years to be in compliance with the MCLs.[111]

Therefore, GSWC is not required to construct PFAS treatment at this time. The soonest the federal MCL could be finalized is this year, 2024. Since water systems have three years to be in compliance with the new MCLs, the soonest possible compliance date would be sometime in 2027. The Commission should not include any PFOA or PFOS treatment facilities in rate base until the facilities can be demonstrated to be necessary, which would be 2027 at the earliest. This GRC includes years 2024, 2025, and 2026 for capital projects. Since 2027 is the attrition year of this GRC, the Commission will authorize GSWC an increase to its rate base based on a prescribed methodology in the Rate Case Plan (RCP).[112] The Commission does not need to authorize this specific project. Instead, this project will be reviewed in GSWC's next GRC. The Commission, at that time, can determine whether GSWC has selected the most cost-effective option to comply with the final adopted MCL.

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[111] Attachment 26: Proposed PFAS National Primary Drinking Water Regulation FAQs for Drinking Water Primacy Agencies at p. A-456

[112] D.04-06-018, footnote 6, p 15

California

The State Water Resources Control Board, Division of Drinking Water (DDW) has yet to establish an MCL for PFOA or PFOS. Health and Safety Code §116365(a) and (b) requires that State Water Board MCLs be consistent with two criteria. MCLs cannot be less stringent than federal MCLs and MCLs must be set as close as technically and economically feasible to the Public Health Goal (PHG).[113]

DDW established notification levels of 5.1 ppt for PFOA and 6.5 ppt for PFOS and response levels of 10 ppt for PFOA and 40 ppt for PFOS. A notification level requires a utility to report results to certain local agencies when the level is exceeded. DDW also encourages utilities to report the exceedance to customers. If a water system exceeds a response level, DDW recommends the utility remove the water source from service, install treatment, or notify the public of the continued use of the source and the health effects of the contaminant along with increasing the contaminant monitoring frequency.

Even though there are federal draft PFOA and PFOS MCLs, USEPA states that the proposed MCLs do not require any action by water systems until the MCLs are finalized.[114] There is currently no final or proposed California State MCL for PFOA or PFOS. Therefore, it was premature for GSWC to build PFOA and PFOS treatment at Imperial Plant, Studebaker Well 3, Clara Plant, and McKinley Well 3 prior to the finalized MCLs being issued. The Commission should not approve any PFOA and PFOS treatment until after the final MCLs have been issued, GSWC demonstrates

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[113] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLReview.html

[114] Attachment 26: Proposed PFAS National Primary Drinking Water Regulation FAQs for Drinking Water Primacy Agencies at p. A-456

a need for treatment for PFOA and PFOS, and the Commission determines that GSWC has selected the most cost-effective option.

2. Construction of PFOA and PFOS Treatment in the Norwalk System at Imperial Plant is Premature

Although GSWC did not provide PFOA nor PFOS sample results from Imperial Well No. 2 and Imperial Well No. 3. Cal Advocates obtained PFOA and PFOS levels in Imperial Well No. 2 and Imperial Well No. 3 from DDW Drinking Water Watch.[115] The most recent water quality results show that the annual average for both PFOA and PFOS at Imperial Well 2 and Imperial Well 3 are below the PFOA and PFOS response levels.

Rather than build premature treatment, GSWC could have temporarily taken Imperial Wells 2 and 3 offline and made up the lost production by purchasing water until the PFOA and PFOS MCLs are finalized. GSWC's Norwalk System has purchased water connections with Metropolitan Water District, the City of Norwalk, the City of Santa Fe Springs, Liberty Utilities – Bellflower/Norwalk, and Suburban Water Systems – La Mirada. Additionally, GSWC's Norwalk System is not fully utilizing Dace Well #2 and Pioneer Well #1. GSWC could have increased the production from these wells while Imperial Wells 1 and 2 are temporarily offline.

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[115] https://sdwis.waterboards.ca.gov/PDWW. Drinking Water Watch is a public web portal containing information about public water systems such as location, facilities, sources, and water quality. The data on Drinking Water Watch is sourced from the US EPA database Safe Drinking Water Information System as well as drinking water quality results hosted on the Electron Data Transfer Library dataset.

3. Construction of PFOA and PFOS Treatment in the Norwalk System at Studebaker Well 3 is premature.

GSWC did not provide PFOA nor PFOS sample results from Studebaker Well No. 3. Cal Advocates obtained PFOA and PFOS levels in Studebaker Well No. 3 from DDW Drinking Water Watch.[116] The most recent water quality results show that the annual average for PFOA at Studebaker Well 3 is above the PFOA response levels. GSWC removed Studebaker Well 3 from service due to the exceedance of PFOA California Response Levels established by DDW and installed treatment. If a water system finds that the PFOA or PFOS concentration exceeds the response level, DDW recommends the system do one of the following three options: 1) take the water source out of service, 2) provide treatment, or 3) notify their customers in writing.[117] GSWC chose the most expensive option, i.e., provide treatment.

GSWC's Norwalk System has purchased water connections with Metropolitan Water District, the City of Norwalk, the City of Santa Fe Springs, Liberty Utilities – Bellflower/Norwalk, and Suburban Water Systems – La Mirada. GSWC had the option to temporarily take Studebaker 3 offline until the PFOA and PFOS MCLs are finalized and makeup the lost production by purchasing water. Also, GSWC's Norwalk System is not fully utilizing Dace Well #2 and Pioneer Well #1. GSWC had the option to increase the production from these wells while Studebaker Well 3 was temporarily offline.

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[116] https://sdwis.waterboards.ca.gov/PDWW. Drinking Water Watch is a public web portal containing information about public water systems such as location, facilities, sources, and water quality. The data on Drinking Water Watch is sourced from the US EPA database Safe Drinking Water Information System as well as drinking water quality results hosted on the Electron Data Transfer Library dataset.

[117] https://www.waterboards.ca.gov/press_room/press_releases/2020/pr02062020_pfoa_pfos_response_levels.pdf

4. Construction of PFOA and PFOS Treatment at Clara Plant in the Bell – Bell Gardens System is Premature

Although GSWC did not provide PFOA nor PFOS sample results from Clara Well No. 2., Cal Advocates obtained PFOA and PFOS levels in Clara Well No. 2 from DDW Drinking Water Watch.[118] PFOA and PFOS response levels are based on an annual average of four consecutive quarters. GSWC has not taken four consecutive quarters of PFOS or PFOA samples from Clara Well 2. Therefore, it cannot be determined whether or not Clara Well 2 is above or below the PFOS and PFOA response levels.

On the other hand, GSWC's Bell-Bell Gardens System has purchased water connections with Metropolitan Water District, the City of Bell Gardens, the City of Huntington Park, Maywood Mutual Water Company, and Tract 180 Water Company. GSWC could have temporarily taken Clara Well 2 offline until the PFOA and PFOS MCLs are finalized and makeup the lost production by purchasing water. Also, GSWC's Bell-Bell Gardens System is not fully utilizing Bissell Well #3, Bissell Well #2, Gage Well #2, Otis Well #3, and Watson Well #1. GSWC had the option to increase production from these wells while Clara Well 2 was temporarily offline.

5. Construction of PFOA and PFOS Treatment at McKinley Well 3 in the Hollydale System is Premature

Although GSWC did not provide PFOA nor PFOS sample results from Imperial Well No. 2 and Imperial Well No. 3., Cal Advocates obtained PFOA and PFOS levels in McKinley Well 3 from DDW Drinking

[118] https://sdwis.waterboards.ca.gov/PDWW. Drinking Water Watch is a public web portal containing information about public water systems such as location, facilities, sources, and water quality. The data on Drinking Water Watch is sourced from the US EPA database Safe Drinking Water Information System as well as drinking water quality results hosted on the Electron Data Transfer Library dataset.

Water Watch.[119] All water quality results show that the level of both PFOA and PFOS at McKinley Well 3 are below the PFOA and PFOS response levels. Therefore, treatment for PFOA and PFOS is not needed at this time.

GSWC's Hollydale System has purchased water connections with the City of Paramount, the City of South Gate, and the City of Downey. GSWC had the option to temporarily take McKinley Wells 3 offline until the PFOA and PFOS MCLs are finalized and makeup the lost production by purchasing water. Also, GSWC's Hollydale System is not fully utilizing Century Well #1. GSWC had the option to increase production from this well while McKinley Well 3 is temporarily offline.

6. The amount to be included in rate base for GSWC Region II PFOA and PFOS treatment is unknown at this time.

GSWC estimates that it will receive $5,085,751 in funding from the Water Replenishment District PFAS Remediation Program.[120] Only amounts that exceed the funding amount are allowed in rate base. Since it is unknown at this time the exact amount of funding that GSWC will receive for PFAS treatment, the Commission should not include any PFOA-PFOS treatment facilities in rate base.

IV. CONCLUSION

The Commission should disallow the benzene treatment at Dace Plant and PFOA-PFOS treatment at Studebaker Well 3, Imperial Plant, Clara Plant, and McKinley Well 3.

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119 https://sdwis.waterboards.ca.gov/PDWW. Drinking Water Watch is a public web portal containing information about public water systems such as location, facilities, sources, and water quality. The data on Drinking Water Watch is sourced from the US EPA database Safe Drinking Water Information System as well as drinking water quality results hosted on the Electron Data Transfer Library dataset.

120 CSN-006 PFAS Treatment Follow Up Response 1.c. (Attachment 6, at p. A-29)

GSWC built these treatment facilities prematurely and without Commission authorization.

CHAPTER 4 Regionwide Projects

I. INTRODUCTION

This Chapter discusses Cal Advocates' review of GSWC's SCADA, permanent generators, and drought tolerant landscaping projects. GSWC requests the projects in most or all of Region II systems.

II. SUMMARY OF RECOMMENDATIONS

The Commission should adopt the following changes to GSWC's treatment plants that were built without authorization:

- Disallow $4,624,000 for the construction of treatment for benzene at Dace Well No. 2 in GSWC's Norwalk system.
- Disallow $3,110,500 for the construction of PFAS treatment facilities in GSWC's Norwalk system.
- Disallow $1,411,500 for the construction of PFAS treatment facilities in GSWC's Hollydale system.
- Disallow $3,045,000 for the construction of PFAS treatment facilities in GSWC's Bell – Bell Gardens system.

III. ANALYSIS

A. SCADA Upgrade Projects

GSWC requests $14,103,300 in Region II for SCADA Upgrade Projects. GSWC did not spend any capital funds on SCADA in Region II between 2018-2022.[121] To prevent rate shock, the Commission should adopt a SCADA budget of $1,207,162 for Region II. *See* Chapter 2 of the Direct Testimony of Sari

[121] SN2-017 (SCADA) Q.1 - SCADA Expenditures 2018-2022 Q1 and Q2 - By Region. Attachment 2-6.

Ibrahim, pages 2-20 – 2-23, for Cal Advocates complete analysis of GSWC's SCADA Upgrade Projects.

B. Backup Generators

GSWC requests $7,530,700 for backup generators at the following sites in Region II:

Table: 4-1

Project	GSWC System	Requested Amount
Centralia Plant, Install Backup Generator	Artesia	$1,102,400
Imperial Plant, Install Backup Generator	Norwalk	$683,300
Bissell Plant, Install Backup Generator	Bell-Bell Gardens	$683,300
Miramonte Plant, Install Backup Generator	Florence-Graham	$676,800
McKinley Plant, Install Backup Generator	Hollydale System	$659,100
Systemwide[122], Install Backup Generators at various plant sites	Southwest System	$3,725,800
Total		$7,530,700

The Commission should deny these requests.

[122] GSWC requests to install backup generators at the following locations in GSWC's Southwest system: Doty Plant, Southern Plant, Dolton Plant, Ballona Plant, and Belhaven Plant.

GSWC proposes to install backup generators at the above sites to deal with climate change issues such as heat waves that cause spikes in energy consumption. During such incidents in 2022, the California state governor issued statewide flex alerts requesting Californians to conserve electricity due to the strain on the electrical grid.

However, GSWC's interpretation of the governor's orders is incorrect. The State's announcement did not request water utilities to purchase and install new generators on their facilities to reduce electric demands. It asks the public and water agencies to utilize existing and available tools (including the existing generators) to mitigate the electric load issues during heat wave events.

GSWC also has the option to rent generators. Besides avoiding significant initial capital investment, renting generators in time of need avoids other costs such as permitting and maintenance costs. Electric utilities such as Southern California Edison maintain programs that provide generators at no cost in case of emergency to critical facilities, such as those in water companies.[123] Southern California Edison is a regulated utility, and its ratepayers are funding such programs. Most GSWC customers also pay SCE for their energy bills. If the Commission allows GSWC to invest in these generators without taking advantage of the SCE's free program, GSWC customers are being asked to pay twice for the same capital investment without additional benefit. Permanent generators come with significant costs including the initial investment cost and ongoing O&M costs. GSWC has less expensive or even free alternatives.

GSWC's requests for generators are not justified and are unnecessary. The Commission should deny GSWC's requests for $7,530,700 to install backup generators at Centralia Plant, Imperial Plant, Bissell Plant, Miramonte Plant,

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[123] https://www.sce.com/wildfire/critical-facilities-infrastructure

McKinley Plant, Doty Plant, Southern Plant, Dolton Plant, Ballona Plant, and Belhaven Plant.

C. Drought Tolerant Landscaping

The Commission should deny GSWC's request to add in rate base its proposed budgets related to Drought Tolerant Landscaping.

In the current GRC, GSWC seeks $2,814,700 across Region II to replace turf at its own properties with "drought tolerant" landscaping.[124] GSWC states that it must replace the turf landscaping with drought tolerant landscaping to lower its water usage and assist in achieving California's water saving goals. There are several rebate programs for businesses and residents in California to replace their turf with drought tolerant landscaping.125 GSWC is encouraged to participate in any of these programs and obtain the most benefit for its customers. However, like homeowners who take advantage of the rebate program for turf replacement, GSWC's shareholders should pay for any amount that exceeds the rebate amount. Ratepayers should not pay for the full cost of turf replacement that doesn't directly benefit them.

The Commission should not allow the budget for the drought tolerant landscaping.

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124 $159,900 in the Artesia system Gisler Testimony p. 100 line 20, $64,000 in the Norwalk System Gisler Testimony p. 110 line 13, $127,600 in the Bell-Bell Gardens System Gisler Testimony p. 115 line 9, $401,300 in the Florence-Graham system Gisler Testimony p. 120 line 12, $88,000 in the Hollydale system Gisler Testimony p. 131 line 6, $171,900 in the Willowbrook system Gisler Testimony p. 136 lines 4-6, $829,200 in the Culver City system Gisler Testimony p. 137 line 14, and $972,800 in the Southwest system Gisler Testimony p. 142 line 15.

125 https://www.gov.ca.gov/2022/09/28/california-is-making-it-cheaper-to-replace-your-lawn-to-save-water-and-save-money/

Attachment: Qualifications of Witness

QUALIFICATIONS AND PREPARED TESTIMONY

OF

CORTNEY SORENSEN

Q1. Please state your name, business address, and position with the California Public Utilities Commission ("Commission").

A1. My name is Cortney Sorensen and my business address is 320 West 4th Street, Suite 500, Los Angeles, California 90013. I am a Senior Utilities Engineer Specialist in the Water Branch of the Public Advocates Office.

Q2. Please summarize your education background and professional experience.

A2. I received a Bachelor of Science Degree in Chemical Engineering from the University of California at Los Angeles and a Master of Accounting Degree from the University of Southern California, Leventhal School of Accounting. I am a registered chemical engineer in the State of California.

I have been employed by the Public Advocates Office – Water Branch since May 2018. From 2002 – 2018, I worked for the State Water Resources Control Board, Division of Drinking Water (DDW) as an Associate Sanitary Engineer. My experience at DDW includes performing inspections of public water systems, writing engineering reports for newly constructed treatment plants, and conducting enforcement activities to bring public water systems into compliance with applicable state laws and regulations.

Q3. What is your responsibility in this proceeding?

A3. My responsibility is Region II capital projects.

Q4. Does this conclude your prepared direct testimony?

A4. Yes, it does.

Attachment 1: Response to CSN-001 PFAS Treatment

September 8, 2023

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-001 (A.23-08-010) PFAS Treatment
Due Date: September 8, 2023

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Question 1:
For the Studebaker PFAS Treatment project (project #2172051-98):

a. List all wells that will be treated.
b. List and explain all alternatives that were considered besides adding ion exchange treatment to the wells in question 1.a. above.
c. Provide the justification and project scope developed by Water Quality and Operations.
d. Provide the memo from the Engineering Planning Department regarding the installation of the treatment facility.
e. Provide the evaluation completed by Odell Engineering.
f. Provide the permit or permit amendment issued by the State Water Resources Control Board, Division of Drinking Water, for the operation of the Studebaker PFAS Treatment system.
g. Provide the permit or permit amendment application and all supporting documents (engineering reports, water quality reports, etc.) submitted to the State Water Resources Control Board, Division of Drinking Water for the issuance of the permit or permit amendment for the operation of the Studebaker PFAS Treatment system.
h. Provide the completion date for this project

Response 1:

a. Studebaker Well No. 3
b. See attachment CSN-001 1.b, this is the conceptual design report prepared by Odell Engineering for the PFOS/PFOA Removal at Studebaker and Imperial Well Sites, dated August 31, 2020. Please see section 1.6 Alternative Discussion.
c. See attachment CSN-001 1.c.
d. See attachment CSN-001 1.d.
e. See attachment CSN-001 1.b.
f. See attachment CSN-001 1.f.
g. See attachment CSN-001 1.g.
h. This project was placed into operation on January 10, 2022, and completed on October 26, 2022.

Question 2:

For the PFAS-PFOS Treatment at Imperial project (project #2172051-99):

a. List all wells that will be treated.
b. List and explain all alternatives that were considered besides adding ion exchange treatment to the wells in question 2.a. above.
c. Provide the justification and project scope developed by Water Quality and Operations.
d. Provide the memo from the Engineering Planning Department regarding the installation of the treatment facility.
e. Provide the evaluation completed by Odell Engineering.
f. Provide the permit or permit amendment issued by the State Water Resources Control Board, Division of Drinking Water, for the operation of the Imperial PFAS-PFOS Treatment system.
g. Provide the permit or permit amendment application and all supporting documents (engineering reports, water quality reports, etc.) submitted to the State Water Resources Control Board, Division of Drinking Water for the issuance of the permit or permit amendment for the operation of the Imperial PFAS-PFOS Treatment system.
h. Provide the completion date for this project

Response 2:

a. Imperial Wells No. 2 and No. 3.
b. Ion exchange was not the selected treatment technology for this location, GAC was recommended and installed. See attachment CSN-001 1.b, this is the conceptual design report prepared by Odell Engineering for the PFOS/PFOA Removal at Studebaker and Imperial Well Sites, dated August 31, 2020. Please see section 1.6 Alternative Discussion.
c. See attachment CSN-001 1.c.
d. See attachment CSN-001 2.d.

e. See attachment CSN-001 1.b
f. See attachment CSN-001 2.f.
g. See attachment CSN-001 2.f, see the appendices for the permit amendment application and supporting documents submitted to the State Water Resources Control Board, Division of Drinking Water for the issuance of the permit amendment for the operation of the VOC and PFAS treatment system to treat Imperial Wells No. 2 and No. 3.
h. This project was placed into operation on December 6, 2022.

Question 3:

For PFAS Treatment for McKinley project (project # 2242154-99):

a. List all wells that will be treated.
b. List and explain all treatment technologies that will be installed at the wells in question 3.a. above.
c. List and explain all alternatives that were considered besides adding the treatment technology described in question 3.b. to the wells in question 3.a. above.
d. Provide all technical reports, memos, justifications, etc. completed in house by GSWC or by outside consultants.
e. Provide the permit or permit amendment issued by the State Water Resources Control Board, Division of Drinking Water, for the operation of the McKinley PFAS Treatment system.
f. Provide the permit or permit amendment application and all supporting documents (engineering reports, water quality reports, etc.) submitted to the State Water Resources Control Board, Division of Drinking Water for the issuance of the permit or permit amendment for the operation of the McKinley PFAS Treatment system.
g. Provide the completion date for this project

Response 3:

a. McKinley Well No. 3
b. The treatment installed at McKinley Well No. 3 includes two cartridge filters to remove sand from the groundwater and two ion exchange filter vessels to remove PFAS from the groundwater.
c. The evaluation completed by Odell Engineering was used as the basis to select the treatment technology at this plant site. Due to the limited space at the McKinley site ion exchange was selected to remove PFAS. See attachment CSN-001 1.b, this is the conceptual design report prepared by Odell Engineering for the PFOS/PFOA Removal at Studebaker and Imperial Well Sites, dated August 31, 2020. Please see section 1.6 Alternative Discussion.
d. See attachment CSN-001 1.b.
e. See attachment CSN-001 3.e.
f. See attachment CSN-001 3.e, see the appendices for the permit application and supporting documents submitted to the State Water Resources Control Board,

Division of Drinking Water for the issuance of the permit amendment for the operation of the PFAS treatment system to treat McKinley Well No. 3.

g. The project was placed into operation on December 27, 2022.

Question 4:

For the PFAS Treatment for Clara Plant project (project # 2242254-99):

a. List all wells that will be treated.
b. List and explain all treatment technology that will be installed at the wells in question 4.a. above.
c. List and explain all alternatives that were considered besides adding the treatment technology described in question 4.b. to the wells in question 4.a. above.
d. Provide all technical reports, memos, justifications, etc. completed in house by GSWC or by outside consultants
e. Provide the permit or permit amendment issued by the State Water Resources Control Board, Division of Drinking Water, for the operation of the Clara Plant PFAS Treatment system.
f. Provide the permit or permit amendment application and all supporting documents (engineering reports, water quality reports, etc.) submitted to the State Water Resources Control Board, Division of Drinking Water for the issuance of the permit or permit amendment for the operation of the Clara Plant PFAS Treatment system
g. Provide the expected completion date for this project.
h. As of the date of GSWC's response to this data request, provide the percent completed for this project.

Response 4:

a. Clara Well No. 2
b. GAC treatment was installed to remove PFAS from the groundwater produced by Clara Well No. 2.
c. The PFAS treatment plant that was under construction to remove PFAS in the groundwater at the Imperial plant site and the nearby Gage Well No. 2 that has VOC concentrations were used to select GAC treatment at this location. See attachment CSN-001 1.b, this is the conceptual design report prepared by Odell Engineering for the PFOS/PFOA Removal at Studebaker and Imperial Well Sites, dated August 31, 2020. Please see section 1.6 Alternative Discussion.
d. See attachment CSN-001 1.b.
e. See attachment CSN-001 4.e.
f. See attachment CSN-001 4.f.
g. The project was placed into operation on August 16, 2023.
h. This project is currently 99% complete.

END OF RESPONSE

Attachment 2: Response to CSN-002 DDW Documents

Golden State Water Company
A Subsidiary of American States Water Company

January 8, 2024

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-002 (A.23-08-010) DDW Documents
Due Date: January 9, 2024

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Question 1:
Provide copies of the Electronic Annual Reports (EARs) to the State Water Resources Control Board, Division of Drinking Water (DDW) for year 2022 for **all** Golden State Water Company (GSWC) water systems.

Response 1:
Please see copies of GSWC's Electronic Annual Reports for 2022 in attachment "2022 EARs".

Question 2:
For **all** GSWC water systems, provide copies of the most recent permit or permit amendment issued by DDW to GSWC.

Response 2:
Please see copies of GSWC's most recent permit or permit amendment in attachment "Permits and PAs".

Question 3:
For **all** GSWC water systems, provide copies of monthly water quality/treatment reports submitted to DDW by GSWC for the following months:

a. February 2023

b. May 2023

c. August 2023

d. November 2023

Response 3:
Please see copies of GSWC's monthly water quality/treatment reports submitted to DDW for February 2023, May 2023, August 2023, and November 2023 in attachment "DDW Monthly Reports".

END OF RESPONSE

Attachment 3: Response to CSN-003
Southwest System Capital Projects

Golden State Water Company
A Subsidiary of American States Water Company

February 2, 2024

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-003 (A.23-08-010) Southwest System Capital Projects
Due Date: February 2, 2024

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Question 1:
Provide a copy of the most recent State Water Resources Control Board, Division of Drinking Water Sanitary Survey inspection report for GSWC's Southwest System.

Response 1:
See CSN-003 Q1 - 08212018 System No. 1910155--2018 Water System Sanitary Survey

Chadron Plant
Question 2:
In Gisler, Insco – Volume 1 Capital Testimony, page 146, lines 11 – 12, states,"Consider replacing the existing Chadron Tank with a new potable water storage tank that meets other requirements of AWWA D-100-21 standard."

a. List the AWWA requirements that Chadron Tank does not meet.
b. Provide a copy of AWWA D-100-21

Response 2:

a. See SW03 - Southwest - 2022 Report Chadron (page Seismic – 4 of 5, pdf page 124) REMARKS c), d), f), h), i) and ANALYSIS NOTES a), which GSWC previously provided in the Prepared Testimony of Ernest Gisler, Mark Insco, Megan McWilliams, Dan Flores, and David Schickling Volume 7 of 13.
b. See CSN-003 Q2b - AWWA D-100-21

Question 3:

Regarding soil remediation at Chadron Plant, provide the following:

a. The total of all expenses that GSWC is spending on remediation in this GRC.
    i. Provide the account(s) where the expenses in a Question 3.above are recorded
b. The total of all Capital funds that GSWC is spending during this GRC
    i. Provide the account(s) the capital funds in Question 3.b above are recorded
c. Provide the CPUC Decision that authorized funds to be spent on soil remediation at Chadron Plant.
d. Provide the month and year that soil remediation was initiated at Chadron Plant
e. Provide the total amount of expenses and capital funds GSWC has spent on soil remediation at Chadron Plant from the initiation date provided in Question 3.d above to December 31, 2023.
f. Provide an estimate of how much more time is needed to complete the soil remediation at Chadron Plant.
g. Provide the following background information:
    i. The cause of the soil contamination
    ii. The nature/extent/and corrective actions needed to remediate the soil contamination at Chadron Plant
    iii. Provide all consultant engineering reports, technical memorandums, letters etc. regarding the soil contamination at Chadron Plant.
    iv. Proved all engineering reports, technical memorandums, letters, citations etc. issued by other agencies such as the California Department of Toxic Substances Control regarding the soil contamination at Chadron Plant.

Response 3:

a. All costs in this GRC are capital.
    i. N/A
b. The proposed capital budget in this GRC (2024 to 2026) is $792,000.00
    i. The costs will be recorded to FP #2471154-02/WO #25003254.
c. The most recent authorization for this project was CPUC Decision 23-06-024.
d. May 1990.
e. The total capital expenditures through December 2023 are $6,627,604.09. We received funding from the State Water Resource Control Board Underground Storage Tank Clean Up Fund in the amount of $1,494,411 that offset the project

costs, so the final capital expenditures through December 2023 are $5,133,193.09.

f. Currently, the request for case closure is planned for 2026. GSWC anticipates a 6-month minimum review time by LARWQCB. While the case is being reviewed, routine semi-annual groundwater monitoring is still required. If case closure is granted, well abandonment of multiple wells will be performed in 2027 for final closure.
g.
   i. Leak from former underground storage tank that impacted soil and groundwater.
   ii. All remediation reports and documents are publicly available on the State Water Board Geo Tracker. Please refer to Chapters 5 (Cleanup Process) and Chapter 6 (Conclusions & Recommendations) of the Semi-Annual Groundwater Monitoring and Cleanup Progress Reports. This is the URL to the Chadron Plant GeoTracker site: https://geotracker.waterboards.ca.gov/profile_report?global_id=T0603704001. Please select Site Maps/Documents for the list of posted documents and scroll down to the Monitoring Reports.
   iii. All remediation reports and documents are publicly available on the State Water Board Geo Tracker.
   iv. All remediation reports and documents are publicly available on the State Water Board Geo Tracker.

Compton Doty Plant, Replace Well No. 1
Question 4:
In Gisler, Insco – Volume 1 Capital Testimony, page 158, lines 6 – 7 state, "…the unit cost of groundwater in the System (comprised of pump tax and energy and operating expenses) is
approximately $625/AF.195" Provide the following:

a. Explain how the operating expense of $625/AF was calculated.
b. List all items/expenses included in the operating expense of $625/AF.
c. In an excel spreadsheet, provide the calculations used to calculate the operating expense of $625/AF.
d. Identify and support each assumption made in the analysis/calculation of the operating expense of $625/AF.

Response 4:

a. The operating expense cost is calculated using yearly cost metrics on a per system basis. Pump tax cost is a constant cost that was established in 7/1/2021 with a cost of $411/AF. Twelve months of energy cost, plant treatment cost, and operating cost are collected for each well in the Southwest system. Each type of cost listed above is then divided by yearly well production in acre feet from all wells in the Southwest system. Total operating expense is the sum of the four costs: pump tax cost, energy cost, plant treatment cost, and plant operating cost.

b. There are 4 categories that contribute to the operating expense cost: pump tax cost, energy cost, plant treatment cost, and plant operating cost.
c. See CSN-003 Q4c - Southwest OM Cost by Well_2022
d. No assumptions are made in this analysis. We used 2022 yearly cost data to determine the total operating cost for the wells in the Southwest system.

Question 5:
Provide the excel spreadsheets/workbook for the cost benefit analysis mentioned in footnote195.

Response 5:
See CSN-003 Q5 - Compton-Doty Replace Well 1 20230221

Question 6:
Identify and support each assumption made in the cost benefit analysis provided in question 5 above.

Response 6:
The production capacity of the new well is assumed to be the same as Compton-Doty Well 1 (600 gpm). The well is assumed online 75% of the time because the well can be out of service for maintenance, pump downs and/or water quality issues.

Question 7:
In Gisler, Insco – Volume 1 Capital Testimony, page 159, lines 5 – 11, contain a section from the State of California Water Code.

a. Provide a citation, including the exact sections, where these statements can be found in the California Water Code.

Response 7:

a. California Water Code; Division 35, Part 1, Chapter 2. Delta Policy, Section 85021. This is URL site to get to California Water Code. https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=WAT&division=35.&title=&part=1.&chapter=2.&article=

Doty Plant, Expand Treatment Capacity for Compton-Doty
Question 8:
Provide the permit or permit amendment issued by the State Water Resources Control Board, Division of Drinking Water for the operation of the Doty Plant treatment system.

Response 8:
See CSN-003 Q8 - 20220817_1910155-014 Doty PA (with Appendices) (signed CD_AK)

Dalton Plant, Replace Well No. 1
Question 9:
In Gisler, Insco – Volume 1 Capital Testimony, page 165, footnote 204 references "Attachment SW14 – Cost Benefit Analysis – Dalton Well No. 1.

a. Provide the excel spreadsheets/workbook for the cost benefit analysis mentioned in footnote 204.

b. Identify and support each assumption made in the cost benefit analysis provided in item a above.

Response 9:

a. See CSN-003 Q9 - Dalton Replace Well 1 20230221
b. The production capacity of the new well is assumed to be the same as Dalton Well 1 (800 gpm). The well is assumed online 75% of the time because the well can be out of service for maintenance, pump downs and/or water quality issues.

Liquid Oxygen
Question 10:
GSWC's response to Question 4.e. in data request LCN-007 states, "As explained in DR LCN-001 Response 7, the recorded cost of 2022 represents actual oxygen rental costs during 2022 at 6 sites: 129th, Belhaven, Southern, Dalton, Ballona, and Doty. These sites implemented dissolved oxygen augmentation at the recommendation of consultants to address water quality issues observed in the groundwater."

a. Provide engineering reports, technical memorandums, etc. from the consultants that explains why dissolved oxygen needs to be added at 129th, Belhaven, Southern, Dalton, Ballona, and Doty sites.
b. Identify the "water quality issues" that need to be addressed in the groundwater.
c. List all the groundwater wells at 129t, Belhaven, Southern, Dalton, Ballona, and Doty that need dissolved oxygen augmentation.
d. Proved any other support GSWC has for the need to implement dissolved oxygen augmentation at 129th, Belhaven, Southern, Dalton, Ballona, and Doty sites.

Response 10:

a. See
CSN-003 Q10-1 - GSWC BOD Report_129th St_Belhaven_Southern 5_DDW
CSN-003 Q10-2 - Final Corona_GSWC_Southern Well 06_BOD__082019_DDW
CSN-003 Q10-3 - FINAL GSSW Dalton BOD Revised 10052020
CSN-003 Q10-4 - Final GSSW Ballona BOD 2020 03 06
CSN-003 Q10-5 - FINAL_Corona_GSWC_Doty BOD 010419_DDW

b. The dissolved oxygen (DO) in the Southwest system wells (129th, Belhaven 3 & 4, Southern 5 & 6, Dalton 1 &2, Ballona 4 & 5, and Doty 1 & 2) is considerably lower than that of Metropolitan Water District of Southern California (MWD). Low DO levels have been attributed to distribution water quality issues such as color, taste, and odor which cause customer complaints.

c. The wells that need/have DO augmentation are 129th Street well 1, Belhaven 3 & 4, Southern 5 & 6, Dalton 1 &2, Ballona 4 & 5, and Doty 1 & 2.
d. N/A

END OF RESPONSE

Attachment 4: Response to CSN-004
Artesia System Capital Projects

Golden State Water Company
A Subsidiary of American States Water Company

February 8, 2024

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-004 (A.23-08-010) Artesia System Capital Projects
Due Date: February 8, 2024

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Artesia System, Replace Filter Media

Question 1:
GSWC requests $2,220,600 to replace filter media at Juan, Hawaiian, Roseton, and Centralia plant sites. Provide the cost breakdown for each site by completing the following table:

Site	**Cost**
Juan	
Hawaiian	
Roseton	
Centralia	
Total:	$2,220,600

Response 1:

Site	Cost
Juan	$555,150
Hawaiian	$555,150
Roseton	$555,150
Centralia	$555,150
Total	$2,220,600

A base cost of $300,000 was used for Mn filter media for each site. The total cost also includes location factor, mobilization, contingency, payment and performance bond, sales tax, escalation, and direct cost for each plant site.

Question 2:
For each plant site (Juan, Hawaiian, Roseton, and Centralia) provide the direct construction costs used to calculate the amounts in the table above.

Response 2:
Direct Construction Cost in the PCE is $1,236,000, so for each plant site is $309,000.

Question 3:
Provide separate project cost estimates for each plant site (Juan, Hawaiian, Roseton, and Centralia).

Response 3:
Each plant site has an equal estimate (i.e. one-fourth of the costs identified on the PCE). Separate cost estimates for each plant site would result in the same total as described in the response table for Question 1 above.

<u>Roseton Plant, Replace Well No. 1</u>

Question 4:
What is the capacity of the replacement well?

Response 4:
The production capacity of the new well is assumed to be the same as Roseton Well 1 (720 gpm).

Question 5:
In Gisler, Insco – Volume 1 Capital Testimony, page 107, lines 20 – 21 state, "…the unit cost of groundwater in the System (comprised of pump tax and energy and operating expenses) is approximately $505/AF." Provide the following:

a. Explain how the unit cost of $505/AF was calculated
b. List all items/expenses included in the operating expense used to calculate $505/AF.
c. In an excel spreadsheet, provide the calculations used to calculate the unit cost of $505/AF.
d. Identify and support each assumption made in the analysis/calculation of the unit cost of $505/AF.

Response 5:

a. The operating expense cost is calculated using yearly cost metrics on a per system basis. Pump tax cost is a constant cost that was established in 7/1/2021 with a cost of $411/AF. Twelve months of energy cost, plant treatment cost, and operating cost are collected for each well in the Artesia system. Each type of cost listed above is then divided by yearly well production in acre feet from all wells in the Artesia system. Total operating expense is the sum of the four costs: pump tax cost, energy cost, plant treatment cost, and plant operating cost for Roseton Well #1.
b. There are 4 categories that contribute to the operating expense cost: pump tax cost, energy cost, plant treatment cost, and plant operating cost.
c. See CSN-004 Q5c - Artesia OM Cost by Well_2022
d. No assumptions are made in this analysis. We use yearly cost data to determine the total operating cost for the wells in the Artesia system.

Question 6:
Is the cost benefit analysis for this project provided in Attachment CBE04?

a. If the answer to question 6 above is yes, provide the following:
    i. The excel spreadsheets/workbook for the cost benefit analysis provided in Attachment CBE04.
    ii. Identify and support each assumption made in the cost benefit alalysis provided in Attachment CBE04.
b. If the answer to question 6 above is no, provide the following:
    i. Provide a cost benefit analysis comparing replacing Roseton Well 1 with purchasing water.
    ii. Provide the excel spreadsheets/workbook for the cost benefit analysis provided in question 6.B.i above.
    iii. Identify and support each assumption made in the cost benefit analysis provided in question 6.B.i above

Response 6:
Yes

a.
   i. See CSN-004 Q6ai - Roseton Replace Well 1 20230221
   ii. The production capacity of the new well is assumed to be the same as Roseton Well 1 (720 gpm). The well is assumed online 75% of the time because the well can be out of service for maintenance, pump downs and/or water quality issues.

b. N/A

Question 7:
Identify and support each assumption made in the cost benefit analysis provided in question 6 above.

Response 7:
Same as Response 6 a. ii.

END OF RESPONSE

Attachment 5: Response to CSN-005
Florence Graham System Capital Projects

Golden State Water Company
A Subsidiary of American States Water Company

February 15, 2024

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-005 (A.23-08-010) Florence Graham System Capital Projects Response
Due Date: February 15, 2024

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Florence-Graham, Drill and Equip New Well (Phase II of Replace Converse Well 1)
Question 1:
What is the capacity of the replacement well?

Response 1:
The production capacity of the new well is assumed to be the same as Converse Well 1 (450 gpm).

Question 2:
In Gisler, Insco – Volume 1 Capital Testimony, page 124, lines 6 – 8 state, "This project is considered "Phase 2" of a two-phased project. "Phase 1", which included land acquisition, was approved in the 2020 GRC."

a. Did GSWC complete the land acquisition by purchasing a new parcel of land?
b. If the answer to question 2.a. is yes, provide the following:
    i. The location of the parcel of land acquired.
    ii. The size of the the parcel of land acquired.
    iii. The cost of the parcel of land acquired.
    iv. The amount approved in the 2020 GRC for "Phase 1" of the Replace Converse Well 1 project.

c. If the answer to question 2.a. is no, provide the following regarding "Phase 1" of the Replace Converse Well 1 project:
   i. The amount approved in the 2020 GRC for "Phase 1".
   ii. The capital projects that were built using the funds approved for "Phase 1".

Response 2:

a. No.
b. N/A
c.
   i. The Proposed and Adopted are the same dollar amount since the Decision adopted a total dollar amount for all Capital Projects and did not identify any projects as being dis-allowed. GSWC Proposed $3,096,700 for this project in the 2020 GRC.
   ii. To date we have spent nearly $8,000 on the land acquisition investigation task and concluded the best alternative is to drill the replacement well at the Hampshire Plant. The remainder of the funds approved in the 2020 GRC for this project were used on other high priority projects within the Region II rate making area to best serve customer needs[1].

Question 3:

In Gisler, Insco – Volume 1 Capital Testimony, page 124, lines 15 – 17 state, "The Converse Plant needs to stay operational during the construction of the new well and due to space limitations at the Converse Plant Site, a new well will be constructed on a separate parcel of land or at the Hampshire Plant site."

a. Has GSWC finalized the construction site?
b. Will GSWC construct the new well at the Hampshire Plant site?

Response 3:

a. Yes, GSWC has determined the best alternative is to drill the replacement well at Hampshire Plant. GSWC is also in the process of bidding and selecting a consultant firm to provide professional services for design, inspection, and construction management to drill a new well.
b. Yes.

Question 4:

Provide the excel spreadsheets/workbook for the cost benefit analysis mentioned in footnote 140 on page 125 of Gisler, Insco – Volume 1 Capital Testimony.

Response 4:

See CSN-005 Q4 - Converse Replace Well 1 20230221

[1] A.20-07-012 Settlement Agreement at 9, and D.23-06-024 at 10.

Question 5:
Identify and support each assumption made in the cost benefit analysis provided in Question 4 above.

Response 5:
The production capacity of the new well is assumed to be the same as Converse Well 1 (450 gpm). The well is assumed online 75% of the time because the well can be out of service for maintenance, pump downs and/or water quality issues.

Roseton Plant, Replace Well No. 1

Question 6:
What is the capacity of the replacement well?

Response 6:
See previous response to CSN-004 Question 4. Based on Question 7 below, we assume this question is regarding Goodyear 4. The production capacity of the replacement well is assumed to be the same as Goodyear 4 (840 gpm).

Question 7:
In Gisler, Insco – Volume 1 Capital Testimony, page 127, lines 5 – 9 state, "Pumping and treating water from the groundwater basin is more cost effective than purchasing water from MWD (the unit cost of MWD water in the Florence-Graham System is currently $1,375 per acre-foot (AF), while the unit cost of groundwater in the System (comprised of pump tax and energy and operating expenses) is approximately $787/AF).143" Provide the following:

a. Provide the Excel spreadsheets/workbook for the cost benefit analysis mentioned in footnote 143.
b. Identify and support each assumption made in the cost benefit analysis provided in question 7.a. above.
c. Explanation of how the unit cost of $787/AF was calculated.
d. List all items/expenses included in the operating expense used to calculate $787/AF.
e. In an excel spreadsheet, provide the calculations used to calculate the unit cost of $787/AF.
f. Identify and support each assumption made in the analysis/calculation of the unit cost of $787AF

Response 7:

Goodyear Well No. 4

a. See CSN-005 Q7a - Goodyear Replace Well 4 20230331
b. The production capacity of the replacement well is assumed to be the same as Goodyear Well 4 (840 gpm). The well is assumed online 75% of the time because the well can be out of service for maintenance, pump downs and/or water quality issues.
c. The operating expense cost is calculated using yearly cost metrics on a per system basis. Pump tax cost is a constant cost that was established in 7/1/2021 with a cost of $411/AF. Twelve months of energy cost, plant treatment cost, and operating cost are collected for each well in the Florence Graham system. Each type of cost listed above is then divided by yearly well production in acre foot from all wells in the Florence Graham system. Total operating expense is the sum of the four costs: pump tax cost, energy cost, plant treatment cost, and plant operating cost for Goodyear Well #4.
d. There are 4 categories that contribute to the operating expense cost: pump tax cost, energy cost, plant treatment cost, and plant operating cost.
e. See CSN-005Q7e - Florence Graham OM Cost by Well_2022
f. We did not use assumptions in our analysis. We used actual yearly cost data to determine the total operating cost for the wells in the Florence Graham system.

Miramonte Plant, Chromium removal and treatment

Question 8:

Provide the permit or permit amendment issued by the State Water Resources Control Board, Division of Drinking Water, for the operation of Miramonte Plant.

Response 8:

See CSN-005 Q8 – DDW Permit

Question 9:

Provide a schematic of the Miramonte Plant, including the location of the proposed Ion Exchange treatment system.

Response 9:

See CSN-005 Q9 - Miramonte Treatment

Question 10:
Provide monthly Division of Drinking Water Miramonte Plant Treatment Reports for all months (January, February, March, April, May, June, July, August, September, October, November, and December) for years 2021, 2022, and 2023.

Response 10:
See CSN-005 Q10-Monthly DDW reports.

END OF RESPONSE

Attachment 6: Response to CSN-006 PFAS Treatment Follow Up

Golden State Water Company
A Subsidiary of American States Water Company

February 23, 2024

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-006 (A.23-08-010) PFAS Treatment Follow Up
Due Date: February 23, 2024

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Question 1:
Please refer to the Water Replenishment District (WRD) PFAS Remediation Program (https://www.wrd.org/pfas-remediation-program) application (https://www.wrd.org/files/cb57ed717/2022+PFAS+Remediation+Program+Application.pdf) and brochure (https://www.wrd.org/pfas-remediation-program-brochure). Provide the following for each PFAS treatment facility (Studebaker, Clara, Imperial, and McKinley) built without Commission authorization:

a. The completed PFAS Remediation Program Application, including all engineering reports, technical memorandums, etc. submitted with the application to WRD.
b. WRD's response to GSWC's PFAS Remediation Program Application
c. The amount of funding received

Response 1:

a. See Attachment 1a for the full submittal package for the PFAS remediation program application. McKinley PFAS treatment system was not included in the application. It did not qualify as part of the WRD remediation program because PFOA, PFOS, PFBS, and PFHxS did not exceed the response levels.

b. WRD did not provide any written comments in response to the application. On March 14, 2023 WRD and GSWC had a meeting to discuss the allocated grand funding amount.
c. No funding has been received but based on the March 2023 meeting, $5,085,751 was the recommended funding amount for the Studebaker, Clara and Imperial plants.

Question 2:
For each PFAS treatment facility (Studebaker, Clara, Imperial, and McKinley), provide any other PFAS funding applications and amounts received from other agencies.

Response 2:
No additional construction funding received for PFAS treatment facilities at Studebaker, Clara, Imperial, and McKinley plants.

Question 3:
For each PFAS treatment facility (Studebaker, Clara, Imperial, and McKinley), provide a year-by-year cost breakdown for the entire useful life of the treatment facilities, including beginning of year book value, depreciation expense, return paid to shareholders, and end of year book value.

PFAS Treatment Facility Name:				
Year	Beginning Book Value	Depreciation Expense	Return Paid to Shareholders	End of Year Book Value
1				
2				
3				
Etc.				
Totals				

Response 3:
GSWC does not know at this time what the depreciation rates to determine depreciation expense or the rate of return on equity will be for the full life of the treatment facilities. However, as detailed below, GSWC is providing the adopted rates for 2022 (if relevant), 2023 and 2024, and the rates proposed for 2025 to 2027 in A.23-08-010, as known to GSWC at the time of this data response.

Beginning Book Value

Studebaker		
UPIS Close Date	Plant Sub-Account	Amount
January-2022	4324	$70,353.63

January-2022	4325	$41,386.86
January-2022	5332	$927,652.08
	Total	$969,038.94

Clara		
UPIS Close Date	Plant Sub-Account	Amount
August-2023	4324	$163,147.69
August-2023	5332	$163,147.69
August-2023	6341	$2,719,128.16
		$3,045,423.54

Imperial		
UPIS Close Date	Plant Sub-Account	Amount
November-2022	3311	$159,866.87
November-2022	4324	$231,841.76
November-2022	4325	$83,829.23
November-2022	5332	$1,506,770.65
		$1,982,308.51

McKinley		
UPIS Close Date	Plant Sub-Account	Amount
March-2023	4324	$302,326.58
March-2023	4325	$76,067.11
March-2023	5332	$978,508.87
		$1,356,902.56

Cost of Capital – applicable to all projects.

		Adopted		
		2022	2023	2024
Cost of Capital *				
Debt	Ratio	43%	43%	43%
	Rate	5.10%	5.10%	5.10%
		2.19%	2.19%	2.19%
Equity	Ratio	57%	57%	57%
	Rate	8.85%	9.36%	10.06%
		5.04%	5.34%	5.73%
Weighted Cost		7.24%	7.53%	7.93%

* On 02/02/2024 the CPUC authorized GSWC to defer its next Cost of Capital filing to 2025, which will be effective in 2026. It is unknown at this time whether the Water Cost of Capital Mechanism (WCCM) will trigger for 2025 to adjust GSWC's authorized cost of equity in 2025, or what the authorized cost of capital will be beyond 2025.

<u>Depreciation Rates applicable to all projects, as applicable</u>

Depreciation rate is applied to original book value.

	Adopted			Proposed		
Plant Sub-Account	2022	2023	2024	2025	2026	2027
3311	1.77%	1.77%	1.77%	1.64%	1.64%	1.64%
4324	3.12%	3.12%	3.12%	2.98%	2.98%	2.98%
4325	4.00%	4.00%	4.00%	3.94%	3.94%	3.94%
5332	3.49%	3.49%	3.49%	3.39%	3.39%	3.39%
6341	5.45%	5.45%	5.45%	5.17%	5.17%	5.17%

* Note that GSWC uses the half-year convention for determining depreciation. The first year an asset is booked to Utility Plant in Service and the last year of depreciation, the depreciation expense is 50% of the expense in the intervening years

END OF RESPONSE

Attachment 7: Response to CSN-007
Pump Tax

February 23, 2024

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-007 (A.23-08-010) Pump Tax
Due Date: February 23, 2024

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Compton Doty Plant, Replace Well No. 1
Question 1:
GSWC's response to data request CSN-03, question 4.a. states, "Pump tax cost is a constant cost that was established in 7/1/2021 with a cost of $411/AF." Provide the following:

a. Explain how the pump tax cost of $411/AF was calculated.
b. List all items/expenses included in pump tax cost of $411/AF.
c. In an excel spreadsheet, provide the calculations used to calculate the pump tax cost of $411/AF.
d. Identify and support each assumption made in the analysis/calculation of the pump tax cost of $411/AF.

Response 1:
See attachment 'CSN-007 Q1-4 – WRD Resolution 22-1177' (item 2, on page 5 of 10), which is the Water Replenishment District (WRD) of Southern California's resolution setting the pump assessment to $411 for FY 2022/2023. Note: the cost estimate was established on 7/1/2022, not 7/1/2021 as previously stated.

Dalton Plant, Replace Well No. 1

Question 2:
In Gisler, Insco – Volume 1 Capital Testimony, page 158, lines 1 – 3 state, "…the unit cost of groundwater in the System (comprised of pump tax and energy and operating expenses) is approximately $591/AF.204" Provide the following:

a. The amount of pump tax cost per acre foot included in the unit cost of $591/AF.
b. Explain how the pump tax cost provided in question 2.a. was calculated.
c. List all items/expenses included in pump tax cost provided in question 2.a.
d. In an excel spreadsheet, provide the calculations used to calculate the pump tax cost provided in question 2.a.
e. Identify and support each assumption made in the analysis/calculation of the pump tax cost provided in question 2.a.

Response 2:

a. $411
b-e. See response to Q1, above.

Roseton Plant, Replace Well No. 1
Question 3:
GSWC's response to data request CSN-04, question 5.a. states, "Pump tax cost is a constant cost that was established in 7/1/2021 with a cost of $411/AF." Provide the following:

a. Explain how the pump tax cost of $411/AF was calculated.
b. List all items/expenses included in pump tax cost of $411/AF.
c. In an excel spreadsheet, provide the calculations used to calculate the pump tax cost of $411/AF.
d. Identify and support each assumption made in the analysis/calculation of the pump tax cost of $411/AF.

Response 3:
See response to Q1, above.

Florence – Graham, Land Acquisition to replace Goodyear Well 4
Question 4:
In Gisler, Insco – Volume 1 Capital Testimony, page 127, lines 5 – 9 state, "Pumping and treating water from the groundwater basin is more cost effective than purchasing water from MWD (the unit cost of MWD water in the Florence-Graham System is currently $1,375 per acre-foot (AF), while the unit cost of groundwater in the System (comprised of pump tax and energy and operating expenses) is approximately $787/AF).143" Provide the following:

a. The amount of pump tax cost per acre foot include in the unit cost of $787/AF.
b. Explain how the pump tax cost provided in question 4.a. was calculated.

c. List all items/expenses included in pump tax cost provided in question 4.a.
d. In an excel spreadsheet, provide the calculations used to calculate the pump tax cost provided in question 4.a.
e. Identify and support each assumption made in the analysis/calculation of the pump tax cost provided in question 4.a.

Response 4:

a. $411
b-e. See response to Q1, above.

Water Rights Lease Agreements

Question 5:

Provide the water rights lease agreement for GSWC's lease of 1,840 acre feet of water from the City of Lakewood in the Central Basin during the 2021-2022 water year (Attachment 1).

Response 5:

See attachment 'CSN-007 Q5 – Lakewood'.

Question 6:

Provide the water rights lease agreement for GSWC's lease of 500 acre feet of water from the City of Lomita in the West Coast Basin during the 2017-2018 water year (Attachment 2).

Response 6:

See attachment 'CSN-007 Q6 – Lomita'.

END OF RESPONSE

Attachment 8: Response to CSN-008 Dalton Plant Replace Well No. 1

February 23, 2024

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-008 (A.23-08-010) Dalton Plant Replace Well No. 1
Due Date: February 23, 2024

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Question 1:
In Gisler, Insco – Volume 1 Capital Testimony, page 164, lines 5 - 6 requests $817,300 in 2026 for design and permit to replace Dalton Well No. 1. Provide the year and the cost breakdown to construct the replacement well.

Response 1:
Design and permitting is considered "Phase 1" of a two-phase project. "Phase 2" to be scheduled in the next GRC timeframe (2027-2029), would construct and equip the well. The estimated cost, in 2022 dollars, to construct and equip the replacement well – also including necessary improvements to electrical facilities, chemical facilities, plant piping and other site work – is approximately $4.8M.

END OF RESPONSE

Attachment 9: Response to CSN-009 Well SWN Owner

Golden State
Water Company
A Subsidiary of American States Water Company

February 23, 2024

To: Cortney Sorensen, Public Advocates Office
CALIFORNIA PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco, CA 94102

From
Subject: Data Request CSN-009 (A.23-08-010) SWN/Owner No.
Due Date: February 26, 2024

Dear Cortney Sorensen,

In response to the above referenced data request number, we are pleased to submit the following responses:

Question 1:
Provide the SWN/Owner No., well name, system served, and whether the well has a generator for each of GSWC's wells in Region II by completing the following tables:

Central Basin

SWN/Owner No.	Well Name	System Served	Generator (yes or no)
002S012W28N005S			
002S012W29A0045			
002S012W30G003S			
002S013W21 E001S/G0004			
002S013W21K004S			
002S013W21K007S			
002S013W23J003S			
002S013W23R002S/Bissel 3			
002S013W24Q004S			
002S013W27E003S/NA003			
002S013W28G001S/MI003			
002S013W28G003S/MI002			
003S011W07E001S			
003S011W18G006S			
003S012W02R006S/ST003			
003S012W07Q005S/CTY01			
003S012W12A002S			
003S012W13A002S			
003S012W13B004S			

003S012W17 A002S/MCK03			
003S012W25Q003S/ROS02			
003S012W36B001S/ROS01			
003S013W04N001S/BEL03			
003S013W04N004S/BEL04			
003S013W10L002S/WLBK1			
003S013W10L004S/WLBK3			
004S011W07H002S/HAW01			
004S011W07L005S/CEN06			
004S011W07L006S/CEN07			
004S011W18F002S			

West Basin

SWN/Owner No.	Well Name	System Served	Generator (yes or no)
003S014W13B003S/BA004			
003S014W13B004S/BA005			
003S014W13J009S/S0005			
003S014W13J010S/S0006			
003S014W14D002S/129-02			
003S014W15B003S			
003S014W15P001S/Doty1			
003S014W15P002S/Doty2			
003S014W22L001S/CD001			
003S014W25P004S/DA001			
003S014W25P006S/DA002			

Response 1:
Central Basin:

SWN/Owner No.	Well Name	System Served	Generator (yes or no)
002S12W28N005S	Clara 2	Bell-Bell Gardens	No
002S12W29A004S	Gage 2	Bell-Bell Gardens	No
002S12W30G003S	Watson 1	Bell-Bell Gardens	No

002S13W21E001S/G0004	Goodyear 4	Florence Graham	No
002S13W21K004S	Converse 1	Florence Graham	No
002S13W21K007S	Converse 2	Florence Graham	No
002S13W23J003S	Bissell 2	Bell-Bell Gardens	No
002S13W23R002S/Bissell 3	Bissell 3	Bell-Bell Gardens	No
002S13W24Q004S	Otis 3	Bell-Bell Gardens	No
002S13W27E003S/NA003	Nadeau 3	Florence Graham	No
002S13W28G001S/MI003	Miramonte 3	Florence Graham	No
002S13W28G003S/MI002	Miramonte 2	Florence Graham	No
003S11W07E001S	Pioneer 1	Norwalk	No
003S11W18G006S	Dace 2	Norwalk	No
003S12W02R006S/ST003	Studebaker 3	Norwalk	No
003S12W07Q005S/CTY01	Century 1	Hollydale	No
003S12W12A002S	Pioneer 3	Norwalk	No
003S12W13A002S	Imperial 2	Norwalk	No
003S12W13B004S	Imperial 3	Norwalk	No
003S12W17A002S/MCK03	McKinley 3	Hollydale	No
003S12W25Q003S/ROS02	Roseton 2	Artesia	No
003S12W36B001S/ROS01	Roseton 1	Artesia	No
003S13W04N001S/BEL03	Belhaven 3	Southwest	No
003S13W04N004S/BEL04	Belhaven 4	Southwest	No

003S13W10L002S/WLBK1	Willowbrook 1	Willowbrook	No
003S13W10L004S/WLBk3	Willowbrook 3	Willowbrook	No
004S11W07H002S/HAW01	Hawaiian 1	Artesia	No
004S11W07L005S/CEN06	Centralia 6	Artesia	No
004S11W07L006S/CEN07	Centralia 7	Artesia	No
004S11W18F002S	Juan 4	Artesia	No

West Basin

003S14W13B003S/BA004	Ballona 4	Southwest	No
003S14W13B004S/BA005	Ballona 5	Southwest	No
003S14W13J009S/SO005	Southern 5	Southwest	No
003S14W13J010S/SO006	Southern 6	Southwest	No
003S14W14D002S/129-02	129th St. 2	Southwest	No
003S14W15B003S	Goldmedal 1	Southwest	No
003S14W15P001S/Doty1	Doty 1	Southwest	No
003S14W15P002S/Doty 2	Doty 2	Southwest	No
003S14W22L001S/CD001	Compton-Doty 1	Southwest	No
003S14W25P004S/DA001	Dalton 1	Southwest	No
003S14W25P006S/DA002	Dalton 2	Southwest	No

Question 2:
Provide the SWN/Owner No., well name, system served, and whether the well has a generator for any GSWC Region II well that was not included in Question 1 above.

Response 2:
Central Basin:

SWN/Owner No.	Well Name	System Served	Generator (yes or no)
03S13W04N01S	Bellhaven 3	Southwest	No
03S13W04N04S	Bellhaven 4	Southwest	No

END OF RESPONSE

Attachment 10: Response to CSN-007 Pump Tax, Attachment Q.1

RESOLUTION NO. 22-1177

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA LEVYING A REPLENISHMENT ASSESSMENT ON THE PRODUCTION OF GROUNDWATER FROM THE GROUNDWATER SUPPLIES WITHIN THE DISTRICT DURING THE FISCAL YEAR COMMENCING JULY 1, 2022, AND ENDING ON JUNE 30, 2023, AS PROVIDED IN SECTION 60317 OF THE CALIFORNIA WATER CODE AND MAKING FINDINGS AND DETERMINATIONS REGARDING SAID ASSESSMENT IN ACCORDANCE WITH SECTIONS 60315 AND 60316 OF THAT CODE

WHEREAS, the Board of Directors (the "Board") of the Water Replenishment District of Southern California (the "District") on February 3, 2022, in compliance with California Water Code § 60300, timely ordered an Engineering Survey and Report (the "ESR") to be made regarding the groundwater supplies and groundwater quality issues within the District; and

WHEREAS, the ESR has been prepared pursuant to the Board's request and the ESR has been available for inspection by any interested party for the time required by law; and

WHEREAS, the Board, by Resolution No. 22-1172, has declared that funds shall be raised to purchase water for replenishment of groundwater supplies within the District during the ensuing fiscal year, beginning July 1, 2022 through June 30, 2023 (FY 2022/23), and to accomplish all acts reasonably necessary pursuant to said replenishment, including, but not limited to, the development and operation of capital projects, and that such funds shall be raised by a replenishment assessment as provided in Chapter 2 of Part 6 of the California Water Code, and further finding that the funds to be raised will benefit, directly or indirectly, all of the persons or real property and improvements within the District; and

WHEREAS, the Board, by Resolution No. 22-1172, has declared that funds shall be raised to remove contaminants from groundwater supplies and to exercise any other power under California Water Code § 60224, including, but not limited to, the development and operation of capital projects, and that such funds shall be raised by a replenishment assessment as provided in Chapter 2 of Part 6 of the California Water Code, and further finding that the funds so raised will benefit, directly or indirectly, all of the persons or real property and improvements within the District; and

WHEREAS, the District prepared a Cost of Service Report dated April 21, 2022, which has been made available to the public, describing the services the District anticipates performing in FY 2022/23, estimating the costs of providing those services, and calculating a Replenishment Assessment that ensures that those costs are spread amongst water producers in an equitable manner; and

WHEREAS, on April 21, 2022, as required by California Water Code § 60307, the Board held a public hearing for the purpose of determining whether and to what extent the estimated cost of water replenishment programs and the estimated cost of water quality programs for the ensuing year shall be paid for by a replenishment assessment; and

WHEREAS, notice of the April 21, 2022 hearing was published as required by law; and

WHEREAS, in addition to the public hearing, the District also held budget workshops that were open to the public, where the District provided the public with information concerning its FY 2023 budget, which is directly related to the Replenishment Assessment; and

WHEREAS, the District's Budget Advisory Committee (BAC) met and the Board has received and considered recommendations from the BAC; and

WHEREAS, all evidence and testimony relevant to the ESR and the Board's determination that such a Replenishment Assessment shall be levied was heard at the public hearing; and

WHEREAS, all other findings required by law have already been made, including, but not limited to, any findings required by California Water Code § 60231; and

WHEREAS, the Board desires to move forward with the levy of a Replenishment Assessment for the upcoming year.

NOW, THEREFORE, BE IT RESOLVED AND DECLARED BY THE BOARD OF DIRECTORS OF THE WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA AS FOLLOWS:

1. That said Board pursuant to §60315 of the Water Code of the State of California finds as follows:

    a) The annual overdraft of the preceding water year, Fiscal Year beginning July 1, 2020, through June 30, 2021was 153,865 acre-feet as provided in the 2022 ESR and any updates.

    b) The estimated annual overdraft for the current water year, Fiscal Year beginning July 1, 2021, through June 30, 2022 , is 101,800 acre-feet as provided in the 2022 ESR and any updates.

c) The estimated annual overdraft for the ensuing water year, Fiscal Year beginning July 1, 2022, through June 30, 2023), is 77,800 acre-feet as provided in the 2022 ESR and any updates.

d) The accumulated overdraft as of the last day of the preceding water year was 809,140 acre-feet as provided in the 2022 ESR and any updates.

e) The estimated accumulated overdraft as of the last day of the current water year is 823,200 acre-feet as provided in the 2022 ESR and any updates.

f) The total production of groundwater from the groundwater supplies within the District during the preceding water year was 213,623 acre-feet as provided in the 2022 ESR and any updates.

g) The estimated total production of groundwater from groundwater supplies within the District for the current water year is 223,000 acre-feet as provided in the 2022 ESR and any updates.

h) The estimated total production of groundwater from the groundwater supplies within the District for the ensuing water year is also 223,000 acre-feet as provided in the 2022 ESR and any updates.

i) Water Year 2020/21 had below normal precipitation, increased pumping, and a below average amount of replenishment by WRD. Therefore, groundwater levels dropped on average 3.9 feet District wide. This led to a decrease in groundwater storage of approximately 66,900 AF. The 2022 ESR and any updates provide details of water levels and basin conditions.

j) The District is currently experiencing 123% of normal rainfall through January 31, 2022. Water levels in the Montebello Forebay rose nearly 17 feet by the start of the winter season and are presently about 8.8 feet higher than the previous water year (January 2021). Basin conditions have not changed much over the past couple water years and are still below pre-drought conditions. The 2022 ESR and any updates provide details of water levels and basin conditions.

k) The quantity of water that should be purchased by the District for the replenishment of the groundwater supplies of the District during the ensuing water year is 92,100 acre-feet, which includes 64,100 acre-feet at the spreading grounds and 28,000 acre-feet at the seawater barrier wells. Details of the calculations for these amounts are presented in the 2022 ESR and any updates, and on budget discussions with the Board and BAC.

l) The source and estimated cost of the water available for the replenishment described in Section (k) is presented in the 2022 ESR and any updates.

m) The estimated net costs of replenishing the groundwater supplies with the water so purchased is $38,953,458 (including Dominguez Gap Barrier water). The derivation of this amount is described in the 2022 ESR, the 2022 Cost of Service Report, and any updates to these documents, and on Board and BAC decisions at various public meetings. The estimated rate of the replenishment assessment required to fund these purchases based on the anticipated pumping in the ensuing year described in Section (h) is $183 per acre-foot of groundwater pumped.

The estimated additional costs to the District for its replenishment program costs, estimated capital costs, and other costs relating to the replenishment of the groundwater supplies, are $41,021,240. The estimated rate of the replenishment assessment required to fund these costs based on the anticipated pumping in the ensuing year described in Section (h) is $193 per acre-foot of groundwater pumped. A listing of the projects and programs and their intended objective – replenishment and/or clean water – is provided in the 2022 ESR and Cost of Service Reports, and any updates to these documents.

n) It is not anticipated that additional replenishment funds need to be raised in the ensuing year for future replenishment water that should be purchased in the ensuing year but cannot be purchased due to an anticipated unavailability of replenishment water in the ensuing year.

o) The estimated rate of the replenishment assessment required to be levied upon the production of groundwater from the groundwater supplies within the District during the ensuing fiscal year for the purposes of accomplishing replenishment activities (replenishment water plus replenishment projects and programs) is $376 per acre-foot.

p) Contaminants should be removed from groundwater supplies during the ensuing fiscal year pursuant to the District's projects and programs described in the 2022 ESR and any updates, the District's capital improvement program, and the District's proposed annual budget document. The estimated costs to the District for the groundwater quality program for the FY 2022/23 fiscal year are estimated at $7,498,570 . The estimated additional rate of replenishment assessment required to be levied upon the production of groundwater from the groundwater supplies within the District during the ensuing fiscal year for those purposes is $35 per acre-foot.

q) The programs for the removal of contaminants or other actions under Water Code § 60224 are multi-year programs.

r) The estimated amount of reserves on hand at the end of the FY 2022/23 will not exceed the applicable limitations provided in Water Code Sections 60290.

2. After accounting for other revenue, possible debt financing, or use of reserves, the estimated rate of the replenishment assessment required to be levied upon the production of groundwater from the groundwater supplies within the District during the ensuing FY 2022/23, for the purpose of accomplishing such replenishment and water quality programs by the District is $411 per acre-foot of yearly groundwater production. After accounting for the use of an estimated $12,510,500 in other revenue, said replenishment assessment will produce the approximate necessary funds to pay the following costs: $376 per acre-foot for the cost of purchasing water, financing capital improvement projects and other costs relating to accomplishing groundwater replenishment, $35 per acre-foot for clean water programs. Of the $376 per acre-foot allocated to accomplishing groundwater replenishment, $90 per acre-foot is allocated to capital projects. Of the $35 per acre-foot allocated to clean water programs, $6 per acre-foot may be allocated to capital projects. General and administrative expenses of the District will be met on a pro tanto basis given each function's (replenishment and clean water) load factor on operations.

3. Prior to accounting for other revenue, possible debt financing, or use of reserves, the entire cost of purchasing water for replenishment for the ensuing fiscal year shall be paid for by the assessment identified in Section 2 above. The cost of removing contaminants from groundwater supplies and taking other actions authorized under Water Code § 60224 shall be paid for by the assessment identified in Section 2 above, from possible debt financing for capital improvement projects, and from reserve funds as necessary maintained in accordance with Water Code § 60290. The costs of those capital projects to be undertaken in the ensuing fiscal year, but for which no capital construction accounts have been established pursuant to Water Code § 60291, shall also be paid for by the reserve fund maintained in accordance with Water Code § 60290.

4. All of the estimated costs for the ensuing fiscal year for water replenishment programs and for groundwater quality programs by the District as found in Section 1 of this Resolution shall be paid for by a replenishment assessment levied pursuant to Water Code § 60317 and by the reserve fund maintained in accordance with Water Code § 60290. There is hereby levied on the production of groundwater from groundwater supplies within the District during the fiscal year commencing July 1, 2022, and ending June 30, 2023, a replenishment assessment in the amount of $411 per acre-foot produced during said fiscal year.

5. This Replenishment Assessment complies with the California Environmental Quality Act ("CEQA"), based on any one of the following grounds:

(a) That the District's groundwater replenishment program is exempt from CEQA pursuant to CEQA Guidelines §15261(a), in that it is an ongoing project commencing at a date such that an environmental impact report has not been required, and the FY 2022/23 program is part of that ongoing project.

(b) Funds generated by the RA will be used for (1) operating expenses, (2) financial reserve needs, (3) purchasing or leasing of, equipment, materials and supplies, and (4) funds for capital projects necessary to maintain service within existing service areas. That Finding is based on documents and information provided in the record of these proceedings, including but not limited to the annual ESR, the 2022 Cost of Service Report, the proposed 2022/23 budget, and the staff's written reports and PowerPoint presentations to the Board. Further, the funds raised by the RA will not be used to expand the area or territory in which the District provides services or to fund capital projects that would expand the District's service area or system. Accordingly, the District finds that its adoption of this resolution exempt from CEQA pursuant to, among other bases, CEQA Section 20180(b) (8) and CEQA Guidelines 15261 and 15273, and the Board directs staff to file an appropriate Notice of Exemption.

(c) Notwithstanding the exemptions cited above, an Environmental Impact Report ("EIR") for the District's groundwater replenishment program was previously prepared and that EIR and program have been approved by the District's Board. Subsequent to the preparation of that EIR, the District prepared and certified a number of Mitigated Negative Declarations and Negative Declarations for various water quality and water supply projects (collectively, the "NDs"). The District has examined the imposition of a water replenishment assessment for the FY 2022/23 to determine whether an additional environmental document must be prepared. Based on this examination, the 2022 Engineering Survey and Report and all other evidence in the administrative record of the District's proceedings herein, the District concludes that: (1) the imposition of a water replenishment assessment for the FY 2022/23 would not have any effects that were not examined in the EIR and NDs; (2) pursuant to CEQA Guidelines §15162, no new effects would occur and no new mitigation measures would be required; and (3) the imposition of a water replenishment assessment for the FY 2022/23 fiscal year is within the scope of the groundwater replenishment program covered by the EIR and NDs and such activity is adequately described in said EIR, and no new environmental document is required.

6. The Replenishment Assessment will be imposed on persons and entities that extract groundwater from the Central Basin and West Coast Basin. Extraction of groundwater from those Basins is governed by court judgments entered in 1962 and 1965 pursuant to groundwater adjudication lawsuits. Those judgments

granted certain parties an allocation to pump water based on prescriptive water rights and not based on any aspect of ownership of land overlying either Basin. Accordingly, since the pumping rights granted by the Judgments were based on prescriptive water rights, the parties do not pump the groundwater pursuant to any tenancy or fee interest in the overlying land or any rights that attach as a result of a tenancy or fee interest in overlying land. Further, neither of the Judgments for the Central and West Coast Basins included a determination of the amount or extent to which any party to said Judgment may extract groundwater from said basin without exceeding the natural safe yield of said basin.

7. The purpose of the Replenishment Assessment is to fund the District's water basin management services. These services are a package of services that make high quality water available to those exercising adjudicated pumping rights and consist of: monitoring the level and quality of groundwater in the basins; purchasing and producing water needed to replenish the basins; preventing seawater contamination of the groundwater supply; funding replenishment operations; and other activities that make the basins a reliable and low-cost source of safe, high-quality water. Every activity of the District is a part of the water basin management services.

The water basin management services benefit those charged. All persons receiving the services or benefitting from the services by exercising pumping allocations are subject to the Replenishment Assessment. Services are not provided to those who are not charged the Replenishment Assessment and do not benefit those who are not charged the Replenishment Assessment. The amount of the Replenishment Assessment does not exceed the District's reasonable costs to provide services, confer benefits and/or grant privileges as described in this paragraph. Consequently, the Replenishment Assessment is not a "tax" within the meaning of Article XIII C, Section 1(e) of the California Constitution.

Pursuant to the recent California Supreme Court decision in *City of San Buenaventura v. United Water Conservation District*, the District does not believe that its replenishment assessment is a "property-related fee" subject to the requirements of Article XIII D, Section 6 of the California Constitution (Proposition 218). Notwithstanding this, in the interest of public participation, the District has conducted a noticed public hearing with respect to the replenishment assessment. The fact the District has done so should not be interpreted to mean that the District believes that the requirements of Article XIII D, Section 6 apply to the replenishment assessment.

The Board also makes the following findings:

(a) Notice of the May 3, 2022, Public Hearing was mailed by the District to the holders of adjudicated pumping rights in the basins.

(b) The purpose of this mailing was to ensure that every adjudicated pumping rights holder in the basins was kept informed of the Replenishment Assessment proposal.

(c) On April 21, 2022, the Board opened the Public Hearing, provided an opportunity for oral and written comment, and then continued to the Public Hearing to May 3, 2022.

(d) On May 3, 2022, the Board considered all written testimony and protests and heard oral comments from all who wished to speak regarding the proposed Replenishment Assessment.

(e) From the date the hearing notice was mailed through the close of the public testimony portion of the Public Hearing on May 3, 2022, the District accepted written testimony and protests, all of which were entered into the record of the Public Hearing and made available for inspection by the public and by members of the Board.

(f) The Board determines that it has not received written protests from a majority of active pumpers.

(g) The rate of the Replenishment Assessment is such that proceeds of the Replenishment Assessment will not exceed the funds required to provide the water basin management services.

(h) Revenues derived from the Replenishment Assessment will not be used for any purpose other than providing water basin management services.

(i) The amount of the Replenishment Assessment imposed upon any parcel or person does not exceed the proportional cost of water basin management services attributable to that parcel or person.

(j) No Replenishment Assessment is imposed upon any person who neither actually uses water basin management services nor has water basin management services immediately available to them.

(k) Water basin management services are not a "general government service" that is available to the general public.

(l) The Board notes that, in addition to replenishment assessment proceeds, the District receives an allocation of ad valorem property tax revenues. It is the intent of the Board that the District's Grants and Sponsorship Program, memberships and dues, water education expenses, and other community programs, be funded from these property tax revenues.

[RECORD OF THE VOTE AND SIGNATURES ON FOLLOWING PAGE]

PASSED, APPROVED AND ADOPTED THIS 3rd day of May 2022 by the following vote:

AYES: 5
NOES: 0
ABSENT: 0
ABSTAIN: 0

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

Board President

ATTEST:

Board Secretary

May 3, 2022
DATE

APPROVED AS TO FORM:

Leal, Trejo APC, Attorneys for the Water
Replenishment District of Southern California

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA • INCORPORATED DEC. 9 1959

Attachment 11: Fact Sheet for Water Systems/Operators on Filter Maintenance (Minnesota Department of Health)

Getting the Most out of Your Filter Media

FACT SHEET FOR WATER SYSTEMS/OPERATORS ON FILTER MAINTENANCE

How long is the typical media life?

Typical media life is between 15 and 20 years, depending on how long filters run and how many gallons are filtered each day. Many systems in Minnesota may have filter media that is near the end of its useful life. If systems are not proactive in maintaining or replacing filter media that is removing regulated contaminants, they may see an increase in violations for their water system.

Why is it important to maintain your filter media?

Many systems have filter media for iron and manganese removal. That filter media may also be removing arsenic or radium if it is present in the water. While filters help clean the water, contaminants can build up on the media over time. Sometimes these contaminants can build up on the media enough to re-enter the drinking water and contaminate it. Filter media have an effective size. The media can become too small from years of abrasion from backwashing or become too big from adsorption or other means. Regular maintenance of filter media can extend the life of media based filters and ensure optimal function of the filters.

How can you maintain your filter media?

Know what the purpose of each chemical feed is

Sometimes a system will stop using a chemical that is designed to help with the removal of manganese or radium. Without this chemical, the media has to do all the work to remove those contaminants. This can shorten the life of the media and could cause an exceedance of a standard for a regulated contaminant. (Remember that changes in treatment are required to be approved by the Minnesota Department of Health before they are implemented.)

Monitor backwashes (or reverse-flow cleaning)

Backwash frequency should be based on monitoring results. Backwashing alone may not get rid of all the built up contaminants however. Make sure to follow specifications for rate, duration, and frequency needed to clean the media. In some cases, filter media may be lost during backwashes, more media may need to be added, and action may need to be taken to reduce media loss.

Factors that indicate a backwash is required:

- Significant or predetermined head loss has occurred (based on engineering design)
- Filter has reached its predetermined filter run time (based on engineering design)
- Floc or contaminant breakthrough
- Return of a filter to service (after being taken offline)

During a backwash, the media should be adequately raised and mixed to get rid of contaminants. This movement should be uniform and even. Any irregularities or unevenness after a backwash may indicate an issue with the backwash operation. Boils during a backwash can also indicate an issue.

Backwashing should allow full expansion of the filter media, which is typically around 20 to 40 percent over the normal filter bed volume. Settled media should be clearly separate. Compaction or shrinkage of the media may indicate ineffective backwashing.

More information: Minnesota Water Works Operations Manual - Filtration (PDF) (https://www.mrwa.com/wp-content/uploads/2021/04/18-Filtration.pdf)

Clean the media

A periodic cleaning with a cleaning product, such as potassium permanganate, can prolong the filter media life and reduce downtime of the filter. The process typically includes allowing the cleaning solution to saturate the media for up to 24 hours. Specialty cleaning products are also available. The filter backwash water can be recycled to the head of the plant or discharged to the sanitary sewer.

At a minimum, a comprehensive filter inspection and evaluation should include:

- Observation of filter backwash
- Visual inspection of filters and filter media
- Inspection of the underdrain and plenum from the manway in the filter pipe gallery
- Determination of media depth
- Filter media sampling and analysis

More information: Treatment Plant Operator - Not to be Neglected (https://www.tpomag.com/editorial/2013/04/not_to_be_neglected_wso)

Dispose of the media if arsenic or radium is present in the media

Test the media to determine what type of disposal is necessary. Be aware of disposal criteria. More information about how to dispose of filter media containing radium and arsenic:

- Radon and Operator Safety in Drinking Water Treatment Plants (https://www.health.state.mn.us/communities/environment/water/factsheet/radonsafety.html)

Know when it’s time to replace your filter media

Believe it or not, sand can and does wear out. Through long-term filter operation, the originally rough edges on sand grains that help catch floc particles may become smooth and less adept at stopping particulate matter. This can result in higher filter bottom turbidity readings and increased head-loss readings, both of which will contribute to increased backwash cycles. Over time, this may contribute to increased operating costs.

In terms of media condition, look for media that is fouled. If the media has become rounded (like a pebble), then its effective filtering capacity may be diminished. Note if the media still meets the effective size originally specified. Finally, media replacement is required if the support gravel has been disrupted so that significant media has been lost through breakthrough to the filter bottom.

It is recommended that the media depth be measured regularly to determine whether an adequate amount is present. The recommended media depth for your plant's filters can be found on the facility plans and specifications. Since media depths can vary with the quality and quantity of water being filtered, it is important to see if the media has changed significantly from the configuration installed during start-up.

The type of media that yields the best filtering results will vary from plant to plant and will depend somewhat on water volume and clarity.

Media replacement is recommended or required at the point where the media size has changed significantly (becoming smaller or larger) from the original specification. When significant changes occur, filter cleaning with an acid solution may prolong media life in some cases. If fouling continues, cleaning may have to be repeated, and eventually you may have to decide if media replacement will be more cost-effective in the long run.

Filter media sampling and analysis should be performed to quantitatively determine the life-cycle of the media and effectiveness in filtering capability.

Minnesota Department of Health
Drinking Water Protection Section
625 N. Robert Street
P. O. Box 64975
St. Paul, Minnesota 55164-0975
651-201-4700
health.drinkingwater@state.mn.us
Drinking Water Protection (https://www.health.state.mn.us/communities/environment/water/dwp.html)

02/2020

Attachment 12: Excerpt from Central Basin Watermaster Report –2022 – 2023 Table 1a – Water Rights Accounting

Table 1a – Water Rights Accounting (acre-feet)

Party	APA 2022-2023 [1]	Net Carryover [2] from 2021-2022	Leases [3]		Storage [4]	Increased Extractions [5]	Total Rights [6]	Assessed Production [7]	Storage Production [8]	Total Production [9]	Balance [10]	One-Year Carryover into 2023-2024
			w/ Flex	w/o Flex								
ABC Unified School District	298.00	54.01	0.00	0.00	0.00		352.01	16.59	0.00	16.59	335.42	178.80
American Textile Maintenance Company	65.00	74.00	0.00	0.00	0.00		139.00	57.44	0.00	57.44	81.56	39.00
Angeles Abbey Memorial Park, Inc.	4.00	20.00	0.00	0.00	0.00		24.00	0.00	0.00	0.00	24.00	20.00
Arco Metals Co.	0.00	34.46	0.00	0.00	0.00		34.46	0.00	0.00	0.00	34.46	10.00
Artesia Cemetery District	12.00	20.00	-12.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Artesia, City	24.00	0.49	0.00	0.00	0.00		24.49	7.98	0.00	7.98	16.51	16.51
Atlas Iron & Metal[2]	0.00	-2.56	0.00	0.00	0.00		-2.56	0.36	0.00	0.36	-2.92	-2.92
Automobile Club of Southern California	6.00	20.00	0.00	0.00	0.00		26.00	0.00	0.00	0.00	26.00	20.00
Baker Commodities Inc.	60.00	36.00	0.00	0.00	0.00		96.00	0.00	0.00	0.00	96.00	36.00
Baker, Mary	28.00	0.00	-28.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Bell Gardens, City	1,914.00	1,298.28	0.00	0.00	0.00		3,212.28	0.00	0.00	0.00	3,212.28	1,148.40
Bellflower Home Garden Water Company	306.00	20.00	-306.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Bellflower Unified School District	89.00	53.40	0.00	0.00	0.00		142.40	0.00	0.00	0.00	142.40	53.40
Bellflower, City	680.00	903.00	-680.00	0.00	0.00		903.00	231.98	0.00	231.98	671.02	20.00
Bellflower-Somerset Mutual Water Company	4,412.88	2,055.73	680.00	0.00	1,000.00		8,148.61	4,667.90	0.00	4,667.90	3,480.71	2,055.73
Boy Scouts of America [2,13]	1.00	-8.80	0.00	0.00	0.00		-7.80	0.00	0.00	0.00	-7.80	-7.80
Buell, Mary	1.00	0.00	-1.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
California American Water Company	2,875.00	1,340.00	0.00	0.00	0.00		4,215.00	1,590.33	0.00	1,590.33	2,624.67	1,725.00
California Domestic Water Company	87.00	20.00	0.00	0.00	0.00		107.00	0.00	0.00	0.00	107.00	52.20
California Water Service Company (East LA)	11,774.00	6,175.76	-1,250.00	0.00	0.00		16,699.76	10,713.45	0.00	10,713.45	5,986.31	2,948.55
California Water Service Company Dominguez	6,480.00	5,417.56	-1,250.00	0.00	0.00		10,647.56	795.63	0.00	795.63	9,851.93	3,138.00
California, State of (Caltrans)[2,13]	50.00	-24,454.19	0.00	0.00	0.00		-24,404.19	4.72	0.00	4.72	-24,408.91	-24,408.91
Central Basin MWD	4.65	20.00	0.00	0.00	0.00		24.65	0.00	0.00	0.00	24.65	20.00
Cerritos Community College District	147.00	88.20	0.00	0.00	0.00		235.20	0.00	0.00	0.00	235.20	88.20
Cerritos, City [11]	4,680.03	1,038.22	524.50	3,750.00	3,720.91		13,713.66	7,103.49	0.00	7,103.49	6,610.17	1,040.91
Chang I-Hsin and Associates	1.00	23.84	0.00	0.00	0.00		24.84	0.00	0.00	0.00	24.84	20.00
Coast Packing Company	530.00	352.21	0.00	0.00	0.00		882.21	142.06	0.00	142.06	740.15	318.00
Commerce, City	5,081.00	3,026.95	-3,000.00	0.00	0.00		5,107.95	517.30	0.00	517.30	4,590.65	1,248.60
Compton Unified School District	38.00	57.80	0.00	0.00	0.00		95.80	0.00	0.00	0.00	95.80	22.80
Compton, City	5,780.00	59.64	0.00	2,400.00	0.00		8,239.64	6,754.06	0.00	6,754.06	1,485.58	1,425.94
Corning Trust	3.75	3.75	-3.75	0.00	0.00		3.75	0.00	0.00	0.00	3.75	3.75
Crandell F.J.	1.00	21.75	0.00	0.00	0.00		22.75	0.00	0.00	0.00	22.75	20.00
Darling-Delaware Company	117.00	111.15	0.00	0.00	0.00		228.15	0.00	0.00	0.00	228.15	70.20
Dolan, J.E. P.A. & T.P.	2.00	8.00	0.00	0.00	0.00		10.00	0.00	0.00	0.00	10.00	10.00
Downey, City [11,12]	16,553.62	6,842.23	0.00	-2,000.00	4,670.00		26,065.85	11,228.39	2,000.00	13,228.39	12,837.46	7,262.17
EcoGas, Inc.	0.00	4.00	0.00	0.00	0.00		4.00	0.00	0.00	0.00	4.00	4.00
El Rancho Unified School District	55.00	63.49	0.00	0.00	0.00		118.49	0.00	0.00	0.00	118.49	33.00
Emoto, John H	2.00	22.00	0.00	0.00	0.00		24.00	0.00	0.00	0.00	24.00	20.00
Equilon Enterprises	6.00	26.00	0.00	0.00	0.00		32.00	0.00	0.00	0.00	32.00	20.00
Flesch, Elizabeth Et Al	14.00	34.00	0.00	0.00	0.00		48.00	0.00	0.00	0.00	48.00	20.00

Table 1a– Water Rights Accounting (Continued)

Party	APA 2022-2023 [1]	Net Carryover [2] from 2021-2022	Leases [3]		Storage [4]	Increased Extractions [5]	Total Rights [6]	Assessed Production [7]	Storage Production [8]	Total Production [9]	Balance [10]	One-Year Carryover into 2023-2024
			w/ Flex	w/o Flex								
Footbridge 1 Trust	3.75	20.00	-3.75	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Ford Motor Company	4.50	24.50	0.00	0.00	0.00		29.00	0.00	0.00	0.00	29.00	20.00
Forestar USA	0.00	20.00	0.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Furr, Nancy [2]	0.00	-0.32	0.00	0.00	0.00		-0.32	0.04	0.00	0.04	-0.36	-0.36
Golden State Water Company	16,439.20	10,983.80	0.00	0.00	0.00	404.00	27,827.00	17,916.34	0.00	17,916.34	9,910.66	9,863.45
Gordon, Robert E.	4.00	24.80	0.00	0.00	0.00		28.80	0.00	0.00	0.00	28.80	20.00
Harada Brothers	6.00	26.00	0.00	0.00	0.00		32.00	0.00	0.00	0.00	32.00	20.00
Hathaway, Loline	4.08	20.00	0.00	0.00	0.00		24.08	0.00	0.00	0.00	24.08	20.00
Hathaway, Merrie F	1.86	20.00	0.00	0.00	0.00		21.86	0.00	0.00	0.00	21.86	20.00
Hathaway, Richard F, Jr.	4.07	16.28	-4.07	0.00	0.00		16.28	0.00	0.00	0.00	16.28	16.28
Hathaway, William A	4.07	20.00	0.00	0.00	0.00		24.07	0.00	0.00	0.00	24.07	20.00
HMB Bandini, LLC	1.00	2.10	0.00	0.00	0.00		3.10	0.00	0.00	0.00	3.10	3.10
Hoke, Barbara	1.50	0.00	-1.50	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Huntington Park, City	3,853.00	2,993.63	0.00	0.00	0.00		6,846.63	2,630.23	0.00	2,630.23	4,216.40	2,311.80
Inglewood Park Cemetery	317.00	55.00	-317.00	0.00	0.00		55.00	0.00	0.00	0.00	55.00	20.00
Julee M. Metz, Jon Schwartz & Darrin Margulies Trust	3.00	3.00	-3.00	0.00	0.00		3.00	0.00	0.00	0.00	3.00	3.00
LA Brickyard	9.00	29.75	0.00	0.00	0.00		38.75	0.00	0.00	0.00	38.75	20.00
Los Angeles County Rancho Los Amigos	490.00	438.36	0.00	0.00	0.00		928.36	183.99	0.00	183.99	744.37	294.00
La Habra Heights County Water District	2,668.00	1,597.92	4.07	0.00	0.00		4,269.99	2,193.59	0.00	2,193.59	2,076.40	1,603.24
Lakewood, City of Water Department [2,11,12]	9,432.00	-5,400.54	2,000.00	-2,250.00	13,354.51		17,135.97	837.83	5,510.34	6,348.17	10,787.80	1,443.63
Liberty Utilities Corporation	1,159.30	1,573.69	3,056.00	0.00	0.00		5,788.99	4,477.04	0.00	4,477.04	1,311.95	1,311.95
Lincoln Memorial Park	34.00	80.64	0.00	0.00	0.00		114.64	6.62	0.00	6.62	108.02	20.40
Little Lake Cemetery District	14.00	33.22	0.00	0.00	0.00		47.22	1.36	0.00	1.36	45.86	20.00
Long Beach, City [2,11,12]	32,692.00	-5,020.93	0.00	0.00	31,459.23		59,130.30	21,128.38	6,538.40	27,666.78	31,463.52	6,538.40
Los Angeles, City of Dept of Water & Power	17,236.00	8,697.20	0.00	0.00	22,943.00		48,876.20	3,297.04	1.31	3,298.35	45,577.85	3,447.20
Lunday-Thagard Oil Company	212.00	8.31	-212.00	0.00	0.00		8.31	0.00	0.00	0.00	8.31	0.00
Lussman, Paul H. Jr., Et Al	7.00	26.76	0.00	0.00	0.00		33.76	0.00	0.00	0.00	33.76	20.00
Lynwood Park Mutual Water Company	222.00	133.20	0.00	0.00	0.00		355.20	59.46	0.00	59.46	295.74	133.20
Lynwood, City	5,337.00	3,233.81	0.00	0.00	0.00		8,570.81	4,412.09	0.00	4,412.09	4,158.72	3,202.20
Maywood Mutual No. 1	741.00	454.26	0.00	0.00	0.00		1,195.26	587.08	0.00	587.08	608.18	444.60
Maywood Mutual No. 2	912.00	528.86	0.00	0.00	0.00		1,440.86	886.86	0.00	886.86	554.00	534.65
Maywood Mutual No. 3	1,407.00	507.22	0.00	0.00	100.00		2,014.22	1,384.35	0.00	1,384.35	629.87	457.23
Mellano, G et al [2]	0.00	-15.93	0.00	0.00	0.00		-15.93	0.00	0.00	0.00	-15.93	-15.93
Mitsuuchi, Mary F Trust	11.00	20.00	0.00	0.00	0.00		31.00	0.00	0.00	0.00	31.00	20.00
Montebello Land and Water Company	1,829.00	1,105.92	1,262.00	-285.00	0.00		3,911.92	2,806.08	0.00	2,806.08	1,105.84	858.56
Montebello, City	386.50	20.00	-386.50	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Nancy Dee Keane Living Trust	4.00	4.00	-4.00	0.00	0.00		4.00	0.00	0.00	0.00	4.00	4.00
New England Mutual Life Insurance Company	2.00	22.00	0.00	0.00	0.00		24.00	0.00	0.00	0.00	24.00	20.00
Newark Group Inc [2,13]	157.00	-3.88	0.00	0.00	0.00		153.12	156.06	0.00	156.06	-2.94	-2.94
Northrop Grumman/Omega Chemical	4.50	40.00	0.00	0.00	0.00		44.50	0.00	0.00	0.00	44.50	20.00
Norwalk, City	2,273.00	1,525.66	0.00	0.00	0.00		3,798.66	468.28	0.00	468.28	3,330.38	1,363.80
Norwalk-La Mirada U.S.D	378.00	324.10	0.00	0.00	0.00		702.10	0.00	0.00	0.00	702.10	226.80

Table 1a– Water Rights Accounting (Continued)

Party	APA 2022-2023 [1]	Net Carryover [2] from 2021-2022	Leases [3]		Storage [4]	Increased Extractions [5]	Total Rights [6]	Assessed Production [7]	Storage Production [8]	Total Production [9]	Balance [10]	One-Year Carryover into 2023-2024
			w/ Flex	w/o Flex								
O N K Farms	8.00	28.00	0.00	0.00	0.00		36.00	0.00	0.00	0.00	36.00	20.00
Oltmans Construction Company	3.00	23.00	0.00	0.00	0.00		26.00	0.00	0.00	0.00	26.00	20.00
Omega OU1/OU3 LLC	0.50	0.00	0.00	0.00	0.00		0.50	0.00	0.00	0.00	0.50	0.50
Omega OU2, LLC	7.47	7.97	0.00	0.00	0.00		15.44	0.00	0.00	0.00	15.44	15.44
Orchard Dale Water District	1,254.00	701.59	0.00	500.00	0.00		2,455.59	1,701.45	0.00	1,701.45	754.14	684.62
OU2 Environmental Remediation Trust	0.00	32.95	0.00	0.00	0.00		32.95	0.00	0.00	0.00	32.95	20.00
PABCO Building Products, LLC	500.00	0.95	-500.00	0.00	0.00		0.95	0.00	0.00	0.00	0.95	0.95
Paradise Memorial Park	16.00	20.95	0.00	0.00	0.00		36.95	6.50	0.00	6.50	30.45	20.00
Paramount Unified School District	46.00	27.60	0.00	0.00	0.00		73.60	3.10	0.00	3.10	70.50	27.60
Paramount, City	5,883.00	4,820.38	0.00	0.00	0.00		10,703.38	2,712.15	0.00	2,712.15	7,991.23	3,529.80
Patrician Associates Inc/Majestic Realty Co.	12.00	32.00	0.00	0.00	0.00		44.00	0.00	0.00	0.00	44.00	20.00
Petersburg, LP	1.00	8.00	0.00	0.00	0.00		9.00	0.00	0.00	0.00	9.00	9.00
Pico Boys Baseball	13.00	20.00	0.00	0.00	0.00		33.00	0.00	0.00	0.00	33.00	20.00
Pico Rivera, City	5,579.00	566.26	0.00	0.00	0.00		6,145.26	3,916.36	0.00	3,916.36	2,228.90	1,662.64
Pico Water District	3,624.00	2,458.66	0.00	-120.00	0.00		5,962.66	2,517.47	0.00	2,517.47	3,445.19	2,174.40
Puente Basin Water Agency [11]	965.00	227.75	-465.00	-500.00	479.00		706.75	0.00	0.00	0.00	706.75	100.00
Rippy, Francine	4.07	20.00	0.00	0.00	0.00		24.07	0.00	0.00	0.00	24.07	20.00
Rockview Dairies	101.00	23.70	0.00	0.00	0.00		124.70	63.10	0.00	63.10	61.60	60.60
Roman Catholic Archbishop	347.00	298.81	0.00	0.00	0.00		645.81	164.69	0.00	164.69	481.12	208.20
Rosales, Elvira C	3.00	25.00	0.00	0.00	0.00		28.00	0.00	0.00	0.00	28.00	20.00
Rosing, Nancy	1.50	0.00	-1.50	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Rowland Water District	1.00	6.17	-1.00	0.00	0.00		6.17	0.00	0.00	0.00	6.17	6.17
San Gabriel Valley Water Company [11]	2,569.42	0.00	386.50	0.00	3,726.48		6,682.40	2,429.91	0.00	2,429.91	4,252.49	526.01
Santa Fe Springs, City	4,035.78	3,704.49	0.00	0.00	0.00		7,740.27	1,520.18	0.00	1,520.18	6,220.09	2,421.47
LA County Public Works - Sativa Water District	0.00	294.59	0.00	0.00	0.00		294.59	1.50	0.00	1.50	293.09	20.00
Scantlebury, Robert P.	4.00	41.49	0.00	0.00	0.00		45.49	0.50	0.00	0.50	44.99	20.00
September Properties LLC [2]	0.00	-0.21	0.00	0.00	0.00		-0.21	0.00	0.00	0.00	-0.21	-0.21
Signal Hill, City	2,022.00	1,920.90	0.00	0.00	0.00		3,942.90	722.60	0.00	722.60	3,220.30	1,213.20
Simmons Survivors Trust	33.00	20.00	-33.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
South Gate, City [2,11,12]	11,183.00	-3,003.20	0.00	-1,900.00	9,659.00		15,938.80	3,597.24	4,500.00	8,097.24	7,841.56	2,235.05
South Montebello Irrigation District	1,268.00	11.97	0.00	500.00	0.00		1,779.97	1,618.42	0.00	1,618.42	161.55	161.55
Southern California Edison Company	670.00	636.50	0.00	0.00	0.00		1,306.50	2.74	0.00	2.74	1,303.76	402.00
St John Bosco School	42.00	31.58	0.00	0.00	0.00		73.58	21.64	0.00	21.64	51.94	25.20
Statewide Stations, Inc.	1.00	35.00	0.00	0.00	0.00		36.00	0.00	0.00	0.00	36.00	20.00
Suburban Water Systems	4,195.00	1,126.14	-2,450.00	-215.00	0.00		2,656.14	1,118.24	0.00	1,118.24	1,537.90	1,047.00
Tesoro Refining & Marketing Company LLC	54.00	67.40	0.00	0.00	0.00		121.40	0.00	0.00	0.00	121.40	32.40
Tract 180 Water Company	2,137.00	1,076.16	-800.00	0.00	0.00		2,413.16	1,204.70	0.00	1,204.70	1,208.46	802.20
Tract 349 Mutual Water Company	423.00	92.16	200.00	0.00	0.00		715.16	609.08	0.00	609.08	106.08	100.80
Tucker, William M. & or Robertson, Bobby Ray Jr.	0.00	0.37	0.00	0.00	0.00		0.37	0.37	0.00	0.37	0.00	0.00
Vangrootheest, Ernest A	10.00	20.00	0.00	0.00	0.00		30.00	0.00	0.00	0.00	30.00	20.00
Vernon Environmental Response Trust	62.00	72.20	0.00	0.00	0.00		134.20	0.00	0.00	0.00	134.20	37.20

Table 1a– Water Rights Accounting (Continued)

Party	APA 2022-2023 [1]	Net Carryover [2] from 2021-2022	Leases [3]		Storage [4]	Increased Extractions [5]	Total Rights [6]	Assessed Production [7]	Storage Production [8]	Total Production [9]	Balance [10]	One-Year Carryover into 2023-2024
			w/ Flex	w/o Flex								
Vernon, City	7,539.00	5,044.57	0.00	0.00	0.00		12,583.57	5,475.42	0.00	5,475.42	7,108.15	4,523.40
Virginia Country Club[2]	274.00	-5.41	0.00	120.00	0.00		388.59	315.85	0.00	315.85	72.74	72.74
Walnut Park Mutual Water Company	1,009.00	456.44	150.00	0.00	1,077.91		2,693.35	1,007.68	0.00	1,007.68	1,685.67	231.80
WEMS, Inc.	8.00	28.00	0.00	0.00	0.00		36.00	0.00	0.00	0.00	36.00	20.00
Whittier Union High School District	100.00	34.12	-50.00	0.00	50.00		134.12	22.98	0.00	22.98	111.14	10.00
Whittier, City [11]	895.00	1,918.75	3,500.00	0.00	1,790.00		8,103.75	5,188.01	0.00	5,188.01	2,915.74	879.00
Wolfsberger, Helen and Chris Joseph	2.00	22.00	0.00	0.00	0.00		24.00	0.00	0.00	0.00	24.00	20.00
Yamamoto, Alice and George	14.00	33.82	0.00	0.00	0.00		47.82	0.07	0.00	0.07	47.75	20.00
TOTAL	**217,367.00**	**52,102.33**	**0.00**	**0.00**	**94,030.04**	**404.00**	**363,903.37**	**143,206.35**	**18,550.05**	**161,756.40**	**202,146.97**	**56,632.52**

[1] APA – Allowed Pumping Allocation

[2] Net Carryover = Drought Carryover + One-year Carryover from the previous year (2021-2022 AY) less the amount of carryover conversion for the current year (2022-2023 AY).
See Table 1b for Drought Carryover totals.
See Table 3 for carryover conversion (water put into storage) per party for 2022-2023 AY.
Net carryover 2021-2022 AY will be negative due to overextractions in prior years or due to carryover conversion of current AY carryover: Lakewood, City of; Long Beach, City of; South Gate, City of.

[3] See Table 10 for information concerning leases. Lease with flex include carryover provisions.

[4] Storage includes all storage carryover conversions for 2022-2023 AY. See Table 2 for a summary of all Storage Accounting per party for 2022-2023 AY.

[5] Increased Extraction: Section IV(K) of the Central Basin Judgment permits increased extraction rights through use of up to 5,000 af of certain parties' West Basin Rights in the Central Basin
The parties include City of Los Angeles, Golden State Water Company, and California Water Service Company.

[6] Total Rights = Allowed Pumping Allocation + Net Carryover + Leases + Storage + Increased Extractions but does not equal the Annual Extraction Limit (see page 5, section D).

[7] Assessed Production for 2022-2023 AY, does not include storage production.

[8] Storage Production includes all withdrawals from a Party's Individual Storage Accounts and Community Storage Accounts, which totaled 18,550.05 af for 2022-2023 AY. See Table 4 for storage withdrawal amounts per party.

[9] Total Production = Assessed Production + Storage Production.

[10] Balance = Total Rights - Total Production

[11] Completed carryover conversion into storage. 2021-2022 AY net carryover:
One-year Carryover: Cerritos, City of: 1,090.91 AF; Downey, City of: 2,000 AF; Puente Basin Water Agency: 479 AF Lakewood, City of: 943.63 AF;
Long Beach, City of: 6,538.40 AF; San Gabriel Valley Water Company: 394.99 AF; South Gate, City of: 5,159 AF; Whittier, City of: 1,790 AF
Current-year Carryover: Lakewood, City of: 6,900.54 AF; City of: Long Beach, City of: 5,025.22 AF, South Gate, City of: 3,450.41

[12] Carryover Correction Agreements: Downey, City of: 670 AF; Lakewood, City of: 794.34 AF; Long Beach, City of: 179.90 AF

[13] Negative One-Year Carryover will be deducted from the subsequent year's APA.

Attachment 13: Excerpt from Central Basin Watermaster Report –2022 – 2023 Appendix A (Groundwater Extractions)

Appendix A

Groundwater Extractions

July 2022 – June 2023

(includes storage production and non-consumptive use)

Appendix A – Groundwater Extractions (Continued)

Appendix A – Groundwater Extractions (acre-feet)

0020 – ABC Unified School District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	4.35	2.28	1.30	1.02	1.02	1.17	1.17	1.33	0.20	0.28	0.71	1.76	16.59
4S/11W-07R03S/MESCH	4.35	2.28	1.30	1.02	1.02	1.17	1.17	1.33	0.20	0.28	0.71	1.76	16.59

0107- American Textile Maintenance Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	4.05	4.65	4.43	4.46	4.44	4.59	4.65	5.20	5.48	4.74	5.48	5.27	57.44
004S012W08N002S/	4.05	4.65	4.43	4.46	4.44	4.59	4.65	5.20	5.48	4.74	5.48	5.27	57.44

0160 – Artesia, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2.02	3.31	1.89	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.24	0.28	7.98
3S/11W-31N02S/1	2.02	3.31	1.89	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.24	0.28	7.98

0225- Atlas Iron & Metal Co	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.09	0.00	0.00	0.09	0.00	0.00	0.09	0.00	0.00	0.09	0.36
002S013W34Q002S/1	0.00	0.00	0.09	0.00	0.00	0.09	0.00	0.00	0.09	0.00	0.00	0.09	0.36

0410 – Bellflower, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	61.14	61.44	54.63	50.49	4.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	231.98
3S/12W-27B02S/1	61.14	61.44	54.63	50.49	4.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	231.98

Appendix A – Groundwater Extractions (Continued)

0445 - Bellflower-Somerset Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	477.66	443.97	421.26	411.94	378.29	347.66	331.12	327.48	377.42	333.07	422.84	395.19	4,667.90
003S012W22M002S/884	35.20	31.77	23.53	24.31	22.91	20.85	21.01	20.38	23.07	21.48	25.96	23.97	294.44
003S012W23E004S/2587	60.10	58.62	57.22	57.15	55.81	55.88	60.74	54.38	59.40	52.81	61.08	55.66	688.85
003S012W26C002S/944	35.82	38.89	35.67	24.87	10.76	7.41	19.74	23.90	17.55	31.79	41.13	41.46	328.99
003S012W27B002S/1	241.41	210.21	204.02	201.48	185.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1042.67
003S012W27R001S/955	64.01	63.57	61.26	62.31	61.42	60.66	29.92	31.12	30.48	29.46	47.92	47.20	589.33
003S012W33B001S/2615	41.12	40.91	39.56	41.82	41.84	42.03	35.10	19.91	24.38	20.81	39.07	44.45	431.00
003S013W14M005S/APX-MW-20A	0.00	0.00	0.00	0.00	0.00	160.83	164.61	177.79	222.54	176.72	207.68	182.45	1292.62

0495 - Boeing Company, Long Beach Site (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	10.59	0.00	0.00	2.35	0.00	0.00	16.96	0.00	0.00	23.25	53.15
004S012W99B999S	0.00	0.00	10.59	0.00	0.00	2.35	0.00	0.00	16.96	0.00	0.00	23.25	53.15

0496 - Boeing Company, Compton (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	8.51	0.00	0.00	13.97	0.00	0.00	13.82	0.00	0.00	13.79	50.09
003S013W22K002S/MWD061	0.00	0.00	8.51	0.00	0.00	13.97	0.00	0.00	13.82	0.00	0.00	13.79	50.09

0679 - California American Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	104.25	133.87	162.56	93.05	30.14	57.39	99.98	143.42	188.78	179.51	178.50	218.88	1,590.33
002S014W14C006S/VERN3	89.31	88.77	109.99	56.38	0.00	0.00	0.00	67.44	90.57	87.19	85.82	114.60	790.07
002S014W14C007S/48THST	14.94	45.10	52.57	36.67	30.14	57.39	60.10	37.95	61.53	49.41	46.76	56.26	548.82
003S012W27B002S/1	0.00	0.00	0.00	0.00	0.00	0.00	39.88	38.03	36.68	42.91	45.92	48.02	251.44

0742 - California Water Service Company (Dominguez)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	73.75	111.95	81.15	65.22	58.74	40.03	42.28	36.82	42.48	42.54	74.95	125.72	795.63
003S013W35F001S	30.23	69.40	60.03	59.57	15.47	0.00	0.00	0.00	0.00	0.00	32.57	82.58	349.85
003S013W35H002S	43.52	42.55	21.12	5.65	43.27	40.03	42.28	36.82	42.48	42.54	42.38	43.14	445.78

Appendix A – Groundwater Extractions (Continued)

0740 - California Water Service Company (East LA)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	765.21	790.46	940.87	970.93	906.33	936.69	918.66	865.21	910.80	871.22	928.70	908.37	10,713.45
002S012W04C001S	34.96	35.19	33.07	34.73	32.37	34.59	31.17	31.38	34.73	33.92	34.96	33.67	404.74
002S012W07G002S	104.47	104.58	98.67	100.08	91.12	98.24	99.38	88.36	99.00	96.18	96.18	96.51	1,172.77
002S012W07H001S	0.00	0.56	8.05	35.31	34.71	35.66	35.18	30.92	35.21	34.13	35.15	34.69	319.57
002S012W07Q004S	66.71	65.88	62.55	64.11	62.28	52.22	63.71	56.99	65.51	66.33	50.51	66.67	743.47
002S012W08F001S	46.73	46.83	41.08	35.57	45.26	46.52	46.20	40.88	46.33	46.23	48.20	46.46	536.29
002S012W08P001S	61.81	63.88	60.24	61.48	56.33	17.13	63.35	58.58	18.35	24.04	63.86	62.09	611.14
002S012W09Q001S/62-01	0.00	40.73	233.72	232.83	200.96	224.65	208.12	178.76	194.09	189.57	197.24	190.84	2,091.51
002S012W09Q002S/62-02	154.04	153.03	141.45	157.46	153.90	184.39	148.98	144.90	140.09	78.40	83.80	72.68	1,613.12
002S012W14M001S/63-01	256.21	239.35	223.75	210.81	194.10	204.28	184.01	198.72	238.49	263.15	278.08	265.16	2,756.11
002S012W17D002S	40.28	40.43	38.29	38.55	35.30	39.01	38.56	35.72	39.00	39.27	40.72	39.60	464.73

0690 - California, State of (Caltrans)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.20	0.16	0.26	0.15	0.24	0.25	2.01	0.12	0.72	0.10	0.17	0.34	4.72
003S012W17E003S/1D3	0.01	0.03	0.03	0.04	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
003S012W17E004S/1D4	0.05	0.06	0.06	0.08	0.03	0.01	0.06	0.03	0.04	0.03	0.05	0.09	0.59
003S012W17E007S/1D7	0.06	0.05	0.10	0.01	0.03	0.04	1.90	0.02	0.47	0.06	0.12	0.16	3.02
003S012W17E008S/1D6A	0.07	0.02	0.07	0.02	0.05	0.20	0.05	0.07	0.21	0.01	0.00	0.00	0.77
003S012W17F002S/1D8	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
003S012W17F004S/1D10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09

0826 - Cerritos, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	674.44	695.77	657.12	625.18	568.30	631.59	535.02	529.87	464.92	522.93	586.35	612.00	7,103.49
003S011W28G005S/C-2	445.82	437.86	368.01	311.20	272.74	297.53	120.52	106.97	142.86	115.70	125.39	149.36	2,893.96
003S011W29N006S/C-1	228.62	227.39	217.45	227.61	216.56	219.84	205.75	172.88	184.46	194.06	227.70	213.44	2,535.76
003S012W26J003S/C-4	0.00	30.52	71.66	86.37	79.00	114.22	208.75	250.02	137.60	213.17	233.26	249.20	1,673.77

Appendix A – Groundwater Extractions (Continued)

0970 - Coast Packing Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	11.10	11.15	12.78	10.77	12.02	12.21	11.29	10.72	12.39	11.85	12.91	12.87	142.06
002S013W11P003S/1	11.10	11.15	12.78	10.77	12.02	12.21	11.29	10.72	12.39	11.85	12.91	12.87	142.06

1017 - Commerce, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	47.31	3.46	7.70	52.13	50.39	52.24	53.31	47.24	53.92	51.07	49.72	48.81	517.30
002S012W21G003S/4	47.31	3.46	7.70	52.13	50.39	52.24	53.31	47.24	53.92	51.07	49.72	48.81	517.30

1020 - Compton, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	646.48	663.64	611.73	581.37	526.36	527.93	499.87	470.82	503.81	510.97	583.23	627.85	6,754.06
003S013W11M003S/17	99.69	77.05	77.03	73.14	71.73	24.19	0.00	51.48	77.97	64.53	47.81	67.77	732.39
003S013W14F001S/18	195.02	203.15	34.93	64.27	93.12	93.51	16.98	58.17	58.53	14.64	132.69	139.90	1,104.91
003S013W14K003S/19	164.52	125.22	230.30	208.02	179.67	181.89	183.66	125.43	141.65	168.43	118.32	127.98	1,955.09
003S013W26C001S/13	131.18	111.60	111.34	79.78	77.11	110.77	130.64	120.12	131.70	120.31	115.54	129.07	1,369.16
003S013W27E002S/11	56.07	51.45	52.75	56.67	55.94	58.05	54.46	47.80	51.80	50.88	53.31	51.64	640.82
003S013W27G001S/15	0.00	95.17	105.38	99.49	48.79	59.52	114.13	67.82	42.16	92.18	115.56	111.49	951.69

1255 - Defense Logistic Agency Energy (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.18	0.00	0.00	1.03	0.00	0.00	1.15	0.00	0.00	1.41	3.77
003S011W99A099S/REMED	0.00	0.00	0.18	0.00	0.00	1.03	0.00	0.00	1.15	0.00	0.00	1.41	3.77

1333 - Demenno/Kerdoon (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.37	0.00	0.00	0.38	0.00	0.00	0.47	0.00	0.00	0.51	1.73
003S013W14E001S/MW-5A	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.05
003S013W14M002S/RW-3	0.00	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.07
003S013W14M003S/RW-6	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02
003S013W14M005S/APX-MW-20A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
003S013W15H002S/RW-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01

Appendix A – Groundwater Extractions (Continued)

1333 - Demenno/Kerdoon (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.37	0.00	0.00	0.38	0.00	0.00	0.47	0.00	0.00	0.51	1.73
003S013W15H003S/RW-7	0.00	0.00	0.12	0.00	0.00	0.09	0.00	0.00	0.23	0.00	0.00	0.10	0.54
003S013W15H004S/RW-8	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.10	0.14
003S013W15H005S/RW-10	0.00	0.00	0.15	0.00	0.00	0.20	0.00	0.00	0.21	0.00	0.00	0.22	0.78
003S013W15J001S/RW-1	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.03	0.06
003S013W15J002S/RW-5	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.04
003S013W15J003S/RW-10R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01

1450 - Downey, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1,375.80	1,310.86	1,259.03	1,223.12	1,057.66	982.96	939.94	875.10	896.87	928.33	1,226.92	1,151.80	13,228.39
002S012W27H001S/2	123.04	106.09	90.09	83.04	4.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	406.88
002S012W27R002S/4	0.00	103.84	346.30	347.67	327.99	324.44	341.70	301.05	331.40	312.29	357.81	331.32	3,425.81
002S012W28J006S/7	43.92	44.79	45.65	45.18	47.33	37.34	37.53	32.64	35.99	19.75	23.37	21.40	434.89
002S012W28Q001S/8	53.89	84.12	90.67	52.48	49.90	56.44	20.50	9.93	12.30	11.05	24.42	33.12	498.82
002S012W33M001S/17	76.26	70.27	61.45	76.75	38.84	36.21	12.91	12.25	12.95	12.65	35.85	47.88	494.27
002S012W34P001S/14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.40	88.91	26.32	162.63
002S012W35D004S/5	38.91	35.50	33.52	33.21	59.78	71.57	58.79	45.34	50.61	39.77	62.77	57.23	587.00
002S012W35P001S/10	0.00	0.00	0.00	66.75	107.70	108.13	97.66	105.47	91.93	137.27	181.32	174.78	1,071.01
003S012W02H004S/12	217.61	203.34	200.64	203.47	196.99	200.78	198.00	180.48	190.73	165.15	199.34	180.89	2,337.42
003S012W02L001S/15	44.85	41.35	32.78	6.95	0.37	9.82	10.69	9.49	9.97	9.29	11.54	8.71	195.81
003S012W03F001S/11	362.51	228.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	590.59
003S012W03J001S/16	106.33	99.91	86.54	79.36	87.71	26.77	0.00	0.00	0.00	0.00	53.95	121.06	661.63
003S012W03M001S/19	54.72	59.12	59.38	36.58	9.91	5.09	5.84	4.92	6.68	8.30	31.53	7.53	289.60
003S012W04D002S/18	29.85	28.96	22.97	6.69	8.36	18.80	18.80	28.14	28.24	35.84	42.16	36.24	305.05
003S012W04Q002S/23	90.19	83.53	82.36	83.32	62.46	43.56	36.08	25.88	27.05	26.84	41.82	40.53	643.62
003S012W09B001S/25	50.96	45.18	30.36	27.86	21.38	25.32	21.70	32.22	15.04	53.19	12.42	13.37	349.00

Appendix A – Groundwater Extractions (Continued)

1450 - Downey, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1,375.80	1,310.86	1,259.03	1,223.12	1,057.66	982.96	939.94	875.10	896.87	928.33	1,226.92	1,151.80	13,228.39
003S012W09G001S/29	82.76	76.78	76.32	73.81	34.32	18.69	18.63	10.36	18.76	17.22	23.38	21.42	472.45
003S012W10N003S/30	0.00	0.00	0.00	0.00	0.00	0.00	61.11	76.93	65.22	32.32	36.33	30.00	301.91

1745 - Furr, Nancy J.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04
3S/12W-21G05S/1	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04

1843 - Golden State Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1,786.12	1,658.54	1,568.54	1,617.15	1,506.58	1,460.91	1,411.97	1,252.81	1,409.15	1,456.22	1,395.76	1,392.59	17,916.34
002S012W28N005S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.14	0.17	0.94	0.68	2.34
002S012W29A004S	85.76	84.31	27.43	68.63	20.34	53.19	54.91	72.70	90.78	87.22	37.66	0.00	682.93
002S012W30G003S	68.01	73.04	75.35	65.95	55.93	63.10	61.87	52.49	66.02	63.18	64.96	17.34	727.24
002S013W21E001S/G0004	79.72	0.25	0.00	15.40	88.38	90.17	89.57	81.03	49.36	0.06	0.00	0.89	494.83
002S013W21K004S	25.30	29.27	29.75	26.65	18.53	13.24	10.38	12.84	15.38	18.35	26.80	30.67	257.16
002S013W21K007S	71.54	71.94	69.47	71.36	69.67	72.08	71.49	65.09	72.36	70.62	72.44	70.60	848.66
002S013W23J003S	2.06	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.00	0.05	0.00	0.00	2.25
002S013W23R002S/Bissel 3	116.14	151.29	202.07	166.53	146.30	109.80	120.96	64.64	116.84	137.85	105.53	142.57	1,580.52
002S013W24Q004S	115.43	78.81	0.00	48.38	107.01	109.98	82.19	25.97	3.74	38.08	109.70	98.90	818.19
002S013W27E003S/NA003	48.44	58.08	56.25	56.35	44.74	45.62	46.70	43.81	52.91	56.25	59.37	58.02	626.54
002S013W28G001S/MI003	77.71	83.84	79.96	78.03	63.98	83.16	100.75	91.66	103.99	96.88	0.00	0.00	859.96
002S013W28G003S/MI002	81.85	88.52	86.22	86.96	75.60	40.04	0.06	0.05	0.00	0.06	0.00	0.00	459.36
003S011W07E001S	69.69	8.73	58.36	62.80	49.07	47.08	8.39	7.57	1.33	3.35	2.09	1.74	320.20
003S011W18G006S	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.10	0.00	0.31	0.00	0.00	0.52
003S012W02R006S/ST003	79.55	81.22	67.62	64.42	64.29	76.97	74.22	63.63	68.70	75.85	81.03	71.21	868.71
003S012W07Q005S/CTY01	0.29	2.95	1.07	0.56	0.20	0.20	0.14	0.11	0.14	1.31	0.65	2.52	10.14

Appendix A – Groundwater Extractions (Continued)

1843 - Golden State Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1,786.12	1,658.54	1,568.54	1,617.15	1,506.58	1,460.91	1,411.97	1,252.81	1,409.15	1,456.22	1,395.76	1,392.59	17,916.34
003S012W12A002S	60.18	65.11	58.15	59.00	37.55	9.15	0.75	6.37	39.63	36.89	31.65	41.41	445.84
003S012W13A002S	0.06	0.00	1.35	1.59	0.21	16.18	41.78	44.31	0.00	0.00	0.55	75.97	182.00
003S012W13B004S	0.03	0.06	0.09	0.24	0.25	45.67	74.05	66.52	61.23	67.24	63.80	42.43	421.61
003S012W17A002S/MCK03	65.39	63.90	58.02	58.35	50.26	47.12	45.23	42.02	45.49	47.73	53.03	54.68	631.22
003S012W25Q003S/ROS02	96.18	106.56	105.65	107.00	31.95	0.00	2.21	24.38	117.95	112.54	115.54	111.56	931.52
003S012W36B001S/ROS01	67.51	66.11	60.72	63.76	80.29	34.15	80.37	82.12	67.56	73.65	83.31	84.68	844.23
003S013W04N001S/BEL03	116.07	104.74	112.63	102.85	98.96	106.76	102.03	99.47	114.22	114.58	105.14	98.23	1,275.68
003S013W04N004S/BEL04	135.23	122.30	131.20	139.30	132.59	139.69	140.89	125.57	137.89	134.30	138.45	136.25	1,613.66
003S013W10L002S/WLBK1	43.21	42.13	38.46	35.09	34.73	40.23	30.74	28.89	31.48	32.32	34.92	35.81	428.01
003S013W10L004S/WLBK3	42.83	43.82	40.65	38.51	31.59	25.73	33.53	30.92	33.53	34.36	36.97	37.88	430.32
004S011W07H002S/HAW01	0.60	0.48	0.55	6.12	0.93	2.94	0.67	0.45	0.33	1.24	1.45	1.16	16.92
004S011W07L005S/CEN06	125.52	116.46	105.05	31.66	0.00	9.85	7.86	4.66	1.78	1.71	0.00	0.00	404.55
004S011W07L006S/CEN07	111.62	114.34	102.05	157.60	199.68	170.05	129.79	114.57	116.15	149.73	166.79	175.17	1,707.54
004S011W18F002S	0.20	0.28	0.42	4.06	3.55	8.76	0.26	0.39	0.22	0.34	2.99	2.22	23.69

2378 - Huntington Park, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	238.16	270.56	260.98	245.65	220.26	216.91	204.49	183.29	192.40	169.12	215.22	213.19	2,630.23
002S013W23H001S/14	49.63	82.43	74.56	48.47	31.89	45.15	51.76	44.39	47.07	56.20	61.86	65.78	659.19
002S013W23J004S/18	102.65	124.60	122.49	128.55	121.26	125.75	120.49	109.29	112.96	78.05	118.63	115.11	1,379.83
002S013W25D004S/16	0.99	0.73	0.31	0.27	0.19	0.29	0.13	0.24	0.18	0.46	0.23	0.20	4.22
002S013W25Q001S/12	84.89	62.80	63.62	68.36	66.92	45.72	32.11	29.37	32.19	34.41	34.50	32.10	586.99

Appendix A – Groundwater Extractions (Continued)

2749 – La Habra Heights County Water District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	296.97	304.59	257.10	237.61	165.77	132.34	84.87	118.04	76.49	152.48	166.52	200.81	2,193.59
002S011W19F001S/8	43.85	42.81	40.21	37.75	39.63	38.13	19.96	27.90	30.54	45.86	50.58	50.55	467.77
002S011W19F001S/8	121.95	128.35	98.87	85.07	36.37	18.78	5.94	1.43	31.32	82.14	14.42	103.75	728.39
002S011W19P002S/10	131.17	133.43	118.02	114.79	89.77	75.43	58.97	88.71	14.63	24.48	101.52	46.51	997.43

2770 – Lakewood, City of Water Department	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	648.58	662.07	581.88	595.27	510.11	486.93	399.99	402.26	465.54	469.26	589.58	536.70	6,348.17
003S012W33A007S/LK002A	56.42	55.57	53.13	59.22	2.21	51.45	33.87	26.51	22.97	34.95	40.45	26.78	463.53
003S012W34F001S/LK018	70.55	69.22	63.09	72.27	53.09	8.34	0.58	1.45	23.53	50.10	14.11	20.99	447.32
004S011W07M001S/LK006	2.50	3.35	7.60	8.95	4.26	6.00	0.00	0.13	0.25	1.95	10.51	11.16	56.66
004S012W03A002S/LK015A	126.59	108.39	0.00	0.00	42.17	0.00	0.00	1.94	20.97	0.00	86.76	104.01	490.83
004S012W03H001S/LK017	105.17	109.49	96.90	110.78	97.83	100.08	72.47	71.21	68.76	77.93	70.55	29.13	1,010.30
004S012W05J001S/LK022	38.73	33.65	23.98	1.02	22.99	17.61	0.00	0.00	0.00	0.00	0.00	0.00	137.98
004S012W10G001S/LK004	75.98	75.16	68.71	79.18	65.25	72.05	54.30	50.52	40.56	46.49	52.87	35.51	716.58
004S012W10H001S/LK010	89.18	95.23	90.23	96.94	63.70	56.74	30.94	40.87	46.36	48.88	64.33	49.84	773.24
004S012W10H003S/LK008	83.46	91.98	86.21	73.03	61.22	1.08	42.46	54.53	61.13	53.50	71.07	57.92	737.59
004S012W10H004S/LK027	0.00	20.03	74.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.45	113.55	240.96
004S012W10H005S/28	0.00	0.00	17.10	93.88	97.39	173.58	165.37	155.10	181.01	155.46	146.48	87.81	1,273.18

3780 – Liberty Utilities Corporation	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	441.99	426.74	411.34	401.70	345.33	328.86	341.21	325.64	355.91	366.98	368.59	362.75	4,477.04
003S012W11K006S/41A	0.00	0.00	0.04	0.04	0.03	0.00	0.00	0.09	0.04	0.06	0.08	0.00	0.38
003S012W16H001S/40D	47.58	48.08	52.91	60.09	36.78	29.68	48.33	52.96	63.04	61.84	59.83	62.81	623.93
003S013W09H001S/19C	213.61	206.95	188.11	184.15	166.01	158.78	157.69	152.67	159.06	167.65	149.84	156.45	2,060.97
003S013W13F004S/4B	35.88	22.17	26.42	19.57	14.20	20.48	20.84	30.33	44.37	46.21	50.13	52.64	383.24

Appendix A – Groundwater Extractions (Continued)

3780 – Liberty Utilities Corporation	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	441.99	426.74	411.34	401.70	345.33	328.86	341.21	325.64	355.91	366.98	368.59	362.75	4,477.04
003S013W16K002S/12C	31.75	36.14	40.57	33.19	27.23	30.50	26.39	20.56	24.82	25.08	35.35	19.83	351.41
003S013W25F004S/9D	113.17	113.40	103.29	104.66	101.08	89.42	87.96	69.03	64.58	66.14	73.36	71.02	1,057.11

2890- Little Lake Cemetery District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.74	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.36
003S011W06N001S/1	0.00	0.74	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.36

2884 – Lincoln Memorial Park Inc	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.93	1.28	1.85	1.52	0.73	0.20	0.00	0.00	0.00	0.08	0.03	0.00	6.62
003S013W28F001S	0.93	1.28	1.85	1.52	0.73	0.20	0.00	0.00	0.00	0.08	0.03	0.00	6.62

2910 – Long Beach, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2,544.76	2,505.87	2,474.91	2,582.47	2,392.82	2,365.41	2,388.95	2,279.04	2,420.84	2,452.16	2,174.24	1,085.31	27,666.78
COM22A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.31	331.33	71.59	225.42	644.65
004S/12W-13F002S/COM21	148.35	147.00	139.69	144.67	100.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	680.22
004S012W03A002S/15A	28.87	0.00	0.00	0.00	58.12	122.15	111.19	121.52	112.26	121.25	0.00	0.00	675.36
004S012W06J002S/NLB11	0.00	7.21	34.15	43.29	45.17	47.24	50.49	47.31	51.45	50.64	36.55	0.00	413.50
004S012W08M001S/NLB12	396.66	395.19	371.81	384.31	360.91	383.74	384.57	329.55	379.29	373.32	224.03	0.00	3,983.38
004S012W10H003S/8	0.00	0.00	0.00	20.86	0.00	60.68	19.71	0.00	0.00	0.13	0.00	0.00	101.38
004S012W10H004S/27	210.26	237.56	164.87	254.46	220.29	104.86	147.20	138.92	181.93	147.03	149.29	0.00	1,956.67
004S012W13G001S	18.81	0.00	32.68	9.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.92
004S012W13H001S/COM20	130.29	131.51	121.98	120.10	111.55	112.61	108.46	93.25	97.68	82.59	83.65	14.31	1,207.98
004S012W14A002S/COM10	93.36	92.81	88.37	90.86	88.91	92.58	95.14	86.09	94.81	88.26	92.92	95.53	1,099.64
004S012W14A004S/COM18	0.00	0.00	107.66	119.79	117.48	121.85	123.82	111.05	121.50	111.67	118.32	20.20	1,073.34
004S012W14B002S/COM17	58.29	57.11	53.46	54.18	52.41	55.01	55.46	47.42	54.06	49.70	52.03	9.02	598.15
004S012W14D004S/COM14	233.27	232.94	241.81	252.47	245.46	256.09	256.46	224.34	243.39	233.62	246.18	72.67	2,738.70

Appendix A – Groundwater Extractions (Continued)

2910 - Long Beach, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2,544.76	2,505.87	2,474.91	2,582.47	2,392.82	2,365.41	2,388.95	2,279.04	2,420.84	2,452.16	2,174.24	1,085.31	27,666.78
004S012W15B003S/COM15	116.42	117.51	74.09	0.00	0.00	0.00	0.00	121.94	162.20	157.92	164.87	44.31	959.26
004S012W15N001S/COM25	103.55	102.90	97.02	100.29	95.60	97.13	95.79	82.64	89.10	86.63	91.54	96.59	1,138.78
004S012W16A001S/COM24	133.21	132.27	126.82	132.07	125.71	135.48	135.88	121.21	134.24	132.24	98.52	106.38	1,514.03
004S012W16J003S/CIT09	122.54	123.14	117.93	122.61	118.76	122.55	122.84	105.58	122.13	117.56	121.25	118.29	1,435.18
004S012W16R001S/CIT08	0.72	0.00	0.00	1.86	0.00	0.00	0.31	0.00	0.53	0.00	0.83	0.00	4.25
004S012W17E001S/DEV09	71.11	67.63	63.01	64.81	62.13	65.52	65.43	58.01	64.28	66.76	48.71	0.00	697.40
004S012W20G001S/DEV05	0.98	0.00	0.00	0.00	0.00	0.00	0.06	0.00	1.01	0.08	1.58	0.00	3.71
004S012W20K001S/CIT10	356.52	350.01	337.42	347.99	338.11	346.39	346.04	306.57	187.82	0.00	277.63	63.30	3,257.80
004S012W23C001S/WIL1A	173.61	172.43	164.42	171.21	166.94	173.97	177.21	159.37	175.16	169.16	176.84	161.15	2,041.47
004S012W24M008S/WIS1A	81.04	74.77	76.17	80.24	20.19	0.00	24.96	65.31	66.74	69.02	69.13	9.36	636.93
004S012W28H006S/ALA8	64.95	63.88	61.55	66.97	64.57	67.56	66.53	58.96	62.98	63.25	45.50	48.78	735.48
004S012W28H012S/ALA13	1.95	0.00	0.00	0.00	0.00	0.00	1.40	0.00	1.97	0.00	3.28	0.00	8.60

4345 - Los Angeles County Public Works - Sativa Water System	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.25	0.30	0.18	0.16	0.11	0.14	0.06	0.23	0.07	0.00	0.00	0.00	1.50
003S013W15G001S/3	0.10	0.23	0.13	0.07	0.04	0.09	0.00	0.18	0.05	0.00	0.00	0.00	0.89
003S013W15M005S/5	0.15	0.07	0.05	0.09	0.07	0.05	0.06	0.05	0.02	0.00	0.00	0.00	0.61

2930 - Los Angeles County Rancho Los Amigos	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	19.06	25.78	17.79	17.77	16.57	9.53	10.51	8.03	13.59	10.74	16.55	18.07	183.99
003S012W05P001S/DW002	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
003S012W05P003S/DW001	19.06	25.78	17.79	17.77	16.55	9.53	10.51	8.03	13.59	10.74	16.55	18.07	183.97

Appendix A – Groundwater Extractions (Continued)

2920 – Los Angeles, City of Dept of Water and Power	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	586.19	576.71	558.41	586.47	302.88	572.76	106.06	2.76	1.78	1.62	1.40	1.31	3,298.35
002S014W23H014S	0.21	0.19	0.23	0.50	0.18	0.19	0.28	0.17	0.36	0.21	0.20	0.17	2.89
002S014W23H018S/MH-PW-12	0.20	0.22	0.21	0.22	0.17	0.25	0.42	0.23	0.23	0.25	0.24	0.24	2.88
002S014W23H019S/MH-PW-11	254.64	248.04	238.92	252.18	130.51	246.80	45.30	1.56	0.31	0.24	0.22	0.21	1,418.93
002S014W23H020S/MH-PW-10	0.18	0.22	0.21	0.22	0.20	0.28	0.43	0.23	0.33	0.28	0.25	0.26	3.09
002S014W23H021S/MH-PW-08	330.67	327.88	318.69	333.21	171.71	325.06	59.40	0.27	0.40	0.36	0.36	0.31	1,868.32
None/1391E	0.29	0.16	0.15	0.14	0.11	0.18	0.23	0.30	0.15	0.28	0.13	0.12	2.24

3080 – Lynwood Park Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	11.19	6.61	6.23	5.68	4.80	7.10	5.32	5.49	4.42	1.39	0.28	0.95	59.46
003S013W10R008S/NW25	0.04	0.16	0.11	0.10	0.13	0.08	0.12	0.09	0.10	0.11	0.14	0.16	1.34
003S013W10R009S/SOUTH	11.15	6.35	6.12	5.48	4.57	7.02	4.90	5.40	4.22	1.08	0.04	0.69	57.02
003S013W15H001S/MONA	0.00	0.10	0.00	0.10	0.10	0.00	0.30	0.00	0.10	0.20	0.10	0.10	1.10

3060 – Lynwood, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	323.53	443.53	397.62	390.77	367.05	358.60	348.22	315.31	350.11	350.35	384.58	382.42	4,412.09
003S013W10K001S/19	30.05	186.46	174.72	203.61	224.49	234.15	231.92	204.85	236.91	225.80	231.65	239.73	2,424.34
003S013W11E001S/11	0.00	0.00	47.75	24.20	3.96	0.69	0.00	0.00	0.00	0.06	0.00	0.00	76.66
003S013W12E004S/8	111.43	85.27	75.71	56.31	47.21	40.12	49.00	42.57	40.34	45.53	62.97	62.59	719.05
003S013W12J001S/5	67.39	62.73	37.75	48.84	42.86	45.28	31.72	30.91	36.17	41.44	35.01	38.11	518.21
003S013W13D001S/9	114.66	109.07	61.69	57.81	48.53	38.36	35.58	36.98	36.69	37.52	54.95	41.99	673.83

3170 – Maywood Mutual Water Company No. 1	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	55.49	57.81	55.42	55.45	49.36	50.83	40.61	26.98	45.77	47.83	50.40	51.13	587.08
002S013W24B002S/4	55.49	57.81	55.42	55.45	49.36	50.83	40.61	26.98	45.77	47.83	50.40	51.13	587.08

Appendix A – Groundwater Extractions (Continued)

3180 – Maywood Mutual Water Company No. 2	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	90.20	91.72	72.99	39.72	74.97	74.20	74.16	65.74	71.67	73.83	74.39	83.27	886.86
002S012W18M001S/52ST	41.00	41.49	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.65
002S013W13M002S/MAYAV	49.20	50.23	71.83	39.72	74.97	74.20	74.16	65.74	71.67	73.83	74.39	83.27	803.21

3190 – Maywood Mutual Water Company No. 3	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	123.10	128.69	128.33	120.53	119.18	105.47	103.65	102.08	106.93	115.07	118.20	113.12	1,384.35
002S012W19C003S/7	0.00	0.83	19.05	23.90	27.76	17.36	5.25	0.00	0.00	0.63	17.80	14.89	127.47
002S012W19J003S	44.04	50.09	36.67	24.66	6.46	8.15	14.36	18.26	18.25	27.42	16.40	17.00	281.76
002S012W19M004S/8	79.06	77.77	72.61	71.97	84.96	79.96	84.04	83.82	88.68	87.02	84.00	81.23	975.12

3360 – Montebello Land and Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	273.73	271.64	253.78	255.47	232.47	218.80	207.06	192.38	208.06	217.62	233.72	241.35	2,806.08
002S012W11G001S/14	69.03	33.96	47.29	84.12	57.60	46.37	63.15	48.40	45.71	52.45	48.44	55.97	652.49
002S012W11R004S/11A	20.46	35.76	22.75	22.13	17.75	5.69	4.47	8.92	13.21	8.04	6.25	10.79	176.22
002S012W12E005S/9	40.71	54.35	52.06	46.80	32.39	41.04	44.09	39.47	43.35	42.55	34.63	36.77	508.21
002S012W12E006S/10	37.78	38.15	33.50	36.20	32.92	27.67	26.64	7.98	0.00	0.00	0.00	0.00	240.84
002S012W12E007S/8A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.49	40.70	87.19
002S012W12E008S/12	50.91	59.29	51.06	43.05	47.85	51.64	27.56	50.33	54.39	65.60	51.91	55.01	608.60
002S012W12M002S/7	54.84	50.13	47.12	23.17	43.96	46.39	41.15	37.28	51.40	48.98	46.00	42.11	532.53

3517 – Newark Group, Inc., The	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	12.70	15.47	13.43	13.18	12.89	12.18	16.92	11.91	11.47	13.21	10.43	12.27	156.06
002S012W20E001S/1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.47	13.21	10.43	12.27	47.38
002S012W20M002S/2	12.70	15.47	13.43	13.18	12.89	12.18	16.92	11.91	0.00	0.00	0.00	0.00	108.68

Appendix A – Groundwater Extractions (Continued)

3546 - Northrop Grumman/Omega Chemical (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.37	0.33	0.21	0.29	0.27	0.27	0.35	0.25	0.38	0.00	0.00	0.00	2.72
DPE-9	0.11	0.11	0.07	0.08	0.07	0.08	0.07	0.06	0.09	0.00	0.00	0.00	0.74
DPE-5	0.06	0.05	0.03	0.05	0.05	0.05	0.07	0.04	0.08	0.00	0.00	0.00	0.48
DPE-4	0.09	0.08	0.05	0.07	0.07	0.07	0.08	0.07	0.07	0.00	0.00	0.00	0.65
DPE-3	0.04	0.04	0.03	0.05	0.04	0.04	0.05	0.05	0.05	0.00	0.00	0.00	0.39

3550 - Norwalk, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	102.84	62.53	35.22	34.47	31.52	30.52	28.53	26.83	26.74	28.42	30.15	30.51	468.28
003S011W18K003S/10	66.21	24.91	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	91.13
003S012W13L001S/LEF	1.86	1.58	0.74	0.86	0.43	3.09	4.46	3.30	1.74	1.24	2.08	3.65	25.03
003S012W13Q001S/TAD	34.77	36.04	34.47	33.61	31.09	27.43	24.07	23.53	25.00	27.18	28.07	26.86	352.12

3607 - Omega OU1/OU3 LLC (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.99
DPE-9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.32
DPE-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.27
DPE-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.26
DPE-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.11
002S011W28E001S/EW-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
002S011W28E005S/EW-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03

3640 - Orchard Dale Water District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	190.32	190.94	170.81	158.64	130.41	123.28	111.41	105.46	106.87	126.93	137.28	149.10	1,701.45
002S011W19F001S/8	28.11	26.83	26.72	25.20	31.18	35.52	26.21	24.92	42.68	38.18	41.70	37.54	384.79
002S011W19P002S/10	78.15	80.46	65.68	56.80	28.61	17.49	7.80	1.27	43.76	68.37	11.89	77.03	537.31
002S011W19P003S/11	84.06	83.65	78.41	76.64	70.62	70.27	77.40	79.27	20.43	20.38	83.69	34.53	779.35

Appendix A – Groundwater Extractions (Continued)

3745 – Paradise Memorial Park	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1.29	1.29	1.37	1.37	0.19	0.00	0.01	0.01	0.01	0.01	0.93	0.02	6.50
3S/12W-01K09S/1	1.29	1.29	1.37	1.37	0.19	0.00	0.01	0.01	0.01	0.01	0.93	0.02	6.50

3760 – Paramount Unified School District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.39	0.64	0.50	0.30	0.15	0.13	0.00	0.30	0.01	0.42	0.17	0.09	3.10
3S/12W-33F02S/COKE	0.39	0.64	0.50	0.30	0.15	0.13	0.00	0.30	0.01	0.42	0.17	0.09	3.10

3755 – Paramount, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	224.21	226.71	219.67	228.48	222.84	224.70	230.33	207.87	233.41	227.99	234.81	231.13	2,712.15
003S012W19E005S/15	224.21	226.71	219.67	228.48	222.84	224.70	230.33	207.87	233.41	227.99	234.81	231.13	2,712.15

3853 – Pico Rivera, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	417.68	420.81	380.29	355.97	297.52	278.37	266.07	259.05	267.18	305.85	332.13	335.44	3,916.36
002S012W12A001S/W1	124.98	76.77	62.70	71.57	121.82	106.27	56.22	58.13	88.72	68.71	61.82	96.71	994.42
002S012W12A005S/W2	62.31	111.54	110.86	97.65	17.64	3.57	71.66	83.96	79.89	92.65	80.06	52.82	864.61
002S012W23B004S/W3	5.84	8.81	6.67	5.70	4.54	4.67	3.86	2.78	3.12	3.99	4.89	5.52	60.39
002S012W23B008S/W4	133.26	138.78	127.86	118.92	126.96	141.31	116.01	95.50	70.97	99.89	142.16	155.93	1,467.55
002S012W25G001S/W12	2.85	1.60	2.72	3.22	2.41	1.99	1.44	1.00	1.42	1.17	2.50	6.87	29.19
002S012W25G002S/W11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.37	0.59	1.96
002S012W26D007S/W5	79.02	72.51	56.95	46.08	17.30	14.19	11.84	11.12	19.70	34.14	28.03	3.41	394.29
002S012W26E003S/W6	9.42	10.80	12.53	12.83	6.85	6.37	5.04	6.56	3.36	5.30	11.30	13.59	103.95

Appendix A – Groundwater Extractions (Continued)

3850 - Pico Water District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	249.62	254.88	235.90	228.14	198.87	186.92	186.73	171.57	174.32	191.32	215.53	223.67	2,517.47
002S011W07P002S/10	27.18	33.09	32.62	33.44	23.04	20.83	28.99	36.41	49.04	36.90	37.51	13.27	372.32
002S012W13L005S/8	0.42	0.00	0.00	16.56	14.43	26.45	29.02	64.86	69.39	53.99	59.22	18.69	353.03
002S012W24E007S/5A	14.34	15.04	14.69	16.28	9.92	38.63	60.80	59.63	44.81	36.21	51.52	25.16	387.03
002S012W24F004S/Well 11	207.68	206.75	188.59	161.86	151.48	101.01	67.92	10.67	11.08	64.22	67.28	166.55	1,405.09

4115 - Rockview Dairies, Inc.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	13.47	16.25	14.92	17.13	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
003S012W05C008S/NEW2	13.47	16.25	14.92	17.13	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10

4150 - Roman Catholic Archbishop of Los Angeles	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	12.11	9.45	12.43	9.06	17.76	5.95	8.79	4.74	17.70	9.45	28.84	28.41	164.69
002S012W06K010S/Service Yard #4	12.11	9.45	12.43	9.06	17.76	5.95	8.79	4.74	17.70	9.45	28.84	28.41	164.69

4330 - San Gabriel Valley Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	229.47	226.79	218.01	196.19	209.10	211.09	167.35	174.50	174.30	204.78	224.92	193.41	2,429.91
002S011W19F007S	229.24	226.73	217.92	125.98	208.91	210.28	167.22	174.33	136.26	0.12	0.00	0.00	1,696.99
002S011W19F008S	0.23	0.06	0.09	70.21	0.19	0.81	0.13	0.17	38.04	204.66	224.92	193.41	732.92

4335 - Santa Fe Springs, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	203.29	202.64	195.95	157.02	99.47	102.32	101.93	92.68	104.28	99.07	101.76	59.77	1,520.18
002S011W05N004S/14	56.75	53.21	50.93	52.37	45.44	35.20	32.24	23.31	35.32	27.49	17.73	6.54	436.53
002S011W07C005S/CB-2	66.42	68.75	65.29	67.21	54.03	43.30	6.86	13.32	0.04	18.74	36.64	23.32	463.92
002S011W07D010S/CB-1	80.12	80.68	79.73	37.44	0.00	23.82	62.83	56.05	68.92	52.84	47.39	29.91	619.73

Appendix A – Groundwater Extractions (Continued)

4349 – Scantlebury, Robert P.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.25	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.20	0.50
003S011W07N001S/1	0.00	0.00	0.25	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.20	0.50

4450 – Signal Hill, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	114.02	117.68	90.26	23.45	24.17	30.00	34.67	52.40	64.15	64.62	54.83	52.35	722.60
003S012W31B001S/7	35.02	34.68	29.26	23.45	24.17	30.00	34.67	15.60	54.95	64.62	54.83	52.35	453.60
004S012W20M001S/9	79.00	83.00	61.00	0.00	0.00	0.00	0.00	36.80	9.20	0.00	0.00	0.00	269.00

4590 - South Gate, City	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	763.53	769.42	738.07	645.02	754.35	583.04	642.41	565.54	611.16	644.95	540.77	838.98	8,097.24
002S012W31Q003S/24	177.71	181.40	118.21	126.15	242.63	126.18	146.45	127.75	142.61	133.54	135.11	131.33	1789.07
002S013W34A003S/29	174.89	178.11	182.12	181.89	195.12	186.23	204.43	169.31	192.20	179.04	195.10	196.17	2234.61
002S013W34Q003S/26	3.04	6.35	10.02	0.83	3.68	14.36	0.70	1.18	5.90	10.14	11.14	8.76	76.10
002S013W34R001S/27	139.13	138.05	140.59	101.37	124.92	90.48	101.61	124.63	136.36	124.93	4.38	269.99	1496.44
002S013W35A002S/28	180.44	171.30	180.09	150.66	146.44	141.10	164.25	139.05	131.79	151.65	178.42	205.44	1940.63
003S012W06D001S/13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.17
003S012W06D002S/14	0.00	0.15	0.00	0.27	0.00	0.00	0.19	0.00	0.00	0.27	0.00	0.00	0.88
003S012W06D003S/18	0.00	0.15	0.00	0.37	0.00	0.00	0.18	0.00	0.00	0.11	0.00	0.00	0.81
003S012W06D004S/19	88.32	93.91	107.04	83.48	41.56	24.69	24.60	3.62	2.30	45.10	16.62	27.29	558.53

4540 – South Montebello Irrigation District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	166.47	170.47	156.90	144.57	132.02	124.43	115.24	111.53	112.24	120.30	129.96	134.29	1,618.42
002S012W13D007S/5	26.81	23.77	22.12	24.51	23.53	30.44	25.04	21.45	24.80	37.30	49.24	60.14	369.15
002S012W14B008S/3	29.55	29.73	33.72	18.00	19.73	40.15	31.04	27.67	34.67	51.60	18.93	0.00	334.79
002S012W22G002S/7	110.11	116.97	101.06	102.06	88.76	53.84	59.16	62.41	52.77	31.40	61.79	74.15	914.48

Appendix A – Groundwater Extractions (Continued)

4549 - Southern California Edison Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.77	0.65	0.33	0.32	0.03	0.03	0.04	0.10	0.08	0.21	0.17	0.01	2.74
3S/12W-19G02S/ABILA	0.77	0.65	0.33	0.32	0.03	0.03	0.04	0.10	0.08	0.21	0.17	0.01	2.74

4300 - St John Bosco School	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	7.00	7.45	4.85	1.70	0.56	0.08	0.00	0.00	0.00	0.00	0.00	0.00	21.64
3S/12W-15K03S/15HP	7.00	7.45	4.85	1.70	0.56	0.08	0.00	0.00	0.00	0.00	0.00	0.00	21.64

4810 - Suburban Water Systems	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	89.52	87.80	93.15	98.47	95.92	93.29	100.04	93.78	91.67	90.76	92.72	91.12	1,118.24
003S011W22L003S/409/W3	0.00	0.00	7.02	7.04	7.02	0.13	8.07	9.08	0.03	0.00	0.00	0.00	38.39
003S011W27L001S/410	89.52	87.80	86.13	91.43	88.90	93.16	91.97	84.70	91.64	88.64	88.01	86.81	1068.71
003S013W15G001S/3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	4.71	4.22	11.01
003S013W15M005S/5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.09	0.13

4980 - Tract 180 Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	107.99	111.76	107.50	106.48	97.05	98.10	96.28	88.04	94.98	95.28	97.72	103.52	1,204.70
2S/13W-25H06S/6	55.88	59.89	55.85	55.28	50.63	51.02	49.61	45.08	48.41	48.60	49.54	52.08	621.87
2S/13W-25H08S/5	52.11	51.87	51.65	51.20	46.42	47.08	46.67	42.96	46.57	46.68	48.18	51.44	582.83

4990 - Tract 349 Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	56.08	57.92	53.29	53.51	49.94	48.49	47.58	43.82	47.67	49.73	51.11	49.94	609.08
002S012W31D001S/3	2.52	3.84	0.72	3.32	1.96	0.52	0.47	1.97	0.71	1.17	0.79	0.73	18.72
002S013W25D006S/Well No.4	53.56	54.08	52.57	50.19	47.98	47.97	47.11	41.85	46.96	48.56	50.32	49.21	590.36

5019 - Tucker, William M. & or Robertson, Bobby Ray Jr.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.04	0.02	0.02	0.02	0.04	0.03	0.02	0.02	0.05	0.04	0.03	0.04	0.37
2S/13W-12P04S/BAND2	0.04	0.02	0.02	0.02	0.04	0.03	0.02	0.02	0.05	0.04	0.03	0.04	0.37

Appendix A – Groundwater Extractions (Continued)

5460 – Vernon, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	535.38	552.14	529.87	520.48	460.55	478.24	449.78	373.27	385.25	372.45	421.69	396.32	5,475.42
002S013W10P005S/11	53.29	73.08	73.03	108.51	89.06	88.99	82.69	75.21	69.42	86.32	27.31	81.78	908.69
002S013W10P008S/16	46.08	43.43	40.77	40.24	37.18	36.63	35.85	31.52	30.69	31.33	31.62	27.88	433.22
002S013W11R006S/17	98.01	97.13	81.22	62.45	51.32	28.69	70.46	56.08	46.19	41.15	46.61	48.89	728.20
002S013W13H002S/20	82.40	82.48	79.48	82.42	71.14	68.78	69.03	59.04	68.57	69.96	68.69	67.51	869.50
002S013W14H004S/15	103.28	125.55	118.38	117.92	106.91	118.46	51.13	0.00	0.00	0.00	119.84	127.69	989.16
002S013W14H005S/19	54.55	58.14	53.27	22.28	30.21	59.81	56.76	107.97	98.73	102.94	49.87	9.69	704.22
002S013W15P011S/9	97.77	72.33	83.72	86.66	74.73	76.88	83.86	43.45	71.65	40.75	77.75	32.88	842.43

5490 – Virginia Country Club	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	56.60	60.03	46.81	28.13	18.40	7.42	3.61	11.43	4.07	24.52	23.50	31.33	315.85
004S013W12M006S/TEX1	56.60	60.03	46.81	28.13	18.40	7.42	3.61	11.43	4.07	24.52	23.50	31.33	315.85

5917- WRD, Vernon Site (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.00	0.00	0.00	7.82	0.00	0.00	16.30	0.00	0.00	14.07	38.19
2S/13W-10F99S	0.00	0.00	0.00	0.00	0.00	7.82	0.00	0.00	16.30	0.00	0.00	14.07	38.19

5610 – Walnut Park Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	96.14	96.88	93.19	91.70	82.58	84.42	67.38	68.05	82.41	74.19	83.35	87.39	1,007.68
002S013W27B020S/10	42.27	36.05	40.69	34.39	29.70	25.95	9.72	32.95	27.03	17.49	0.00	0.00	296.24
002S013W27B022S/11	30.72	30.99	35.07	29.41	23.78	31.83	26.41	22.70	24.45	22.70	58.41	44.12	380.59
002S013W27B024S/12	23.15	29.84	17.43	27.90	29.10	26.64	31.25	12.40	30.93	34.00	24.94	43.27	330.85

5670 – Whittier Union High School District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2.69	2.72	3.69	3.29	2.07	1.16	0.17	0.59	1.06	1.62	1.83	2.09	22.98
2S/11W-32J04S/SH550	2.69	2.72	3.69	3.29	2.07	1.16	0.17	0.59	1.06	1.62	1.83	2.09	22.98

Appendix A – Groundwater Extractions (Continued)

5660 – Whittier, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	474.30	438.43	401.75	316.11	264.55	324.15	406.79	409.59	401.58	527.44	646.17	577.15	5,188.01
002S011W05N004S/14	132.41	115.11	104.44	105.43	120.84	111.52	128.69	103.03	122.95	147.71	134.03	63.15	1,389.31
002S011W07C005S	154.95	148.75	133.85	135.31	143.71	137.16	27.32	58.82	0.15	99.40	223.29	225.19	1,487.90
002S011W07D010S	186.94	174.57	163.46	75.37	0.00	75.47	250.78	247.74	278.48	280.33	288.85	288.81	2,310.80

5800 – Yamamoto, George and Alice Acct.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
3S/12W-29J02S/68TH	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07

Attachment 14: Excerpt from Central Basin Watermaster Report – 2021 – 2022
Table 1a – Water Rights Accounting

Table 1a – Water Rights Accounting (acre-feet)

Party	APA 2021-2022 [1]	Net Carryover [2] from 2020-2021	Leases [3]		Storage [4]	Increased Extractions [5]	Total Rights [6]	Assessed Pumping [7]	Storage Withdrawals [8]	Total Pumping [9]	Balance [10]	One-Year Carryover into 2022-2023
			w/ Flex	w/o Flex								
ABC Unified School District	298.00	54.01	-250.00	0.00	0.00		102.01	11.65	0.00	11.65	90.36	28.80
American Textile Maintenance Company	65.00	74.00	0.00	0.00	0.00		139.00	25.17	0.00	25.17	113.83	39.00
Angeles Abbey Memorial Park, Inc.	4.00	20.00	0.00	0.00	0.00		24.00	0.00	0.00	0.00	24.00	20.00
Arco Metals Co.	0.00	34.46	0.00	0.00	0.00		34.46	0.00	0.00	0.00	34.46	10.00
Artesia Cemetery District	12.00	20.00	-12.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Artesia, City	24.00	-15.35	0.00	14.00	0.00		22.65	22.16	0.00	22.16	0.49	0.49
Atlas Iron & Metal [12]	0.00	-2.24	0.00	0.00	0.00		-2.24	0.32	0.00	0.32	-2.56	-2.56
Automobile Club of Southern California	6.00	20.00	0.00	0.00	0.00		26.00	0.00	0.00	0.00	26.00	20.00
Baker Commodities Inc.	60.00	36.00	0.00	0.00	0.00		96.00	0.00	0.00	0.00	96.00	36.00
Baker, Mary	28.00	0.00	-28.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Bell Gardens, City	1,914.00	1,298.28	0.00	0.00	0.00		3,212.28	202.17	0.00	202.17	3,010.11	1,148.40
Bellflower Home Garden Water Company	306.00	20.00	-306.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Bellflower Unified School District	89.00	53.40	0.00	0.00	0.00		142.40	0.00	0.00	0.00	142.40	53.40
Bellflower, City	1,380.00	901.82	-680.00	0.00	0.00		1,601.82	678.39	0.00	678.39	923.43	420.00
Bellflower-Somerset Mutual Water Company	4,412.88	2,000.13	680.00	0.00	1,000.00		8,093.01	4,885.27	0.00	4,885.27	3,207.74	2,055.73
Boy Scouts of America [12]	1.00	-9.80	0.00	0.00	0.00		-8.80	0.00	0.00	0.00	-8.80	-8.80
Buell, Mary	1.00	0.00	-1.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
California American Water Company	2,175.00	1,340.00	0.00	0.00	0.00		3,515.00	2,039.70	0.00	2,039.70	1,475.30	1,305.00
California Domestic Water Company	87.00	20.00	-87.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
California Water Service Company (East LA)	11,774.00	8,206.68	-1,250.00	0.00	0.00		18,730.68	10,275.36	0.00	10,275.36	8,455.32	5,417.56
California Water Service Company (Dominguez)	6,480.00	3,138.00	-1,250.00	0.00	0.00		8,368.00	1,320.42	0.00	1,320.42	7,047.58	3,138.00
California, State of (Caltrans) [12]	50.00	-24,500.01	0.00	0.00	0.00		-24,450.01	4.18	0.00	4.18	-24,454.19	-24,454.19
Central Basin MWD	4.65	17.20	0.00	0.00	0.00		21.85	0.00	0.00	0.00	21.85	20.00
Cerritos Community College District	147.00	88.20	0.00	0.00	0.00		235.20	0.00	0.00	0.00	235.20	88.20
Cerritos, City [11]	4,680.03	1,678.69	774.50	3,500.00	2,630.00		13,263.22	7,675.23	0.00	7,675.23	5,587.99	1,090.91
Chang I-Hsin and Associates	1.00	23.84	0.00	0.00	0.00		24.84	0.00	0.00	0.00	24.84	20.00
Coast Packing Company	530.00	352.21	0.00	0.00	0.00		882.21	152.53	0.00	152.53	729.68	318.00
Commerce, City	5,081.00	3,926.95	-3,000.00	0.00	0.00		6,007.95	528.95	0.00	528.95	5,479.00	1,248.60
Compton Unified School District	38.00	57.80	0.00	0.00	0.00		95.80	0.00	0.00	0.00	95.80	22.80
Compton, City	5,780.00	524.72	0.00	900.00	0.00		7,204.72	7,145.08	0.00	7,145.08	59.64	0.00
Corning Trust	3.75	3.75	-3.75	0.00	0.00		3.75	0.00	0.00	0.00	3.75	3.75
Crandell F.J.	1.00	21.75	0.00	0.00	0.00		22.75	0.00	0.00	0.00	22.75	20.00
Darling-Delaware Company	117.00	111.15	0.00	0.00	0.00		228.15	0.00	0.00	0.00	228.15	70.20
Dolan, J.E. P.A. & T.P.	2.00	6.00	0.00	0.00	0.00		8.00	0.00	0.00	0.00	8.00	8.00
Downey, City [11]	16,553.62	6,842.23	0.00	-2,000.00	4,000.00		25,395.85	12,455.78	2,000.00	14,455.78	10,940.07	7,932.17
EcoGas, Inc.	2.00	2.00	0.00	0.00	0.00		4.00	0.00	0.00	0.00	4.00	4.00
El Rancho Unified School District	55.00	63.49	0.00	0.00	0.00		118.49	0.00	0.00	0.00	118.49	33.00
Emoto, John H	2.00	22.00	0.00	0.00	0.00		24.00	0.00	0.00	0.00	24.00	20.00
Equilon Enterprises	6.00	26.00	0.00	0.00	0.00		32.00	0.00	0.00	0.00	32.00	20.00
Exide Technologies	62.00	72.20	0.00	0.00	0.00		134.20	0.00	0.00	0.00	134.20	37.20

Party	APA 2021-2022 [1]	Net Carryover [2] from 2020-2021	Leases [3] w/ Flex	Leases [3] w/o Flex	Storage [4]	Increased Extractions [5]	Total Rights [6]	Assessed Pumping [7]	Storage Withdrawals [8]	Total Pumping [9]	Balance [10]	One-Year Carryover into 2022-2023
Flesch, Elizabeth Et Al	14.00	34.00	0.00	0.00	0.00		48.00	0.00	0.00	0.00	48.00	20.00
Footbridge 1 Trust	3.75	20.00	-3.75	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Ford Motor Company	4.50	24.50	0.00	0.00	0.00		29.00	0.00	0.00	0.00	29.00	20.00
Forestar USA	0.00	20.00	0.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Furr, Nancy[12]	0.00	-0.32	0.00	0.00	0.00		-0.32	0.08	0.00	0.08	-0.40	-0.40
Golden State Water Company	16,439.20	9,902.09	1,840.00	0.00	0.00	1,190.00	29,371.29	18,387.49	0.00	18,387.49	10,983.80	10,936.59
Gordon, Robert E.	4.00	24.80	0.00	0.00	0.00		28.80	0.00	0.00	0.00	28.80	20.00
Harada Brothers	6.00	26.00	0.00	0.00	0.00		32.00	0.00	0.00	0.00	32.00	20.00
Hathaway, Loline	4.08	20.00	0.00	0.00	0.00		24.08	0.00	0.00	0.00	24.08	20.00
Hathaway, Merrie F	1.86	20.00	0.00	0.00	0.00		21.86	0.00	0.00	0.00	21.86	20.00
Hathaway, Richard F, Jr.	4.07	16.28	-4.07	0.00	0.00		16.28	0.00	0.00	0.00	16.28	16.28
Hathaway, William A	4.07	20.00	0.00	0.00	0.00		24.07	0.00	0.00	0.00	24.07	20.00
Hoke, Barbara	1.50	0.00	-1.50	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Huntington Park, City	3,853.00	2,993.63	0.00	0.00	0.00		6,846.63	2,941.75	0.00	2,941.75	3,904.88	2,311.80
Inglewood Park Cemetery	317.00	55.00	-317.00	0.00	0.00		55.00	0.00	0.00	0.00	55.00	20.00
Julee M. Metz, Jon Schwartz & Darrin Margulies Trust	3.00	3.00	-3.00	0.00	0.00		3.00	0.00	0.00	0.00	3.00	3.00
LA Brickyard	9.00	29.75	0.00	0.00	0.00		38.75	0.00	0.00	0.00	38.75	20.00
La Habra Heights County Water District	2,666.00	1,438.27	404.07	0.00	0.00		4,508.34	2,910.42	0.00	2,910.42	1,597.92	1,597.92
Lakewood, City of Water Department [11]	9,432.00	1,500.00	-1,840.00	-500.00	5,620.51		14,212.51	6,148.37	904.51	7,052.88	7,159.63	943.63
Liberty Utilities Corporation	1,159.30	2,469.18	2,677.00	0.00	0.00		6,305.48	4,731.79	0.00	4,731.79	1,573.69	1,573.69
Lincoln Memorial Park	34.00	80.64	0.00	0.00	0.00		114.64	10.63	0.00	10.63	104.01	20.40
Little Lake Cemetery District	14.00	33.22	0.00	0.00	0.00		47.22	4.73	0.00	4.73	42.49	20.00
Long Beach, City [11]	32,692.00	4.29	0.00	0.00	26,254.11		58,950.40	19,874.42	6,538.40	26,412.82	32,537.58	6,538.40
Los Angeles County Rancho Los Amigos	490.00	438.36	0.00	0.00	0.00		928.36	224.26	0.00	224.26	704.10	294.00
Los Angeles, City of Dept of Water & Power	17,236.00	8,697.20	0.00	0.00	22,943.00		48,876.20	4,561.71	0.00	4,561.71	44,314.49	3,447.20
Lunday-Thagard Oil Company	212.00	35.46	-130.00	0.00	0.00		117.46	69.24	0.00	69.24	48.22	39.91
Lussman, Paul H. Jr., Et Al	7.00	26.76	0.00	0.00	0.00		33.76	0.00	0.00	0.00	33.76	20.00
Lynwood Park Mutual Water Company	222.00	133.20	0.00	0.00	0.00		355.20	83.19	0.00	83.19	272.01	133.20
Lynwood, City	5,337.00	3,233.81	0.00	0.00	0.00		8,570.81	4,427.27	0.00	4,427.27	4,143.54	3,202.20
Maywood Mutual No. 1	741.00	454.26	0.00	0.00	0.00		1,195.26	632.48	0.00	632.48	562.78	444.60
Maywood Mutual No. 2	912.00	686.55	0.00	0.00	0.00		1,598.55	1,069.69	0.00	1,069.69	528.86	509.51
Maywood Mutual No. 3	1,407.00	516.88	0.00	0.00	100.00		2,023.88	1,416.66	0.00	1,416.66	607.22	434.58
Mitsuuchi, Mary F Trust	11.00	20.00	0.00	0.00	0.00		31.00	0.00	0.00	0.00	31.00	20.00
Montebello Land and Water Company	1,829.00	1,035.31	901.00	285.00	0.00		4,050.31	2,984.30	0.00	2,984.30	1,066.01	818.73
Montebello, City	386.50	223.80	-386.50	0.00	0.00		223.80	0.00	0.00	0.00	223.80	20.00
Nancy Dee Keane Living Trust	4.00	4.00	-4.00	0.00	0.00		4.00	0.00	0.00	0.00	4.00	4.00
New England Mu. Life Insurance Company	2.00	22.00	0.00	0.00	0.00		24.00	0.00	0.00	0.00	24.00	20.00
Newark Group, Inc.[12]	157.00	0.61	0.00	0.00	0.00		157.61	161.49	0.00	161.49	-3.88	-3.88
Northrop Grumman/Omega Chemical	4.50	40.00	0.00	0.00	0.00		44.50	0.00	0.00	0.00	44.50	20.00
Norwalk, City	2,273.00	1,525.66	0.00	0.00	0.00		3,798.66	908.69	0.00	908.69	2,889.97	1,363.80
Norwalk-La Mirada U.S.D	378.00	324.10	0.00	0.00	0.00		702.10	0.00	0.00	0.00	702.10	226.80
O N K Farms	8.00	28.00	0.00	0.00	0.00		36.00	0.00	0.00	0.00	36.00	20.00
Oltmans Construction Company	3.00	23.00	0.00	0.00	0.00		26.00	0.00	0.00	0.00	26.00	20.00

Table 1a– Water Rights Accounting (Continued)

Party	APA 2021-2022 [1]	Net Carryover [2] from 2020-2021	Leases [3] w/ Flex	Leases [3] w/o Flex	Storage [4]	Increased Extractions [5]	Total Rights [6]	Assessed Pumping [7]	Storage Withdrawals [8]	Total Pumping [9]	Balance [10]	One-Year Carryover into 2022-2023
Omega OU2, LLC	7.97	0.00	0.00	0.00	0.00		7.97	0.00	0.00	0.00	7.97	7.97
Orchard Dale Water District	1,254.00	492.63	400.00	500.00	0.00		2,646.63	1,945.04	0.00	1,945.04	701.59	632.07
OU2 Environmental Remediation Trust	0.00	32.95	0.00	0.00	0.00		32.95	0.00	0.00	0.00	32.95	20.00
PABCO Building Products, LLC	500.00	0.95	-500.00	0.00	0.00		0.95	0.00	0.00	0.00	0.95	0.95
Paradise Memorial Park	16.00	20.95	0.00	0.00	0.00		36.95	9.76	0.00	9.76	27.19	20.00
Paramount Unified School District	46.00	27.60	0.00	0.00	0.00		73.60	18.29	0.00	18.29	55.31	27.60
Paramount, City	5,883.00	4,820.38	0.00	-14.00	0.00		10,689.38	2,705.61	0.00	2,705.61	7,983.77	3,529.80
Patrician Associates Inc/Majestic Realty Co.	12.00	32.00	0.00	0.00	0.00		44.00	0.00	0.00	0.00	44.00	20.00
Petersburg, LP	1.00	7.00	0.00	0.00	0.00		8.00	0.00	0.00	0.00	8.00	8.00
Pico Boys Baseball	13.00	20.00	0.00	0.00	0.00		33.00	0.00	0.00	0.00	33.00	20.00
Pico Rivera, City	5,579.00	1,223.19	-1,800.00	0.00	0.00		5,002.19	4,435.93	0.00	4,435.93	566.26	0.00
Pico Water District	3,624.00	2,186.63	0.00	-600.00	0.00		5,210.63	2,743.00	0.00	2,743.00	2,467.63	2,174.40
Puente Basin Water Agency	965.00	706.75	0.00	-500.00	0.00		1,171.75	0.00	0.00	0.00	1,171.75	579.00
Rippy, Francine	4.07	20.00	0.00	0.00	0.00		24.07	0.00	0.00	0.00	24.07	20.00
Rockview Dairies	101.00	27.96	10.00	50.00	0.00		188.96	165.26	0.00	165.26	23.70	23.70
Roman Catholic Archbishop	347.00	298.81	0.00	0.00	0.00		645.81	344.20	0.00	344.20	301.61	208.20
Rosales, Elvira C	3.00	25.00	0.00	0.00	0.00		28.00	0.00	0.00	0.00	28.00	20.00
Rosing, Nancy	1.50	0.00	-1.50	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Rowland Water District	1.00	5.17	0.00	0.00	0.00		6.17	0.00	0.00	0.00	6.17	6.17
San Gabriel Valley Water Company [11]	2,569.42	0.00	386.50	0.00	3,331.49		6,287.41	2,560.93	0.00	2,560.93	3,726.48	394.99
Santa Fe Springs, City	4,035.78	3,704.49	0.00	0.00	0.00		7,740.27	2,376.88	0.00	2,376.88	5,363.39	2,421.47
Sativa Water District- LA County Public Works	474.00	446.99	-254.00	0.00	0.00		666.99	2.57	0.00	2.57	664.42	132.00
Scantlebury, Robert P.	4.00	41.49	0.00	0.00	0.00		45.49	0.76	0.00	0.76	44.73	20.00
September Properties LLC[12]	0.00	-0.21	0.00	0.00	0.00		-0.21	0.00	0.00	0.00	-0.21	-0.21
Signal Hill, City	2,022.00	1,920.90	0.00	0.00	0.00		3,942.90	991.04	0.00	991.04	2,951.86	1,213.20
Simmons Survivors Trust	33.00	20.00	0.00	0.00	0.00		53.00	0.00	0.00	0.00	53.00	20.00
South Gate, City[11]	11,183.00	1,082.26	0.00	-1,950.00	4,500.00		14,815.26	8,159.46	0.00	8,159.46	6,655.80	1,708.59
South Montebello Irrigation District	1,268.00	23.21	0.00	500.00	0.00		1,791.21	1,779.24	0.00	1,779.24	11.97	11.97
Southern California Edison Company	670.00	636.50	0.00	0.00	0.00		1,306.50	6.75	0.00	6.75	1,299.75	402.00
St John Bosco School	42.00	33.25	0.00	0.00	0.00		75.25	43.67	0.00	43.67	31.58	18.91
Statewide Stations, Inc.	1.00	35.00	0.00	0.00	0.00		36.00	0.00	0.00	0.00	36.00	20.00
Suburban Water Systems	3,721.00	1,440.93	-1,900.00	-985.00	0.00		2,276.93	1,150.79	0.00	1,150.79	1,126.14	1,091.14
Taurek, Mary	0.00	1.00	0.00	0.00	0.00		1.00	0.00	0.00	0.00	1.00	0.00
Tesoro Refining & Marketing Company LLC	54.00	67.40	0.00	0.00	0.00		121.40	0.00	0.00	0.00	121.40	32.40
Tract 180 Water Company	2,137.00	870.71	-450.00	0.00	0.00		2,557.71	1,285.21	0.00	1,285.21	1,272.50	1,012.20
Tract 349 Mutual Water Company	423.00	128.59	200.00	0.00	0.00		751.59	659.43	0.00	659.43	92.16	86.88
Tucker, William M. & or Robertson, Bobby Ray Jr.	1.00	1.93	0.00	0.00	0.00		2.93	0.46	0.00	0.46	2.47	2.47
Vangrootheest, Ernest A	10.00	20.00	-10.00	0.00	0.00		20.00	0.00	0.00	0.00	20.00	20.00
Vernon, City	7,539.00	5,044.57	0.00	0.00	0.00		12,583.57	6,512.94	0.00	6,512.94	6,070.63	4,523.40
Virginia Country Club[12]	274.00	3.87	0.00	100.00	0.00		377.87	383.28	0.00	383.28	-5.41	-5.41

Party	APA 2021-2022 [1]	Net Carryover [2] from 2020-2021	Leases [3]		Storage [4]	Increased Extractions [5]	Total Rights [6]	Assessed Pumping [7]	Storage Withdrawals [8]	Total Pumping [9]	Balance [10]	One-Year Carryover into 2022-2023
			w/ Flex	w/o Flex								
Walnut Park Mutual Water Company	1,009.00	456.44	250.00	0.00	1,077.91		2,793.35	1,065.10	0.00	1,065.10	1,728.25	251.80
WEMS, Inc.	8.00	28.00	0.00	0.00	0.00		36.00	0.00	0.00	0.00	36.00	20.00
Whittier Union High School District	100.00	34.12	-50.00	0.00	50.00		134.12	32.26	0.00	32.26	101.86	10.00
Whittier, City	895.00	1,990.73	6,000.00	700.00	0.00		9,585.73	5,876.98	0.00	5,876.98	3,708.75	3,708.75
Wolfsberger, Helen and Chris Joseph	2.00	22.00	0.00	0.00	0.00		24.00	0.00	0.00	0.00	24.00	20.00
Yamamoto, Alice and George	14.00	33.82	0.00	0.00	0.00		47.82	0.97	0.00	0.97	46.85	20.00
TOTAL	**217,367.00**	**70,788.81**	**0.00**	**0.00**	**71,507.02**	**1,190.00**	**360,852.83**	**164,226.83**	**9,442.91**	**173,669.74**	**187,183.09**	**59,954.03**

[1] APA – Allowed Pumping Allocation

[2] Net Carryover = Drought Carryover + One-year Carryover from the previous year (AY 2020-21) less the amount of carryover conversion for the current year (AY 2021-22).

See Table 1b for Drought Carryover totals.

See Table 3 for carryover conversion (water put into storage) per party for AY 2021-22.

[3] See Table 10 for information concerning leases. Lease with flex include carryover provisions.

[4] Storage includes storage carryover conversions for AY 2021-22. See Table 2 for a summary of all Storage Accounting per party for AY 2021-22.

[5] Increased Extraction: Section IV(K) of the Central Basin Judgment permits increased extraction rights through use of up to 5,000 af of certain parties' West Basin Rights in the Central Basin

The parties include City of Los Angeles, Golden State Water Company, and California Water Service Company.

[6] Total Rights = Allowed Pumping Allocation + Net Carryover + Leases + Storage + Increased Extractions, but does not necessarily equal Annual Extraction Limit (see page 5, section D).

[7] Assessed Pumping does not include storage withdrawals.

[8] Storage Withdrawals include all withdrawals from a Party's Individual Storage Accounts and Community Storage Accounts, which totaled 9,442.91 af for AY 2021-22. See Table 4 for storage withdrawal amounts per party.

[9] Total Pumping = Assessed Pumping + Storage Withdrawals

[10] Balance = Total Rights - Total Pumping

[11] Completed carryover conversion into storage. 2020-2021 net carryover:

Cerritos, City of: 500 AF; Downey, City of: 2,000 AF; Lakewood, City of: 4,670.73 AF

Long Beach, City of: 6,538.40 AF; San Gabriel Valley Water Company: 333.07 AF; South Gate, City of: 4,000 AF

[12] Negative One-Year Carryover will be deducted from the subsequent year's APA.

Attachment 15: Excerpt from Central Basin Watermaster Report – 2021 – 2022 Appendix A (Groundwater Extractions)

Appendix A

Groundwater Extractions

July 2021 – June 2022

(includes storage extractions)

Appendix A – Groundwater Extractions (acre-feet)

0020 – ABC Unified School District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2.16	4.10	0.50	0.00	0.00	0.09	2.01	0.18	0.00	0.82	0.00	1.79	11.65
4S/11W-07R03S/MESCH	2.16	4.10	0.50	0.00	0.00	0.09	2.01	0.18	0.00	0.82	0.00	1.79	11.65

0107- American Textile Maintenance Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.00	0.00	0.00	0.00	3.23	4.21	4.85	7.25	1.13	4.50	25.17
004S012W08N002S/	0.00	0.00	0.00	0.00	0.00	0.00	3.23	4.21	4.85	7.25	1.13	4.50	25.17

0160 – Artesia, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2.56	3.36	2.91	1.52	0.48	0.19	1.22	1.17	1.86	2.00	2.93	1.96	22.16
3S/11W-31N02S/1	2.56	3.36	2.91	1.52	0.48	0.19	1.22	1.17	1.86	2.00	2.93	1.96	22.16

0225- Atlas Iron & Metal Co	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.0	0.0	0.08	0.0	0.0	0.08	0.0	0.0	0.08	0.0	0.0	0.08	0.32
002S013W34Q002S/1	0.0	0.0	0.08	0.0	0.0	0.08	0.0	0.0	0.08	0.0	0.0	0.08	0.32

0387 – Bell Gardens, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	95.05	89.99	17.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	202.17
2S/12W-28M02S/1	95.05	89.99	17.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	202.17

0410 – Bellflower, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	57.93	65.75	61.02	56.37	50.83	42.17	46.04	49.64	57.46	53.57	61.09	76.52	678.39
3S/12W-27B02S/1	57.93	65.75	61.02	56.37	50.83	42.17	46.04	49.64	57.46	53.57	61.09	76.52	678.39

Appendix A – Groundwater Extractions Continued

0445 – Bellflower-Somerset Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	481.11	467.62	442.83	419.89	416.34	348.30	388.89	287.47	401.23	392.42	436.72	402.45	4,885.27
003S012W22M002S/884	0.00	0.00	10.34	39.92	37.59	28.69	30.27	28.79	18.22	21.63	24.09	25.83	265.37
003S012W23E004S/2587	67.92	61.90	58.29	58.48	59.53	55.30	39.98	54.50	60.40	55.31	61.02	58.23	690.86
003S012W26C002S/944	72.43	82.17	57.28	29.60	27.11	5.54	13.69	10.34	30.63	29.25	28.70	33.83	420.57
003S012W27B0025/1	240.24	233.71	219.31	197.86	231.23	183.14	231.86	111.67	200.86	186.48	215.29	184.18	2,435.83
003S012W27R001S/955	62.99	62.35	59.90	62.77	60.88	59.24	37.27	53.90	49.51	60.51	64.93	60.37	694.62
003S012W22M002S/884	37.53	27.49	37.71	31.26	0.00	16.39	35.82	28.27	41.61	39.24	42.69	40.01	378.02

0495 – Boeing Company (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	13.40	0.00	0.00	6.45	0.00	0.00	6.43	0.00	0.00	8.21	34.49
4S/12W-99B99S/	0.00	0.00	13.40	0.00	0.00	6.45	0.00	0.00	6.43	0.00	0.00	8.21	34.49

0679 – California American Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	137.15	163.28	207.60	162.80	158.71	201.58	166.32	161.56	200.47	157.80	157.31	165.12	2,039.70
002S014W10Q002S/CREN	96.23	74.89	92.82	72.37	69.94	89.19	70.17	69.52	86.11	66.84	65.97	51.95	906.00
002S014W14C006S/VERN3	40.92	88.39	114.78	90.43	88.77	112.39	96.15	92.04	114.36	90.96	91.34	113.17	1,133.70

0742 – California Water Service Company (Dominguez)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	128.18	127.61	120.52	114.39	115.36	116.12	122.50	111.21	87.20	92.90	94.71	89.72	1,320.42
003S013W35F001S/290-01	86.56	86.00	80.55	78.71	75.96	77.61	79.69	73.63	76.35	75.41	77.12	74.51	942.10
003S013W35H002S/297-01	41.62	41.61	39.97	35.68	39.40	38.51	42.81	37.58	10.85	17.49	17.59	15.21	378.32

Appendix A – Groundwater Extractions Continued

0740 – California Water Service Company (East LA)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	797.30	729.20	760.76	911.60	870.52	802.81	961.20	945.52	982.50	947.34	799.20	767.41	10,275.36
002S012W04C001S/25-01	29.00	30.30	33.90	28.30	33.71	34.25	34.40	30.39	35.13	34.01	34.80	34.06	392.25
002S012W07G002S/39-02	84.13	107.10	104.60	107.00	104.97	106.44	111.22	86.58	92.37	103.49	82.50	102.75	1,193.15
002S012W07H001S/22-01	28.20	26.10	25.10	24.00	23.41	24.23	25.42	19.57	11.99	5.27	0.00	12.00	225.29
002S012W07Q004S/10-03	72.11	71.00	68.30	69.50	67.41	26.91	71.00	59.58	70.08	66.71	66.71	66.71	776.02
002S012W08F001S/43-01	48.90	48.70	58.00	59.10	45.85	46.92	47.79	40.33	46.95	45.23	47.37	45.46	580.60
002S012W08P001S/54-01	0.86	55.80	61.20	62.90	58.88	61.28	63.41	53.60	62.56	60.26	63.32	60.52	664.59
002S012W09Q001S/62-01	209.20	154.10	235.71	250.50	235.32	231.42	229.39	196.76	243.47	235.17	47.66	0.00	2,268.70
002S012W09Q002S/62-02	282.20	193.20	132.75	267.80	259.42	254.08	230.72	195.95	114.24	106.89	153.07	150.39	2,340.71
002S012W14M001S/63-01	0.00	0.00	0.00	0.00	0.00	0.00	135.91	227.38	264.17	251.08	268.97	255.24	1,402.75
002S012W17D002S/13-02	42.70	42.90	41.20	42.50	41.55	17.28	11.94	35.38	41.54	39.23	34.80	40.28	431.30

0690 – California, State of (Caltrans)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1.43	0.22	0.22	0.13	0.15	0.24	0.38	0.35	0.25	0.44	0.17	0.20	4.18
003S012W17E003S/1D3	0.93	0.03	0.03	0.01	0.03	0.01	0.02	0.01	0.06	0.02	0.03	0.05	1.23
003S012W17E004S/1D4	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.14	0.04	0.01	0.02	0.02	0.39
003S012W17E005S/1D5	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.14
003S012W17E007S/1D7	0.05	0.04	0.01	0.02	0.01	0.01	0.04	0.07	0.03	0.04	0.01	0.05	0.38
003S012W17E008S/1D6A	0.12	0.02	0.05	0.06	0.01	0.00	0.25	0.03	0.05	0.32	0.03	0.05	0.99
003S012W17F002S/1D8	0.11	0.01	0.01	0.00	0.01	0.01	0.00	0.09	0.05	0.01	0.03	0.01	0.34
003S012W17F003S/1D9	0.02	0.01	0.06	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.14
003S012W17F004S/1D10	0.06	0.02	0.02	0.01	0.02	0.03	0.03	0.01	0.02	0.04	0.05	0.02	0.33
003S012W17F005S/1D11	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
003S012W17F006S/1D12	0.10	0.05	0.02	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.20

Appendix A – Groundwater Extractions Continued

0826 - Cerritos, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	768.76	787.21	724.10	661.40	633.24	513.05	487.44	549.01	630.70	618.26	655.20	646.86	7,675.23
003S011W28G005S/C-2	327.18	344.97	299.46	224.57	54.70	279.79	265.42	342.54	410.30	401.98	425.22	427.24	3,803.37
003S011W29N006S/C-1	228.15	226.82	214.90	227.02	216.99	233.26	222.02	206.47	220.40	216.28	229.98	219.62	2,661.91
003S012W26J003S/C-4	213.43	215.42	209.74	209.81	361.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,209.95

0970 - Coast Packing Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	14.12	12.71	12.13	12.27	12.76	13.67	12.79	10.77	13.27	13.70	12.73	11.61	152.53
002S013W11P003S/1	14.12	12.71	12.13	12.27	12.76	13.67	12.79	10.77	13.27	13.70	12.73	11.61	152.53

1017 - Commerce, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	27.31	50.50	49.68	52.28	52.68	53.45	45.40	49.82	47.86	50.17	49.80	528.95
002S012W21G003S/4	0.00	27.31	50.50	49.68	0.00	52.68	53.45	45.40	49.82	47.86	50.17	49.80	476.67
002S012W21R002S/7	0.00	0.00	0.00	0.00	52.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.28

1020 - Compton, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	697.43	684.89	643.17	625.80	566.68	498.42	529.43	524.17	570.23	586.11	610.62	608.13	7,145.08
003S013W11M003S/17	97.13	84.75	85.06	60.43	29.70	23.42	46.71	72.74	45.76	31.21	99.60	95.11	771.62
003S013W14F001S/18	92.35	146.41	85.13	80.22	90.00	129.96	162.67	172.50	107.02	176.51	203.75	207.27	1,653.79
003S013W14K003S/19	220.98	171.78	210.31	198.77	215.66	156.41	132.84	99.62	173.82	114.83	110.35	163.45	1,968.82
003S013W26C001S/13	134.76	134.09	127.33	126.61	95.31	62.54	106.64	121.22	123.48	129.03	132.50	86.29	1,379.80
003S013W27E002S/11	65.47	68.93	64.83	66.54	64.55	65.98	62.97	58.09	61.43	57.56	57.49	56.01	749.85
003S013W27G001S/15	86.74	78.93	70.51	93.23	71.46	60.11	17.60	0.00	58.72	76.97	6.93	0.00	621.20

1255 - Defense Logistic Agency Energy (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	1.26	0.00	0.00	1.41	0.00	0.00	1.05	0.00	0.00	0.23	3.95
003S011W99A099S/REMED	0.00	0.00	1.26	0.00	0.00	1.41	0.00	0.00	1.05	0.00	0.00	0.23	3.95

Appendix A – Groundwater Extractions Continued

1333 - Demenno/Kerdoon (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.78	0.00	0.00	0.68	0.00	0.00	0.59	0.00	0.00	0.64	2.69
003S013W14E001S/MW-5A	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.08
003S013W14M002S/RW-3	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.03	0.11
003S013W14M003S/RW-6	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.00	0.01	0.05
003S013W15H003S/RW-7	0.00	0.00	0.28	0.00	0.00	0.29	0.00	0.00	0.22	0.00	0.00	0.30	1.39
003S013W15H004S/RW-8	0.00	0.00	0.04	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.03	0.13
003S013W15H005S/RW-10	0.00	0.00	0.36	0.00	0.00	0.26	0.00	0.00	0.21	0.00	0.00	0.22	1.05
003S013W15H007S/RW-9	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
003S013W15J001S/RW-1	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.08
003S013W15J002S/RW-5	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.05

1450 - Downey, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1,497.24	1,317.73	1,354.38	1,234.28	1,123.71	993.47	1,045.82	1,033.24	1,183.82	1,121.88	1,303.40	1,246.81	14,455.78
002S012W27H001S/2	136.35	119.75	124.29	124.65	115.93	103.17	103.35	112.72	122.40	100.05	118.38	117.81	1,398.85
002S012W27R002S/4	0.00	0.00	5.27	1.78	0.00	0.00	299.80	338.14	199.66	342.86	375.65	89.42	1,652.58
002S012W28J006S/7	57.66	52.52	79.70	78.31	74.57	80.56	47.56	31.28	33.12	32.16	35.97	33.01	636.42
002S012W28Q001S/8	90.52	87.06	84.23	131.08	123.47	125.31	118.35	97.25	105.91	48.29	46.70	43.97	1,102.14
002S012W33M001S/17	102.05	90.95	96.60	75.68	12.25	10.26	16.04	14.40	23.04	80.88	102.40	81.47	706.02
002S012W35D004S/5	75.62	71.51	68.78	51.80	41.61	68.30	26.57	18.72	48.87	69.45	69.75	60.06	671.04
002S012W35P001S/10	115.98	64.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	180.33
003S012W02H004S/12	186.55	162.66	173.52	173.88	163.61	150.87	121.27	123.55	161.27	173.98	196.84	195.56	1,983.56
003S012W02L001S/15	61.38	51.88	33.26	27.63	6.80	7.76	8.89	5.26	19.66	40.49	46.39	41.46	350.86
003S012W03F001S/11	377.05	324.71	281.14	263.56	287.51	258.30	74.25	0.00	157.07	0.00	0.00	250.46	2,274.05
003S012W03J001S/16	30.16	45.72	90.23	48.72	72.86	50.08	75.91	106.01	113.27	73.51	98.53	105.56	910.56
003S012W03M001S/19	48.62	51.68	69.88	68.27	66.64	54.95	9.65	16.51	23.11	13.71	35.44	52.38	510.84
003S012W04D002S/18	27.35	25.83	16.62	9.65	22.56	8.45	30.84	35.71	35.23	25.58	31.39	26.66	295.87

Appendix A – Groundwater Extractions Continued

1450 - Downey, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1,497.24	1,317.73	1,354.38	1,234.28	1,123.71	993.47	1,045.82	1,033.24	1,183.82	1,121.88	1,303.40	1,246.81	14,455.78
003S012W04Q002S/23	89.92	76.31	95.76	76.11	45.09	33.75	38.44	62.43	70.79	65.01	73.62	76.72	803.95
003S012W09B001S/25	71.46	58.86	51.10	40.52	69.31	22.92	55.05	53.07	50.77	34.79	50.28	44.35	602.48
003S012W09G001S/29	26.57	33.94	84.00	62.64	21.50	18.79	19.85	18.19	19.65	21.12	22.06	27.92	376.23

1745 - Furr, Nancy J.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.08
3S/12W-21G05S/1	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.08

1843 - Golden State Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1,658.42	1,840.50	1,635.35	1,529.91	1,489.09	1,495.37	1,288.39	1,178.71	1,439.90	1,502.09	1,690.00	1,639.76	18,387.49
002S012W28N005S/Clara #2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.06	0.00	0.00	0.30
002S012W29A004S/GAGE2	57.09	86.86	83.98	89.02	85.54	88.71	87.92	78.88	82.17	85.84	88.17	84.70	998.88
002S012W30G003S/WATSON1	37.53	34.56	34.86	64.00	61.85	58.91	59.23	72.72	86.29	60.90	67.50	67.75	706.10
002S013W21E001S/G0004	70.85	90.20	37.05	93.47	89.66	90.01	90.99	82.07	26.65	15.04	93.33	89.65	868.97
002S013W21K004S/CONVERSE1	8.06	33.45	26.71	26.52	21.16	19.35	22.05	23.82	39.16	39.79	19.63	23.05	302.75
002S013W21K007S/CONVERSE2	18.12	70.53	68.65	60.09	69.76	70.88	72.14	64.73	72.28	68.74	72.69	70.02	778.63
002S013W23J003S/Bissel 2	0.00	0.26	7.18	72.57	64.60	62.79	67.59	62.94	64.94	71.00	28.76	33.23	535.86
002S013W23R002S/Bissel 3	193.62	140.35	111.50	0.00	0.00	0.00	0.00	0.00	0.00	0.51	68.19	30.19	544.36
002S013W24Q004S/OTIS #3	2.25	75.52	73.10	37.36	60.65	84.33	26.15	0.00	1.40	13.78	96.44	90.29	561.27
002S013W27E003S/NA003	53.84	47.15	50.13	44.28	39.66	37.20	36.87	38.01	53.23	52.90	36.77	45.70	535.74
002S013W28G001S/MI003	60.93	45.18	59.71	76.51	71.03	67.30	66.09	64.27	70.59	77.14	73.54	72.79	805.08
002S013W28G002S/MI001	70.62	64.53	62.63	1.43	0.00	0.07	0.00	0.08	0.00	0.13	0.09	0.00	199.58
002S013W28G003S/MI002	78.18	67.09	65.93	78.86	74.48	71.11	73.18	65.45	71.37	79.58	81.38	78.57	885.18
003S011W07E001S/PIONEER1	68.85	69.02	63.84	71.85	68.88	71.15	65.06	63.46	64.01	67.11	70.06	65.95	809.24

Appendix A – Groundwater Extractions Continued

1843 - Golden State Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1,658.42	1,840.50	1,635.35	1,529.91	1,489.09	1,495.37	1,288.39	1,178.71	1,439.90	1,502.09	1,690.00	1,639.76	18,387.49
003S011W18G006S/Dace Well #2	17.17	124.50	31.98	0.16	0.00	0.16	0.00	0.17	0.00	0.20	0.00	0.06	174.40
003S012W02R006S/ST003	0.00	0.00	0.00	0.00	0.00	2.61	51.15	65.54	72.60	64.59	48.09	76.69	381.27
003S012W07Q005S/CTY01	6.32	8.17	7.22	5.02	6.51	4.21	3.00	0.72	3.79	3.54	0.89	0.34	49.73
003S012W12A002S/PIONEER3	66.08	52.80	60.53	48.47	57.80	55.24	49.95	49.16	61.24	59.84	49.88	48.09	659.08
003S012W13A002S/IMPERIAL2	0.00	0.08	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.11	0.05	0.00	0.32
003S012W13B004S/IMPERIAL3	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.00	0.06	0.09	0.04	0.00	0.26
003S012W17A002S/MCK03	64.52	60.92	55.15	54.22	50.66	46.60	48.06	51.18	54.39	53.60	60.24	61.00	660.54
003S012W25Q003S/ROS02	101.97	104.72	100.25	102.43	100.63	102.33	102.18	95.39	105.86	104.29	105.59	102.54	1,228.18
003S012W36B001S/ROS01	75.71	66.37	62.60	67.13	60.32	61.62	61.53	56.63	60.10	60.15	63.49	61.62	757.27
003S013W04N001S/BEL03	122.56	119.66	120.27	116.90	119.74	121.75	24.46	0.73	89.07	114.45	118.68	110.79	1,179.06
003S013W04N004S/BEL04	135.54	136.25	138.22	142.95	137.44	140.51	28.38	0.76	82.25	133.00	139.75	121.04	1,336.09
003S013W10L002S/WLBK1	0.00	0.00	16.50	38.94	38.01	37.44	38.65	34.02	11.27	0.00	0.00	19.19	234.02
003S013W10L004S/WLBK3	84.92	85.12	64.42	38.86	38.04	37.48	38.65	34.14	66.75	74.36	79.63	62.15	704.52
004S011W07H002S/HAW01	0.23	1.29	0.34	20.03	12.84	0.00	0.00	0.00	0.00	0.00	0.22	0.92	35.87
004S011W07L005S/CEN06	132.25	124.95	129.45	143.92	99.46	83.51	66.64	86.53	103.00	109.00	117.98	119.54	1,316.23
004S011W07L006S/CEN07	118.98	124.62	89.51	21.39	30.34	79.84	108.47	86.66	97.04	91.89	108.76	103.57	1,061.07
004S011W18F002S/Juan04	12.23	6.32	13.64	13.53	29.95	0.26	0.00	0.41	0.35	0.46	0.16	0.33	77.64

2378 - Huntington Park, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	287.48	293.53	263.99	275.95	269.19	224.23	225.34	210.24	231.14	220.35	224.14	216.17	2,941.75
002S013W23H001S/14	57.27	66.15	48.35	49.11	51.12	34.67	42.14	38.08	36.43	39.82	42.70	37.19	543.03
002S013W23J004S/18	137.87	139.20	133.60	139.02	133.00	101.76	96.72	85.92	101.40	97.81	100.45	99.70	1,366.45
002S013W25D004S/16	2.74	0.61	0.50	0.45	0.23	0.28	0.34	3.13	3.39	1.13	1.05	0.44	14.29
002S013W25Q001S/12	89.60	87.57	81.54	87.37	84.84	87.52	86.14	83.11	89.92	81.59	79.94	78.84	1,017.98

Appendix A – Groundwater Extractions Continued

2749 – La Habra Heights County Water District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	330.84	327.35	287.68	267.74	237.23	147.67	146.66	188.72	223.19	229.71	256.30	267.33	2,910.42
002S011W19F001S/8	54.36	65.27	47.80	54.67	57.25	52.58	53.63	61.53	61.02	47.87	48.94	43.65	648.57
002S011W19M001S/9	53.97	56.51	54.63	57.02	52.24	51.05	49.74	48.14	18.38	0.00	0.00	0.00	441.68
002S011W19P002S/10	110.49	74.65	68.10	50.69	25.53	3.22	27.80	19.02	87.51	47.47	78.43	110.83	703.74
002S011W19P003S/11	112.02	130.92	117.15	105.36	102.21	40.82	15.49	60.03	56.28	134.37	128.93	112.85	1,116.43

2770 – Lakewood, City of Water Department	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	778.45	685.00	679.11	600.28	558.38	519.63	428.15	480.38	537.99	588.49	593.96	603.06	7,052.88
003S012W33A007S/LK002A	64.50	56.50	56.41	44.37	57.65	66.66	60.07	58.48	41.66	51.87	61.79	55.04	675.00
003S012W34F001S/LK018	85.52	70.44	68.27	51.16	66.38	85.04	74.45	70.71	30.45	30.10	73.46	69.15	775.13
004S011W07M001S/LK006	6.56	6.16	6.37	3.71	4.86	2.03	0.01	3.59	2.66	2.30	2.25	6.01	46.51
004S012W03A002S/LK015A	178.42	148.30	151.22	152.93	95.36	26.17	0.00	0.00	0.00	56.22	78.82	111.37	998.81
004S012W03H001S/LK017	111.23	96.62	104.96	102.28	99.75	126.22	105.09	102.99	79.26	77.86	110.67	98.99	1,215.92
004S012W05J001S/LK022	52.70	36.41	42.02	17.20	12.98	3.48	11.41	23.19	32.12	27.10	37.12	36.64	332.37
004S012W10G001S/LK004	88.62	70.05	76.81	73.86	67.85	80.41	74.99	76.07	53.80	52.08	85.97	72.45	872.96
004S012W10H001S/LK010	102.18	68.13	85.83	69.97	79.83	81.99	74.83	85.73	78.04	71.26	73.48	79.43	950.70
004S012W10H003S/LK008	88.26	57.81	87.22	84.80	73.72	47.63	27.30	59.62	75.65	70.04	70.40	73.98	816.43
004S012W10H004S/LK027	0.46	74.58	0.00	0.00	0.00	0.00	0.00	0.00	144.35	149.66	0.00	0.00	369.05

3780 – Liberty Utilities Corporation	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	467.07	455.36	426.62	400.02	369.14	340.51	350.31	346.82	390.61	384.43	405.65	395.25	4,731.79
003S012W11K006S/41A	0.10	0.06	0.00	0.05	0.00	0.11	0.00	0.00	0.04	0.06	0.05	0.00	0.47
003S012W16H001S/40D	45.14	50.11	46.30	43.53	37.77	38.96	43.85	50.85	50.66	46.69	44.66	43.16	541.68
003S013W09H001S/19C	208.67	204.89	182.06	165.74	182.69	164.02	170.66	164.76	192.18	188.56	195.09	192.99	2,212.31
003S013W13F004S/4B	60.10	48.54	53.43	53.41	51.55	52.57	51.82	46.29	54.78	57.06	37.40	20.17	587.12
003S013W16K002S/12C	64.91	62.29	63.35	60.98	27.94	25.00	22.49	25.81	23.10	28.37	34.37	34.68	473.29

Appendix A – Groundwater Extractions Continued

3780 – Liberty Utilities Corporation	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	467.07	455.36	426.62	400.02	369.14	340.51	350.31	346.82	390.61	384.43	405.65	395.25	4,731.79
003S013W25F004S/9D	88.15	89.47	81.48	76.31	69.19	59.85	61.49	59.11	69.85	63.69	94.08	104.25	916.92

2890- Little Lake Cemetery District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	1.43	3.21	4.73
003S011W06N001S/1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	1.43	3.21	4.73

2884 – Lincoln Memorial Park Inc	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2.59	1.82	1.69	0.36	0.67	0.04	0.09	0.44	0.58	0.16	0.77	1.42	10.63
003S013W28F001S/	2.59	1.82	1.69	0.36	0.67	0.04	0.09	0.44	0.58	0.16	0.77	1.42	10.63

2910 – Long Beach, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2,859.49	2,726.28	2,718.84	2,645.25	2,612.04	2,619.84	2,330.28	2,236.72	204.90	486.40	2,528.05	2,444.73	26,412.82
004S/12W-13F002S/COM21	145.68	142.47	135.82	145.45	143.93	148.93	151.20	138.51	0.00	19.45	155.89	147.93	1,475.26
004S012W03A002S/LK015A	0.00	0.00	9.99	9.92	35.92	0.00	0.00	0.00	0.00	0.00	58.27	27.65	141.75
004S012W06J002S/NLB11	21.40	20.82	19.58	20.08	18.76	18.82	19.10	20.91	1.13	0.00	0.00	0.00	160.60
004S012W08M001S/NLB12	407.32	402.65	385.55	393.53	380.51	390.34	395.04	358.99	0.00	144.23	422.38	392.22	4,072.76
004S012W10H003S/LK008	0.00	0.00	0.00	0.00	0.00	27.62	45.89	24.01	0.00	0.00	0.00	0.00	97.52
004S012W10H004S/LK027	251.08	123.60	240.21	244.50	227.94	243.87	225.58	219.57	63.20	35.16	216.39	235.68	2,326.78
004S012W13G001S/1	23.57	14.68	15.72	15.31	0.00	7.16	0.00	10.98	0.00	13.31	13.81	17.20	131.74
004S012W13H001S/COM20	140.97	137.41	127.01	126.23	121.01	121.06	118.86	22.86	0.00	0.00	0.00	33.19	948.60
004S012W14A002S/COM10	90.10	91.61	84.96	79.77	89.05	92.47	93.30	85.03	9.96	2.68	96.27	91.85	907.05
004S012W14A004S/COM18	64.41	66.79	61.48	65.88	64.55	68.04	69.54	64.19	18.06	34.02	5.08	0.00	582.04
004S012W14B002S/COM17	60.84	61.33	56.48	58.79	56.60	57.98	57.39	52.61	6.19	7.66	60.72	57.54	594.13
004S012W14D004S/COM14	225.19	225.18	210.56	215.32	209.54	216.99	218.44	201.17	0.00	78.88	248.68	229.89	2,279.84
004S012W15A001S/COM16	134.47	133.25	125.14	128.51	123.34	126.35	126.94	24.10	0.00	0.00	0.00	16.54	938.64
004S012W15B003S/COM15	115.75	116.09	109.42	61.54	54.19	77.28	80.61	99.91	12.42	32.87	120.56	103.92	984.56

Appendix A – Groundwater Extractions Continued

2910 – Long Beach, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2,859.49	2,726.28	2,718.84	2,645.25	2,612.04	2,619.84	2,330.28	2,236.72	204.90	486.40	2,528.05	2,444.73	26,412.82
004S012W15N001S/COM25	95.74	92.78	85.08	83.80	79.37	81.99	86.58	81.41	0.00	34.39	111.15	101.96	934.25
004S012W16A001S/COM24	132.13	131.59	124.65	126.97	122.56	126.15	126.43	118.93	0.00	4.97	143.80	131.01	1,289.19
004S012W16J003S/CIT09	123.35	117.26	96.00	120.53	115.40	122.41	125.29	112.97	0.00	16.32	127.86	118.46	1,195.85
004S012W16R001S/CIT08	0.00	0.00	0.00	0.00	1.50	0.48	0.00	1.57	0.69	0.00	0.00	1.57	5.81
004S012W17E001S/DEV09	75.03	73.66	60.65	64.32	62.83	64.54	70.18	62.94	0.00	26.62	79.99	71.03	711.79
004S012W20G001S/DEV05	11.68	11.15	7.47	0.63	2.08	0.00	0.00	0.90	0.00	0.00	0.00	2.19	36.10
004S012W20K001S/CIT10	344.84	344.01	329.03	338.77	326.83	237.45	0.00	244.44	84.84	12.46	377.47	346.65	2,986.79
004S012W21M007S/CIT7A	148.37	141.77	133.85	58.22	79.75	88.83	0.00	0.00	0.00	0.00	0.00	0.00	650.79
004S012W23C001S/WIL1A	162.72	143.36	147.13	141.10	153.00	155.16	169.17	155.65	0.00	3.46	177.59	170.36	1,578.70
004S012W24M008S/WIS1A	0.00	51.67	78.71	79.32	78.56	81.33	83.35	72.94	8.41	9.68	35.81	80.54	660.32
004S012W28H006S/ALA8	68.69	68.09	64.63	65.82	63.10	64.59	67.39	60.67	0.00	10.24	76.33	63.93	673.48
004S012W28H012S/ALA13	16.16	15.06	9.72	0.94	1.72	0.00	0.00	1.46	0.00	0.00	0.00	3.42	48.48

4345 – Los Angeles County Public Works – Sativa Water System	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.15	0.50	0.23	0.12	0.06	0.08	0.14	0.46	0.22	0.15	0.24	0.22	2.57
003S013W15G001S/3	0.06	0.06	0.08	0.07	0.03	0.03	0.10	0.38	0.15	0.04	0.12	0.11	1.23
003S013W15M005S/5	0.09	0.44	0.15	0.05	0.03	0.05	0.04	0.08	0.07	0.11	0.12	0.11	1.34

2930 – Los Angeles County Rancho Los Amigos	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	25.31	26.79	19.13	21.03	12.14	11.57	11.70	18.79	18.08	15.97	25.97	17.78	224.26
003S012W05P001S/DW002	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
003S012W05P003S/DW001	25.31	26.79	19.13	21.03	12.14	11.57	11.70	18.79	18.08	15.97	25.96	17.78	224.25

Appendix A – Groundwater Extractions Continued

2920 – Los Angeles, City of Dept of Water and Power	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	3.47	377.66	514.42	471.90	495.04	512.61	165.49	523.20	487.34	502.90	507.68	4,561.71
002S014W23H014S/5	0.00	0.29	0.42	0.22	0.32	0.26	0.31	0.22	0.19	0.20	0.16	0.50	3.09
002S014W23H018S/MH-PW-12	0.00	0.28	185.49	253.11	231.81	242.37	250.52	80.40	246.42	237.47	245.03	126.08	2,098.98
002S014W23H019S/MH-PW-11	0.00	1.97	191.10	260.30	239.13	251.68	261.07	84.24	275.86	248.89	257.10	240.19	2,311.53
002S014W23H020S/MH-PW-10	0.00	0.30	0.22	0.35	0.18	0.26	0.23	0.21	0.24	0.26	0.22	0.21	2.68
002S014W23H021S/MH-PW-08	0.00	0.35	0.25	0.33	0.30	0.25	0.25	0.28	0.24	0.28	0.28	140.58	143.39
No state well number/1391E	0.00	0.28	0.18	0.11	0.16	0.22	0.23	0.14	0.25	0.24	0.11	0.12	2.04

3010 – Lunday-Thagard Oil Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	7.16	6.91	5.48	7.07	6.77	6.42	6.80	5.03	6.58	6.40	4.62	0.00	69.24
3S/12W-05D05S/SLY	7.16	6.91	5.48	7.07	6.77	6.42	6.80	5.03	6.58	6.40	4.62	0.00	69.24

3080 – Lynwood Park Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	6.15	7.54	3.94	7.13	7.88	5.11	7.74	5.87	5.24	6.93	7.28	12.38	83.19
003S013W10R008S/NW25	0.07	0.09	0.09	0.06	0.11	0.06	0.08	0.12	0.14	0.09	0.08	0.09	1.08
003S013W10R009S/SOUTH	5.68	6.75	3.55	6.97	7.67	5.05	7.56	5.75	5.00	6.84	7.10	12.29	80.21
003S013W15H001S/MONA	0.40	0.70	0.30	0.10	0.10	0.00	0.10	0.00	0.10	0.00	0.10	0.00	1.90

3060 – Lynwood, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	494.41	497.13	458.26	428.21	375.10	351.64	331.69	285.52	304.98	294.66	304.60	301.07	4,427.27
003S013W10K001S/19	212.63	208.06	193.20	173.98	159.80	101.51	0.00	0.00	0.00	0.00	0.00	0.00	1,049.18
003S013W12E004S/8	131.51	132.61	124.05	104.12	103.41	127.67	150.70	119.16	119.18	114.35	119.45	112.47	1,458.68
003S013W12J001S/5	25.88	32.07	44.71	32.32	13.04	44.74	64.38	57.42	63.77	60.21	70.79	68.50	577.83
003S013W13D001S/9	124.39	124.39	96.30	117.79	98.85	77.72	116.61	108.94	122.03	120.10	114.36	120.10	1,341.58

Appendix A – Groundwater Extractions Continued

3170 – Maywood Mutual Water Company No. 1	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	59.47	59.37	55.05	54.59	50.32	48.01	50.58	45.74	51.60	50.82	54.11	52.82	632.48
002S013W24B002S/4	51.77	57.21	53.07	52.21	47.43	45.98	50.58	45.74	51.60	50.82	54.11	52.82	613.34
002S013W24F001S/3	7.70	2.16	1.98	2.38	2.89	2.03	0.00	0.00	0.00	0.00	0.00	0.00	19.14

3180 – Maywood Mutual Water Company No. 2	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	84.66	151.43	86.52	83.84	81.53	77.97	77.75	75.62	86.51	84.59	81.64	97.63	1,069.69
002S012W18M001S/52ST	84.66	88.34	77.50	25.20	20.76	44.91	13.96	25.50	41.32	47.64	47.82	44.78	562.39
002S013W13M002S/MAYAV	0.00	63.09	9.02	58.64	60.77	33.06	63.79	50.12	45.19	36.95	33.82	52.85	507.30

3190 – Maywood Mutual Water Company No. 3	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	132.16	133.12	122.90	121.21	104.12	126.30	107.12	108.17	115.97	114.26	116.44	114.89	1,416.66
002S012W19C003S/7	26.48	25.67	16.54	17.89	13.52	9.95	0.00	0.00	0.00	0.00	0.00	0.00	110.05
002S012W19J003S/Well	20.56	24.95	28.00	23.34	10.10	32.05	28.80	38.03	39.18	39.82	40.29	42.89	368.01
002S012W19M004S/8	85.12	82.50	78.36	79.98	80.50	84.30	78.32	70.14	76.79	74.44	76.15	72.00	938.60

3360 – Montebello Land and Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	283.49	283.62	265.85	253.18	238.03	222.47	214.16	214.49	234.28	257.92	259.07	257.74	2,984.30
002S012W11G001S/14	67.09	61.84	69.36	58.80	48.27	35.50	50.57	60.05	46.16	82.37	71.16	61.15	712.32
002S012W11R004S/11A	21.73	17.48	15.93	7.20	7.26	3.35	8.27	8.14	3.27	0.00	0.00	14.38	107.01
002S012W12E005S/9	16.49	32.44	31.12	25.67	24.04	38.57	27.47	35.62	41.20	33.93	48.32	52.31	407.18
002S012W12E006S/10	37.80	43.70	24.21	34.84	44.85	29.24	34.79	30.42	37.06	33.98	17.78	35.37	404.04
002S012W12E007S/8A	50.45	36.99	34.34	39.59	34.30	36.00	9.50	0.00	0.00	0.00	0.00	0.00	241.17
002S012W12E008S/12	46.77	49.91	50.11	44.34	39.66	33.37	36.44	29.24	43.85	39.37	65.10	46.26	524.42
002S012W12M002S/7	43.16	41.26	40.78	42.74	39.65	46.44	47.12	51.02	62.74	68.27	56.71	48.27	588.16

Appendix A – Groundwater Extractions Continued

3517 - Newark Group, Inc., The	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	13.35	13.91	11.02	13.09	15.86	14.41	14.03	12.81	14.32	14.25	12.78	11.66	161.49
002S012W20E001S/1	13.35	13.91	11.02	13.09	15.86	10.95	6.71	0.00	3.38	14.25	10.37	2.32	115.21
002S012W20M002S/2	0.00	0.00	0.00	0.00	0.00	3.46	7.32	12.81	10.94	0.00	2.41	9.34	46.28

3546 - Northrop Grumman/Omega Chemical (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.46	0.31	0.32	0.18	0.16	0.32	0.40	0.33	0.40	0.37	0.38	0.30	3.93
002S011W28E004S/EW-4	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
002S011W28E005S/EW-5	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.10
No state well number/DPE-8	0.10	0.06	0.07	0.03	0.02	0.07	0.08	0.05	0.06	0.06	0.07	0.05	0.72
No state well number/DPE-3	0.06	0.04	0.04	0.03	0.02	0.03	0.02	0.04	0.05	0.05	0.04	0.03	0.45
No state well number/DPE-9	0.20	0.14	0.14	0.06	0.06	0.09	0.11	0.09	0.12	0.10	0.11	0.09	1.31
No state well number/DPE-4	0.09	0.06	0.06	0.03	0.03	0.06	0.10	0.08	0.09	0.08	0.09	0.07	0.84
No state well number/DPE-5	0.00	0.00	0.00	0.03	0.02	0.06	0.08	0.06	0.07	0.07	0.06	0.05	0.50

3550 - Norwalk, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	123.66	106.50	118.36	72.03	84.41	92.13	67.41	38.50	33.39	32.73	34.29	105.28	908.69
003S011W18K003S/10	83.84	66.96	81.37	37.24	53.21	63.01	37.35	9.01	0.01	0.00	0.00	71.14	503.14
003S012W13L001S/LEF	1.36	1.86	3.51	3.62	1.48	2.30	0.69	0.10	1.63	1.52	7.92	0.93	26.92
003S012W13Q001S/TAD	38.46	37.68	33.48	31.17	29.72	26.82	29.37	29.39	31.75	31.21	26.37	33.21	378.63

3640 - Orchard Dale Water District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	204.42	206.45	183.04	170.71	151.26	130.16	129.88	130.86	150.64	149.60	167.38	170.64	1,945.04
002S011W19F001S/	33.59	41.17	30.42	34.86	36.50	46.34	47.50	42.67	41.19	31.17	31.96	27.86	445.23
002S011W19M001S/	33.34	35.64	34.75	36.35	33.31	45.00	44.04	33.38	12.40	0.00	0.00	0.00	308.21
002S011W19P002S/10	68.27	47.08	43.33	32.32	16.28	2.84	24.62	13.19	59.07	30.92	51.22	70.75	459.89
002S011W19P003S/	69.22	82.56	74.54	67.18	65.17	35.98	13.72	41.62	37.98	87.51	84.20	72.03	731.71

Appendix A – Groundwater Extractions Continued

3745 – Paradise Memorial Park	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.15	0.15	0.14	0.14	0.03	0.27	0.27	0.27	0.45	0.98	3.16	3.75	9.76
3S/12W-01K09S/1	0.15	0.15	0.14	0.14	0.03	0.27	0.27	0.27	0.45	0.98	3.16	3.75	9.76

3760 – Paramount Unified School District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2.45	2.45	2.45	0.75	0.75	0.75	0.75	0.75	1.51	1.28	1.28	3.12	18.29
3S/12W-33F02S/COKE	2.45	2.45	2.45	0.75	0.75	0.75	0.75	0.75	1.51	1.28	1.28	3.12	18.29

3755 – Paramount, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	247.09	243.41	225.25	229.99	224.11	230.63	230.83	207.87	227.28	187.78	233.22	218.15	2,705.61
003S012W19E005S/15	247.09	243.41	225.25	229.99	224.11	230.63	230.83	207.87	227.28	187.78	233.22	218.15	2,705.61

3853 – Pico Rivera, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	460.81	446.79	410.82	370.20	333.71	299.32	312.41	311.98	360.34	353.06	388.81	387.68	4,435.93
002S011W05P001S/GOLF1	5.97	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.37
002S012W12A001S/W1	46.06	36.32	66.46	98.48	123.52	4.98	0.00	0.00	52.00	92.74	99.29	42.09	661.94
002S012W12A005S/W2	103.07	116.49	75.05	19.82	0.00	177.87	212.14	193.53	151.32	87.28	96.02	148.01	1,380.60
002S012W23B004S/W3	0.00	2.32	5.15	4.18	5.67	2.37	8.92	9.43	5.62	5.89	4.85	7.12	61.52
002S012W23B008S/W4	138.89	170.81	157.58	105.59	131.03	80.74	72.21	86.57	117.19	117.19	118.86	117.45	1,414.11
002S012W25G001S/W12	131.68	34.82	11.77	114.95	16.08	11.20	0.00	0.00	2.46	5.53	5.94	4.57	339.00
002S012W25G002S/W11	4.58	8.75	7.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.05
002S012W26D007S/W5	22.29	65.23	74.51	23.15	50.73	17.05	12.88	13.71	24.36	38.75	54.53	60.79	457.98
002S012W26E003S/W6	8.27	10.65	12.58	4.03	6.68	5.11	6.26	8.74	7.39	5.68	9.32	7.65	92.36

3850 – Pico Water District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	277.33	277.88	255.01	233.26	217.63	189.70	192.08	195.49	224.51	215.96	233.28	230.87	2,743.00
002S011W07P002S/10	38.88	38.26	15.07	41.74	24.28	11.80	25.43	12.59	22.69	7.13	5.96	12.58	256.41
002S011W18B008S/4A	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04

Appendix A – Groundwater Extractions Continued

3850 – Pico Water District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	277.33	277.88	255.01	233.26	217.63	189.70	192.08	195.49	224.51	215.96	233.28	230.87	2,743.00
002S012W13L005S/8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.43	37.87	45.42	38.36	126.08
002S012W24E007S/5A	4.24	8.01	24.21	51.32	22.39	28.58	57.28	24.95	42.24	13.92	5.92	17.06	300.12
002S012W24F004S/Well	234.21	231.57	215.73	140.20	170.96	149.32	109.37	157.95	155.15	157.04	175.98	162.87	2,060.35

4115 – Rockview Dairies, Inc.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	12.97	13.25	14.69	15.42	14.07	12.24	13.63	13.61	15.90	13.01	14.18	12.29	165.26
003S012W05C008S/NEW2	12.97	13.25	14.69	15.42	14.07	12.24	13.63	13.61	15.90	13.01	14.18	12.29	165.26

4150 – Roman Catholic Archbishop of Los Angeles	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	45.96	39.22	49.77	32.02	23.10	4.21	15.80	22.24	29.10	36.79	34.14	11.85	344.20
002S012W06K010S/Service Yard #4	45.96	39.22	49.77	32.02	23.10	4.21	15.80	22.24	29.10	36.79	34.14	11.85	344.20

4330 – San Gabriel Valley Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	213.19	247.67	230.89	234.19	219.36	198.25	180.99	193.21	220.31	197.15	212.06	213.66	2,560.93
002S011W18Q001S/W-1C	0.57	0.42	0.50	0.51	0.49	0.48	0.07	0.09	0.12	0.43	0.00	0.07	3.75
002S011W19F007S/W-6C	208.84	241.63	230.24	233.61	218.65	187.12	0.24	0.60	0.16	0.49	0.12	156.23	1,477.93
002S011W19F008S/W-6D	3.78	5.62	0.15	0.07	0.22	10.65	180.68	192.52	220.03	196.23	211.94	57.36	1,079.25

4335 – Santa Fe Springs, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	201.89	204.18	216.73	203.15	193.29	188.82	194.00	182.50	201.60	197.20	197.83	195.69	2,376.88
002S011W07C005S	94.29	94.98	89.10	91.05	86.03	82.68	89.06	84.75	93.22	90.53	90.65	84.83	1,071.17
002S011W07D010S	107.60	109.20	107.59	112.10	107.26	106.14	104.94	97.75	108.38	106.67	107.18	110.86	1,285.67
003S011W20R009S/2	0.00	0.00	20.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.04

Appendix A – Groundwater Extractions Continued

4349 – Scantlebury, Robert P.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.30	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.26	0.76
003S011W07N001S/1	0.00	0.00	0.30	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.26	0.76

4450 – Signal Hill, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	83.54	57.94	56.91	61.45	73.39	54.90	92.75	99.72	113.72	75.47	105.74	115.51	991.04
003S012W31B001S/7	83.54	57.94	56.91	61.45	64.39	54.90	43.75	41.72	40.72	69.47	35.74	39.51	650.04
004S012W20M001S/9	0.00	0.00	0.00	0.00	9.00	0.00	49.00	58.00	73.00	6.00	70.00	76.00	341.00
003S011W20R009S/2	0.00	0.00	20.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.04

4590 – South Gate, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	787.45	788.81	678.46	700.11	630.09	645.26	538.47	599.72	692.71	651.19	746.97	700.22	8,159.46
002S012W31Q003S/24	169.78	181.42	149.95	161.98	142.47	93.75	137.95	142.45	175.00	144.11	192.84	189.13	1,880.83
002S013W34A003S/29	186.56	178.67	173.62	206.80	183.61	208.09	184.80	181.21	206.30	181.64	192.55	175.97	2,259.82
002S013W34Q003S/26	15.78	5.10	3.56	2.23	0.00	0.00	0.00	17.40	0.28	2.76	8.29	4.14	59.54
002S013W34R001S/27	137.96	132.37	129.11	152.11	134.89	142.80	129.47	128.90	146.95	124.23	138.90	114.84	1,612.53
002S013W35A002S/28	157.33	187.42	166.09	9.67	23.13	26.25	85.89	129.76	147.49	132.53	185.82	179.05	1,430.43
003S012W06B003S/23	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
003S012W06D001S/13	0.17	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35
003S012W06D002S/14	0.19	0.23	0.38	0.29	0.71	0.21	0.19	0.00	0.00	0.32	0.00	0.00	2.52
003S012W06D003S/18	0.12	0.17	0.22	0.21	13.06	0.19	0.17	0.00	0.00	0.26	0.13	0.00	14.53
003S012W06D004S/19	119.56	103.43	55.53	166.50	132.22	173.97	0.00	0.00	16.69	65.34	28.44	37.09	898.77

4540 – South Montebello Irrigation District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	164.09	171.24	158.28	148.72	143.63	129.45	130.47	128.58	147.66	141.92	155.31	159.89	1,779.24
002S012W13D007S/5	18.02	13.17	23.29	33.19	34.39	27.56	30.92	33.38	22.99	17.58	19.44	30.78	304.71
002S012W14B008S/3	19.79	16.84	22.41	13.49	10.64	13.96	9.62	7.53	22.78	18.16	20.88	28.77	204.87
002S012W15J004S/6	41.37	28.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	70.06

Appendix A – Groundwater Extractions Continued

4540 – South Montebello Irrigation District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	164.09	171.24	158.28	148.72	143.63	129.45	130.47	128.58	147.66	141.92	155.31	159.89	1,779.24
002S012W22G002S/7	84.91	112.54	112.58	102.04	98.60	87.93	89.93	87.67	101.89	106.18	114.99	100.34	1,199.60

4549 – Southern California Edison Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.82	0.68	0.89	0.61	0.30	0.14	0.10	1.05	0.92	0.28	0.40	0.56	6.75
3S/12W-19G02S/ABILA	0.82	0.68	0.89	0.61	0.30	0.14	0.10	1.05	0.92	0.28	0.40	0.56	6.75

4300 – St John Bosco School	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	7.10	7.90	4.50	4.56	3.89	0.45	1.45	1.27	2.22	0.73	3.50	6.10	43.67
3S/12W-15K03S/15HP	7.10	7.90	4.50	4.56	3.89	0.45	1.45	1.27	2.22	0.73	3.50	6.10	43.67

4810 – Suburban Water Systems	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	89.04	115.11	125.04	98.01	95.63	88.55	100.91	81.01	89.04	86.85	95.62	85.98	1,150.79
003S011W22L003S/409	0.59	26.35	39.07	9.01	9.45	0.00	11.57	0.00	0.00	0.00	6.77	0.00	102.81
003S011W27L001S/410	88.45	88.76	85.97	89.00	86.18	88.55	89.34	81.01	89.04	86.85	88.85	85.98	1,047.98

4980 – Tract 180 Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	117.12	119.36	112.31	109.92	104.31	96.84	103.62	96.10	106.54	102.96	111.13	105.00	1,285.21
2S/13W-25H06S/6	59.50	60.48	56.78	55.90	52.86	62.48	103.62	96.10	71.86	53.16	57.06	54.25	784.05
2S/13W-25H08S/5	57.62	58.88	55.53	54.02	51.45	34.36	0.00	0.00	34.68	49.80	54.07	50.75	501.16

4990 – Tract 349 Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	68.35	62.78	58.33	56.69	51.72	50.84	50.37	47.98	53.34	49.26	54.48	55.29	659.43
002S012W31D001S/3	17.09	0.48	8.10	5.69	1.66	23.13	0.11	8.89	5.58	14.35	0.57	1.07	86.72
002S013W25D006S/Well	51.26	62.30	50.23	51.00	50.06	27.71	50.26	39.09	47.76	34.91	53.91	54.22	572.71

Appendix A – Groundwater Extractions Continued

5019 – Tucker, William M. & or Robertson, Bobby Ray Jr.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.04	0.09	0.04	0.02	0.02	0.04	0.04	0.06	0.03	0.02	0.03	0.03	0.46
2S/13W-12P04S/BAND2	0.04	0.09	0.04	0.02	0.02	0.04	0.04	0.06	0.03	0.02	0.03	0.03	0.46

5460 – Vernon, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	596.56	608.92	570.77	590.55	503.38	498.86	490.87	489.76	536.77	525.45	575.94	525.11	6,512.94
002S013W10P005S/11	89.63	98.27	94.04	91.97	72.46	85.27	82.94	77.77	80.41	77.53	85.66	79.31	1,015.26
002S013W10P008S/16	62.45	60.11	56.38	58.52	55.68	55.94	55.03	49.10	52.44	48.63	48.24	46.52	649.04
002S013W11R006S/17	117.88	118.54	112.76	118.29	98.87	87.16	85.13	74.07	85.57	96.64	83.20	82.22	1,160.33
002S013W13H002S/20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.70	46.06	103.76
002S013W14H004S/15	150.89	154.23	142.95	147.54	142.00	140.44	124.93	119.62	150.28	140.62	133.08	111.77	1,658.35
002S013W14H005S/19	92.30	98.47	80.62	82.96	57.42	66.55	73.04	86.00	83.29	84.96	85.68	82.27	973.56
002S013W15P011S/9	83.41	79.30	84.02	91.27	76.95	63.50	69.80	83.20	84.78	77.07	82.38	76.96	952.64

5490 – Virginia Country Club	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	55.27	55.62	45.47	21.91	18.82	4.73	6.40	15.40	26.00	30.71	50.06	52.89	383.28
004S013W12M006S/TEX1	55.27	55.62	45.47	21.91	18.82	4.73	6.40	15.40	26.00	30.71	50.06	52.89	383.28

5610 – Walnut Park Mutual Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	93.04	89.38	94.68	91.76	90.41	89.66	79.24	81.54	86.82	90.03	88.01	90.53	1,065.10
002S013W27B020S/10	31.09	0.95	23.86	28.40	25.78	39.19	20.41	22.57	21.42	39.91	29.28	27.42	310.28
002S013W27B022S/11	55.72	62.92	38.86	37.24	34.27	40.37	17.22	37.78	29.03	39.40	24.90	30.23	447.94
002S013W27B024S/12	6.23	25.51	31.96	26.12	30.36	10.10	41.61	21.19	36.37	10.72	33.83	32.88	306.88

5670 – Whittier Union High School District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	4.89	3.74	4.54	1.38	2.21	0.03	0.51	0.99	2.40	2.10	3.80	5.67	32.26
2S/11W-32J04S/SH550	4.89	3.74	4.54	1.38	2.21	0.03	0.51	0.99	2.40	2.10	3.80	5.67	32.26

Appendix A – Groundwater Extractions Continued

5660 – Whittier, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	601.43	573.95	514.17	469.81	379.34	439.15	448.02	476.10	517.12	499.55	498.86	459.48	5,876.98
002S011W05N004S/14	217.48	203.16	189.55	150.70	79.69	120.55	111.95	178.35	195.71	193.83	186.59	186.80	2,014.36
002S011W07C005S/CB-2	179.31	172.49	147.06	143.02	133.37	139.51	154.28	138.27	148.62	140.35	143.07	118.21	1,757.56
002S011W07D010S/CB-1	204.64	198.30	177.56	176.09	166.28	179.09	181.79	159.48	172.79	165.37	169.20	154.47	2,105.06

5800 – Yamamoto, George and Alice Acct.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.09	0.10	0.08	0.03	0.03	0.01	0.03	0.11	0.08	0.15	0.14	0.12	0.97
3S/12W-29J02S/68TH	0.09	0.10	0.08	0.03	0.03	0.01	0.03	0.11	0.08	0.15	0.14	0.12	0.97

Attachment 16: GSWC Miramonte Chromium Treatment Cost Estimate

Estimate Creator

For copy and paste to Capital Project List

RMA	CSA	System	Cost Center	BUDGET GROUP	BUDGET GROUP (TEXT FORMAT)	Funding Project Number	PROJECT NAME	Type	Scope Data Collected	Data Sent to Planning	Estimator	Estimate Total
	Central Basin West	Florence Graham System					Miramonte Plant, Chromium removal & treatment				Chin Pak	$ -

Filter Selection For Typical Project Types

Well - Drill & Equip | (blank) | (blank) | (blank) | (blank) | (blank) | (blank) | (blank)

(blank) | (blank) | Water Quality – Treatm... | (blank) | (blank) | (blank) | (blank)

Filter Selection for Previous Cost Data

From GSWC Master Cost Cross Reference 2019

(blank)

Control Quantities

Site area (SF)	7,000	Building height interior	10
Site perimeter (LF)	400	Building height at peak	14
Building area (GSF)	800	Tank pad (DI)	100
Building perimeter (LF)	200		
Volume (CF)	8,000		

Database Info

Estimator Contact	Trish Drew
	DCW Cost Management
	www.dcwcost.com
	trish@dcwcost.com
	(206) 259-2991
Last Updated	9/28/2022
Updated By	Trish Drew, DCW

Use the below filters in combination with any of the above filters. You can also search just by Category or Subcategory.

Typical | (blank)

Category

(blank) | Building Structure | Electrical | Mechanical

Plumbing | Site Paving, Structure & Landscaping | Site Preparation & Demolition | Site Utilities

Subcategory

(blank)

These are your Project Type tags. You can use the drop down to assign a tag to a line item. One line item may have multiple tags.

Include In Estimate? (NO / YES)	Item	Quantity	Unit	Unit Cost W/ Location Mark-up	Total	Location Markup	Unit Cost	Notes / Source	DCW Cost Source	Category	Subcategory	Typically Included?
YES	Electrical - wiring, conduit, panel and appurtenances	1	LS	$ 15,450.00	$ 15,450.00	3%	$ 15,000.00	Highway Well, Uranium Tre	DCW updated Q3 2022			Typical
YES	Electrical and Instrumentation	1	LS	$ 97,850.00	$ 97,850.00	3%	$ 95,000.00	Ball Well 1, Fe & Mn Remov	DCW updated Q3 2022			Typical
YES	Electrical Conduits/Wiring/Plugs/Switches/Connections	1	LS	$ 97,850.00	$ 97,850.00	3%	$ 95,000.00	Bissell Plant, Expansion of I	DCW updated Q3 2022			Typical
YES	Foundation for Equipment	1	LS	$ 20,600.00	$ 20,600.00	3%	$ 20,000.00	Ball Well 1, Fe & Mn Remov	DCW updated Q3 2022			Typical
YES	Geotechnical report	1	EA	$ 12,360.00	$ 12,360.00	3%	$ 12,000.00	Indian Hill North, Install Nitr	DCW updated Q3 2022			Typical
YES	Instrumentation & Control Devices	1	LS	$ 61,800.00	$ 61,800.00	3%	$ 60,000.00	Bissell Plant, Expansion of I	DCW updated Q3 2022			Typical
YES	Plant piping	150	LF	$ 309.00	$ 46,350.00	3%	$ 300.00	Cost range for 18" di pipe D	DCW updated Q3 2022			Typical
YES	PLC Modifications & Programming	1	LS	$ 18,540.00	$ 18,540.00	3%	$ 18,000.00	Bissell Plant, Expansion of I	DCW updated Q3 2022			Typical
YES	Run to Waste Modifications	1	LS	$ 37,080.00	$ 37,080.00	3%	$ 36,000.00	Sycamore Plant, Site impro	DCW updated Q3 2022			Typical
YES	Ion Exchange System	2	LS	$ 822,000.00	$ 1,644,000.00	0%	$ 822,000.00	Estimate used. From AqueoUSvets in 2023				

Item	From GSWC Database	DCW 2020 Booster Station Model	Well - Drill & Equip	Reservoir - New	Reservoir - Recoat	Reservoir - Seismic/Structural Improvements	Booster Station - New	PRV Station – New	Elec – New MCC	Elec – Install VFD	SCADA – New	Water Quality – Disinfection Facilities	Water Quality – Treatment	Plant Site – New Building	Generator – Permanent	Land Acquisition	Purchased water interconnection
Electrical - wiring, conduit, panel and appurtenances													Water Quality – Treatment				
Electrical and Instrumentation													Water Quality – Treatment				
Electrical Conduits/Wiring/Plugs/Switches/Connections													Water Quality – Treatment				
Foundation for Equipment													Water Quality – Treatment				
Geotechnical report													Water Quality – Treatment				
Instrumentation & Control Devices													Water Quality – Treatment				
Plant piping			Well - Drill & Equip										Water Quality – Treatment				
PLC Modifications & Programming													Water Quality – Treatment				
Run to Waste Modifications													Water Quality – Treatment				
Ion Exchange System																	

Attachment 17: Cal Advocates Miramonte Chromium Treatment Cost Estimate

Recorded Output 2/25/2024 6:55:12 PM

Parameter	Value	Units
Technology	AX	
Contaminant	other contaminant	
System Size Category	large	
Design Flow	2.88	MGD (excludes bypass flow)
Average Flow	2.16	MGD (excludes bypass flow)
# of treatment trains	2	
# of vessels in series	1	(i.e., parallel or series operation)
Total EBCT	3	minutes
EBCT per vessel	3	minutes
Bed depth	4.3	feet
Vessel geometry	upright	
Height (straight)	7	feet
Diameter	11	feet
Component level	low cost	
System automation	manual	
Resulting Costs (in year 2021 dollars)		
Direct Capital Cost	$ 995,379	Details
Add-on Cost	$ 5,599	Details
Indirect Capital Cost	$ 462,648	Details
Total Capital Cost	$ 1,639,262	Details
Annualized Capital Cost (per year over 34 years at 7%)	$ 127,529	Details
Annual O&M Cost (per year)	$ 179,239	Details
Total Annualized Cost (per year, 42% capital, 58% O&M)	$ 306,768	Details
Annualized cost per 1,000 gallons average flow	$ 0.39	
Annualized cost per household per year	$ 54	

Direct Capital Cost Details (items in italics, without a 1 in the "Use?" column, represent alternate costs and are excluded from total)

WBS #	Item	Design Quantity	Design Size	Size used in estimate	Unit Cost	Total Cost	Useful Life	Use?
1	**Pressure Vessels**							
1.1	*Stainless Steel*	*3 units*	*4,976 gal*	*4,976 gal*	*$ 124,490*	*$ 373,471*	*35*	*0*
1.1	*Carbon Steel - Stainless Internals*	*3 units*	*4,976 gal*	*4,976 gal*	*$ 79,776*	*$ 239,327*	*35*	*0*
1.1	**Carbon Steel - Plastic Internals**	**3 units**	**4,976 gal**	**4,976 gal**	**$ 65,928**	**$ 197,783**	**35**	**1**
1.1	*Fiberglass*	*3 units*	*4,976 gal*	*4,976 gal*	*contact vendor*	*--*	*25*	*0*
2	**Anion Resin**							
2.1	**Strong base polystyrenic gel-type Type I**	**1,226 cf**	**NA**	**NA**	**$ 232.14**	**$ 284,591**	**N/A**	**1**
3	**Tanks**							
3.1	Backwash Tanks							
3.1.1	**Steel**	**1 units**	**24,817 gal**	**24,817 gal**	**$ 49,396**	**$ 49,396**	**35**	**1**
3.1.1	*Fiberglass*	*1 units*	*24,817 gal*	*24,817 gal*	*contact vendor*	*--*	*25*	*0*
3.1.1	*Plastic/HDPE Tanks*	*1 units*	*24,817 gal*	*24,817 gal*	*contact vendor*	*--*	*25*	*0*
3.2	Brine Storage Tanks							
3.2.1	**Plastic/XLPE**	**1 units**	**1,055 gal**	**1,055 gal**	**$ 2,108**	**$ 2,108**	**10**	**1**
3.2.1	*Fiberglass*	*1 units*	*1,055 gal*	*1,055 gal*	*$ 12,043*	*$ 12,043*	*10*	*0*
3.2.1	*Stainless Steel*	*1 units*	*1,055 gal*	*1,055 gal*	*$ 9,138*	*$ 9,138*	*35*	*0*
3.3	Caustic Storage Tanks							
3.3.1	*Plastic/XLPE*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.3.1	*Fiberglass*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.3.1	*Stainless Steel*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.3.2	*Heat Tracing*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.3.3	*Insulation*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.3.4	*Secondary Containment - Concrete Curbing*	*0 cy*	*NA*	*NA*	*NA*	*--*	*NA*	
3.3.5	*Secondary Containment - Chemical Resistant Coating*	*0 gal*	*NA*	*NA*	*NA*	*--*	*NA*	
3.4	Caustic Day Tanks							
3.4.1	*Plastic/XLPE*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.4.1	*Fiberglass*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.4.1	*Stainless Steel*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.4.2	*Heat Tracing*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.4.3	*Insulation*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.4.4	*Secondary Containment - Concrete Curbing*	*0 cy*	*NA*	*NA*	*NA*	*--*	*NA*	
3.4.5	*Secondary Containment - Chemical Resistant Coating*	*0 gal*	*NA*	*NA*	*NA*	*--*	*NA*	
3.5	Residuals Holding Tanks/Basins							
3.5.1	*Concrete Basins (includes Excavation, Backfill, and Compaction)*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.5.1	*Steel Tanks*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.5.1	*Fiberglass Tanks*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.5.1	*Plastic/HDPE Tanks*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.6	Ferric Chloride Storage Tanks							
3.6.1	*Plastic/XLPE*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.6.1	*Fiberglass*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.6.2	*Secondary Containment - Concrete Curbing*	*0 cy*	*NA*	*NA*	*NA*	*--*	*NA*	
3.6.3	*Secondary Containment - Chemical Resistant Coating*	*0 gal*	*NA*	*NA*	*NA*	*--*	*NA*	
3.7	Polymer Storage Tanks							
3.7.1	*Plastic/XLPE*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.7.1	*Fiberglass*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
3.7.1	*Stainless Steel*	*0 units*	*NA*	*NA*	*NA*	*--*	*NA*	
4	**Piping**							
4.1	Backwash Piping							
4.1.1	*CPVC*	*150 lf*	*6 in. diam*	*6 in. diam*	*$ 46.61*	*$ 6,991*	*22*	*0*
4.1.1	**PVC**	**150 lf**	**6 in. diam**	**6 in. diam**	**$ 9.73**	**$ 1,459**	**22**	**1**
4.1.1	*Stainless Steel*	*150 lf*	*6 in. diam*	*6 in. diam*	*$ 258.56*	*$ 38,783*	*45*	*0*
4.1.1	*Steel*	*150 lf*	*6 in. diam*	*6 in. diam*	*$ 108.72*	*$ 16,308*	*35*	*0*
4.2	Brine Piping							
4.2.1	*CPVC*	*60 lf*	*6 in. diam*	*6 in. diam*	*$ 46.61*	*$ 2,796*	*22*	*0*
4.2.1	**PVC**	**60 lf**	**6 in. diam**	**6 in. diam**	**$ 9.73**	**$ 584**	**22**	**1**
4.2.1	*Stainless Steel*	*60 lf*	*6 in. diam*	*6 in. diam*	*$ 258.56*	*$ 15,513*	*45*	*0*
4.2.1	*Steel*	*60 lf*	*6 in. diam*	*6 in. diam*	*$ 108.72*	*$ 6,523*	*35*	*0*
4.3	Process Piping							
4.3.1	*Ductile Iron*	*120 lf*	*8 in. diam*	*8 in. diam*	*$ 122.07*	*$ 14,649*	*40*	*0*
4.3.1	*CPVC*	*120 lf*	*8 in. diam*	*8 in. diam*	*$ 75.19*	*$ 9,023*	*22*	*0*
4.3.1	**PVC**	**120 lf**	**8 in. diam**	**8 in. diam**	**$ 14.05**	**$ 1,686**	**22**	**1**
4.3.1	*Stainless Steel*	*120 lf*	*8 in. diam*	*8 in. diam*	*$ 318.43*	*$ 38,211*	*45*	*0*
4.3.1	*Steel*	*120 lf*	*8 in. diam*	*8 in. diam*	*$ 141.81*	*$ 17,018*	*35*	*0*
4.4	Bypass Piping							
4.4.1	*CPVC*	*0 lf*	*NA*	*NA*	*NA*	*--*	*NA*	
4.4.1	*PVC*	*0 lf*	*NA*	*NA*	*NA*	*--*	*NA*	
4.4.1	*Stainless Steel*	*0 lf*	*NA*	*NA*	*NA*	*--*	*NA*	
4.4.1	*Steel*	*0 lf*	*NA*	*NA*	*NA*	*--*	*NA*	
4.5	Influent and Treated Water Piping							
4.5.1	*Ductile Iron*	*120 lf*	*10 in. diam*	*10 in. diam*	*$ 141.74*	*$ 17,009*	*40*	*0*
4.5.1	*CPVC*	*120 lf*	*10 in. diam*	*10 in. diam*	*$ 110.97*	*$ 13,317*	*22*	*0*
4.5.1	**PVC**	**120 lf**	**10 in. diam**	**10 in. diam**	**$ 19.15**	**$ 2,298**	**22**	**1**
4.5.1	*Stainless Steel*	*120 lf*	*10 in. diam*	*10 in. diam*	*$ 366.95*	*$ 44,034*	*45*	*0*
4.5.1	*Steel*	*120 lf*	*10 in. diam*	*10 in. diam*	*$ 174.28*	*$ 20,914*	*35*	*0*
4.6	Caustic Piping							
4.6.1	*CPVC*	*0 lf*	*NA*	*NA*	*NA*	*--*	*NA*	
4.6.1	*PVC*	*0 lf*	*NA*	*NA*	*NA*	*--*	*NA*	

4.6.1	Stainless Steel	0 lf	NA	NA		NA		--	NA	
4.7	Residuals Piping									
4.7.1	CPVC	100 lf	6 in. diam	6 in. diam	$	46.61	$	4,661	22	0
4.7.1	**PVC**	**100 lf**	**6 in. diam**	**6 in. diam**	**$**	**9.73**	**$**	**973**	**22**	**1**
4.7.1	Stainless Steel	100 lf	6 in. diam	6 in. diam	$	258.56	$	25,856	45	0
4.7.1	Steel	100 lf	6 in. diam	6 in. diam	$	108.72	$	10,872	35	0
4.7.2	**Excavation**	**43 cy**	**NA**	**NA**	**$**	**30.88**	**$**	**1,326**	**22**	**1**
4.7.3	**Bedding**	**1 cy**	**NA**	**NA**	**$**	**45.35**	**$**	**64**	**22**	**1**
4.7.4	**Backfill and Compaction**	**43 cy**	**NA**	**NA**	**$**	**18.65**	**$**	**801**	**22**	**1**
4.7.5	**Thrust Blocks**	**2 cy**	**NA**	**NA**	**$**	**739.61**	**$**	**1,316**	**22**	**1**
4.8	Ferric Chloride Piping									
4.8.1	CPVC	0 lf	NA	NA		NA		--	NA	
4.8.1	PVC	0 lf	NA	NA		NA		--	NA	
4.9	Polymer Piping									
4.9.1	CPVC	0 lf	NA	NA		NA		--	NA	
4.9.1	PVC	0 lf	NA	NA		NA		--	NA	
4.9.1	Stainless Steel	0 lf	NA	NA		NA		--	NA	
4.9.1	Steel	0 lf	NA	NA		NA		--	NA	
5	**Valves and Fittings**									
5.1	Motor/Air Operated									
5.1.1	Process - Polypropylene/PVC	0 units	8 in. diam	8 in. diam	$	2,569		--	25	
5.1.1	Process - Stainless Steel	0 units	8 in. diam	8 in. diam	$	4,698		--	25	
5.1.1	Process - Cast Iron	0 units	8 in. diam	8 in. diam	$	2,569		--	25	
5.1.2	Backwash - Polypropylene/PVC	0 units	6 in. diam	6 in. diam	$	1,785		--	25	
5.1.2	Backwash - Stainless Steel	0 units	6 in. diam	6 in. diam	$	3,097		--	25	
5.1.2	Backwash - Cast Iron	0 units	6 in. diam	6 in. diam	$	6,663		--	25	
5.1.3	Brine - Polypropylene/PVC	0 units	6 in. diam	6 in. diam	$	1,785		--	25	
5.1.3	Brine - Stainless Steel	0 units	6 in. diam	6 in. diam	$	3,097		--	25	
5.1.4	Bypass - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.1.4	Bypass - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.1.4	Bypass - Cast Iron	0 units	NA	NA		NA		--	NA	
5.1.5	Caustic - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.1.5	Caustic - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.1.6	Residuals - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.1.6	Residuals - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.1.6	Residuals - Cast Iron	0 units	NA	NA		NA		--	NA	
5.1.7	Ferric Chloride - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.1.8	Polymer - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.1.8	Polymer - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.1.8	Polymer - Cast Iron	0 units	NA	NA		NA		--	NA	
5.2	Manual									
5.2.1	**Influent and treated water - Polypropylene/PVC**	**2 units**	**10 in. diam**	**10 in. diam**	**$**	**1,775**	**$**	**3,551**	**25**	**1**
5.2.1	Influent and treated water - Stainless Steel	2 units	10 in. diam	10 in. diam	$	2,293	$	4,585	25	0
5.2.1	Influent and treated water - Cast Iron	2 units	10 in. diam	10 in. diam	$	2,468	$	4,935	25	0
5.2.2	**Process - Polypropylene/PVC**	**13 units**	**8 in. diam**	**8 in. diam**	**$**	**1,249**	**$**	**16,237**	**25**	**1**
5.2.2	Process - Stainless Steel	13 units	8 in. diam	8 in. diam	$	1,865	$	24,241	25	0
5.2.2	Process - Cast Iron	13 units	8 in. diam	8 in. diam	$	1,954	$	25,400	25	0
5.2.3	**Backwash - Polypropylene/PVC**	**12 units**	**6 in. diam**	**6 in. diam**	**$**	**820**	**$**	**9,835**	**25**	**1**
5.2.3	Backwash - Stainless Steel	12 units	6 in. diam	6 in. diam	$	1,429	$	17,144	25	0
5.2.3	Backwash - Cast Iron	12 units	6 in. diam	6 in. diam	$	1,446	$	17,351	25	0
5.2.4	**Brine - Polypropylene/PVC**	**7 units**	**6 in. diam**	**6 in. diam**	**$**	**820**	**$**	**5,737**	**25**	**1**
5.2.4	Brine - Stainless Steel	7 units	6 in. diam	6 in. diam	$	1,429	$	10,001	25	0
5.2.5	Bypass - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.2.5	Bypass - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.2.5	Bypass - Cast Iron	0 units	NA	NA		NA		--	NA	
5.2.6	Caustic - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.2.6	Caustic - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.2.7	Residuals - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.2.7	Residuals - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.2.7	Residuals - Cast Iron	0 units	NA	NA		NA		--	NA	
5.2.8	Ferric Chloride - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.2.9	Polymer - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.2.9	Polymer - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.2.9	Polymer - Cast Iron	0 units	NA	NA		NA		--	NA	
5.3	Check Valves									
5.3.1	**Backwash - Polypropylene/PVC**	**2 units**	**6 in. diam**	**6 in. diam**	**$**	**1,226**	**$**	**2,452**	**25**	**1**
5.3.1	Backwash - Stainless Steel	2 units	6 in. diam	6 in. diam	$	2,809	$	5,619	25	0
5.3.1	Backwash - Cast Iron	2 units	6 in. diam	6 in. diam	$	2,863	$	5,725	25	0
5.3.2	**Residuals - Polypropylene/PVC**	**1 units**	**6 in. diam**	**6 in. diam**	**$**	**1,226**	**$**	**1,226**	**25**	**1**
5.3.2	Residuals - Stainless Steel	1 units	6 in. diam	6 in. diam	$	2,809	$	2,809	25	0
5.3.2	Residuals - Cast Iron	1 units	6 in. diam	6 in. diam	$	2,863	$	2,863	25	0
5.3.3	**Influent and treated water - Polypropylene/PVC**	**2 units**	**10 in. diam**	**10 in. diam**	**$**	**2,970**	**$**	**5,939**	**25**	**1**
5.3.3	Influent and treated water - Stainless Steel	2 units	10 in. diam	10 in. diam	$	6,356	$	12,712	25	0
5.3.3	Influent and treated water - Cast Iron	2 units	10 in. diam	10 in. diam	$	8,481	$	16,962	25	0
5.3.4	Bypass - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.3.4	Bypass - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.3.4	Bypass - Cast Iron	0 units	NA	NA		NA		--	NA	
5.3.5	Caustic - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.3.5	Caustic - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.3.6	Ferric Chloride - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.3.7	Polymer - Polypropylene/PVC	0 units	NA	NA		NA		--	NA	
5.3.7	Polymer - Stainless Steel	0 units	NA	NA		NA		--	NA	
5.3.7	Polymer - Cast Iron	0 units	NA	NA		NA		--	NA	
6	**Pumps**									
6.1	**Booster**	**2 units**	**1,875 gpm**	**1,875 gpm**	**$**	**29,505**	**$**	**59,010**	**20**	**1**
6.2	**Backwash**	**2 units**	**356 gpm**	**356 gpm**	**$**	**9,284**	**$**	**18,568**	**20**	**1**
6.3	Residuals	0 units	NA	NA		NA		--	NA	
6.4	Caustic Metering for pH Adjustment									
6.4.1	PVC - Motor Driven	0 units	NA	NA		NA		--	NA	
6.4.1	Stainless Steel - Motor Driven	0 units	NA	NA		NA		--	NA	
6.4.1	PVC - Electric	0 units	NA	NA		NA		--	NA	
6.4.1	Stainless Steel - Electric	0 units	NA	NA		NA		--	NA	
6.5	Ferric Chloride Metering									
6.5.1	PVC - Motor Driven	0 units	NA	NA		NA		--	NA	
6.5.1	PVC - Electric	0 units	NA	NA		NA		--	NA	
6.6	Polymer Metering									
6.6.1	PVC - Motor Driven	0 units	NA	NA		NA		--	NA	
6.6.1	Stainless Steel - Motor Driven	0 units	NA	NA		NA		--	NA	
6.6.1	PVC - Electric	0 units	NA	NA		NA		--	NA	
6.6.1	Stainless Steel - Electric	0 units	NA	NA		NA		--	NA	
7	**Mixers**									
7.1	Brine Mixers									
7.1.1	Portable	1 units	1 hp	1 hp	$	2,674	$	2,674	25	0
7.1.1	**Mounted**	**1 units**	**1 hp**	**1 hp**	**$**	**3,221**	**$**	**3,221**	**25**	**1**
7.2	Residuals Mixers									
7.2.1	Portable	0 units	NA	NA		NA		--	NA	
7.2.1	Mounted	0 units	NA	NA		NA		--	NA	
7.2.1	Impeller	0 units	NA	NA		NA		--	NA	
7.3	Mixers for Caustic Storage Tanks									

7.3.1	Portable	0 units	NA	NA	NA	--	NA	
7.3.1	Mounted	0 units	NA	NA	NA	--	NA	
7.3.1	Impeller	0 units	NA	NA	NA	--	NA	
7.4	Mixers for Caustic Day Tanks							
7.4.1	Portable	0 units	NA	NA	NA	--	NA	
7.4.1	Mounted	0 units	NA	NA	NA	--	NA	
7.4.1	Impeller	0 units	NA	NA	NA	--	NA	
7.5	Mixers for Ferric Chloride Storage Tanks							
7.5.1	Portable	0 units	NA	NA	NA	--	NA	
7.5.1	Mounted	0 units	NA	NA	NA	--	NA	
7.5.1	Impeller	0 units	NA	NA	NA	--	NA	
7.6	Mixers for Polymer Storage Tanks							
7.6.1	Portable	0 units	NA	NA	NA	--	NA	
7.6.1	Mounted	0 units	NA	NA	NA	--	NA	
7.6.1	Impeller	0 units	NA	NA	NA	--	NA	
8	**Chemical Feed and Solids Transfer**							
8.1	Eductors for brine							
8.1.1	**Stainless Steel**	**1 units**	**6 in. diam**	**6 in. diam**	**$ 9,660**	**$ 9,660**	**45**	**1**
8.1.1	Plastic	1 units	6 in. diam	6 in. diam	contact vendor	--	22	0
8.2	Manual holding tank solids transfer, no equipment needed	0 units	NA	NA	NA	--	NA	
9	**Salt Saturator**							
9.1	Fiberglass	0 units	NA tons	NA tons	NA	--	NA	
9.1	Reinforced Plastic	0 units	NA tons	NA tons	NA	--	NA	
10	**Instrumentation and Controls**							
10.1	Flow Meters - Influent and Treated Water							
10.1.1	Orifice Plate	1 units	10 in. diam	10 in. diam	$ 4,627	$ 4,627	15	0
10.1.1	**Propeller**	**1 units**	**10 in. diam**	**10 in. diam**	**$ 6,008**	**$ 6,008**	**15**	**1**
10.1.1	Venturi	1 units	10 in. diam	10 in. diam	$ 4,013	$ 4,013	15	0
10.1.1	Magnetic	1 units	10 in. diam	10 in. diam	$ 8,446	$ 8,446	15	0
10.2	Flow Meters - Process							
10.2.1	Orifice Plate	0 units	8 in. diam	8 in. diam	$ 4,075	--	15	
10.2.1	Propeller	0 units	8 in. diam	8 in. diam	$ 5,273	--	15	
10.2.1	Venturi	0 units	8 in. diam	8 in. diam	$ 3,520	--	15	
10.2.1	Magnetic	0 units	8 in. diam	8 in. diam	$ 7,293	--	15	
10.3	Flow Meters - Backwash							
10.3.1	Orifice Plate	1 units	6 in. diam	6 in. diam	$ 3,418	$ 3,418	15	0
10.3.1	**Propeller**	**1 units**	**6 in. diam**	**6 in. diam**	**$ 4,479**	**$ 4,479**	**15**	**1**
10.3.1	Venturi	1 units	6 in. diam	6 in. diam	$ 3,069	$ 3,069	15	0
10.3.1	Magnetic	1 units	6 in. diam	6 in. diam	$ 6,186	$ 6,186	15	0
10.4	Flow Meters - Residuals							
10.4.1	Orifice Plate	1 units	6 in. diam	6 in. diam	$ 3,418	$ 3,418	15	0
10.4.1	**Propeller**	**1 units**	**6 in. diam**	**6 in. diam**	**$ 4,479**	**$ 4,479**	**15**	**1**
10.4.1	Venturi	1 units	6 in. diam	6 in. diam	$ 3,069	$ 3,069	15	0
10.4.1	Magnetic	1 units	6 in. diam	6 in. diam	$ 6,186	$ 6,186	15	0
10.5	Level Switch/Alarm (for vessels)	0 units	NA	NA	NA	--	NA	
10.6	**High/Low Alarm (for backwash tanks)**	**1 units**	**NA**	**NA**	**$ 600**	**$ 600**	**15**	**1**
10.7	**High/Low Alarm (for brine tanks)**	**1 units**	**NA**	**NA**	**$ 600**	**$ 600**	**15**	**1**
10.8	High/Low Alarm (for caustic tanks)	0 units	NA	NA	NA	--	NA	
10.9	High/Low Alarm (for holding tanks)	0 units	NA	NA	NA	--	NA	
10.1	**Temperature meters**	**1 units**	**NA**	**NA**	**$ 795**	**$ 795**	**15**	**1**
10.11	Head loss sensors	0 units	NA	NA	$ 2,389	--	15	
10.12	Sampling Ports							
10.12.1	**Stainless Steel**	**12 units**	**NA**	**NA**	**$ 50**	**$ 600**	**35**	**1**
10.12.1	Carbon Steel	12 units	NA	NA	$ 50	$ 600	25	0
10.13	Electrical Enclosure	0 units	NA	NA	$ 1,400	--	22	
10.14	ORP sensors	0 units	NA	NA	$ 2,733	--	15	
10.15	pH Meters	0 units	NA	NA	$ 3,047	--	15	
10.16	**Turbidity meters**	**1 units**	**NA**	**NA**	**$ 6,184**	**$ 6,184**	**15**	**1**
10.17	Conductivity meters	0 units	NA	NA	$ 2,280	--	15	
10.18	Nitrate Analyzer	0 units	NA	NA	$ 25,804	--	15	
11	**System Controls**							
11.1	PLC Units							
11.1.1	PLC racks/power supplies	0 units	NA	NA	NA	$ -	NA	
11.1.2	CPUs	0 units	NA	NA	NA	$ -	NA	
11.1.3	I/O discrete input modules	0 units	NA	NA	NA	$ -	NA	
11.1.4	I/O discrete output modules	0 units	NA	NA	NA	$ -	NA	
11.1.5	I/O combination analog modules	0 units	NA	NA	NA	$ -	NA	
11.1.6	Ethernet modules	0 units	NA	NA	NA	$ -	NA	
11.1.7	Base expansion modules	0 units	NA	NA	NA	$ -	NA	
11.1.8	Base expansion controller modules	0 units	NA	NA	NA	$ -	NA	
11.1.9	UPSs	0 units	NA	NA	NA	$ -	NA	
11.2	Operator Equipment							
11.2.1	Drive controllers	0 units	NA	NA	NA	$ -	15	
11.2.2	Operator interface units	0 units	NA	NA	NA	$ -	NA	
11.2.3	PC Workstations	0 units	NA	NA	NA	$ -	NA	
11.2.4	Printers - laser jet	0 units	NA	NA	NA	$ -	NA	
11.3	Controls Software							
11.3.1	Operator interface software	0 units	NA	NA	NA	$ -	NA	
11.3.2	PLC programming software	0 units	NA	NA	NA	$ -	NA	
11.3.3	PLC data collection software	0 units	NA	NA	NA	$ -	NA	
11.3.4	Plant intelligence software	0 units	NA	NA	NA	$ -	NA	
12	**Building Structures**							
12.1	Building 1							
12.1.1	Small Low Cost Shed	- units	3,220 sf	3,220 sf	NA	--	N/A	
12.1.1	**Low Quality**	**1 units**	**3,220 sf**	**3,220 sf**	**$ 75.88**	**$ 244,341**	**40**	**1**
12.1.1	Medium Quality	1 units	3,220 sf	3,220 sf	$ 91.01	$ 293,059	40	0
12.1.1	High Quality	1 units	3,220 sf	3,220 sf	$ 125.43	$ 403,872	40	0
12.2	Heating System							
12.2.1	Electric resistance	1 zones	65 MBH	65 MBH	$ 28,498	$ 28,498	25	0
12.2.1	Natural gas non-condensing furnace	1 zones	65 MBH	65 MBH	$ 20,373	$ 20,373	25	0
12.2.1	**Natural gas condensing furnace**	**1 zones**	**65 MBH**	**65 MBH**	**$ 20,373**	**$ 20,373**	**25**	**1**
12.2.1	Standard efficiency oil furnace	1 zones	65 MBH	65 MBH	$ 23,271	$ 23,271	25	0
12.2.1	Mid-efficiency oil furnace	1 zones	65 MBH	65 MBH	$ 23,271	$ 23,271	25	0
12.3	Cooling System							
12.3.1	Air conditioner	NA	NA	NA	NA	--	NA	
12.3.1	Heat pump	NA	NA	NA	NA	--	NA	
12.4	Building 2							
12.4.1	Small Low Cost Shed	- units	- sf	- sf	NA	--	N/A	
12.4.1	Low Quality	- units	- sf	- sf	NA	--	N/A	
12.4.1	Medium Quality	- units	- sf	- sf	NA	--	N/A	
12.4.1	High Quality	- units	- sf	- sf	NA	--	N/A	
12.5	Heating System							
12.5.1	Electric resistance	NA	NA	NA	NA	--	NA	
12.5.1	Natural gas non-condensing furnace	NA	NA	NA	NA	--	NA	
12.5.1	Natural gas condensing furnace	NA	NA	NA	NA	--	NA	
12.5.1	Standard efficiency oil furnace	NA	NA	NA	NA	--	NA	
12.5.1	Mid-efficiency oil furnace	NA	NA	NA	NA	--	NA	
12.6	Cooling System							
12.6.1	Air conditioner	NA	NA	NA	NA	--	NA	

12.6.1	*Heat pump*	*NA*		*NA*		*NA*			*NA*	*--*	*NA*	
12.7	**Concrete Pad**	**1**	**units**	**55**	**cy**	**55**	**cy**	**$**	**492.75**	**$ 27,101**	**40**	**1**
13	**Septic System**											
13.1	*Septic Tanks*	*-*	*units*	*NA*	*gal*	*NA*	*gal*		*NA*	*--*	*NA*	
13.2	*Excavation for Septic Tanks*	*-*	*cy*	*NA*		*NA*			*NA*	*--*	*NA*	
13.3	*Distribution Boxes*	*-*	*units*	*NA*		*NA*			*NA*	*--*	*NA*	
13.4	*Distribution Pipe (Perforated PVC)*	*-*	*lf*	*NA*	*in. diam*	*NA*	*in. diam*		*NA*	*--*	*NA*	
13.5	*Drain Field Trench Excavation*	*-*	*cy*	*NA*		*NA*			*NA*	*--*	*NA*	
13.6	*Drain Field Gravel*	*-*	*cy*	*NA*		*NA*			*NA*	*--*	*NA*	
14	**Evaporation Ponds**											
14.1	*Excavation*	*0*	*cells*	*NA*		*NA*			*NA*	*--*	*NA*	
14.2	*Backfill*	*0*	*cells*	*NA*		*NA*			*NA*	*--*	*NA*	
14.3	*Liner*	*0*	*cells*	*NA*		*NA*			*NA*	*--*	*NA*	
14.4	*Dike Construction*	*0*	*cells*	*NA*		*NA*			*NA*	*--*	*NA*	
15	**Solids drying pad**											
15.1	*Solids drying pad*	*0*	*units*	*-*	*cy*	*-*	*cy*	*$*	*493*	*$ -*	*NA*	

Total of direct line items above:		Total	Guidance
	Process costs	$ 703,565	Excludes components in italics (which are alternate costs for comparison). Includes installation, transportation, and O&P
	Building costs	$ 291,815	See input sheet to exclude buildings/HVAC; indirect assumptions sheet to exclude concrete pad
	Total direct capital cost	**$995,379**	Total of process and building costs

Add-on Cost Details (See indirect assumptions sheet to exclude individual add-on items)

Add-on Line Item	Total	Guidance
Permits	$ 5,599	
Pilot Study	$ -	
Land Cost	$ -	For 0.19 acres
Total add-on costs	**$5,599**	Total of permits, piloting, and land

Indirect Capital Cost Details (See indirect assumptions sheet to exclude individual indirect items)

Indirect Line Item	Total	Percent	Guidance
Mobilization and Demobilization	$ -	0%	Excluded for pre-engineered packages
Architectural Fees for Treatment Building	$ 23,345	8%	Excluded by default for small systems
Installation, Transportation, and O&P	$ -	0%	
Site Work	$ 48,916		Calculated based on system requirements.
Yard Piping	$ 9,293		Calculated based on system requirements.
Geotechnical	$ 8,740		Calculated based on system requirements. Excluded by default for low and medium cost systems, but always included for systems w/ exacava
Standby Power	$ -		Calculated based on system requirements. Excluded by default for small systems.
Electrical (including yard wiring)	$ 70,356	10%	Percentage is applied only to process cost. Building direct costs include electrical components.
Instrumentation and Control	$ -	0%	
Contingency	$ -	0%	Included for high cost systems only.
Process Engineering	$ 119,446	12%	
Miscellaneous Allowance	$ 99,538	10%	
Legal, Fiscal, and Administrative	$ 19,908	2%	
Sales Tax	$ -	0%	
Financing during Construction	$ -	0%	
Construction Management and GC Overhead	$ 63,107		
Total indirect capital cost	**$462,648**		Total of indirect line items

TOTAL CAPITAL COST DETAILS

Assumption	Value	Guidance
City Index for Total Capital Cost	1.1	User adjustable. Can be used to adjust estimated costs to be more reflective of a specific geographical location

Capital Cost Category	Total
Total Direct Capital Cost (from above)	$ 995,379
Total Add-on Cost (from above)	$ 5,599
Total Indirect Cost (from above)	$ 462,648
Grand total capital cost (incorporating city index)	**$ 1,639,262**

Annual Operating and Maintenance Cost Details (items in italics, without a 1 in the "Use?" column, represent alternate costs and are excluded from total)

Assumption	Value	Guidance
City Index for Total O&M Cost	1.1	User adjustable. Can be used to adjust estimated costs to be more reflective of a specific geographical location

Item	Quantity		Unit Cost			Total Cost	Use?	Guidance
Labor								
Manager	**55**	**hrs/yr**	**$**	**64.53**	**/hr**	**$ 3,579**	**1**	
Administrative	**55**	**hrs/yr**	**$**	**42.48**	**/hr**	**$ 2,356**	**1**	
Operator	**555**	**hrs/yr**	**$**	**38.46**	**/hr**	**$ 21,332**	**1**	Includes labor for regular operations, maintenance, regeneration, etc.
Materials								
Materials for booster pumps	***calculated as a percentage of capital***					**$ 590**	**1**	
Materials for backwash pumps	*calculated as a percentage of capital*					*$ -*	*0*	
Materials for residuals pumps	*calculated as a percentage of capital*					*$ -*	*0*	
Building and HVAC maintenance (materials and labor)	**3,220**	**sf**	**$**	**6.63**	**/sf/yr**	**$ 21,341**	**1**	
Chemicals								
Sodium Chloride - Small Qty	**56,214**	**lbs/yr**	**$**	**0.29**	**/lb**	**$ 16,280**	**1**	
Sodium Hydroxide 50%	*-*	*lbs/yr*		*NA*	*/lb*	*NA*	*0*	
Ferric Chloride	*-*	*lbs/yr*		*NA*	*/lb*	*NA*	*0*	
Polymers	*-*	*lbs/yr*		*NA*	*/lb*	*NA*	*0*	
Resin loss replacement								
Strong base polystyrenic gel-type Type I	**37**	**cf/yr**	**$**	**232.14**	**/cf**	**$ 8,538**	**1**	
Complete bed replacement (annual average)								
Strong base polystyrenic gel-type Type I	**170**	**cf/yr**	**$**	**232.14**	**/cf**	**$ 39,436**	**1**	
Energy								
Energy for backwash pumps	**0.01**	**Mwh/yr**	**$**	**0.11**	**/kwh**	**$ 1**	**1**	
Energy for booster pumps	**190.36**	**Mwh/yr**	**$**	**0.11**	**/kwh**	**$ 20,943**	**1**	
Energy for residuals pumps	*-*	*Mwh/yr*		*NA*		*--*	*0*	
Energy for lighting	**1**	**Mwh/yr**	**$**	**0.11**	**/kwh**	**$ 59**	**1**	
Energy for ventilation	**3**	**Mwh/yr**	**$**	**0.11**	**/kwh**	**$ 352**	**1**	
Energy for cooling								
Air conditioning	*-*	*Mwh/yr*	*$*	*0.11*	*/kwh*	*$ -*	*0*	
Heat pump (cooling mode)	*-*	*Mwh/yr*	*$*	*0.11*	*/kwh*	*$ -*	*0*	
Energy for heating								
Electric resistance	*0*	*Mwh/yr*	*$*	*0.11*	*/kwh*	*$ -*	*0*	
Heat pump	*0*	*Mwh/yr*	*$*	*0.11*	*/kwh*	*$ -*	*0*	
Natural gas non-condensing furnace	*-*	*therms/yr*	*$*	*0.58*	*/therm*	*$ -*	*0*	
Natural gas condensing furnace	**6,357**	**therms/yr**	**$**	**0.58**	**/therm**	**$ 3,678**	**1**	
Standard efficiency oil furnace	*-*	*gal/yr*	*$*	*3.83*	*/gal*	*$ -*	*0*	
Mid-efficiency oil furnace	*-*	*gal/yr*	*$*	*3.83*	*/gal*	*$ -*	*0*	
Residuals Discharge/Disposal								
POTW discharge fees	**667,292**	**gal/yr**	**$**	**0.010**	**/gal**	**$ 6,591**	**1**	
Spent resin disposal	**4**	**ton/yr**	**$**	**112.16**	**/ton**	**$ 410**	**1**	
Miscellaneous Allowance	**10%**					**$ 14,549**	**1**	
Total Annual O&M Cost (incorporating city index)						**$ 179,239**		

ANNUALIZED COSTS

Assumption	Value	Guidance

Discount rate	7%	User adjustable
Calculate households based on:	ground water	User adjustable
Household size (people per household)	2.53	User adjustable

Calculation	Value	Units	
Useful Life (Reciprocal Weighted Average)	34.0	years	
Number of households served	5,702.5	households	
Annualized Capital Cost	**$127,529**	/year	
Annual O&M Cost	**$179,239**	/year	
Total Annualized Cost	**$306,768**	/year	42% annualized capital, 58% annual O&M
Annualized cost per 1,000 gallons average flow	$0.39	/kgal	
Annualized cost per household	$54	/household/year	

Location Factors - Residential/Commercial - V2

Costs shown in *Square Foot Costs with RSMeans data* are based on national averages for materials and installation. To adjust these costs to a specific location, simply multiply the base cost by the factor for that city. The data is arranged alphabetically by state and postal zip code numbers. For a city not listed, use the factor for a nearby city with similar economic characteristics.

STATE/ZIP	CITY	Residential	Commercial
ALABAMA			
350-352	Birmingham	.84	.86
354	Tuscaloosa	.84	.86
355	Jasper	.82	.86
356	Decatur	.83	.85
357-358	Huntsville	.83	.85
359	Gadsden	.81	.86
360-361	Montgomery	.84	.87
362	Anniston	.80	.84
363	Dothan	.84	.86
364	Evergreen	.79	.84
365-366	Mobile	.83	.85
367	Selma	.81	.86
368	Phenix City	.82	.86
369	Butler	.80	.85
ALASKA			
995-996	Anchorage	1.17	1.16
997	Fairbanks	1.21	1.16
998	Juneau	1.21	1.16
999	Ketchikan	1.22	1.22
ARIZONA			
850,853	Phoenix	.84	.87
851,852	Mesa/Tempe	.83	.86
855	Globe	.82	.86
856-857	Tucson	.84	.86
859	Show Low	.84	.87
860	Flagstaff	.88	.89
863	Prescott	.87	.88
864	Kingman	.84	.86
865	Chambers	.87	.86
ARKANSAS			
716	Pine Bluff	.77	.82
717	Camden	.78	.81
718	Texarkana	.79	.82
719	Hot Springs	.75	.80
720-722	Little Rock	.83	.82
723	West Memphis	.82	.83
724	Jonesboro	.81	.82
725	Batesville	.78	.80
726	Harrison	.80	.80
727	Fayetteville	.77	.80
728	Russellville	.78	.79
729	Fort Smith	.83	.81
CALIFORNIA			
900-902	Los Angeles	1.15	1.12
903-905	Inglewood	1.13	1.08
906-908	Long Beach	1.11	1.09
910-912	Pasadena	1.11	1.09
913-916	Van Nuys	1.14	1.11
917-918	Alhambra	1.15	1.10
919-921	San Diego	1.10	1.09
922	Palm Springs	1.09	1.08
923-924	San Bernardino	1.13	1.08
925	Riverside	1.13	1.11
926-927	Santa Ana	1.14	1.10
928	Anaheim	1.13	1.11
930	Oxnard	1.13	1.10
931	Santa Barbara	1.12	1.09
932-933	Bakersfield	1.12	1.10
934	San Luis Obispo	1.15	1.10
935	Mojave	1.13	1.08
936-938	Fresno	1.19	1.13
939	Salinas	1.22	1.16
940-941	San Francisco	1.32	1.30
942,956-958	Sacramento	1.19	1.15
943	Palo Alto	1.26	1.22
944	San Mateo	1.33	1.26
945	Vallejo	1.25	1.19
946	Oakland	1.31	1.25
947	Berkeley	1.33	1.24
948	Richmond	1.33	1.22
949	San Rafael	1.32	1.25
950	Santa Cruz	1.25	1.19
951	San Jose	1.32	1.27
952	Stockton	1.20	1.14
953	Modesto	1.20	1.14

STATE/ZIP	CITY	Residential	Commercial
CALIFORNIA (CONT'D)			
954	Santa Rosa	1.28	1.22
955	Eureka	1.27	1.18
959	Marysville	1.21	1.14
960	Redding	1.24	1.19
961	Susanville	1.22	1.18
COLORADO			
800-802	Denver	.91	.92
803	Boulder	.90	.88
804	Golden	.88	.89
805	Fort Collins	.89	.90
806	Greeley	.88	.88
807	Fort Morgan	.90	.88
808-809	Colorado Springs	.87	.89
810	Pueblo	.86	.88
811	Alamosa	.85	.89
812	Salida	.87	.89
813	Durango	.88	.87
814	Montrose	.84	.87
815	Grand Junction	.91	.90
816	Glenwood Springs	.85	.88
CONNECTICUT			
060	New Britain	1.10	1.07
061	Hartford	1.09	1.09
062	Willimantic	1.10	1.08
063	New London	1.09	1.05
064	Meriden	1.10	1.06
065	New Haven	1.10	1.08
066	Bridgeport	1.10	1.08
067	Waterbury	1.10	1.08
068	Norwalk	1.10	1.08
069	Stamford	1.11	1.11
D.C.			
200-205	Washington	.92	.96
DELAWARE			
197	Newark	1.01	1.04
198	Wilmington	1.01	1.04
199	Dover	1.02	1.04
FLORIDA			
320,322	Jacksonville	.81	.84
321	Daytona Beach	.82	.85
323	Tallahassee	.83	.85
324	Panama City	.82	.85
325	Pensacola	.83	.86
326,344	Gainesville	.79	.83
327-328,347	Orlando	.82	.84
329	Melbourne	.82	.87
330-332,340	Miami	.83	.85
333	Fort Lauderdale	.82	.86
334,349	West Palm Beach	.83	.84
335-336,346	Tampa	.81	.85
337	St. Petersburg	.80	.85
338	Lakeland	.78	.84
339,341	Fort Myers	.79	.84
342	Sarasota	.83	.85
GEORGIA			
300-303,399	Atlanta	.90	.89
304	Statesboro	.77	.85
305	Gainesville	.79	.83
306	Athens	.78	.82
307	Dalton	.81	.85
308-309	Augusta	.87	.87
310-312	Macon	.84	.86
313-314	Savannah	.86	.87
315	Waycross	.79	.84
316	Valdosta	.75	.83
317,398	Albany	.84	.86
318-319	Columbus	.84	.86
HAWAII			
967	Hilo	1.18	1.16
968	Honolulu	1.22	1.19

Attachment 18: Purolite Hexavalent Chromium Removal

Hexavalent Chromium Removal:

Design Guide for Potable Water

Discover the most cost-effective ion exchange solutions for your site to be in compliance with state and federal maximum contaminant levels (MCLs).

Purolite®
An Ecolab Company

Purolite®
An Ecolab Company

About Purolite

Purolite is a leading manufacturer of ion exchange, catalyst, adsorbent and specialty resins. With global headquarters in the United States of America, Purolite focuses 100% of its resources on the development and production of resin technology.

Responding to our customers' needs, Purolite has a wide variety of products and the industry's largest technical sales force. Globally, we have strategically located research and development centers and application laboratories. Our ISO 9001 certified manufacturing facilities in the USA, United Kingdom, Romania and China combined with more than 40 sales offices in 30 countries ensure complete worldwide coverage.

Purolite has been part of Ecolab since 2021. A trusted partner at nearly three million commercial customer locations, Ecolab (ECL) is the global leader in water, hygiene and infection prevention solutions and services. Ecolab delivers comprehensive solutions, data-driven insights and personalized service to advance food safety, maintain clean and safe environments, optimize water and energy use, and improve operational efficiencies and sustainability for customers in the food, healthcare, hospitality and industrial markets in more than 170 countries around the world.

PREMIER PRODUCTS

The quality and consistency of our products is fundamental to our performance. Throughout all Purolite plants, production is carefully controlled to ensure that our products meet the most stringent criteria, regardless of where they are produced.

RELIABLE SERVICE

We are technical experts and problem solvers. Reliable and well trained, we understand the urgency required to keep businesses operating smoothly. Purolite employs the largest technical sales team in the industry.

INNOVATIVE SOLUTIONS

Our continued investment in research and development means we are always perfecting and discovering innovative uses for ion exchange resins and adsorbents. We strive to make the impossible possible.

Hexavalent Chromium Removal: Design Guide for Potable Water

Contents

Introduction

Chromium is a heavy metal that occurs throughout the environment. The trivalent form is a required nutrient, while the hexavalent form, also commonly known as Chromium (VI), Cr (VI), Chrome 6 or Cr-6, is a known carcinogen and an emerging health concern for groundwater. Treatment options should be chosen carefully as technologies are sensitive to water conditions.

Key Factors affecting treatment include alkalinity, sulfate, TOC, Cr-6 and uranium levels. Costs associated with equipment, residual disposal and operational preferences can affect the selection of treatment and process.

Purolite offers several industry-leading solutions that work within a variety of site and operational conditions. Regenerable Purolite A600E/9149, Purolite PGW6002E or Purolite S106 can provide cost-effective solutions for reducing or eliminating contamination to meet compliance with state and federal maximum contaminant levels (MCLs).

Advantages of Purolite ion exchange resins for hexavalent chrome removal include:

- Single supplier for the full range of resin options available in the industry.
- Reliable modeling software for ease of design, capacity and operational expectations.
- Customizable brine minimization approach or single-pass approach.
- Multi-contaminant design approach is possible for simultaneous removal with other contaminants.
- Turn-key solutions for resin supply, resin removal, and assistance coordinating with waste disposal facilities.

Each treatment site will have its combination of factors that must be carefully evaluated and modeled. As a rule of thumb, WBA resin tends to be favored for water with increasing levels of sulfate and total dissolved solids. On the other hand, high sulfate levels usually mean more frequent regeneration of SBA resins and therefore increasing cost for regenerant and wastewater disposal. Below is a more in-depth discussion of the merits of both types of resins.

With SBA resin, no pH adjustment is normally needed and the resin can be reused multiple times by using a brine solution periodically to elute the chromium from the resin. The SBA design must include proper treatment and disposal of the spent chromium-containing brine. Choosing between WBA and SBA resin technology will depend on:

A. The impact of competing anions (e.g. SO_4, NO_3, HCO_3, Cl) on resin capacity

B. The size of the treatment plant and the availability of operators for daily maintenance

C. The target treatment level for chrome VI

D. Whether acid and caustic for pH control with WBA resin can be accommodated

E. The site options available for handling and disposal of chromium-containing brine

Design Guidelines

Recommended Design Guidelines for Chrome VI Treatment Systems

Pretreatment

Prefilters to prevent total suspended solids (TSS) accumulation in the resin bed is vital to good operation. The longer the resin will be in service, especially with single-use ion exchange resins, the more important proper design and operation of a prefiltration system is to the resin performance. A particle size distribution analysis can help determine the size of incoming solids. If the well produces any sand, a de-sander is also recommended.

Resin performs best when foulants are eliminated. If any of these are present in the water in concentrations high enough to affect resin performance, they need to be adequately removed:

- Iron <.5 ppm
- Manganese >20 ppb
- Oil and Grease: Any concentration is detrimental
- Oxidants: Any concentration is detrimental
- Langelier Saturation Index: Ensure there is no scaling potential
- Microbes: Influent water must be bacteria-free
- TOC > 2 ppm

Weak Base Anion Exchange: Purolite S106

Purolite S106 is a single-use epoxy polyamine weak base anion resin (WBA) that exhibits excellent selectivity and kinetics in the removal of ppb levels of hexavalent chromium.

Single-use "load and dispose" systems do not utilize an on-site regeneration process and are ideal in locations with significant footprint constraints or where accessibility to brine disposal options is limited. After the resin is spent, it can be sent to a landfill for disposal or transferred to a chrome recovery facility. Resin will then be replaced for on-going treatments.

As with all water treatment applications, a detailed raw water analysis is needed for proper resin selection and system design. Water parameters needed include:

- pH
- Total Dissolved Solids (TDS)
- Total Suspended Solids (TSS)
- Alkalinity
- Nitrate
- Sulfate
- Chloride
- Uranium

With WBA resin, it is necessary to reduce the influent water pH using an acid.

Operation of two ion exchange vessels in a lead-lag configuration within a pH range of 5.0 to 6.0 is recommended. Reducing the pH converts most of the chrome-6 from its divalent to its monovalent state — this essentially doubles the loading capacity of the resin for chromium-6 and facilitates single-use operation of the resin to meet targeted MCLs in the treated water

A reduction of over 99% can be achieved when operating at a service flowrate of 20 bed volumes per hour. Resin can treat between 100,000 and 300,000 bed volumes between replacements.

Consideration should be given to the following design and operating factors:

- The pH of the influent water must be reduced to between 5.5 and 6 before the Purolite S106.
- The bicarbonate alkalinity of the raw water will determine the acid dosage needed.
- The pH of the treated water must be re-adjusted upward to the influent levels before the water is sent to the distribution system.
- Most drinking water well quality is amenable to WBA treatment with Purolite S106.

- Any uranium present in the influent water will also be removed by the resin; this can sometimes limit loading capacity and can determine disposal cost for the spent resin.
- Purolite S106 resin can generally treat hundreds of thousands of bed volumes of water before it is spent, making it economically feasible in many cases. Please contact a Purolite technical sales representative to help determine throughput estimates.
- Purolite S106 contains no formaldehyde and does NOT require preconditioning that other phenol-formaldehyde type WBA resin do for chrome VI.

Residuals Handling

- Adjust pH to less than 6 before ion exchange (IX) vessels using mineral acid or CO_2 gas.
- Readjust pH to feed levels after IX vessels using caustic or by degasification.
- Test for uranium accumulation in spent resin.

TABLE 1 Weak Base Anion Design Parameters

Design Parameter	Value
Resin Depth	3 ft minimum (0.91 m)
Linear Velocity	8 to 12 gpm/ft^2 (20 to 30 m/h)
Specific Flow Rate	1 to 5 gpm/ft^3 (8 to 40 BV/h)
Empty Bed Contact Time	2–3 minutes minimum
Influent pH	5.5–5.9

Vessels are generally designed in a lead/lag configuration
1 bed volume = 1 unit of water/1 unit of resin

WBA Example

In this example, the influent chromium-6 is 15 ppb. The goal is to be less than or equal to 8 ppb. Therefore, partial treatment and blending is most economical. The sulfate level is 120 ppm, so SBA regeneration is not feasible. WBA is the best solution in this case.

A throughput projection can be done by contacting Purolite. We assume an estimated Cr-6 leakage of 1 ppb.

TABLE 2A Raw Groundwater Parameters

Raw Water Parameter	Value
Well Pump Flow Rate	227.1 m^3/h (1,000 gpm)
Treated Flow Rate	113.6 m^3/h (500 gpm)
Bypassed Flow Rate	113.6 m^3/h (500 gpm)
Total Chromium	15.5 ppb
Chrome VI	15 ppb
Alkalinity as $CaCO_3$	120 ppm as $CaCO_3$
Chloride	120 ppm
Sulfate	120 ppm
Nitrate as N	5 ppm as N
Uranium	2 ppm
pH	7.5

TABLE 2B Example Case Design Information

Design Parameter	Value
Total Flow Rate	227.1 m^3/h (1,000 gpm)
Influent Chrome VI	15 ppb
Leakage Chrome VI	1 ppb
Effluent Concentration Goal of Chrome VI (Blended)	8 ppb
Bypass Flow Percent	50%
Bypassed Flow Rate	113.6 m^3/h (500 gpm)
Treated Flow Rate	113.6 m^3/h (500 gpm)
Number of Trains	1
Vessel Diameter	2.4 m (8 ft)
Flow per Vessel	113.6 m^3/h (500 gpm)
Volume per Supersack	42 ft^3
Number of Supersacks per Vessel	5
Media Volume per Vessel	5,947 l (210 ft^3)
Media Volume Total Onsite	11,893 l (420 ft^3)
Vessel Area	4.6 m^2 (50 ft^2)
Bed Depth	1.3 m (4.2 ft)
Linear Velocity	29.1 m/h (11.9 gpm/ft^2)
Specific Flow Rate	23.3 BV/h (2.9 gpm/ft^3)
EBCT Goal: 2.5 to 3 min.	2.4 minutes
Projected Throughput	193,333 BV
Days Between Exchanges	422 days

Design Steps

- Determine treated flow

$$\textbf{Bypass Percentage} = \frac{\textbf{(Effluent Concentration Goal – Leakage Concentration)}}{\textbf{(Influent Concentration – Leakage Concentration)}}$$

$$\textbf{Example: Bypass Percentage} = \frac{\textbf{(8 ppb – 1 ppb)}}{\textbf{(15 ppb – 1 ppb)}} = \textbf{50\%}$$

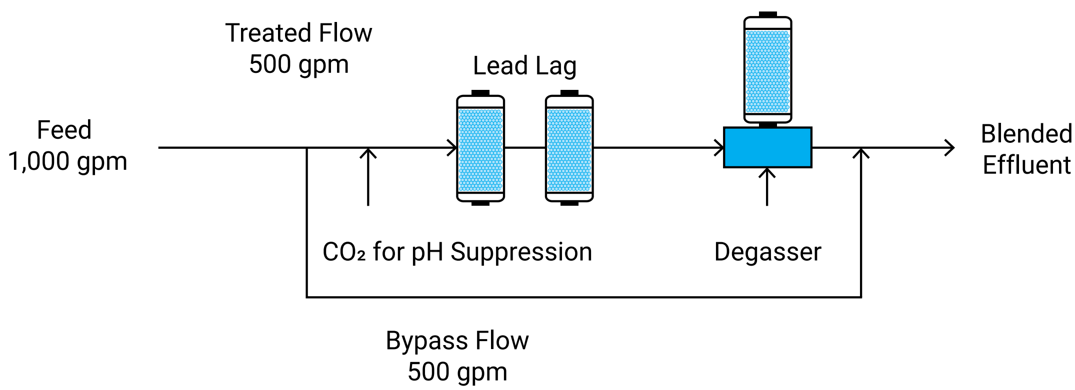
Bypass Flow = Bypass Percentage x Total Flow Rate

Example: Bypass Flow = 50% x 1,000 gpm = 500 gpm

- Determine available equipment diameter.
- Determine number of trains to meet appropriate design conditions.
- Determine volume of resin to achieve the minimum bed depth by varying the number of supersacks. It is much easier to load and unload based on using full supersack volumes (42 cu ft per supersack).

FIGURE 1

WBA Design with S106



Strong Base Anion Exchange Resins

Strong base anion exchange resins are effective over a wider pH range and do not typically require pH adjustment. Water passes through the resin where chrome VI and other anions are exchanged for chloride initially.

Purolite A600E/9149 is a Type I strong base anion (SBA) gel ion exchange resin. Purolite A600E/9149 exchanges chrome VI anions for less strongly held chloride ions on the resin beads and requires periodic regeneration with salt solution (brine) and disposal and/or treatment of the Cr-6 laden brine. Regeneration frequencies of between 5,000 and 25,000 bed volumes can be achieved between regenerations depending on the influent water chemistry.

Purolite PGW6002E is a high capacity Type I SBA resin that works well as a single use resin with lower sulfate levels.

SBA resin is more selective for chrome-6 vs other major anions typically present:

$$CrO_4^{2-} > SO_4^{2-} > NO_3^{-} > Cl^{-} > HCO_3^{-} > F^{-}$$

Depending on the water chemistry — especially sulfates — SBA resins can be used as either a single-use or a regenerable resin.

The reaction is:

$$CrO_4^{2-} + Resin - Cl_2 \rightarrow \leftarrow Resin - CrO_4^{2} + 2Cl^{-}$$

Single-Use SBA Resin: Purolite PGW6002E

When sulfates are very low, Purolite PGW6002E, a high capacity SBA resin, can last months to years in the field. Economic evaluation is necessary to determine the throughput and change-out costs as well as the capital savings of a single-use system. The advantages of Purolite PGW6002E are no generation of liquid waste (i.e. no spent brine) and no need for pH adjustment.

Residuals Handling

- Test for uranium accumulation in spent resin

TABLE 3 Single-Use SBA Resin Design Parameters

Design Parameter	Value
Resin Depth	3 ft minimum (0.91 m)
Linear Velocity	8 to 12 gpm/ft^2 (20 to 30 m/h)
Specific Flow Rate	1 to 5 gpm/ft^3 (8 to 40 BV/h)
Empty Bed Contact Time	2–3 minutes minimum

Vessels are generally designed in a lead/lag configuration

SBA Single-Use Example with Purolite PGW6002E

In this example, the influent chromium-6 is 15 ppb. The goal is to be less than or equal to 8 ppb. Therefore, partial treatment and blending is most economical. The sulfate level is 5 ppm, so SBA single-use is a good option.

A throughput projection can be done by contacting Purolite. We assume an estimated Cr-6 leakage of 2 ppb.

TABLE 4A Raw Groundwater Parameters

Raw Water Parameter	Value
Well Pump Flow Rate	227.1 m^3/h (1,000 gpm)
Treated Flow Rate	122.6 m^3/h (540 gpm)
Bypassed Flow Rate	104.5 m^3/h (460 gpm)
Total Chromium	15.5 ppb
Chrome VI	15 ppb
Alkalinity as $CaCO_3$	100 ppm as $CaCO_3$
Chloride	30 ppm
Sulfate	5 ppm
Nitrate as N	2 ppm as N
Uranium	2 ppm
pH	7.5

TABLE 4B Example Case Design Information

Design Parameter	Value
Total Flow Rate	227.1 m^3/h (1,000 gpm)
Influent Chrome VI	15 ppb
Leakage Chrome VI	2 ppb
Effluent Concentration Goal (Blended)	8 ppb
Bypass Flow Percent	46%
Bypassed Flow Rate	104.5 m^3/h (460 gpm)
Treated Flow Rate	122.6 m^3/h (540 gpm)
Number of Trains	1
Vessel Diameter	2.4 m (8 ft)
Flow per Vessel	136.3 m^3/h (600 gpm)
Volume per Supersack	1,189 l (42 ft^3)
Number of Supersacks per Vessel	5
Media Volume per Vessel	5,947 l (210 ft^3)
Media Volume Total Onsite	11,893 l (420 ft^3)
Vessel Area	4.6 m^2 (50 ft^2)
Bed Depth	1.3 m (42 ft)
Linear Velocity	26.2 m/h (10.7 gpm/ft^2)
Specific Flow Rate	23.3 BV/h (2.9 gpm/ft^3)
EBCT: Goal 2 to 3 min	2.6 minutes
Projected Throughput	50,000 BV
Days Between Exchanges	90 days

Design Steps

- Determine treated flow

Bypass Percentage = (Effluent Concentration Goal – Leakage Concentration) / (Influent Concentration – Leakage Concentration)

$$\textbf{Bypass Percentage} = \frac{\textbf{(Effluent Concentration Goal – Leakage Concentration)}}{\textbf{(Influent Concentration – Leakage Concentration)}}$$

$$\textbf{Example: Bypass Percentage} = \frac{\textbf{(8 ppb – 2 ppb)}}{\textbf{(15 ppb – 2 ppb)}} = \textbf{46\%}$$

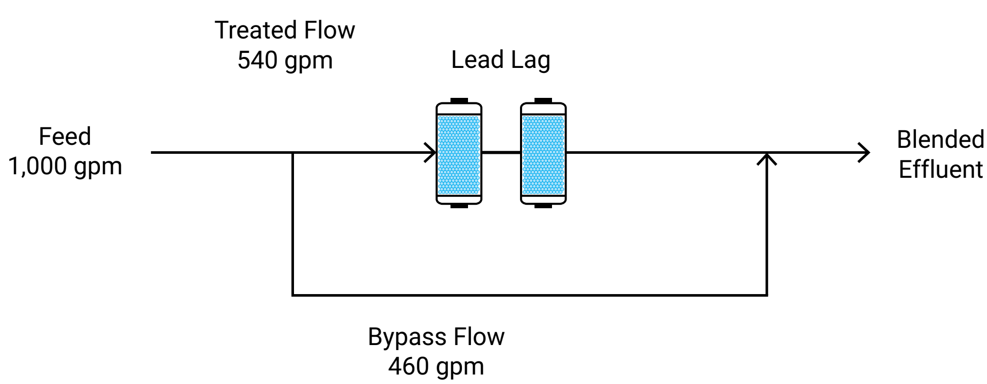
Bypass Flow = Bypass Percentage x Total Flow Rate

Example: Bypass Flow = 46% x 1,000 gpm = 460 gpm

- Determine available equipment diameter.
- Determine number of trains to meet appropriate design conditions.
- Determine volume of resin to achieve the minimum bed depth by varying the number of supersacks. It is much easier to load and unload based on using full supersack volumes.

FIGURE 2

SBA Single-Use Design with PGW6002E



Regenerable SBA Resin with Purolite A600E/9149

Using Purolite A600E/9149, a regenerable SBA resin is feasible when the concentrations of sulfate and other competing anions are moderate and regeneration is needed every few weeks or longer.

When a vessel of resin has reached its change-out criteria, the vessel is taken out of service in preparation for regeneration. During the regeneration step, several bed volumes of sodium chloride (NaCl) brine regenerant are pumped through the resin at a high enough concentration to strip the chrome VI and other anions from the resin and put the resin back in the chloride form. The brine will contain high concentrations of both sodium chloride and chrome VI. The system then goes through a slow rinse to displace the last contaminants followed by a fast rinse, mainly to displace the NaCl. The vessel is then ready to be placed back in service.

High chrome VI in the spent brine may result in it being classified as hazardous — a brine analysis will usually be needed.

Brine Disposal Options

In most cases, spent brine cannot be discharged. The impacts on wastewater treatment plant discharges and National Pollutant Discharge Elimination System (NPDES) requirements must be evaluated for each system.

Spent brine will also concentrate other anions in the water. Complete characterization is necessary to ensure uranium concentration does not exceed NPDES requirements.

TABLE 5 SBA Regenerable Design Parameters

Design Parameter	Value
Resin Depth	3 ft minimum (0.91 m)
Linear Velocity	8 to 12 gpm/ft^2 (20 to 30 m/h)
Specific Flow Rate	1 to 5 gpm/ft^3 (8 to 40 BV/h)
Empty Bed Contact Time	2–3 minutes minimum

Systems are generally designed with several vessels in parallel service and one in standby or regeneration mode: i.e. n + 1

Regeneration

Purolite A600E/9149 can be regenerated using a 10-15% brine solution. It is important to allow adequate contact between the resin and the brine solution to optimize performance. For hard to treat water, a combination of 10–15% brine provide the extra cleaning efficiency needed. Standard operating and regenerating conditions for sodium chloride co-flow service are provided in Table 6 below.

TABLE 6 Standard Operating and Regenerating Conditions for Co-Flow Service

Step	Design Basis	Duration
Service	8–16 BV/h 1–2 gpm/ft^3	Dependent on influent organic loading and desired breakpoint.
Backwash	Set for minimum water temperature to give 50% bed expansion. Refer to Figure 2 for details.	1 BV for clean water supplies and 2–3 BVs where suspended solids are higher.
Bed Settle	To allow the bed to reform fully classified.	5 minutes
NaCl Injection	5 BV of 12% brine solution at 2–4 BV/h (0.25 to 0.5 gpm/ft^3).	Typically, 60–90 minutes depending on regeneration level and flow rate.
Displacement Rinse	Flow similar to the brine solution at 2–4 BV/h (0.25–0.5 gpm/ft^3); rinse volume 2 BV or 15 gal/ft^3.	Typically, 30–40 minutes depending on water volume applied and flow rate.
Final Rinse	3–6 BV (22.5 to 45 gal/ft^3) preferably at service flow rate 8–16 BV/h (1–2 gpm/ft^3).	Typically, 10–20 minutes. Less displacement rinse will require more final rinse.

BV = Bed Volumes
BV/h = Bed Volumes per hour

SBA Regenerable Example with Purolite A600E/9149

In this example, the influent chromium-6 is 15 ppb. The goal is to be less than or equal to 8 ppb. Therefore, partial treatment and blending is most economical. The sulfate level is 25 ppm, so SBA regenerable is a good option.

A throughput projection can be done by contacting your resin supplier. We assume an estimated Cr-6 leakage of 2 ppb for regenerated resin.

TABLE 7A **Raw Groundwater Parameters**

Raw Water Parameter	Value
Well Pump Flow Rate	227.1 m^3/h (1,000 gpm)
Treated Flow Rate	122.6 m^3/h (540 gpm)
Bypassed Flow Rate	104.5 m^3/h (460 gpm)
Total Chromium	15.5 ppb
Chrome VI	15 ppb
Alkalinity as $CaCO_3$	120 ppm as $CaCO_3$
Chloride	120 ppm
Sulfate	25 ppm
Nitrate as N	5 ppm as N
Uranium	2 ppm
pH	7.5

TABLE 7B Example of SBA Regenerable

Design Parameter	Value
Total Flow Rate	227.1 m^3/h (1,000 gpm)
Influent Chrome VI	15 ppb
Leakage Chrome VI	2 ppb
Effluent Concentration Goal of Chrome VI (Blended)	8 ppb
Bypass Flow Percent	46%
Bypassed Flow Rate	460 gpm
Treated Flow Rate	540 gpm
Number of Vessels in Service	2
Number of Vessels in Standby	1
Number of Vessels Total	3
Flow per Vessel	270 gpm
Vessel Diameter	1.8 m (6 ft)
Volume per Supersack	1,189.3 l (42 ft^3)
Number of Supersacks per Vessel	3
Media Volume per Vessel	3,568 l (126 ft^3)
Media Volume Total Onsite	10,704 l (378 ft^3)
Vessel Area	2.6 m^2 (28 ft^2)
Bed Depth per Vessel	1.4 m (4.5 ft)
Linear Velocity	26.2 m/h (9.5 gpm/ft^2)
Specific Flow Rate	16.8 BV/h (2.1 gpm/ft^3)
EBCT	3.5 minutes
BV/hour	17
Estimated Throughput	7,000 BV
Bed Life	17 days

TABLE 8 Regeneration: Based on 5 BV NaCl and 12% Brine Solution

Step	Design Basis	Flow	Time	Total Waste per Step
Backwash*	2.4 gpm/ft^2	68 gpm	28 min	1,885 gallons
Brine Step	0.5 gpm/ft^3	63 gpm	75 min	4,725 gallons
Slow Rinse	0.5 gpm/ft^3	63 gpm	40 min	2,520 gallons
Fast Rinse	–	270 gpm	20 min	5,400 gallons
Totals	–	–	163 min	14,530 gallons

* Backwash based on using a typical Type I SBA resin. Influent water temperature 20 °C, 50% backwash expansion occurs at approximately 2.4 gpm/ft^2. Time is based on backwashing 2 bed volumes.

Design Steps

- Determine treated flow

$$\textbf{Bypass Percentage} = \frac{\textbf{(Effluent Concentration Goal – Leakage Concentration)}}{\textbf{(Influent Concentration – Leakage Concentration)}}$$

$$\textbf{Example: Bypass Percentage} = \frac{\textbf{(8 ppb – 2 ppb)}}{\textbf{(15 ppb – 2 ppb)}} = \textbf{46\%}$$

Bypass Flow = Bypass Percentage x Total Flow Rate

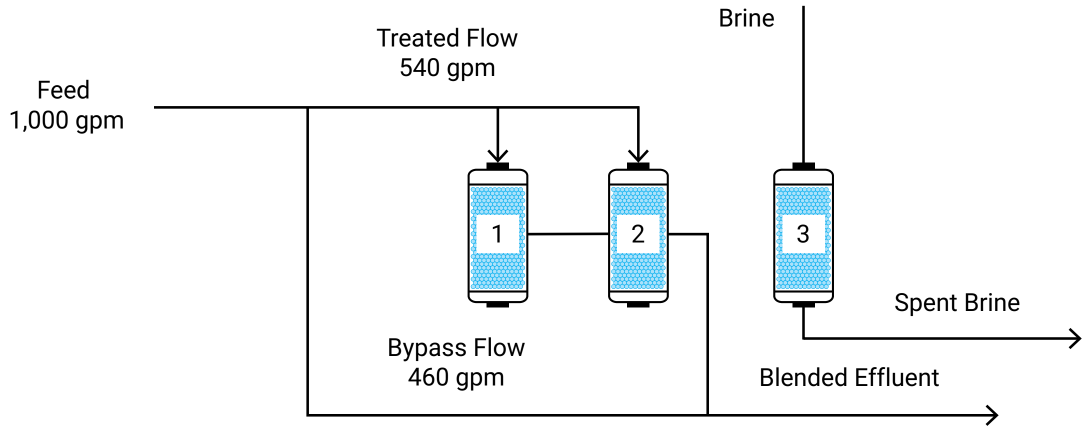
Example: Bypass Flow = 46% x 1,000 gpm = 460 gpm

- Determine available equipment diameter.
- Determine number of trains to meet appropriate design conditions.
- Determine volume of resin to achieve the minimum bed depth by varying the number of supersacks. It is much easier to load and unload based on using full supersack volumes.
- Design regeneration protocol.

FIGURE 3

Co-Flow Regeneration Example: Vessel 3 is Off-Line While in Regeneration

SBA Regeneration



Notes

Notes

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P-000230-NPOLD-1222-R4-ENG-PCO

Attachment 19: Excerpt from West Coast Basin Watermaster Report – 2022 – 2023 Table 1a – Water Rights Accounting

Table 1 – Water Rights Accounting (acre-feet)

Party	AR 2022-2023 [1]	Net Carryover [2] from 2021-2022	Leases [3] with Flex	Leases [3] w/o Flex	Storage [4]	Increased Extractions [5]	Total Rights [6]	Amount Pumped [7]	Balance [8]	Allowable carryover into 2023-2024 Drought [9]	Allowable carryover into 2023-2024 Normal	Allowable carryover into 2023-2024 Total
ABC Nursery	24.10	24.10	0.00	0.00	0.00		48.20	9.00	39.20	0.00	24.10	24.10
Asahi Fancy Koi	2.00	34.20	0.00	0.00	0.00		36.20	0.00	36.20	32.20	2.00	34.20
Automation Industries	0.70	4.10	0.00	0.00	0.00		4.80	0.00	4.80	3.40	0.70	4.10
Cal. Water Service Co.	4,070.00	4,070.00	-40.00	0.00	0.00		8,100.00	889.54	7,210.46	0.00	4,030.00	4,030.00
Cal. Water Service Co. Dominguez	10,417.45	10,417.45	0.00	0.00	0.00		20,834.90	3,975.66	16,859.24	0.00	10,417.45	10,417.45
Cal. Water Service Co./Hawthorne Lease	0.00	1,882.00	1,882.00	0.00	0.00		3,764.00	347.69	3,416.31	0.00	1,882.00	1,882.00
Carson-Harbor Village Mobile Home Park	7.00	7.00	0.00	0.00	0.00		14.00	0.00	14.00	0.00	7.00	7.00
Carson-Madrona Co.	104.00	104.00	0.00	0.00	0.00		208.00	0.00	208.00	0.00	104.00	104.00
CBS, Inc.	9.50	9.50	0.00	0.00	0.00		19.00	0.00	19.00	0.00	9.50	9.50
Century Builders	4.70	4.70	0.00	0.00	0.00		9.40	0.00	9.40	0.00	4.70	4.70
Chandler Palos Verdes Sand & Gravel Company	4.20	4.20	0.00	0.00	0.00		8.40	0.00	8.40	0.00	4.20	4.20
Chevron USA	4,601.30	4,601.30	0.00	0.00	0.00		9,202.60	0.00	9,202.60	0.00	4,601.30	4,601.30
Coastline Church of Christ	0.70	4.10	0.00	0.00	0.00		4.80	0.00	4.80	3.40	0.70	4.10
Curtis, Owen W	0.36	3.08	0.00	0.00	0.00		3.44	0.00	3.44	2.72	0.36	3.08
Delaney, Golda Estate of	4.10	14.30	0.00	0.00	0.00		18.40	0.00	18.40	10.20	4.10	14.30
Eco Services Operations	521.00	521.00	0.00	0.00	0.00		1,042.00	342.74	699.26	0.00	521.00	521.00
El Segundo, City	953.00	953.00	0.00	0.00	0.00		1,906.00	0.00	1,906.00	0.00	953.00	953.00
Engelsma, Susan Trust	12.10	12.10	-12.10	0.00	0.00		12.10	0.00	12.10	0.00	0.00	0.00
Evergreen America Corp.	5.40	5.40	0.00	0.00	0.00		10.80	0.00	10.80	0.00	5.40	5.40
Fujimoto, SR. & St & JK	20.00	32.28	0.00	0.00	0.00		52.28	0.00	52.28	12.28	20.00	32.28
Gillingham, Florence R	2.40	2.40	0.00	0.00	0.00		4.80	0.00	4.80	0.00	2.40	2.40
Golden State Water Co.	7,502.24	4,202.47	0.00	0.00	3,300.00	-404.00	14,600.71	6,274.55	8,326.16	3.39	4,202.24	4,205.63
Hawthorne, City	1,882.00	0.00	-1,882.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Hillside Memorial Park	104.10	22.01	0.00	0.00	0.00		126.11	116.35	9.76	0.00	9.76	9.76
Hollywood Park Land Co.	282.00	0.00	-282.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Honeywell International	22.50	22.50	0.00	0.00	0.00		45.00	0.00	45.00	0.00	22.50	22.50
Honold, Kristin Brandsma	11.80	11.80	0.00	0.00	0.00		23.60	0.00	23.60	0.00	11.80	11.80
Inglewood Park Cemetery	0.00	35.00	0.00	0.00	0.00		35.00	0.00	35.00	35.00	0.00	35.00
Inglewood, City	4,449.89	4,731.89	282.00	0.00	0.00		9,463.78	1,851.26	7,612.52	0.00	4,731.89	4,731.89
Kinder Morgan Liquids Terminals	167.00	167.00	0.00	0.00	0.00		334.00	38.34	295.66	0.00	167.00	167.00
L.A. County Department of Parks & Rec	363.70	11.92	0.00	0.00	0.00		375.62	207.78	167.84	0.00	167.84	167.84
L.A. County Sanitation Districts-JWPCP	102.00	102.00	0.00	0.00	0.00		204.00	0.00	204.00	0.00	102.00	102.00
Leuzinger, Emma L Estate of	1.40	5.90	0.00	0.00	0.00		7.30	0.00	7.30	4.50	1.40	5.90
Lockheed Martin Corporation	0.10	0.10	0.00	0.00	0.00		0.20	0.00	0.20	0.00	0.10	0.10
Lomita, City	1,352.00	1,102.00	-150.00	0.00	0.00		2,304.00	0.00	2,304.00	0.00	1,202.00	1,202.00
Long Beach, City	0.70	0.70	0.00	40.00	0.00		41.40	20.50	20.90	0.00	0.70	0.70
Lopes, Frank	3.70	13.10	0.00	0.00	0.00		16.80	0.00	16.80	9.40	3.70	13.10
Los Angeles, City	1,503.00	1,503.00	0.00	0.00	0.00		3,006.00	0.00	3,006.00	0.00	1,503.00	1,503.00
Loyola Marymount University	48.10	48.10	0.00	0.00	0.00		96.20	0.00	96.20	0.00	48.10	48.10
Manhattan Beach, City	1,131.20	226.24	0.00	-40.00	2,262.40		3,579.84	489.56	3,090.28	0.00	226.24	226.24
McDonnell Douglas Corp.	1.70	1.70	0.00	0.00	0.00		3.40	0.00	3.40	0.00	1.70	1.70

Party	AR 2022-2023 [1]	Net Carryover [2] from 2021- 2022	Leases [3] with Flex	Leases [3] w/o Flex	Storage [4]	Increased Extractions [5]	Total Rights [6]	Amount Pumped [7]	Balance [8]	Allowable carryover into 2023-2024 Drought [9]	Allowable carryover into 2023-2024 Normal	Allowable carryover into 2023-2024 Total
Montrose Chemical Corp.	1.20	1.20	0.00	0.00	0.00		2.40	0.00	2.40	0.00	1.20	1.20
Mori, Roy H and Kenji	3.60	12.80	0.00	0.00	0.00		16.40	0.00	16.40	9.20	3.60	12.80
Myron Z Chlavin & Nettie Desser Trust & JHD Properties	0.00	0.00	12.10	0.00	0.00		12.10	0.00	12.10	0.00	12.10	12.10
Northrop Corp	38.15	38.15	0.00	0.00	0.00		76.30	0.00	76.30	0.00	38.15	38.15
Nozaki, Sumikichi	7.00	7.00	0.00	0.00	0.00		14.00	0.00	14.00	0.00	7.00	7.00
Pacific Crest Cemetery Co.[10]	0.00	-8.09	40.00	0.00	0.00		31.91	35.83	-3.92	0.00	-3.92	-3.92
Palos Verdes Begonia Farm	0.00	7.40	0.00	0.00	0.00		7.40	0.00	7.40	7.40	0.00	7.40
Phillips 66 Co.	6,170.00	6,748.67	0.00	0.00	0.00		12,918.67	4,965.49	7,953.18	787.78	6,170.00	6,957.78
Rehor, Josephine P	2.20	2.20	0.00	0.00	0.00		4.40	0.00	4.40	0.00	2.20	2.20
Rolling Hills Country Club	290.00	133.00	0.00	0.00	0.00		423.00	199.00	224.00	0.00	224.00	224.00
Roman Catholic Archbishop	72.30	181.50	150.00	0.00	0.00		403.80	177.32	226.48	0.00	222.30	222.30
SCI California Funeral Services Inc	39.40	0.00	0.00	0.00	0.00		39.40	0.00	39.40	0.00	39.40	39.40
Shell Oil Company	1,019.50	0.00	-1,019.50	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Southern California Edison Co.	57.10	63.32	0.00	0.00	0.00		120.42	17.81	102.61	6.22	57.10	63.32
Tesoro Refining & Marketing Co LLC	8,741.00	9,760.50	1,019.50	0.00	0.00		19,521.00	10,607.01	8,913.99	0.00	8,913.99	8,913.99
Torrance Refining Company LLC	2,596.40	2,626.83	0.00	0.00	0.00		5,223.23	954.97	4,268.26	30.43	2,596.40	2,626.83
Torrance, City	5,638.86	1,127.77	0.00	0.00	11,277.20		18,043.83	961.16	17,082.67	0.00	1,127.77	1,127.77
Vukelich, Mike[10]	10.00	-21.08	0.00	0.00	0.00		-11.08	0.00	-11.08	0.00	-11.08	-11.08
Watson Land Co.	80.20	80.20	0.00	0.00	0.00		160.40	0.00	160.40	0.00	80.20	80.20
Wiseburn School District	8.20	8.20	0.00	0.00	0.00		16.40	0.00	16.40	0.00	8.20	8.20
TOTAL:	**64,468.25**	**55,687.21**	**0.00**	**0.00**	**16,839.60**	**-404.00**	**136,591.06**	**32,481.56**	**104,109.50**	**957.52**	**54,484.49**	**55,442.01**

[1] AR – Adjudicated Rights
[2] Net Carryover is the sum of all carryover (drought and one-year) from the previous year AY 2021-2022 less the amount of carryover conversion for the current AY 2022-2023. See Table 3 for carryover conversion (water put into storage) per party for AY 2022-2023.
[3] See Table 10 for information concerning leases. Leases with flex include carryover provisions.
[4] Storage includes carryover conversions for AY 2022-2023. See Table 2 for a summary of all Storage Accounting per party.
[5] Increased Extraction: Section IV(K) of the Central Basin Judgment permits increased extraction rights through use of up to 5,000 af of certain Parties' West Basin Rights in the Central Basin The aforementioned Parties include City of Los Angeles, Golden State Water Company, and California Water Service Company.
[6] Total Rights = Adjudicated Rights + Net Carryover + Leases + Storage + Increased Extraction.
[7] Amount pumped column does not include storage withdrawals (Table 4), which totaled zero for AY 2022-2023.
[8] Balance = Total Rights - Amount Pumped
[9] Drought = drought carryover created in 1991.
[10] Negative One-Year Carryover will be deducted from the subsequent year's AR.

Attachment 20: Excerpt from West Coast Basin Watermaster Report – 2022 – 2023 Appendix A (Groundwater Extractions)

Appendix A

Groundwater Extractions

July 2022– June 2023

Appendix A – Groundwater Extractions (acre-feet)

7002 - ABC Nursery, Inc.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	3.00	2.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	9.00
003S013W29F011S/1	3.00	2.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	9.00

7052 - California Water Service Co./Hawthorne Lease	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	9.88	75.47	72.72	68.72	6.32	0.00	0.00	0.00	0.00	0.00	30.04	84.54	347.69
3S/14W-09M01S/13	9.88	75.47	72.72	68.72	6.32	0.00	0.00	0.00	0.00	0.00	30.04	84.54	347.69

7050 - California Water Service Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	90.41	77.31	65.92	64.41	5.22	88.79	86.39	68.52	80.16	84.11	84.62	93.68	889.54
003S014W29H001S	0.02	0.00	0.09	0.31	0.80	0.00	0.67	0.65	0.00	1.33	0.76	0.01	4.64
003S014W29J001S	0.89	0.87	1.06	0.64	1.10	16.97	0.87	0.54	1.51	2.09	0.84	0.93	28.31
003S014W32A002S	89.50	76.44	64.77	63.46	3.32	71.82	84.85	67.33	78.65	80.69	83.02	92.74	856.59

7053 - California Water Service Company (Dominguez)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	494.75	234.25	285.31	178.91	121.90	199.96	179.53	388.41	476.69	496.49	485.53	433.93	3,975.66
004S013W11P002S	208.90	0.00	205.18	105.66	53.54	99.66	69.94	75.11	98.12	99.46	102.93	92.33	1,210.83
004S013W15A011S	70.21	68.92	59.47	70.75	68.36	99.09	101.38	97.19	104.41	107.19	76.53	35.22	958.72
004S013W15A014S	183.94	134.79	0.00	2.50	0.00	0.88	0.56	139.29	181.91	185.98	188.04	188.74	1,206.63
004S013W15F001S	31.70	30.54	20.66	0.00	0.00	0.00	0.00	0.10	0.29	18.03	32.07	31.64	165.03
004S013W20C001S	0.00	0.00	0.00	0.00	0.00	0.32	7.65	76.72	91.96	85.83	85.96	86.00	434.44
004S013W29E006S	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01

7623 - Eco Services Operations, LLC	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	42.50	20.94	39.10	28.12	24.09	20.93	17.09	39.90	15.97	43.70	21.20	29.20	342.74
004S013W10C004S/2	42.50	20.94	39.10	28.12	24.09	20.93	17.09	39.90	15.97	43.70	21.20	29.20	342.74

Appendix A – Groundwater Extractions (Continued)

7226 - Golden State Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	462.94	341.44	316.47	294.10	521.90	613.72	672.04	602.76	378.22	484.72	701.01	885.23	6,274.55
003S014W13B003S/BA004	1.19	0.04	0.05	0.09	0.00	0.03	3.37	0.00	0.08	0.00	0.00	3.50	8.35
003S014W13B004S/BA005	0.45	2.06	2.11	0.03	0.00	0.10	4.10	0.00	0.10	0.00	0.00	4.82	13.77
003S014W13J009S/S0005	0.00	0.00	0.00	0.00	5.47	0.00	0.57	1.96	35.34	0.00	10.06	133.04	186.44
003S014W13J010S/S0006	0.48	0.09	0.00	0.20	0.02	0.00	0.21	110.56	15.67	0.00	6.33	78.03	211.59
003S014W14D002S/129-02	143.50	9.81	0.00	0.00	83.69	89.93	144.54	130.87	76.80	96.53	138.77	139.39	1,053.83
003S014W15B003S	0.14	0.70	0.00	0.00	0.00	79.68	47.55	0.21	0.16	0.26	0.00	0.70	129.40
003S014W15P001S/Doty1	0.13	0.29	2.99	0.07	63.73	55.89	88.70	78.81	45.76	55.05	87.06	83.66	562.14
003S014W15P002S/Doty2	0.19	0.45	4.80	0.00	92.38	83.69	133.35	117.78	69.96	85.12	132.88	130.21	850.81
003S014W22L001S/CD001	0.03	0.00	0.02	0.23	0.00	0.00	0.16	0.13	0.18	0.00	0.07	0.06	0.88
003S014W25P004S/DA001	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	3.95	0.14	4.26
003S014W25P006S/DA002	316.78	328.00	306.50	293.48	276.61	304.40	249.49	162.44	134.17	247.64	321.89	311.68	3,253.08

7270 - Hillside Memorial Park	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	22.75	17.88	11.13	12.38	6.52	2.65	0.00	5.97	0.00	11.91	9.73	15.43	116.35
002S014W19K004S/3	22.75	17.88	11.13	12.38	6.52	2.65	0.00	5.97	0.00	11.91	9.73	15.43	116.35

7310 - Inglewood, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	143.99	151.23	137.01	152.41	169.33	172.86	168.19	152.95	158.97	151.98	155.47	136.87	1,851.26
002S014W33F001S/Well	143.99	151.23	137.01	138.72	137.45	142.70	140.81	125.01	131.15	125.08	129.51	114.29	1,616.95
003S014W10G004S/2	0.00	0.00	0.00	13.69	31.88	30.16	27.38	27.94	27.82	26.90	25.96	22.58	234.31

7364 - Kinder Morgan Liquids Terminals LLC	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	3.11	3.54	2.28	4.03	3.31	2.87	2.00	2.94	2.85	3.22	3.33	4.86	38.34
REMED	3.11	3.54	2.28	4.03	3.31	2.87	2.00	2.94	2.85	3.22	3.33	4.86	38.34

Appendix A – Groundwater Extractions Continued

7390 - Long Beach, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.50	20.50
004S013W14K011S/1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.50	20.50

7435 - Los Angeles County Department of Parks & Recreation	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	47.45	46.66	53.75	16.82	19.39	14.15	0.00	9.49	0.07	0.00	0.00	0.00	207.78
003S014W27C001S/00761	47.45	46.66	53.75	16.82	19.39	14.15	0.00	9.49	0.07	0.00	0.00	0.00	207.78

7490 - Manhattan Beach, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	14.31	57.16	75.65	79.13	1.27	4.75	15.14	58.17	38.13	40.67	59.29	45.89	489.56
003S014W29C003S/15	0.10	0.00	0.00	0.00	1.06	0.00	1.56	29.81	0.00	0.00	0.00	0.00	32.53
003S014W29D005S/11-A	14.21	57.16	75.65	79.13	0.21	4.75	13.58	28.36	38.13	40.67	59.29	45.89	457.03

7514 - Montrose Chemical Corp.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	-0.24	0.16	-0.43	0.00	0.00	0.00	-0.17	-0.10	-0.26	0.00	0.00	-0.33	-1.37
004S014W01N002S/G-IW-1	-0.09	-6.68	-7.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-14.54
004S014W01N003S/G-IW-3	-0.09	-8.19	-8.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-16.75
004S014W01N004S/G-IW-7	-0.06	-5.79	-6.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-12.54
004S014W01P002S/UBAEW1	0.00	0.20	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42
004S014W12A001S/G-IW-2	0.00	0.00	0.00	0.00	0.00	0.00	-0.17	-0.10	-0.26	0.00	0.00	-0.33	-0.86
004S014W12B002S/UBAEW3	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35
004S014W12B005S/BF-EW-1	0.00	0.96	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
004S014W12B006S/G-EW-1	0.00	7.02	7.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.64
004S014W12G001S/BF-EW-3	0.00	3.21	3.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.58
004S014W12J002S/BF-EW-4	0.00	6.02	6.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.34
004S014W12J003S/G-EW-2	0.00	1.81	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.71
004S014W12L001S/G-EW-3	0.00	1.60	1.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.28

Appendix A – Groundwater Extractions Continued

7580 - Pacific Crest Cemetery Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	6.37	6.35	4.84	3.94	0.23	2.18	1.49	1.67	0.33	1.52	2.78	4.13	35.83
003S014W33E001S	6.37	6.35	4.84	3.94	0.23	2.18	1.49	1.67	0.33	1.52	2.78	4.13	35.83

7093 - Phillips 66 Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	489.53	509.28	408.14	401.18	378.01	491.81	448.83	441.06	330.01	281.07	390.54	396.03	4,965.49
004S013W21J003S/5	65.84	62.31	57.57	56.41	50.68	48.84	43.62	34.78	41.58	39.20	39.29	37.42	577.54
004S013W21R011S/CBP Well	261.92	290.98	288.24	282.80	265.86	286.48	257.41	257.91	222.03	234.93	274.78	257.94	3,181.28
004S013W31N004S/LA006	34.04	64.22	62.32	61.97	61.47	61.91	60.49	53.20	38.16	0.00	16.96	23.30	538.04
004S013W31P003S/7	127.73	91.77	0.01	0.00	0.00	94.58	87.31	95.17	28.24	6.94	59.51	77.37	668.63

7655 - Rolling Hills Country Club	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	64.00	29.00	31.00	8.00	4.00	0.00	0.00	4.00	5.00	8.00	16.00	30.00	199.00
004S014W34H002S/Lake Well 2	64.00	0.00	31.00	8.00	4.00	0.00	0.00	4.00	5.00	8.00	16.00	30.00	170.00
004S014W35F002S/PLANT	0.00	29.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.00

7659 - Roman Catholic Archbishop of Los Angeles	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	13.59	19.55	26.16	18.69	16.70	5.12	1.68	10.51	1.17	11.18	27.98	24.99	177.32
002S014W18J001S/AA	13.59	19.55	26.16	18.69	16.70	5.12	1.68	10.51	1.17	11.18	27.98	24.99	177.32

7701 - Shell Oil Co (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	12.22	10.28	13.53	8.45	6.65	4.06	6.11	9.41	8.11	8.39	8.93	7.44	103.58
004S013W10E007S/DD-3	6.35	5.65	6.47	1.32	0.95	2.44	2.47	4.27	1.72	2.58	2.08	0.98	37.28
004S013W10K002S/DOM-GSP-R2M	5.87	4.63	7.06	7.13	5.70	1.62	3.64	5.14	6.39	5.81	6.85	6.46	66.30

Appendix A – Groundwater Extractions (Continued)

7720 - Southern California Edison Co.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1.62	2.80	2.51	1.84	0.35	0.30	0.49	0.76	0.80	1.72	2.31	2.31	17.81
003S014W34N004S/SCECO	1.62	2.80	2.51	1.84	0.35	0.30	0.49	0.76	0.80	1.72	2.31	2.31	17.81

7807 - Tesoro Refining & Marketing Co., LLC	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	752.75	880.98	859.53	976.97	896.88	923.29	883.31	814.51	957.28	921.38	905.38	834.75	10,607.01
004S013W16J006S/WW-14	46.57	47.71	44.82	32.84	40.08	36.48	32.69	33.53	36.86	35.47	36.20	35.52	458.77
004S013W16R003S/Well 11	326.03	370.60	364.24	323.85	322.51	346.25	372.50	321.92	394.75	379.25	389.42	331.02	4,242.34
004S013W21H008S/Well 16	262.17	271.32	261.18	243.14	229.83	216.33	195.84	206.00	217.19	207.75	207.59	216.76	2,735.10
004S013W22F007S/SRP12	15.08	14.02	14.26	14.41	13.52	13.57	11.63	11.48	12.53	8.89	12.86	11.91	154.16
004S013W27L005S/18	0.00	0.00	0.00	181.74	143.47	147.96	127.63	112.39	26.94	0.00	0.00	0.00	740.13
004S013W27M006S	96.95	175.53	61.46	0.00	0.00	0.00	0.00	0.00	123.37	150.45	102.75	104.29	814.80
004S013W27N006S	0.00	0.00	106.87	167.25	139.44	156.41	139.06	122.39	136.40	131.82	145.83	124.81	1,370.28
009S099W99P099S/REMED	5.95	1.80	6.70	13.74	8.03	6.29	3.96	6.80	9.24	7.75	10.73	10.44	91.43

7510 - Torrance Refining Company LLC	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	90.57	84.47	88.09	70.07	52.58	79.98	69.16	82.20	91.32	88.87	72.02	85.64	954.97
004S014W02F001S/EW-5	22.66	3.58	26.66	17.64	9.68	32.65	33.28	31.70	35.34	34.70	26.97	29.58	304.44
004S014W02L002S/EW-3	17.08	24.87	16.35	10.37	5.62	16.40	13.35	20.47	23.00	22.38	18.97	20.86	209.72
004S014W02M004S/EW-1	28.78	28.96	24.26	28.93	28.93	27.76	22.53	30.03	32.98	31.79	26.08	31.21	342.24
004S014W02P001S/EW-02R	22.05	27.06	20.82	13.13	8.35	3.17	0.00	0.00	0.00	0.00	0.00	3.99	98.57

Appendix A – Groundwater Extractions (Continued)

7850 - Torrance, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	169.12	127.98	148.92	163.04	153.71	44.53	0.00	11.91	137.43	4.52	0.00	0.00	961.16
003S014W34C003S/9	169.12	127.98	148.92	163.04	153.71	44.53	0.00	11.91	54.10	1.08	0.00	0.00	874.39
003S014W34F005S/Well 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	70.51	0.82	0.00	0.00	71.33
003S014W34F006S/Well 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.82	2.62	0.00	0.00	15.44

7917- Water Replenishment District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	459.29	299.88	239.82	258.56	219.72	234.64	237.55	289.85	402.72	444.79	413.30	283.05	3,783.17
004S014W04R001S/Delthorne Park	295.04	251.57	239.82	258.56	219.72	234.64	237.55	209.92	268.76	284.76	226.57	164.51	2,891.42
004S014W04R002S/City Yard	164.25	48.31	0.00	0.00	0.00	0.00	0.00	79.93	133.96	160.03	186.73	118.54	891.75

Attachment 21: Excerpt from West Coast Basin Watermaster Report – 2021 – 2022 Table 1a – Water Rights Accounting

Table 1 – Water Rights Accounting (acre-feet)

Party	AR 2021-2022 [1]	Net Carryover [2] from 2020-2021	Leases [3]		Storage [4]	Increased Extractions [5]	Total Rights [6]	Amount Pumped [7]	Balance [8]	Allowable carryover into 2022-2023		
			with Flex	w/o Flex						Drought [9]	Normal	Total
ABC Nursery	24.10	24.10	0.00	0.00	0.00		48.20	14.40	33.80	0.00	24.10	24.10
Asahi Fancy Koi	2.00	34.20	0.00	0.00	0.00		36.20	0.00	36.20	32.20	2.00	34.20
Automation Industries	0.70	4.10	0.00	0.00	0.00		4.80	0.00	4.80	3.40	0.70	4.10
Cal. Water Service Co.	4,070.00	4,050.00	0.00	0.00	0.00		8,120.00	1,258.26	6,861.74	0.00	4,070.00	4,070.00
Cal. Water Service Co. Dominguez	10,417.45	10,417.45	0.00	0.00	0.00		20,834.90	2,045.99	18,788.91	0.00	10,417.45	10,417.45
Cal. Water Service Co./Hawthorne Lease	0.00	1,882.00	1,882.00	0.00	0.00		3,764.00	79.80	3,684.20	0.00	1,882.00	1,882.00
Carson-Harbor Village Mobile Home Park	7.00	7.00	0.00	0.00	0.00		14.00	0.00	14.00	0.00	7.00	7.00
Carson-Madrona Co.	104.00	104.00	0.00	0.00	0.00		208.00	0.00	208.00	0.00	104.00	104.00
CBS, Inc.	9.50	9.50	0.00	0.00	0.00		19.00	0.00	19.00	0.00	9.50	9.50
Century Builders	4.70	4.70	0.00	0.00	0.00		9.40	0.00	9.40	0.00	4.70	4.70
Chandler Palos Verdes Sand & Gravel Company	4.20	4.20	0.00	0.00	0.00		8.40	0.00	8.40	0.00	4.20	4.20
Chevron USA	4,601.30	4,601.30	0.00	0.00	0.00		9,202.60	0.00	9,202.60	0.00	4,601.30	4,601.30
Coastline Church of Christ	0.70	4.10	0.00	0.00	0.00		4.80	0.00	4.80	3.40	0.70	4.10
Curtis, Owen W	0.36	3.08	0.00	0.00	0.00		3.44	0.00	3.44	2.72	0.36	3.08
Delaney, Golda Estate of	4.10	14.30	0.00	0.00	0.00		18.40	0.00	18.40	10.20	4.10	14.30
Eco Services Operations	521.00	514.59	0.00	0.00	0.00		1,035.59	336.33	699.26	0.00	521.00	521.00
El Segundo, City	953.00	953.00	0.00	0.00	0.00		1,906.00	0.00	1,906.00	0.00	953.00	953.00
Engelsma, Susan Trust	12.10	12.10	0.00	0.00	0.00		24.20	0.00	24.20	0.00	12.10	12.10
Evergreen America Corp.	5.40	5.40	0.00	0.00	0.00		10.80	0.00	10.80	0.00	5.40	5.40
Fujimoto, SR. & St & JK	20.00	32.28	0.00	0.00	0.00		52.28	0.00	52.28	12.28	20.00	32.28
Gillingham, Florence R	2.40	2.40	0.00	0.00	0.00		4.80	0.00	4.80	0.00	2.40	2.40
Golden State Water Co.	7,502.24	2,500.15	0.00	0.00	3,300.00	-1,190.00	12,112.39	4,609.92	7,502.47	3.39	4,199.08	4,202.47
Hawthorne, City	1,882.00	0.00	-1,882.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Hillside Memorial Park	104.10	-6.72	50.00	0.00	0.00		147.38	125.37	22.01	0.00	22.01	22.01
Hollywood Park Land Co.	282.00	0.00	-282.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Honeywell International	22.50	22.50	0.00	0.00	0.00		45.00	0.00	45.00	0.00	22.50	22.50
Honold, Kristin Brandsma	11.80	11.80	0.00	0.00	0.00		23.60	0.00	23.60	0.00	11.80	11.80
Inglewood Park Cemetery	0.00	35.00	0.00	0.00	0.00		35.00	0.00	35.00	35.00	0.00	35.00
Inglewood, City	4,449.89	4,731.89	282.00	0.00	0.00		9,463.78	2,012.60	7,451.18	0.00	4,731.89	4,731.89
Kinder Morgan Liquids Terminals	167.00	167.00	0.00	0.00	0.00		334.00	37.22	296.78	0.00	167.00	167.00
L.A. County Department of Parks & Rec	363.70	16.85	0.00	0.00	0.00		380.55	368.63	11.92	0.00	11.92	11.92
L.A. County Sanitation Districts-JWPCP	102.00	102.00	0.00	0.00	0.00		204.00	0.00	204.00	0.00	102.00	102.00
Leuzinger, Emma L Estate of	1.40	5.90	0.00	0.00	0.00		7.30	0.00	7.30	4.50	1.40	5.90
Lockheed Martin Corporation	0.10	0.00	0.00	0.00	0.00		0.10	0.00	0.10	0.00	0.10	0.10
Lomita, City	1,352.00	1,055.00	-250.00	0.00	0.00		2,157.00	0.03	2,156.97	0.00	1,102.00	1,102.00
Long Beach, City	0.70	0.70	0.00	0.00	0.00		1.40	0.00	1.40	0.00	0.70	0.70
Lopes, Frank	3.70	13.10	0.00	0.00	0.00		16.80	0.00	16.80	9.40	3.70	13.10
Los Angeles, City	1,503.00	1,503.00	0.00	0.00	0.00		3,006.00	0.00	3,006.00	0.00	1,503.00	1,503.00
Loyola Marymount University	48.10	48.10	0.00	0.00	0.00		96.20	0.00	96.20	0.00	48.10	48.10
Manhattan Beach, City	1,131.20	226.24	0.00	0.00	2,262.40		3,619.84	270.59	3,349.25	0.00	226.24	226.24
McDonnell Douglas Corp.	1.70	1.70	0.00	0.00	0.00		3.40	0.00	3.40	0.00	1.70	1.70

Party	AR 2021-2022 [1]	Net Carryover [2] from 2020-2021	Leases [3]		Storage [4]	Increased Extractions [5]	Total Rights [6]	Amount Pumped [7]	Balance [8]	Allowable carryover into 2022-2023		
			with Flex	w/o Flex						Drought [9]	Normal	Total
Montrose Chemical Corp.	1.20	1.20	0.00	0.00	0.00		2.40	0.00	2.40	0.00	1.20	1.20
Mori, Roy H and Kenji	3.60	12.80	0.00	0.00	0.00		16.40	0.00	16.40	9.20	3.60	12.80
Northrop Corp.	38.15	38.15	0.00	0.00	0.00		76.30	0.00	76.30	0.00	38.15	38.15
Nozaki, Sumikichi	7.00	7.00	0.00	0.00	0.00		14.00	0.00	14.00	0.00	7.00	7.00
Ocean Industries	0.00	0.10	0.00	0.00	0.00		0.10	0.00	0.10	0.00	0.00	0.00
Pacific Crest Cemetery Co. [11]	39.40	18.24	0.00	0.00	0.00		57.64	65.73	-8.09	0.00	-8.09	-8.09
Palos Verdes Begonia Farm	0.00	7.40	0.00	0.00	0.00		7.40	0.00	7.40	7.40	0.00	7.40
Phillips 66 Co.	6,170.00	6,957.78	0.00	0.00	0.00		13,127.78	6,379.11	6,748.67	787.78	5,960.89	6,748.67
Rehor, Josephine P	2.20	2.20	0.00	0.00	0.00		4.40	0.00	4.40	0.00	2.20	2.20
Rolling Hills Country Club	290.00	176.00	0.00	0.00	0.00		466.00	333.00	133.00	0.00	133.00	133.00
Roman Catholic Archbishop	72.30	196.19	200.00	0.00	0.00		468.49	286.99	181.50	0.00	181.50	181.50
Shell Oil Company	1,019.50	0.00	-1,019.50	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Southern California Edison Co.	57.10	63.32	0.00	0.00	0.00		120.42	23.27	97.15	6.22	57.10	63.32
Tesoro Refining & Marketing Co., LLC	8,741.00	9,760.50	1,019.50	0.00	0.00		19,521.00	9,521.96	9,999.04	0.00	9,760.50	9,760.50
Torrance Refining & Marketing Co.	2,596.40	2,626.83	0.00	0.00	0.00		5,223.23	986.33	4,236.90	30.43	2,596.40	2,626.83
Torrance, City[10]	5,638.86	0.07	0.00	0.00	11,277.20		16,916.13	1,825.30	15,090.83	0.00	1,127.77	1,127.77
Vukelich, Mike[11]	10.00	-31.08	0.00	0.00	0.00		-21.08	0.00	-21.08	0.00	-21.08	-21.08
Watson Land Co.	80.20	80.20	0.00	0.00	0.00		160.40	0.00	160.40	0.00	80.20	80.20
Wiseburn School Dist.	8.20	8.20	0.00	0.00	0.00		16.40	0.00	16.40	0.00	8.20	8.20
TOTAL:	**64,468.25**	**53,043.11**	**0.00**	**0.00**	**16,839.60**	**-1,190.00**	**133,160.96**	**30,580.83**	**102,580.13**	**957.52**	**54,729.69**	**55,687.21**

[1] AR – Adjudicated Rights

[2] Net Carryover is the sum of all carryover (drought and one-year) from the previous year AY 2020-21 less the amount of carryover conversion for the current AY 2021-22. See Table 3 for carryover conversion (water put into storage) per party for AY 2021-22.

[3] See Table 10 for information concerning leases. Leases with flex include carryover provisions.

[4] Storage includes carryover conversions for AY 2021-22. See Table 2 for a summary of all Storage Accounting per party.

[5] Increased Extraction: Section IV(K) of the Central Basin Judgment permits increased extraction rights through use of up to 5,000 af of certain Parties' West Basin Rights in the Central Basin The aforementioned Parties include City of Los Angeles, Golden State Water Company, and California Water Service Company.

[6] Total Rights = Adjudicated Rights + Net Carryover + Leases + Storage + Increased Extraction.

[7] Amount pumped column does not include storage withdrawals (Table 4), which totaled zero for AY 2021-22.

[8] Balance = Total Rights - Amount Pumped

[9] Drought = drought carryover created in 1991.

[10] Completed carryover conversions into storage. 2020-21 net carryover reduced by carryover conversion into storage for 2021-22:
Torrance, City of: 1,127.70 AF

[11] Negative One-Year Carryover will be deducted from the subsequent year's AR.

Attachment 22: Excerpt from West Coast Basin Watermaster Report – 2021 – 2022 Appendix A (Groundwater Extractions)

Appendix A

Groundwater Extractions

July 2021– June 2022

Appendix A – Groundwater Extractions (acre-feet)

7002 - ABC Nursery, Inc.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	14.40
3S/13W-29F11S/1	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	14.40

7052 - California Water Service Co./Hawthorne Lease	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	14.02	0.00	0.00	0.00	0.59	0.00	0.60	0.00	0.00	4.64	44.90	15.05	79.80
3S/14W-09M01S/13	14.02	0.00	0.00	0.00	0.59	0.00	0.60	0.00	0.00	4.64	44.90	15.05	79.80

7050 - California Water Service Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	182.05	174.18	166.89	114.63	82.80	85.08	105.41	76.74	48.22	86.34	65.82	70.10	1,258.26
003S014W29H001S/30-01	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.40	0.09	0.00	0.00	0.23	0.90
003S014W29J001S/22-01	87.62	85.62	82.70	76.73	82.80	84.76	50.88	0.58	0.79	1.02	18.69	17.50	589.69
003S014W32A002S/08-02	94.43	88.56	84.19	37.90	0.00	0.32	54.35	75.76	47.34	85.32	47.13	52.37	667.67

7053 - California Water Service Company (Dominguez)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	155.83	153.26	138.70	196.40	178.48	188.15	133.92	113.61	323.59	101.51	107.90	254.64	2,045.99
004S013W11P002S/294-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	195.07	0.00	0.00	0.00	195.07
004S013W15A011S/215-01	76.19	79.72	74.50	79.90	77.13	74.51	78.70	62.66	78.30	75.48	69.88	63.43	890.40
004S013W15A014S/298-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14	0.00	26.63	180.51	209.28
004S013W15F001S/277-01	0.00	0.00	0.00	0.00	60.37	57.39	55.05	50.95	48.08	26.03	11.39	10.70	319.96
004S013W20C001S/279-01	79.64	73.51	64.20	116.50	40.98	56.25	0.17	0.00	0.00	0.00	0.00	0.00	431.25
004S013W29E006S/275-01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03

7623 - Eco Services Operations, LLC	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	30.83	31.10	31.02	29.76	31.73	46.60	20.43	25.44	29.57	16.28	17.20	26.37	336.33
004S013W10C004S/2	30.83	31.10	31.02	29.76	31.73	46.60	20.43	25.44	29.57	16.28	17.20	26.37	336.33

Appendix A – Groundwater Extractions Continued

7226 - Golden State Water Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	420.75	414.79	384.42	386.38	386.51	394.26	477.97	467.91	309.28	288.80	272.35	406.50	4,609.92
003S014W13B003S/BA004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.77	0.00	0.05	0.00	0.03	3.85
003S014W13B004S/BA005	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.04	0.00	1.81	2.09
003S014W13J009S/S0005	0.18	0.11	0.19	0.43	0.29	0.24	0.00	0.00	0.00	0.00	0.00	0.00	1.44
003S014W13J010S/S0006	0.65	0.07	0.24	0.65	0.45	0.45	0.98	0.00	1.38	0.92	0.38	0.32	6.49
003S014W14D002S/129-02	0.35	2.43	2.25	1.48	0.70	0.15	86.80	130.19	53.88	11.20	1.96	130.17	421.56
003S014W15B003S/Goldmedal	0.00	0.21	0.00	0.07	0.00	0.23	0.05	4.93	0.61	0.10	0.07	0.26	6.53
003S014W15P001S/Doty1	0.47	6.81	0.00	0.14	0.00	0.12	0.40	4.17	0.72	0.03	0.11	0.31	13.28
003S014W15P002S/Doty2	0.00	1.70	0.00	0.31	0.00	0.14	0.62	6.22	5.45	0.21	0.14	0.39	15.18
003S014W22L001S/CD001	0.21	0.16	0.12	0.08	0.14	0.10	0.27	0.08	0.12	0.09	0.04	0.10	1.51
003S014W25P004S/DA001	96.72	96.13	92.43	95.30	90.62	90.86	86.58	28.67	0.00	0.00	0.00	0.04	677.35
003S014W25P006S/DA002	322.08	307.08	289.19	287.92	294.31	301.97	302.27	289.88	247.06	276.16	269.65	273.07	3,460.64

7270 - Hillside Memorial Park	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	15.01	16.60	12.44	7.08	3.21	1.02	3.45	7.92	9.49	13.43	17.01	18.71	125.37
002S014W19K004S/3	15.01	16.60	12.44	7.08	3.21	1.02	3.45	7.92	9.49	13.43	17.01	18.71	125.37

7310 - Inglewood, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	176.10	219.59	192.49	172.34	171.97	163.43	159.35	144.40	158.95	151.41	155.32	147.25	2,012.60
002S014W33F001S/Well	167.72	165.18	162.33	166.41	158.54	163.43	159.35	144.40	158.95	151.41	155.32	147.25	1,900.29
003S014W10G004S/2	8.38	54.41	30.16	5.93	13.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	112.31

7364 - Kinder Morgan Liquids Terminals LLC	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	3.77	1.29	3.17	1.78	3.48	2.75	4.15	2.91	3.26	3.47	4.68	2.51	37.22
No state well number	3.77	1.29	3.17	1.78	3.48	2.75	4.15	2.91	3.26	3.47	4.68	2.51	37.22

Appendix A – Groundwater Extractions Continued

7450 - Lomita, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
004S014W35E007S/5	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03

7435 - Los Angeles County Department of Parks & Recreation	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	40.88	43.45	39.93	26.18	24.03	4.32	5.24	17.74	34.60	34.22	58.29	39.75	368.63
003S014W27C001S/00761	40.88	43.45	39.93	26.18	24.03	4.32	5.24	17.74	34.60	34.22	58.29	39.75	368.63

7490 - Manhattan Beach, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	12.22	19.08	17.12	14.94	13.13	2.99	11.70	20.74	51.09	36.99	35.26	35.33	270.59
003S014W29C003S/15	12.22	19.08	17.12	14.94	12.38	2.58	11.21	15.91	0.00	0.00	0.00	0.00	105.44
003S014W29D005S/11A	0.00	0.00	0.00	0.00	0.75	0.41	0.49	4.83	51.09	36.99	35.26	35.33	165.15

7514 - Montrose Chemical Corporation of California	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.02	0.00	0.11	0.08	0.22	-0.08	-0.24	0.30	0.20	0.00	0.32	0.03	0.96
004S014W12B006S/G-EW-1	2.33	11.06	9.05	7.32	7.00	11.26	0.19	6.71	17.8	4.94	19.71	10.29	107.66
004S014W12A003S/G-IW-5	-1.69	-8.2	-4.36	-5.32	-4.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-24.38
004S014W01P003S/BF-EW-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.10
004S014W12B005S/BF-EW-1	0.16	1.52	1.24	1.00	0.96	1.54	0.03	0.92	2.44	0.68	2.69	1.41	14.59
004S014W12J003S/G-EW-2	0.45	2.15	1.73	1.42	1.36	2.19	0.04	1.30	3.46	0.96	4.17	2.49	21.72
004S014W01P002S/UBAEW1	0.07	0.32	0.26	0.21	0.20	0.32	0.01	0.19	0.51	0.14	0.56	0.29	3.08
004S014W01N004S/G-IW-7	0.00	-3.94	-5.54	-0.85	-0.01	-7.82	-0.28	-5.08	-15.82	-4.49	-16.10	-8.83	-68.76
004S014W01N002S/G-IW-1	-2.11	-8.25	-6.32	-7.73	-4.56	-11.06	-0.06	-6.12	-15.86	-3.69	-19.31	-10.74	-95.81
004S014W12G001S/BF-EW-3	0.36	1.71	1.38	1.13	1.08	1.74	0.03	1.04	2.75	1.04	7.15	4.51	23.92
004S014W12L001S/G-EW-3	0.27	1.26	1.02	0.84	0.80	1.29	0.02	0.77	2.03	0.56	3.01	2.30	14.17
004S014W12B002S/UBAEW3	0.12	0.57	0.47	0.38	0.36	0.58	0.01	0.35	0.91	0.14	1.01	0.53	5.43
004S014W01N003S/G-IW-3	-2.27	-9.26	-7.74	-5.46	-9.16	-11.37	-0.42	-6.47	-15.84	-4.62	-19.43	-10.82	-102.86

Appendix A – Groundwater Extractions Continued

7514 - Montrose Chemical Corp of California (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.02	0.00	0.11	0.08	0.22	-0.08	-0.24	0.30	0.20	0.00	0.32	0.03	0.96
004S014W12J002S/BF-EW-4	1.00	4.74	3.82	2.96	3.00	4.82	0.08	2.88	7.63	2.97	16.86	8.60	59.36
No state well number/G-EW-4	1.33	6.32	5.10	4.18	4.00	6.43	0.11	3.81	10.19	1.27	0.00	0.00	42.74

7580 - Pacific Crest Cemetery Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	6.38	11.94	4.36	5.57	3.93	1.83	2.76	5.08	4.62	4.89	7.23	7.14	65.73
003S014W33E001S/7Z	6.38	11.94	4.36	5.57	3.93	1.83	2.76	5.08	4.62	4.89	7.23	7.14	65.73

7093 - Phillips 66 Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	554.05	549.53	513.67	494.80	513.76	524.48	534.57	506.67	572.69	593.36	529.20	492.33	6,379.11
004S013W21J003S/5	0.00	0.00	7.01	25.96	0.00	107.88	154.18	127.52	130.89	100.10	87.04	63.92	804.50
004S013W21R011S/CBP Well	312.74	325.53	296.69	266.62	336.34	249.64	217.67	216.67	255.16	293.99	242.80	242.50	3,256.35
004S013W31N004S/LA006	58.36	58.00	55.67	56.69	53.67	54.02	44.71	60.24	66.07	62.92	64.03	60.90	695.28
004S013W31P003S/7	182.95	166.00	154.30	145.53	123.75	112.94	118.01	102.24	120.57	136.35	135.33	125.01	1,622.98

7655 - Rolling Hills Country Club	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	45.00	33.00	25.00	16.00	8.00	3.00	2.00	20.00	24.00	32.00	48.00	77.00	333.00
004S014W34H002S/Lake Well 2	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.00	77.00	115.00
004S014W35F002S/PLANT	43.00	33.00	25.00	16.00	8.00	3.00	2.00	20.00	24.00	32.00	12.00	0.00	218.00

7659 - Roman Catholic Archbishop of Los Angeles	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	0.00	18.91	39.64	27.58	32.37	12.06	15.25	20.95	33.00	32.50	39.95	14.78	286.99
002S014W18J001S/AA	0.00	18.91	39.64	27.58	32.37	12.06	15.25	20.95	33.00	32.50	39.95	14.78	286.99

Appendix A – Groundwater Extractions Continued

7701 - Shell Oil Co (NCWUP)	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	17.77	16.15	17.24	18.45	16.59	11.47	5.23	9.31	11.06	11.49	12.36	11.29	158.41
004S013W09D001S/DR-7	0.01	0.04	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
004S013W10E007S/DD-3	8.14	8.95	8.44	8.99	7.69	3.17	1.86	3.67	4.12	4.25	5.79	6.17	71.24
004S013W10K002S/DOM-GSP-R2M	9.62	7.16	8.77	9.45	8.90	8.30	3.37	5.64	6.94	7.24	6.57	5.12	87.08

7720 - Southern California Edison Co.	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	2.00	3.00	2.00	2.00	1.00	0.93	0.75	2.45	1.98	2.25	1.54	3.37	23.27
003S014W34N004S/SCECO	2.00	3.00	2.00	2.00	1.00	0.93	0.75	2.45	1.98	2.25	1.54	3.37	23.27

7807 - Tesoro Refining & Marketing Co., LLC	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	807.38	828.29	794.19	694.21	696.33	889.74	790.56	847.58	804.09	811.74	772.71	785.14	9,521.96
004S013W16J006S/WW-14	99.84	99.47	94.28	79.75	66.69	56.52	66.75	71.17	67.09	57.84	60.41	55.41	875.22
004S013W16R003S/Well 17	312.50	329.34	308.67	283.40	298.73	306.04	319.65	324.29	334.65	332.01	262.40	337.45	3,749.13
004S013W21H008S/Well 16	271.74	320.57	308.67	257.67	251.52	228.41	246.33	254.18	255.74	247.41	255.62	258.95	3,156.81
004S013W22F007S/SRP12	16.24	15.44	16.55	18.00	17.67	17.16	16.40	14.64	13.11	14.11	14.28	13.35	186.95
004S013W27M006S/15	37.49	0.00	0.00	0.00	0.00	202.71	110.27	178.89	126.01	157.36	171.51	113.81	1,098.05
004S013W27N006S/SHE12	59.60	53.86	54.40	45.99	54.36	68.26	24.11	0.00	0.00	0.00	0.00	0.00	360.58
009S099W99P099S/REMED	9.97	9.61	11.62	9.40	7.36	10.64	7.05	4.41	7.49	3.01	8.49	6.17	95.22

7510 - Torrance Refining & Marketing Company	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	81.55	67.17	84.44	81.85	85.63	84.42	70.53	92.90	105.91	95.84	61.89	74.20	986.33
004S014W02F001S/EW-5	26.16	25.68	26.82	28.86	26.97	27.22	24.77	23.15	28.27	31.65	35.21	34.13	338.89
004S014W02L002S/EW-3	12.15	0.85	12.32	4.89	12.90	12.83	0.36	12.21	13.99	16.50	6.02	16.37	121.39
004S014W02L003S/EW-4	0.00	0.00	0.00	0.00	0.00	0.00	6.23	13.48	14.44	16.75	6.47	0.01	57.38
004S014W02M004S/EW-1	21.90	29.05	29.71	31.09	29.52	28.68	28.12	26.86	28.67	6.02	0.00	2.45	262.07
004S014W02P001S/EW-02R	21.34	11.59	15.59	17.01	16.24	15.69	11.05	17.20	20.54	24.92	14.19	21.24	206.60

Appendix A – Groundwater Extractions Continued

7850 - Torrance, City of	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	156.17	127.15	153.49	168.41	172.84	92.28	172.55	146.97	174.41	156.18	149.81	155.04	1,825.30
003S014W34C003S/9	156.17	127.15	153.49	168.41	172.84	92.28	172.55	146.97	174.41	156.18	149.81	155.04	1,825.30

7917- Water Replenishment District	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SWN/Owner No.	312.68	412.66	428.71	416.93	377.12	331.87	275.84	237.00	549.15	440.60	438.53	426.52	4,647.61
004S014W04R001S/Delthorne Park	223.72	279.97	272.31	286.73	238.70	231.17	220.80	139.98	248.46	270.10	274.07	277.77	2,963.78
004S014W04R002S/City Yard	88.96	132.69	156.40	130.20	138.42	100.70	55.04	97.02	300.69	170.50	164.46	148.75	1,683.83

Attachment 23: EPA Work Breakdown Structure-Based Cost Model for Anion Exchange Drinking Water Treatment

United States
Environmental Protection
Agency

Work Breakdown Structure-Based Cost Model for Anion Exchange Drinking Water Treatment

Office of Water (4607M)
EPA ***-*-*****
March 2023

Table of Contents

1. Introduction

This report is one of a series of reports describing cost models for drinking water treatment technologies. Most of these technologies are used in drinking water systems to remove or destroy pollutants such as arsenic, radon, disinfection byproducts, sulfates, hardness and waterborne pathogens. In addition, several of these technologies can be used as add-on technologies to existing treatment systems. For example, some of the technologies can be installed to provide pre-oxidation to improve contaminant removal efficiency by subsequent treatment processes.

1.1 Background

The Safe Drinking Water Act Amendments of 1996, as well as a number of other statutes and executive orders, require that the U.S. Environmental Protection Agency (EPA or the Agency) estimate regulatory compliance cost as part of its rulemaking process. EPA developed the models described in this document to assist in fulfilling this requirement. In other words, the primary purpose of these models is to aid EPA in estimating national compliance costs. The models might be acceptable, however, for other uses (e.g., developing a preliminary site-specific estimate for a water system) if sufficient care is taken to account for site- or project-specific factors appropriate to the intended use.

The compliance cost models described in this document differ from the drinking water cost models previously used by the Agency in that the new models are based on a work breakdown structure (WBS) approach to developing cost estimates. In general, the WBS approach involves breaking a process down into discrete components for the purpose of estimating unit costs. EPA pursued this approach as part of an effort to address recommendations made by the Technology Design Panel, which convened in 1997 to review the Agency's methods for estimating drinking water compliance costs (U.S. EPA, 1997).[1]

1.2 Objectives

In developing WBS-based models for estimating drinking water treatment system costs, EPA had the following objectives:

- Transparency of process design and cost
- Defensibility of design criteria and assumptions
- Ease of use and updating
- Modularity of components for use with centralized cost database.

The Agency determined that the best way to meet these goals was to develop spreadsheet-based engineering models drawing from a central database of component unit costs. Each engineering model contains the work breakdown for a particular treatment process and preprogrammed engineering criteria and equations that estimate equipment requirements for user-specified design requirements (e.g., system size and influent water quality). Each model also provides unit and total cost information by component (e.g., individual items of capital equipment) and totals the

[1] The panel consisted of nationally recognized drinking water experts from U.S. EPA, water treatment consulting companies, public and private water utilities, suppliers, equipment vendors and Federal and state regulators in addition to cost estimating professionals.

individual component costs to obtain a direct capital cost. Additionally, the models estimate add-on costs (permits, pilot study and land acquisition costs for each technology), indirect capital costs and annual operating and maintenance (O&M) costs, thereby producing a complete compliance cost estimate.

1.3 Organization of the Report

This report is organized as follows:

- Chapter 2 provides an overview of the general model components and the methods used in these components to estimate treatment system costs.
- Subsequent chapters describe the individual models, design criteria and assumptions for the selected treatment technologies.
- Appendices provide additional information on methods EPA used to estimate design requirements and costs for specific components, such as buildings, system controls, indirect capital costs and annual O&M costs.

1.4 List of Abbreviations and Symbols in this Chapter

EPA	U.S. Environmental Protection Agency
O&M	operating and maintenance
WBS	work breakdown structure

1.5 References

U.S. Environmental Protection Agency (U.S. EPA). 1997. *Discussion Summary: EPA Technology Design Workshop.* Washington, D.C.: U.S. EPA, Office of Groundwater and Drinking Water.

2. WBS Model Overview

This chapter includes the following sections:

- An overview of how the models are structured (Section 2.1)
- A description of how this structure was developed using the work breakdown structure (WBS) approach (Section 2.2)
- A brief users guide describing how to operate the models (Section 2.3), including documentation of general design assumptions
- Documentation of the general cost assumptions incorporated in all of the models (Section 2.4).

2.1 Model Structure

The WBS-based engineering models integrate the following structural features to generate treatment cost estimates:

- Treatment component selection, design and cost output based on a WBS approach
- Process design based on state-of-the-art techniques and generally recommended engineering practices (GREPs)
- A centralized reference database containing unit costs for components and reference tables for component sizing and chemical properties.

Exhibit 2-1 shows how these features are integrated in a series of spreadsheets that include an Excel workbook for each technology and a central cost and engineering reference database (the WBS cost database).[2] An input sheet allows the user to define treatment requirements such as system design and average flows, target contaminant and raw water quality. **Exhibit 2-2** provides an example of an input spreadsheet. The information provided via the input sheet interacts with three critical design assumptions sheets (one each for process design, operating and maintenance [O&M] and indirect capital costs) to generate inputs to the engineering design sheets. Although the critical design assumption values are based on GREPs and can be used without modification, the user can also revise these values to reflect site-specific requirements. Each model also has a predetermined list of treatment equipment needs (e.g., tanks, vessels and instrumentation) identified using the WBS approach. The engineering design sheets calculate equipment quantity and size requirements based on the treatment needs and critical design assumptions. The technology chapters of this report describe technology-specific content and function of each sheet. General design and cost assumptions are described in Sections 2.3.5 and 2.4.

[2] EPA maintains the central WBS cost database in a separate Excel workbook. The WBS cost database itself is not provided along with the publicly released WBS models. Instead, for ease of review and to maintain vendor confidentiality, relevant cost and engineering data have been extracted from the database and included directly in the WBS model workbooks. Thus, users can review (and adjust, if needed) the information from the central cost database in the same manner as other WBS model inputs and assumptions.

Exhibit 2-1. Structure of the WBS Models

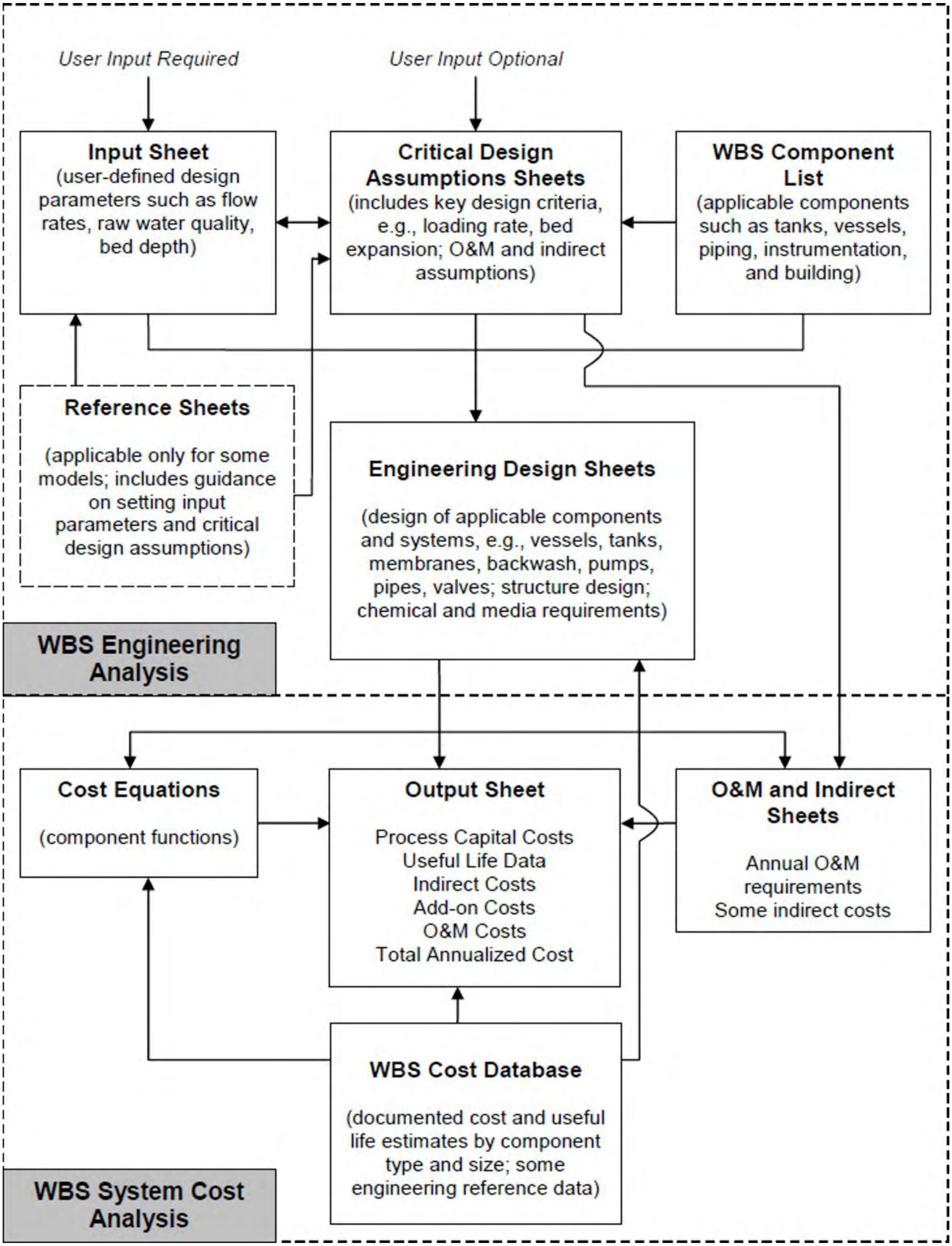


Exhibit 2-2. Sample of Input Spreadsheet

MULTI-STAGE BUBBLE AERATION SYSTEM DESIGN AND COST INPUT

STEP 1
Select Contaminant — TCE — For VOCs, default designs available up to 1 MGD only, because information on using MSBA for these contaminants in larger systems is limited

STEP 2:

Select one of the eight standard designs at right

OR

Select "CLEAR FOR MANUAL ENTRY"

- 0.030 mgd standard design <- Using this design
- 0.124 mgd standard design
- 0.305 mgd standard design
- 0.740 mgd standard design
- 2.152 mgd standard design
- 7.365 mgd standard design
- 22.614 mgd standard design
- 75.072 mgd standard design
- CLEAR FOR MANUAL ENTRY

See model documentation for more information on standard designs

STEP 3:
(Optional for standard designs)
Enter or change values in the gold and blue cells below, under "Manual Inputs"

Input Complete -- Results Ready

STEP 4:

Results are ready (no need to click button) — Generate Results

Results summary (see OUTPUT sheet for details)
Direct Capital Cost: $107,797
Total Capital Cost: $158,997
Annual O&M Cost: $7,292
Annualized Cost: $23,629 (15.3 years at 7%)

MANUAL INPUTS
Cells in gold are required; cells in blue are optional

	Value	Select units	Notes
Design Flow	0.030	MGD	
Average Flow	0.007	MGD	
For information:			
Treatment system design flow	0.030	MGD	
Bypass design flow	0.000	MGD	Current bypass percentage is 0%. Go to Critical Design Assumptions to change this value.
		Flow Input OK	Adjust bypass percentage

	Value	Units	Notes
Design Type (Optimize Number of Basins)	pre-engineered package	<---pick one	Vendor packages include aboveground stainless steel, plastic, or fiberglass basins and typically are used by small systems
Number of operating basins	1	units	
Air to water ratio	40		Guidance: For VOCs, typical air to water ratios are between 10:1 and 300:1
Maximum water depth	3	feet	Guidance: VOCs require no more than 2 to 3 feet water depth, beyond this depth no significant gain is realized (Lowry peer review comments)
Number of stages	8		Guidance: for VOCs, minimum of 6 stages, maximum of 12 stages, vendor uses 8 stages for most applications (Lowry peer review comments)
Pilot rate constant	0.11	1/min	
Pilot air intensity	2.54	cfm/cubic ft	
For information:			
Theoretical Percent Removal	90.07%		Estimate only, based on pilot rate constant and air intensity. To increase, increase air to water ratio and/or number of stages
Number of Basins (including redundancy)	1	units	
Basin Length (including quiescent chamber)	4	feet	
Basin Width	2.5	feet	
Basin Height (including freeboard)	5	feet	Adjust freeboard
Diffusers per stage	1	units	
Total diffusers	8	units	Adjust basin length constraints
		Basin Inputs OK	Adjust diffuser access space requirements

	Value	Units	Notes
Influent water concentration	5	ug/L	Used only to determine whether air pollution control might be required; not part of system design
Percent removal		not required	Using theoretical removal from above
VOC release at which air pollution control system is needed	1	lbs/day	CMRP (2000) states this is the maximum emission level for all VOCs for California South Coast AQMD, but other districts may require different emissions standards based on location of the site and regional ambient air quality.
For information:	Off-gas control system may not be required		
Off-gas pollution control technology	none	<---pick one	
Heat recovery type		not required	
Spent GAC regeneration		not required	
GAC bed life		not required	
		Off-gas Inputs OK	

	Value	Units	Notes
Number of booster pumps		pumps	Enter 0 to exclude booster pumps (i.e., use existing pumps). Clear cell to accept model defaults (included for all sizes in this technology)
For information: # of booster pumps	2	pumps	
Number of blowers		blowers	Designs should always include at least one blower. Leave blank to accept model default calculations.
For information: # of blowers (including	2	blowers	Adjust number of redundant blowers
Number of redundant basins to be added		units	Leave blank to accept redundancy specified in critical design assumptions
For information: Redundant basins	0	units	
Component level		<--pick or leave blank	Leave blank to use low cost components
System automation	fully automated	<--pick or leave blank	Leave blank to allow model to pick based on component level
For information: Component level	low cost		
Automation	fully automated		
		Optional Inputs OK	

Exhibit 2-3 shows an example of an output spreadsheet. The output sheet summarizes the results of the calculations performed by the engineering design sheets, listing size and quantity required for each item of equipment and the corresponding unit cost from the database. The output sheet multiplies unit cost by quantity to determine total component cost for each WBS component. The output sheet also lists the estimated useful life of every WBS component. The models use the component useful lives in estimating total annualized cost (see Section 2.4.6).

For many of the components, there are optional materials, all of which are illustrated on the output worksheet. For example, pressure vessels can be constructed with different types of body material (stainless steel or carbon steel) and different types of internal materials (stainless steel or plastic). Where there are optional materials, the output sheet selects from among these materials. The specific selections are determined by input values and documented in the "use?" column of the output worksheet. Direct capital cost is the sum of the selected component costs.

The output sheet also contains sections that calculate add-on costs, indirect capital costs, annual O&M costs and total annualized cost. Annual O&M costs are based on the annual requirements calculated on the O&M sheet. Indirect capital costs for certain items (standby power, geotechnical, site work and yard piping) are based on calculations performed by the indirect sheet. Other indirect capital costs and add-on costs are based on assumptions described in Sections 2.4.3 and 2.4.4. Section 2.4.6 describes the calculation of total annualized cost.

The output sheet obtains unit costs (both capital and O&M) either from the central WBS cost database or from estimated equipment cost curves. All of the treatment technology models use information from the WBS cost database, which consists of a series of lookup tables that contain costs by equipment or O&M element type and size. The database also provides useful life estimates and documents the source of information. The central WBS cost database also contains several tables that are used by the engineering design sheets of each model. For example, these tables include information used in selecting pipe diameters, footprint for pumps and chemical properties.

The WBS cost database itself is not provided along with the publicly released WBS models. Instead, for ease of review and to maintain vendor confidentiality, relevant cost and engineering data have been extracted from the database and included directly in the WBS model workbooks. Thus, users can review (and adjust, if needed) the information from the central cost database in the same manner as other WBS model inputs and assumptions.

Exhibit 2-3. Sample of Output Spreadsheet

OUTPUT SUMMARY

Parameter		Value	Units
Technology	MSBA		
Contaminant Type	TCE		
System Size Category	small		
Design Flow		0.03	MGD (excludes bypass flow)
Average Flow		0.007	MGD (excludes bypass flow)
Number of Basins		1	units
Number of Stages per Basin		8	stages
Basin Length		4	feet
Basin Width		2.5	feet
Basin Height		5	feet
Diffusers per Stage		1	units
Total diffusers		8	units
Off-Gas Treatment	none		
Resulting Costs (in year 2012 dollars)			
Direct Capital Cost	$	107,797	Details
Add-on Cost	$	1,038	Details
Indirect Capital Cost	$	50,162	Details
Total Capital Cost	$	158,997	Details
Annual O&M Cost	$	7,292	Details
Annualized Cost (16.9 years at 7%)	$	23,623	Details
Per 1,000 gallons average flow	$	9.25	
Per household per year	$	958	

Direct Capital Cost Details *(items in italics, without a 1 in the "Use?" column, represent alternate costs and are excluded from total)*

WBS #	Item	Design Quantity		Design Size		Size used in estimate		Unit Cost		Total Cost		Useful Life	Use?
1.	**Aeration Basins**												
1.1	Custom Designed												
1.1.1	*Concrete*	*0*	*units*	*NA*		*NA*			*NA*		*--*	*NA*	
1.1.2	*Excavation*	*-*	*cy*	*NA*		*NA*			*NA*		*--*	*NA*	
1.1.3	*Backfill and Compaction*	*-*	*cy*	*NA*		*NA*			*NA*		*--*	*NA*	
1.1.4	*Steel Cover*	*-*	*sf*	*NA*		*NA*			*NA*		*--*	*NA*	
1.2	Pre-engineered Package												
1.2.1	*Stainless Steel*	*1*	*units*	*374*	*gal*	*374*	*gal*	*$*	*23,655*	*$*	*23,655*	*20*	*0*
1.2.1	**Plastic**	**1**	**units**	**374**	**gal**	**374**	**gal**	**$**	**2,114**	**$**	**2,114**	**7**	**1**
1.2.1	*Fiberglass*	*1*	*units*	*374*	*gal*	*374*	*gal*	*$*	*23,259*	*$*	*23,259*	*18*	*0*
1.3	Baffles												
1.3.1	**Baffles**	**8**	**units**	**12.5**	**sf/baffle**	**12.5**	**sf/baffle**	**$**	**123**	**$**	**982**	**7**	**1**
1.4	Aerators												
1.4.1	**Diffusers**	**8**	**units**	**14**	**cfm**	**14**	**cfm**	**$**	**49**	**$**	**395**	**10**	**1**
2.	**Pumps and Blowers**												
2.1	**Booster Pumps**	**2**	**units**	**13**	**gpm**	**13**	**gpm**	**$**	**4,516**	**$**	**9,032**	**17**	**1**
	ADDITIONAL WBS COMPONENTS NOT SHOWN												
8.6.1	*Heat pump*	*NA*		*NA*		*NA*			*NA*		*--*	*NA*	
8.7	**Concrete Pad**	**1**	**units**	**2**	**cy**	**2**	**cy**	**$**	**657**	**$**	**1,314**	**37**	**1**

Total of direct line items above:

Direct cost category		Total	Guidance
Process costs	$	101,538	Excludes alternate cost line items in italics, without a 1 in the "Use?" column. Includes installation, transportation, and O&P
Building costs	$	6,259	See indirect assumptions sheet to exclude buildings
Total direct capital cost		**$107,797**	Total of process and building costs

Add-on Cost Details *(See indirect assumptions sheet to exclude individual add-on items)*

Add-on Line Item		Total	Guidance
Permits	$	111	
Pilot Study	$	-	No pilot study required for this technology
Land Cost	$	926	For 0.04 acres
Total add-on costs		**$1,038**	Total of permits, piloting, and land

Indirect Capital Cost Details *(See indirect assumptions sheet to exclude individual indirect items)*

Indirect Line Item		Total	Percent	Guidance
Mobilization and Demobilization	$	-	0%	Excluded for pre-engineered packages
Architectural Fees for Treatment Building	$	-	9%	Excluded by default for small systems
Installation, Transportation, and O&P	$	-	0%	
Site Work	$	1,423		Calculated based on system requirements.
Yard Piping	$	1,107		Calculated based on system requirements.
Geotechnical	$	-		Calculated based on system requirements.
Standby Power	$	-		Calculated based on system requirements. Excluded by default for small systems.
Electrical (including yard wiring)	$	10,154	10%	Percentage is applied only to process cost. Building direct costs include electrical components.
Instrumentation and Control	$	-	0%	
Contingency	$	-	0%	Included for high cost systems only.
Process Engineering	$	21,559	20%	
Miscellaneous Allowance	$	10,780	10%	
Legal, Fiscal, and Administrative	$	2,156	2%	
Sales Tax	$	-	0%	
Financing during Construction	$	-	0%	
Construction Management and GC Overhead	$	2,983		Includes bond and insurance only for pre-engineered packages
Total indirect capital cost		**$50,162**		Total of indirect line items

TOTAL CAPITAL COST DETAILS

Assumption	Value	Guidance
City Index	1.0	User adjustable. Can be used to adjust estimated costs to be more reflective of a specific geographical location.

Capital Cost Category		Total
Total Direct Capital Cost (from above)	$	107,797
Total Add-on Cost (from above)	$	1,038
Total Indirect Cost (from above)	$	50,162
Grand total capital cost *(incorporating city in*	**$**	**158,997**

Annual Operating and Maintenance Cost Details *(items in italics, without a 1 in the "Use?" column, represent alternate costs and are excluded from total)*

Item	Quantity		Unit Cost			Total Cost ($/yr		Use?	Guidance
Labor									
Manager	14	hrs/yr	$	40.12	/hr	$	566	1	
Administrative	14	hrs/yr	$	27.03	/hr	$	381	1	
Operator	141	hrs/yr	$	28.30	/hr	$	3,994	1	Includes labor for regular operations, maintenance, etc.
Materials									
Materials for blowers	*calculated as a percentage of capital*					$	566	1	

2.2 The WBS Approach

These models represent improvements over past cost estimating methods by increasing comprehensiveness, flexibility and transparency. By adopting a WBS-based approach to identify the components that should be included in a cost analysis, the models produce a more comprehensive assessment of the capital requirements for a treatment system. The models are flexible in that users can change certain design parameters; warning messages indicate when user inputs violate GREPs or logical functions. The transparent structure of each model allows users to see how costs are built up from component unit costs to total treatment costs, which enables users to identify cost drivers and determine whether the input assumptions generate a cost-effective treatment design. Users also can perform sensitivity analyses showing how changes in water quality parameters, chemical feed doses and equipment configuration affect cost.

Unlike prior EPA models, which used a variety of cost build-up methods, the WBS-based engineering models have been developed using a consistent framework. **Exhibit 2-4** shows this framework. For each technology, the result is an engineering spreadsheet model that combines user-identified inputs with pre-programmed engineering criteria and equations to generate appropriate treatment design and equipment requirements. The models also result in a system-level cost estimate for regulatory cost analysis.

Exhibit 2-4. Framework for Developing the WBS-Based Models

Step	Process
Step 1	Identify the treatment requirements based on the contaminant requiring removal, the flow for which treatment is required, the influent water quality and treated water quality requirement, and then select a treatment technology or combination of technologies capable of meeting the requirements.
Step 2	Develop the general design assumptions that apply to all the technologies (e.g., chemical storage capacity).
Step 3	Develop site- and technology-specific design assumptions that might affect treatment performance and, thereby, design requirements (e.g., assumptions related to influent water constituents such as alkalinity or water quality parameters such as pH).
Step 4	Construct a typical process flow diagram or P&ID showing the main unit processes for the technology and identify equipment requirements.
Step 5	Calculate the equipment requirements, including dimensions and quantities, for the core elements of each unit process. At each component (or group) level, identify choices of material (e.g., stainless steel or PVC pipe material).
Step 6	Link the treatment equipment requirements to a database that contains unit costs by equipment type, size and material. Multiplying the unit costs by the dimension and quantity requirements developed in Step 5 provides the component-level design costs.
Step 7	Tally the costs of the selected components to determine direct capital cost.
Step 8	Develop and add indirect and add-on costs to determine total system capital cost.
Step 9	Develop operation and maintenance cost estimates.

The WBS approach provides EPA with a consistent method for identifying components to include in a cost estimate. For each technology, the WBS approach develops a process and instrumentation diagram (P&ID) or a typical schematic layout showing the main unit processes needed to achieve the contaminant removal goals.

Exhibit 2-5 provides examples of several classes of components that can be included in a P&ID. The models often include further breakdown for alternative materials of construction for each component, because costs can differ substantially across materials. For example, most pipes can be constructed of stainless steel, steel, polyvinyl chloride (PVC) or chlorinated PVC. Stainless steel piping can cost twice as much as PVC.

Exhibit 2-5. Component Classes Included in the WBS Inventory

Component Classes	Example Components
Vessels	Pressure vessels
Tanks/basins	Storage Backwash Mixing Contact Flocculation Sedimentation Filtration
Pipes	Process Backwash Chemical Inlet/outlet Bypass
Valves (see Appendix A for further details)	Check (one-way) Motor- or air-operated Manual
Pumps	Booster Backwash High-pressure (for membrane systems) Chemical metering
Mixers	Rapid Flocculation Inline static
Instrumentation (see Appendix A for further details)	Pressure gauge Level switch/alarm Chlorine residual analyzer Flow meter pH meter Air monitor/alarm High/low pressure alarm Gas flow meters—rotameters Scales
System controls (see Appendix A for further details)	Programmable logic control units Operator interface equipment Controls software
Chemicals	Acids Bases Coagulants and coagulant aids Antiscalants Corrosion control Oxidants and disinfectants
Treatment media	Activated alumina Activated carbon Membranes Sand Resins

Component Classes	Example Components
Building (see Appendix B for further details)	Structure Heating and air conditioning systems Concrete pad
Indirect Capital Components (see Appendix D for further details)	Geotechnical investigations Standby power generators

The level of component detail (and by implication, design detail) in **Exhibit 2-5** indicates that the WBS-based approach is more sophisticated, and potentially more time consuming, than the factored or parametric cost estimating methods used in earlier efforts. Nevertheless, the Technology Design Panel considered it the right approach to developing unit costs for policy analysis. Furthermore, EPA believes that developing unit cost models that are more comprehensive, flexible and transparent will facilitate the policy analysis process by addressing a frequent topic of dispute over regulatory cost estimates. Finally, the WBS-based models are driven by technical scope and selection of suitable equipment and material to achieve a defined treatment objective. This approach is superior to cost estimating methods that are not defined by a desired treatment level or that cannot be changed easily to reflect raw water quality.

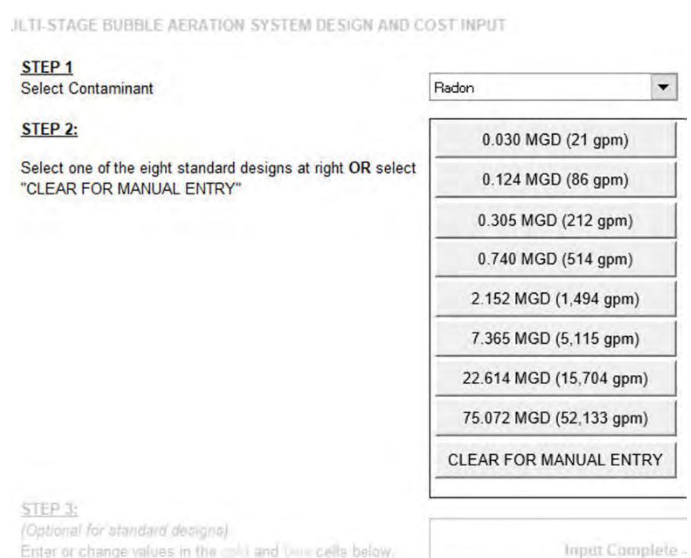
2.3 Model Use

This section provides basic guidance on operating the WBS technology models. As discussed above, each model is an Excel workbook comprising a series of spreadsheets. In general, users need only be concerned with the input sheet and output sheet, although advanced users might also wish to examine the critical design assumptions spreadsheets.

2.3.1 Input Sheet Structure and Use

The input sheet in each of the technology models is similar to that pictured in **Exhibit 2-2**. A step-by-step input process allows the user to quickly generate costs for standard designs built into the model, modify those designs or construct an alternative design.

Overview of the Input Process



Many models require basic information from the user before choosing an appropriate standard design. For example, contaminant selection is the first choice that must be made in several of the models. Such choices are made using a drop-down list at the top of the input sheet.

After making any basic, top-level choices, the user can click on one of the eight standard design buttons. Each button corresponds to a system size category in the flow characterization paradigm described below in **Exhibit 2-6**. The model will populate all inputs with values appropriate for the selected design, then compute all costs. The direct capital cost, total capital cost and annual O&M cost are displayed on the input sheet; details are available on the output sheet (see Section 2.3.4). More information on the standard designs is provided below.

Exhibit 2-6. Standard Flow Rate Categories Used in WBS Standard Designs

Size Category	Population Served	Design Flow (MGD)	Average Flow (MGD)
1	25 to 100	0.030	0.007
2	101 to 500	0.124	0.035
3	501 to 1,000	0.305	0.094
4	1,001 to 3,300	0.740	0.251
5	3,301 to 10,000	2.152	0.819
6	10,001 to 50,000	7.365	3.200
7	50,001 to 100,000	22.614	11.087
8	Greater than 100,000	75.072	37.536

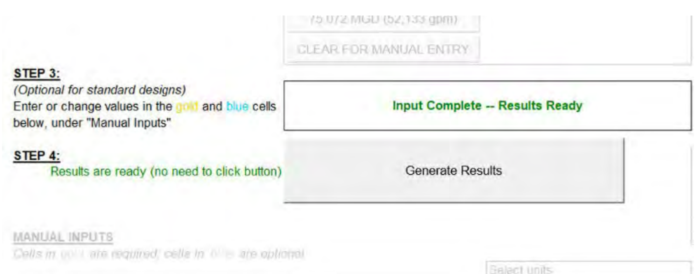
The standard designs, with their corresponding buttons, are primarily for EPA's use in estimating costs for a median sized system in each size category, although some users may find them useful as a starting point (see the examples in Section 2.3.3). The user can modify the standard designs after clicking one of the buttons by entering values in the gold and blue input cells, under the "Manual Inputs" heading on the input sheet. Alternately, many users will want to click the button marked "CLEAR FOR MANUAL ENTRY" and enter all of the input values by hand. In any case, the manual inputs section contains several types of cells:

- Required user inputs, highlighted in gold
- Optional user inputs, highlighted in blue
- Greyed-out inputs, which are not required for a given design
- Information and guidance, with text in green.

Some inputs, such as system flows, must contain a numeric value. Others have a drop-down arrow that appears when the cursor is positioned in the input cell. These cells must contain one of the drop-down values. Required inputs must be populated; optional inputs can be left blank to accept model defaults or changed by the user to examine the effect of different assumptions. The Autosize button, described below, is available in some models to facilitate design.

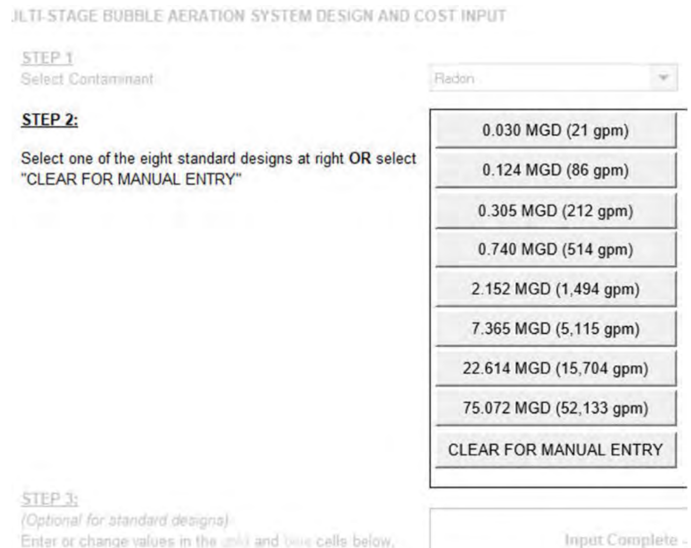
The input sheet in each model verifies user inputs against certain design constraints that reflect GREPs. If user inputs result in designs that violate these constraints, a warning message appears on the input sheet, explaining which input value needs to be corrected. In addition, the message "Input Incomplete—Check for Error Messages Below" appears at the top of the input sheet.

Once all inputs are complete and the model has verified that they meet design constraints, the message at the top of the input sheet changes to "Input Complete—Press 'Generate Results'." The user must click the "Generate Results" button to tell the model to generate costs. Once the user has clicked



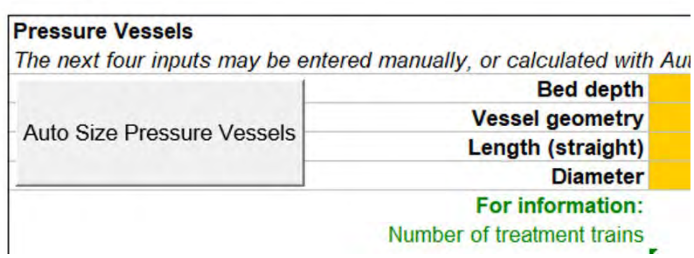
the button, the message at the top of the model changes to “Input Complete—Results Ready,” and total costs are displayed on the input sheet. The output sheet provides more details for the total costs.

Standard Designs



The input sheet in each of the technology models contains up to eight buttons, which correspond to the eight standard flow sizes in the flow characterization paradigm for public water systems (see **Exhibit 2-6**). These buttons populate all of the input fields with appropriate values for the selected design flow. The values in each standard design meet all relevant design constraints. Each model includes a separate sheet, entitled “standard inputs,” that documents the specific input values included in each standard design. Advanced users can adjust the standard designs by changing the values on the standard input sheet. For example, a user could change all the standard designs to use high cost components, rather than the default of low cost components (see Section 2.3.2 under “Component Level”), by changing values in the appropriate column on the standard input sheet. The standard input sheet highlights values that have been changed by the user and includes a button (“Reset to Defaults”) that resets the standard designs back to their original settings. Users that make significant adjustments to the standard designs should take care to verify that their new designs still meet design constraints by checking for warning messages on the input sheet after each new design is run.

The Autosize Routine



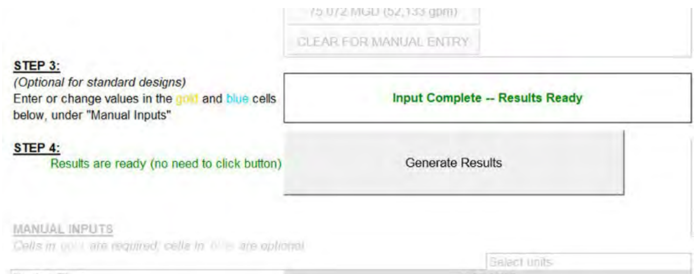
The models also can be used to estimate costs for systems with design flows other than the eight standard sizes. To aid in developing designs for other flows, some models include a button labeled “Autosize.” This button activates a computer-aided design routine that attempts to find a design meeting all relevant design constraints for a given design and average flow. For example, the user could change design flow to 3 million gallons per day (MGD) and average flow to 1 MGD, then click the autosize button. This would populate some input fields with values that are both appropriate for a 3 MGD system and that meet all design constraints. More information on the autosize routines, including details on which inputs are and are not populated, is available in the technology-specific chapters of this document.

In the rare case that the autosize routine cannot find a design meeting all constraints, it will display a pop-up warning message. This does not mean that it is impossible to design a system for the selected size. The user might still be able to develop a design by manually adjusting the input values, paying careful attention to the warning messages on the input sheet. It might be necessary to relax some of the design constraints by adjusting values on the critical design assumptions sheet.

Manual Input and "Generate Results"

All of the models allow the user to enter input values by typing them directly into the appropriate fields on the input sheet. Users can develop complete designs from scratch, populating all the input fields manually. Users also can adjust designs generated by the standard design or autosize buttons, by adjusting one or more input fields manually after clicking one of these buttons. In either case, after completing the manual changes, users should do two things:

- Verify that no warning messages appear to ensure that the design meets all relevant constraints
- Click the button labeled "Generate Results."

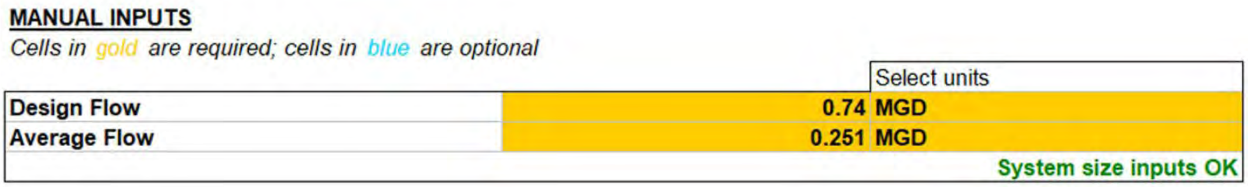


The second step is necessary to tell the models that the design process is complete and to select the appropriate items of equipment for inclusion in total costs on the output sheet. This step is particularly important if the system automation or component level inputs are adjusted manually, because these inputs have a significant impact on the selection of equipment. To ensure correct calculation of costs, however, users should click the "Generate Results" button after completing manual changes to *any* of the inputs. It is not necessary to click this button when the input sheet message reads "Input Complete—Results Ready." This message will appear, for example, when the standard designs or autosize routine are used without subsequent manual changes to input values. The standard design buttons and the autosize button automatically incorporate the "Generate Results" step, telling the models to select the appropriate items of equipment.

2.3.2 Common Inputs

The user inputs in each model are largely technology-specific and are described in detail in the technology chapters of this document. There are certain inputs, however, that are common to all of the technology models. These common inputs are described below.

Design and Average Flow

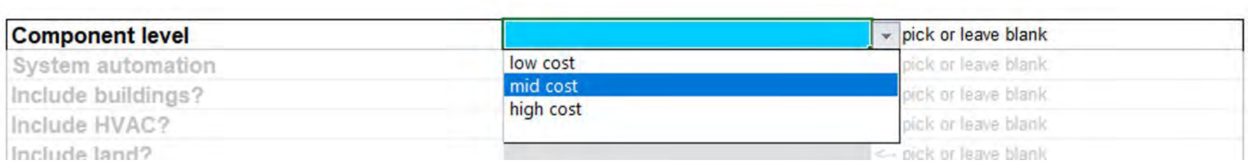


Each model needs the design and average flow to determine the size and number of treatment components needed. Design flow is the peak instantaneous flow of product water from a treatment system, while average flow is the annual average flow, taking into account daily and seasonal variations in demand.

Design flow can be entered in MGD or in gallons per minute (gpm). In either case, the design flow is meant to represent a maximum instantaneous flow. Average flow can be entered in MGD, in gpm or as a percentage of design flow.

The standard design functions included in each model (see above) can populate design and average flow with values based on the flow characterization paradigm for public water systems. The flow paradigm includes eight model size categories, as shown in **Exhibit 2-6**. These size categories represent populations ranging from 25 persons to greater than 100,000 persons. Based on the values in **Exhibit 2-6**, the ratio of average flow to design flow ranges from 25 percent for very small systems to 50 percent for large systems.

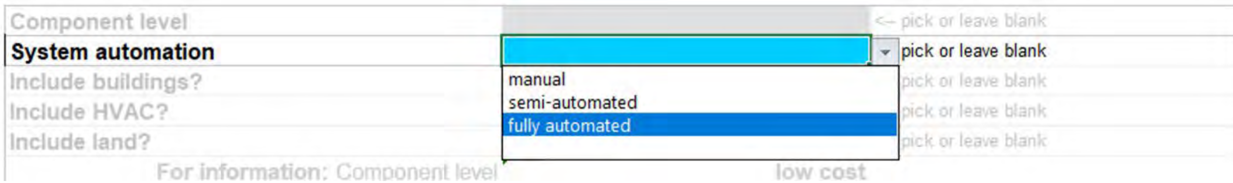
Component Level



Each model includes an optional input that determines whether the cost estimate generated is a low, medium or high cost estimate. This input, labeled "component level" or "cost level," drives the selection of materials for items of equipment that can be constructed of different materials. For example, a low cost system might include fiberglass pressure vessels and PVC piping. A high cost system might include stainless steel pressure vessels and stainless steel piping. The component level input also drives other model assumptions that can affect the total cost of the system, including assumptions about system automation (see "System Automation" below), building quality and heating and cooling (see Appendix B).[3] If the component level input is left blank, the models will generate a low cost estimate. The user can change this input to select a medium or high cost estimate.

[3] In some cases (e.g., the membrane models, which are under development), this input also determines the source water quality that the model treats. In these models the input is called the "cost level."

System Automation



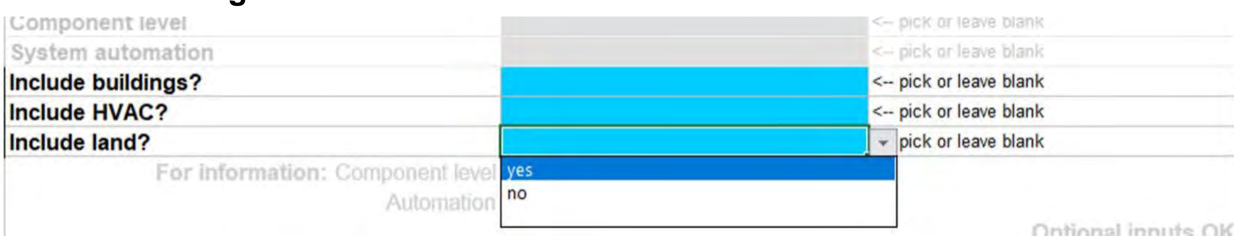
As described in Appendix A, control of drinking water treatment systems can be manual, automated or semi-automated. The method of control can have a significant impact on both capital and O&M costs. Each model includes an optional input that allows the user to select from among the three control options. If the system automation input is left blank, the control option selected is determined by the system size and the component level input selected (see above), using the logic shown in **Exhibit 2-7**. The user can change the system control input to force the design of a system with manual, automated or semi-automated control.

Exhibit 2-7. Default Assumptions for System Control

Component Cost Level Selected	System Size (Design Flow) Less than 1 MGD	System Size (Design Flow) 1 MGD or greater
Low	Manual	Manual
Medium	Manual*	Automated
High	Automated	Automated

* Automated for some models.

Include Buildings?



By default, the WBS models include the capital cost of buildings to house the treatment system, as discussed in Section 2.4.1 and Appendix B. Each model includes an optional input that allows the user to exclude the capital cost of buildings. If the user excludes the capital cost of buildings, the model also excludes the O&M cost of building maintenance and lighting.

Include Heating, Ventilating and Air Conditioning (HVAC)?

By default, the WBS models choose whether to include the cost of heating and cooling systems depending on system size, building structure type and user input for component level, as discussed in Section 2.4.1 and Appendix B. Each model includes an optional input that allows the user to override the model's default selection and choose to include or exclude the cost (both capital and O&M) of HVAC systems.

Include Land?

Regardless of whether a system needs to purchase additional land on which to build the new treatment train, there is an opportunity cost associated with using land for water treatment rather than an alternative use. By default, the WBS models include an add-on cost for land, as discussed in Section 2.4.4. Each model includes an optional input that allows the user to exclude the add-on cost for land.

2.3.3 Input Sheet Examples

Several examples are presented here to clarify the use of the WBS model input sheet. The examples refer to particular technology models. Detailed information about the inputs for these models can be found in the appropriate technology-specific chapters.

Standard Design

The simplest way to generate a design is by use of the standard design buttons. Suppose that a user wishes to estimate costs for a system designed to treat trichloroethylene (TCE) using granular activated carbon (GAC), serving a population of approximately 8,000 people. The following are step-by-step instructions for using the adsorptive media model to generate such a cost estimate:

1. Open the Excel workbook named “WBS GAC.xlsm.”[4] Depending on your settings and version of Excel, a message might appear regarding “active content” in the workbook. For the models to function properly, macros must be enabled. Take the appropriate steps to enable macros (for example, clicking “Options” and selecting “Enable this content,” depending on your version of Excel).

2. Navigate to the input sheet by clicking on the tab labeled “INPUT” at the bottom of the Excel window. (It is also possible to page through the sheets by pressing Ctrl-Page Up and Ctrl-Page Down.) Scroll to the top of the input sheet.

3. The GAC model requires that the user first choose the contaminant. Select “TCE” from the “Select Contaminant” dropdown list.

4. The GAC model also requires that the user choose between pressure and gravity designs (see the appropriate technology chapter for discussion of the difference between design types). Select “Pressure” from the “Select Design Type” dropdown list.

5. The user wishes to use a standard design appropriate for a population of 8,000 people. **Exhibit 2-6** indicates that size category 5, with a design flow of 2.152 MGD, is appropriate for such a system. Therefore, click on the design button labeled “2.152 MGD standard design.” After a few seconds, the model will display the message “Using this design” next to the design button and “Input Complete—Results Ready” underneath the buttons. It displays the direct capital cost, total capital cost and annual O&M cost on the input sheet.

6. If desired, scroll down on the input sheet to see what inputs are used for the standard design. For instance, the 2.152 MGD standard design for GAC treating TCE with a pressure design uses a design flow of 2.152 MGD and an average flow of 0.819 MGD. It

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[4] Note that your model file name might vary. It likely will include a date following the model title (e.g., “WBS GAC 042514.xlsm” for April 25, 2014).

assumes a carbon life of 66,600 bed volumes and a total theoretical empty bed contact time (EBCT) of 7.5 minutes.

Modified Standard Design

Suppose that the user wishes to design a GAC system treating TCE for a population of 1,000, using source water that entails a different carbon life and EBCT than that assumed in the standard designs (e.g., because the source water contains a higher initial concentration of TCE). The user determines that the source water characteristics entail a carbon life of 40,000 bed volumes and an EBCT of 10 minutes. The following are step-by-step instructions for using the GAC model to generate such a cost estimate:

1. Open the Excel workbook named "WBS GAC.xlsm"[5] and take the appropriate steps to enable macros (see Step 1 described in the "Standard Design" section above). Navigate to the input sheet, scroll to the top of that sheet and select "TCE" and "Pressure" from the appropriate dropdowns (see Steps 2, 3 and 4 described in the "Standard Design" section above).

2. The user wishes to design a system for a population of 1,000 people**. Exhibit 2-6** indicates that size category 3, with design flow 0.305 MGD, is appropriate for this population, so start by clicking the "0.305 MGD standard design" button.

3. The user wishes to design a system with a carbon life of 40,000 bed volumes. Scrolling down the input sheet, note that the standard design uses an input carbon life of 66,600 bed volumes. Type the number 40,000 in the gold input cell to change the carbon. Note that the green informational text below the input cell changes to show the number of months between regenerations. Note also that the message above the manual inputs changes to "Input Complete—Press 'Generate Results'" to indicate that costs have not been updated for your new input.

4. The user wishes to design a system with an EBCT of 10 minutes. Scroll down to the cell labeled "Theoretical Empty Bed Contact Time" and enter the number 10.

5. Changing the EBCT will change the optimal vessel geometry. To quickly estimate costs for this new EBCT, click the "Autosize" button next to the inputs for vessel geometry. The input values will flicker briefly while the model tries several different values and then settles on a new value. Because the Autosize button was clicked, it is not necessary to click the "Generate Results" button; the message above the manual inputs reads "Input Complete—Results Ready," and the total costs are displayed on the input sheet.

Suppose that the user also wishes to estimate a high-end cost for this system. In this case, take the following additional steps:

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[5] Again, your model file name might vary. It likely will include a date following the model title (e.g., "WBS GAC 042514.xlsm" for April 25, 2014).

6. Scroll down and place the cursor in the input cell labeled "Component Level." A dropdown arrow appears to the right of the cell. Click on the arrow and choose "high cost."

7. Scroll back to the top of the sheet. Note that the sheet indicates that the user must click "Generate Results." Click that button. The model displays costs for the high-end system. To see what components are included, switch to the Output sheet and examine the details.

2.3.4 Output Sheet Structure and Use

The output sheet in each of the technology models is similar to that pictured in **Exhibit 2-3**. In addition to the details described in Section 2.1, the output sheet includes several important totals:

- Process cost, which is the sum of the installed capital cost of all equipment required for the treatment process
- Building cost, which is the sum of the installed capital cost of all buildings and the concrete pad
- Direct capital cost, which is the sum of the process and building costs
- Total capital cost, which is the total of the direct capital cost, the indirect capital costs and add-on costs (see Sections 2.4.3 and 2.4.4)
- Annual O&M cost (see Section 2.4.5)
- Total annualized cost (see Section 2.4.6).

The capital equipment section of the output sheet includes a column labeled "Use?" This column tells the model which line items to include in the direct capital cost. Specifically, items with a value of 1 in the "Use?" column are included in the total; items with a value of 0 or a blank are not included in the total. Advanced users can manually adjust this column to include or exclude certain items of equipment. For example, a user could examine process costs without booster pumps by changing the "Use?" value to 0 for those pumps. The "Generate Results" button, which is present on both the input and output sheets, will reset the "Use?" values back to pre-programmed default values, as driven by system size and input values.

The output sheet also includes a button labeled "Record Output in a New Workbook." This button generates a complete copy of the output sheet that will not change. Using this button allows users to record the detailed design output for comparison purposes. For example, a user could record the output from the standard design for 0.03 MGD, then select the 0.124 MGD standard design and compare the output results for the two designs.

2.3.5 Critical Design Assumptions Sheet Structure and Use

Each of the technology models includes at least three critical design assumptions sheets:

- One for process and building design assumptions
- One for assumptions used in calculating annual O&M costs
- One for assumptions used in calculating certain indirect capital costs

Some models include additional critical design assumptions sheets (e.g., in the aeration models, for assumptions associated with off-gas treatment).

These sheets contain design constraints and structural and chemical engineering assumptions based on GREPs. Users can review these sheets for details on significant assumptions used in the models. Advanced users might want to modify certain assumptions, particularly if adapting a model for use with a source water quality different than assumed in the standard designs or to reflect site-specific conditions. Most of the assumptions include a comment column explaining the use of the assumption and/or providing guidance on appropriate values.

Most of the significant design assumptions are technology-specific and discussed in detail in the technology chapters of this report. However, there are certain assumptions that are common to many of the models. **Exhibit 2-8** summarizes the general design assumptions that are common across most of the models. As **Exhibit 2-8** indicates, these assumptions are based on a combination of sources, including standard design handbooks, engineering textbooks and comments of external reviewers. Note that some of the general design assumptions (and some technology-specific assumptions, as discussed in the relevant technology chapters) differ for small versus large systems. In general, these differences are because small systems can often be built as packaged, pre-engineered or skid-mounted systems. In most cases, the different design and cost assumptions for small systems are based on comparison of model outputs with as-built designs and costs for actual small treatment systems.

The user can change some of the assumptions shown in **Exhibit 2-8** by editing the critical design assumptions sheet; others can be edited in the data extracted from WBS cost database. The final column of **Exhibit 2-8** provides guidance on how to change each assumption. For example, the design of pumps for any treatment system is based on the peak flow requirements of the system, including a safety factor. As specified in **Exhibit 2-8**, the critical design assumptions sheet assumes a safety factor of 25 percent. A user could change this factor based on an actual pump performance curve.

Exhibit 2-8. General Design Assumptions Used in the WBS-based Models

Element	Assumption	Can be changed by:
Influent pumps	Include flooded suction	Replacing unit costs or cost coefficients extracted from the WBS cost database
All pumps	Design flow incorporates a safety factor of 25 percent	Editing the critical design assumptions sheet of each technology
Access space for pumps	Provide a minimum of 4 feet of service space around three sides of each unit, assuming the fourth side can share access space with relevant tanks or vessels	Editing the critical design assumptions sheet of each technology
Pipe size	Based on a maximum of 3 feet of head loss per 100 feet of pipe	Editing the engineering lookup table extracted from the WBS cost database
Process pipe size	Based on maximum flow to each unit (not total system flow)	Cannot be changed
Tank and pressure vessel capacity	Based on design capacity, freeboard and standard manufactured sizes	Cannot be changed
Pressure vessel diameter	Based on user input, within limits specified on a technology-specific basis	Changing user inputs (for diameter) and editing the critical design assumptions sheet of each technology (for constraints)
Storage tank diameter	Assumes a cylindrical design, with diameter equal to one half of the height	Cannot be changed

Element	Assumption	Can be changed by:
Access space for tanks and pressure vessels	Provide service space around each unit equal to its diameter (half its diameter for small systems), to a maximum of 6 feet	Editing the critical design assumptions sheet of each technology (only maximum can be changed)
Process vessels and basins, all pumps and chemical feed systems	Multiple units required to protect from single point failure	Editing the critical design assumptions or input sheet of each technology (depending on the specific item)
Chemical storage	Storage requirement based on 30-day delivery frequency	Editing the critical design assumptions sheet of each technology
Concrete pad under heavy equipment	1 foot thick for large systems, 6 inches thick for small systems	Editing the critical design assumptions sheet of each technology
Office space	100 square feet per employee for large systems (excluded for small systems)	Editing the critical design assumptions sheet of each technology

Sources: U.S. EPA (1997); AWWA (1990); AWWA/ASCE (1998); Viessman and Hammer (1993); GREPs; and information from manufacturers and technology experts who reviewed model critical design assumptions.

Cost Estimation Method

Equipment unit costs can be derived in one of two ways. The first (and recommended) method uses component-specific cost equations developed from unit costs collected from equipment vendors. The component cost equations are best-fit equations (developed using statistical regression analysis across the sizes available for each item) that estimate the unit cost of an item of equipment as a function of its size. Under the cost equation option, the models will generate unit costs for each item of equipment by applying the appropriate cost equation to the exact size determined by the design calculations.

The second method uses unit cost lookup tables extracted from the WBS cost database. These lookup tables are based on quotes from equipment manufacturers for discrete equipment sizes. To maintain vendor confidentiality, the tables do not identify the individual vendors associated with the quotes and the unit costs typically are averages across multiple vendors. Under the lookup table option, for each item of equipment, the models will search the appropriate lookup table to locate a unit cost that best meets the design requirements for the component. In general, this means that the models will select the discrete equipment size for each item of equipment that is equal to or greater than the size determined by design calculations.

Each model includes a critical design assumption, labeled “cost estimating method,” that determines the method used to derive equipment costs. By default, the assumption is set to 1, to use the component-specific cost equations. The user can set the assumption to a blank value to select the lookup table method. EPA believes the cost equations method is most appropriate for generating national cost estimates and for most user-specified designs. Using the equations, instead of the price quotes, allows the models to generate unit costs for equipment of the exact size determined by the design calculations. For example, a WBS model design might require a 250 gallon steel tank, but the available price quotes might be limited to 100 gallon, 500 gallon and various larger sizes. The cost equation for steel tanks will allow the WBS model to generate a unit cost for the intermediate sized 250 gallon tank. The lookup table method would use the cost for the 500 gallon tank. The models retain the lookup table method for users who wish to examine the specific cost data points on which the component-specific cost equations are based.

2.3.6 Index Sheet Structure and Use

Each technology model includes an index of all inputs and critical design assumptions, including hyperlinks to their locations. **Exhibit 2-9** shows an example of the index sheet. The sheet provides an alphabetized list of all inputs and assumptions. Due to the great number of inputs and assumptions in the WBS models, the Find feature in Excel can be useful in locating a specific input or assumption.

Next to the description of each input or assumption is a blue, underlined hyperlink. It shows the internal name of the input or assumption used in the engineering formulas throughout the WBS model. Clicking on the hyperlink takes the user to the cell where the assumption can be viewed or adjusted.

Exhibit 2-9. Sample of Index Spreadsheet

INDEX	
This page provides an index to all user-adjustable inputs and assumptions. Click on a variable name to go directly to the adjustable cells.	
User-adjustable Input or Assumption	**Variable Name and Link**
Access space per pump/blower for custom designed systems	space_pumps_cust
Access space per pump/blower for pre-engineered packages	space_pumps_pre
Additional blower head above water depth	add_blow_head
Additional building after...	add_2nd_building
Administrative LOE as a percent of average technical labor	Clerical_percent
Air conditioning EER	EER
Air to water ratio	air_water_ratio
Always include NEPA compliance costs?	include_NEPA
Annual cooling degree days	cool_DD
Annual heating degree days	heat_DD
Average Flow	average_flow_I
Basin excavation depth above which deeper boreholes are needed	deep_bore_need
Bedding depth below pipe	bedding_depth
Bedding depth surrounding the pipe	bedding_pct
Blower efficiency	blower_effcy
Blower safety factor	blower_safety_factor
Borehole depth (package systems)	bore_depth_p
Borehole depth for deep basins	bore_depth_max
Borehole depth for shallow basins	bore_depth_min
Borehole needed every x square feet	hole_per_sf
Boreholes per job	hole_per_job
Buffer space around other sides of buildings	non_fire_buffer
Builder's risk insurance percentage	br_ins_pct
Building height	Building_height
Coefficient of passive pressure	Coeff_Kp
Communications hardware	comm_hardware
Component level	component_level_I
Computer workstations per x operators	workstation_ratio
Concrete pad thickness	pad_thick
Concrete pad thickness for small systems	pad_thick_small
Concrete thickness	conc_thick
Contaminant-Specific Off-gas Assumptions	contaminant_lookup
Cooling table for buildings 500 square feet or greater	cooling_table
Cooling table for buildings less than 500 ft2	cooling_table_shed
Cooling ventilation/infiltration load	cool_vload
Cost for parts & maintenance for pumps and blowers	pump_maint_rate
Density of air	PA
Design Flow	design_flow_I
Design safety factor for standby power	std_safety_factor
Design Type	design_type_I
Diffuser access space	diffuser_access_space
Drive controllers per blower	S_blower
Drive controllers per booster pump	S_booster_pump
Drive controllers per catalytic oxidizer	S_CO
Drive controllers per thermal oxidizer	S_TO
Efficiency of pumps	pump_effcy
Electric resistance heating efficiency	resist_eff
Electrical percentage	elect_pct
Engineering percentage for large systems	eng_pct_large
Engineering percentage for medium systems	eng_pct_medium
Engineering percentage for small systems	eng_pct_small
Ethernet modules	plc_ethernet
Excess air required	CO_ex_air
Excess air required	TO_ex_air
External air piping	air_pipe_add
Financing percentage	finance_pct

2.4 General Cost Assumptions

An important feature of the WBS models is that they build up cost estimates from component-level data. Each model shows the user the cost build-up, which makes the cost estimates more transparent, giving the user an opportunity to evaluate the impact of design and unit cost assumptions on treatment costs. There are several types of costs that need to be aggregated into a total cost estimate: equipment costs, building cost, residuals discharge cost, indirect capital costs, add-on costs and annual O&M costs. The sections below describe how each type of cost enters the WBS models.

The build-up process for equipment costs is straightforward. The design sheets in the model generate the required dimensions and quantities for each item in the WBS list of equipment components and materials. Then, the model obtains unit costs to match the component size and material (e.g., a 10-inch diameter PVC pipe or a 4,000-gallon steel backwash tank). The model multiplies unit costs by the quantity estimate (e.g., 30 feet of pipe or 2 tanks) to obtain total component costs. Direct capital cost equals the sum of these costs across the selected components, including costs for treatment equipment and buildings.

The models enable equipment unit costs to be derived in one of two ways (using lookup tables or cost equations, as described in Section 2.3.5 under "Cost Estimation Method"). Regardless of the method used, the estimates are intended to provide enough information to establish a budgetary or preliminary cost estimate. Therefore, although the model results are point estimates shown to the nearest $1, this precision is not meant to imply that the results are accurate to $1. Instead, EPA's goal is for the resulting costs to be within +30 percent to -15 percent of actual cost. To validate the engineering design methods used by the models and assess the accuracy of the resulting cost estimates with this goal, EPA has subjected the individual models to a process of external peer review by nationally recognized technology experts. The technology-specific chapters of this document include a discussion of peer reviewer opinions on the accuracy of each model's results. Users are encouraged to review all documentation, modify inputs and assumptions as appropriate to their specific purpose, and form their own informed opinions about the accuracy and suitability of the results.

Consistent with providing a budgetary or preliminary cost estimate, WBS models contain several cost-related assumptions that allow the models to produce costs for some components without having detailed site-specific information (e.g., pipe fitting sizes). **Exhibit 2-10** summarizes these assumptions.

Exhibit 2-10. General Equipment Cost Assumptions

1. Costs are preliminary estimates based on major components as shown on piping and instrumentation diagrams or typical layout drawings. Costs include consideration of package plants where relevant (see model-specific chapters for more details).
2. All equipment costs include costs of transportation and installation.
3. All equipment costs are based on cost quotes from manufacturers or RSMeans database.
4. Long-term storage of chemicals (greater than 30 days) is not taken into account unless specifically mentioned.
5. Cost of waste disposal (residuals) is accounted for using the methods outlined in Section 2.4.2 and Appendix C.
6. Building layout is for the process itself, with room for operation, maintenance and replacing equipment, if needed.
7. Building costs are estimated using unit costs per square foot (see Section 2.4.1 and Appendix B for more details).
8. Costs for a reinforced-concrete pad floor to handle equipment loads are added to building costs. Costs associated with special unit or site-specific foundation requirements are not included and should be evaluated on a case-by-case basis.
9. To account for the cost of fittings, pipe lengths are determined by applying a multiplier to the overall system building layout length. The resulting lengths are considered conservative (i.e., erring on the high side), so that the resulting cost covers the installed cost of the pipe and fittings. The specific multipliers are as follows:

   Combined influent and treated water pipe length is 2 times the length of the overall system building layout length.
   Process pipe length is 2 times the length of the overall system building layout length.
   Backwash pipe length is 2.5 times the overall system layout length.
   Bypass pipe length is 2.5 times the overall system layout length.
   Chemical pipe length is 1 times the overall system layout length.
   Residuals pipe length is 1 times the overall system layout length.

2.4.1 Building Costs

The WBS model building costs use three sources: RSMeans *2020 Square Foot Costs* (RSMeans, 2020), Saylor *2020 Commercial Square Foot Building Costs* (Saylor, 2020) and the Craftsman 2020 National Building Cost Estimator software model (described in Craftsman, 2020). Appendix B provides a detailed description of these sources and the approach to developing building costs.

In each WBS technology model, there are four possible design configurations for buildings: three construction design and quality categories (low, medium and high) and small, very low cost, prefabricated ("shed-type"). The WBS models select from among these configurations based on system size, structure size and user input for component level (see Section 2.3.2), as shown in Appendix B. Unit costs (in dollars per square foot) for each configuration vary by structure size. When appropriate, the WBS models add costs for building heating and cooling systems as line items separate from the base building costs. Whether the WBS models include these systems also depends on system size, structure type and user input for component level, as shown in Appendix B.

As discussed in Section 2.3.2, the input sheet of each model includes optional inputs that allow the user to choose whether or not to include the costs of buildings and HVAC systems.

2.4.2 Residuals Management Costs

Many of the treatment technologies covered by the WBS-based models generate liquid, semi-solid (sludge) and/or solid residuals. For these technologies, each model includes a sheet that estimates the cost of various options for managing these residuals. The residuals management options available for a given technology vary depending on the types of residuals generated, their quantity, the frequency of generation (e.g., intermittent versus continuous) and their characteristics. Examples of residuals management options include (but are not limited to): direct discharge to surface water, discharge to a publicly owned treatment works, land disposal of solids and storage and/or treatment of sludge or liquid waste prior to disposal or discharge. The individual technology chapters of this document describe the specific residuals management options available for each technology. Appendix C provides detailed information about the data and assumptions used to estimate costs for the various residuals handling and disposal options.

2.4.3 Indirect Capital Costs

Indirect capital costs are costs that are not directly related to the treatment technology used or the amount or quality of the treated water produced, but are associated with the construction and installation of a treatment process and appurtenant water intake structures. Indirect costs can be considerable and must be added to cost estimates if they are not included as a line item component or a factor in the major (cost driver) elements of a technology. They include indirect material costs (such as yard piping and wiring), indirect labor costs (such as process engineering) and indirect burden expenses (such as administrative costs).

The WBS models compute the costs of site work, geotechnical investigation, yard piping and standby power based on the system requirements, as determined during the direct capital cost buildup. Other indirect costs are computed as a percentage of the installed process cost, building cost or direct capital cost estimate. The indirect assumptions sheet in each WBS model (see Section 2.3.5) contains guidance regarding a typical range of percentages for each item and indicates the base cost to which the percentage will be applied. The guidance also describes conditions that might require an assumption outside the range of typical values. Finally, guidance on the output sheet notes that items such as installation costs and contractor overhead and profits are already included in the direct capital cost estimate, but entries can be made to increase these cost items should circumstances merit higher costs. Any of these costs can also be excluded by modifying assumptions on the indirect assumptions sheet. Costs that are computed as a percentage can be excluded simply by setting the percentage to zero. Those that are computed based on system requirements can be included or excluded by setting the appropriate flag to one or zero on the indirect assumptions sheet.

The WBS models report the total capital cost directly below this section of the output sheet so the user can determine the impact of altering the indirect cost assumptions on total capital costs.

Appendix D provides descriptions of the default assumptions for the following indirect costs:

- Mobilization and demobilization
- Architectural fees for treatment building
- Equipment transportation, installation and contractor overhead and profit
- Construction management and general contractor overhead
- Process engineering
- Site work
- Yard piping

- Geotechnical
- Standby power
- Yard wiring
- Instrumentation and control
- Contingency
- Financing during construction
- Legal, fiscal and administrative
- Sales tax
- City index
- Miscellaneous allowance.

2.4.4 Add-on Costs

Add-on costs are costs that may be attributed to one or more aspects of the treatment technology. These add-on costs include permit costs (e.g., for construction and discharge permits), pilot and bench testing costs and land use costs. Users can include or exclude these costs by setting appropriate flags on the indirect assumptions sheet (see Section 2.3.5).

Permits

Systems installing new treatment technologies to comply with revised drinking water standards will often need to build a new structure to house the new treatment train and might need to build auxiliary structures to store chemicals (e.g., chlorine, which must be stored in a separate building). In all jurisdictions, such construction activities require a building permit and inspections to ensure that the structure meets local building codes. New treatment trains can also create a new waste stream or supplement an existing one. New waste streams such as new point source discharges to surface water generally require a state or federal permit; additions to existing flows often require revisions to existing permits. The WBS models include costs for the following permits:

- Building permits
- Permits under the National Pollutant Discharge Elimination System (when residuals discharge to surface water is present)
- Storm water permits (for systems requiring one acre of land or greater)
- Risk management plans (when certain chemicals are present in large quantities)
- Compliance with the National Environmental Protection Act (included by default only at the high cost component level – see Section 2.3.2).

Pilot Study

Site-specific pilot tests are often required by regulatory agencies to better define design conditions and to ensure that the proposed technology will protect public health. In addition, pilot tests and bench-scale tests can be run for non-regulatory reasons, e.g., to determine appropriate loading and chemical feed rates, waste handling requirements or other process parameters. Options for pre-design and pre-construction testing can include full- or small-scale pilot studies, bench tests and desktop feasibility studies. Costs for pilot testing vary accordingly.

Pilot studies range from inexpensive small-scale efforts to full-scale tests that might be warranted by site-specific conditions. Three variables affecting the costs of a pilot study are: technology requirements, testing protocols and state requirements. Some states determine test requirements on a case-by-case basis, particularly where drinking water standards or regulations such as noise, air emissions, plume abatement or surface water discharges (e.g., the National Pollutant Discharge Elimination System) are relatively stringent. The diversity of state requirements, along with the many options for pre-design testing, means that requirements for pilot- or bench-scale studies are difficult to define. Nevertheless, the WBS models include default pilot study costs based on vendor quotes and estimated analysis costs. The user can alter these costs by adjusting the cost data extracted from the central WBS cost database if site-specific conditions warrant.

Land Cost

Regardless of whether a system needs to purchase additional land on which to build the new treatment train, there is an opportunity cost associated with using land for water treatment rather than an alternative use. The WBS models capture this cost in a land cost estimate that is based on the calculated land requirement (in acres) and a unit cost per acre. As discussed in Section 2.3.2, the input sheet of each model includes an optional input that allows the user to choose whether or not to include the cost of land.

Each model estimates land required for the treatment system, plus a 40-foot buffer on one side for emergency vehicle access and 10 feet on the other three sides. The user can change the assumptions about buffer spacing using the critical design assumptions sheet for each technology.

The WBS models incorporate land costs based on unit land costs that vary by system size and land requirements that vary by technology and system size. Average land costs per acre are estimated as probability-weighted averages using data from the Safe Drinking Water Information System on system size and location, data for rural land costs for 50 states and data on urban land costs for approximately 125 cities and metropolitan areas.

2.4.5 Annual O&M Costs

The O&M costs in each WBS model include annual expenses for:

- Labor to operate and maintain the new treatment equipment and buildings
- Chemicals and other expendable items (e.g., replacement media) required by the treatment technology
- Materials needed to carry out maintenance on equipment and buildings
- Energy to operate all equipment and provide building heating, cooling, lighting and ventilation
- Residuals discharge fees.

The individual technology chapters of this document describe additional, technology-specific O&M costs.

O&M costs calculated in the models do not include annual costs for commercial liability insurance, inspection fees, domestic waste disposal, property insurance and other miscellaneous expenditures that are not directly related to the operation of the technology. These costs are highly site-specific. Users wishing to include them should add the appropriate site-specific estimates to the model results.

The WBS models calculate annual O&M costs based on the inputs provided by the user in the input and O&M assumptions sheet. These inputs include system size, raw and finished water quality parameters and other factors that affect operation requirements. Appendix E contains the design assumptions used to develop default costs for the O&M sheet.

2.4.6 Total Annualized Cost

The output sheet in each model includes an estimated useful life, in years, for each WBS component. The models take these component useful lives from the WBS cost database. The useful lives vary by component type (e.g., buildings generally last longer than mechanical equipment) and by material (e.g., steel tanks generally last longer than plastic tanks). The models use the component useful lives to calculate an average useful life for the entire system. The calculation uses a reciprocal weighted average approach, which is based on the relationship between a component's cost (C), its useful life (L) and its annual depreciation rate (A) under a straight-line depreciation method. The formula below shows the reciprocal weighted average calculation:

$$\text{Average Useful Life} = \frac{\sum_{n=1}^{N} C_n}{\sum_{n=1}^{N} A_n} = \frac{C}{A}$$

where:

C_n denotes the cost of component n, n=1 to N
C denotes total cost of all N components
A_n denotes the annual depreciation for component n, which equals C_n/L_n
A denotes total annual depreciation for the N components.

The models use this average useful life for the system, along with a discount rate, to annualize total capital cost, resulting in capital cost expressed in dollars per year. The models use a default discount rate of 7 percent, which users can adjust directly on the output sheet. The models add annual O&M cost to the annualized capital cost to arrive at a total annual cost in dollars per year.

2.4.7 Updating and Adjusting Costs

There are many factors that contribute to the variation in capital and O&M costs for the same treatment technology. One variable is location, which is captured by the city index indirect cost. Another is time—over time, the nominal price of materials, labor and land can change due to inflation. If relative prices do not change over time (i.e., if innovative materials or production technologies do not affect production cost relative to the price of other goods), then nominal component prices can be adjusted using standard cost indices. The WBS cost database incorporates the following indices to adjust prices to values in a common year:

- The Producer Price Index (PPI) consists of a family of indices that measure the average trends in prices received by producers for their output (BLS, 2010). Within the PPI is the family of commodity-based indices. The commodity classification structure of the PPI organizes products by similarity of end use or material composition. Fifteen major commodity groupings (at the two-digit level) make up the all-commodities index. Each major commodity grouping includes (in descending order of aggregation) subgroups (three-digit level), product classes (four-digit level), subproduct classes (six-digit level) and individual items (eight-digit level). The WBS cost database assigns components to the most closely related PPI commodity index. The selected price index for a component is generally the index with the smallest product space. For example, prices for stainless steel pressure vessels are escalated using a four-digit level index called BLS1072 Metal Tanks.
- Building and construction costs are escalated using either the Engineering News-Record Construction Cost Index or the Building Cost Index (ENR, 2020).
- Labor costs are escalated using the Employment Cost Index for "not seasonally adjusted, total compensation, private industry and public utilities" (BLS, 2000; SIC series: 252). The Bureau of Labor Statistics releases this index quarterly. The WBS cost database utilizes an annual average.
- The Consumer Price Index is used to adjust land costs and components that have not been assigned a specific PPI (BLS, 2007).

2.5 List of Abbreviations and Symbols in this Chapter

EBCT	empty bed contact time
EPA	U.S. Environmental Protection Agency
GAC	granular activated carbon
gpm	gallons per minute
GREPs	generally recommended engineering practices
HVAC	heating, ventilating and air conditioning
MGD	million gallons per day
O&M	operating and maintenance
P&ID	process and instrumentation diagram
PPI	Producer Price Index
TCE	trichloroethylene
WBS	work breakdown structure

2.6 References

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3. Anion Exchange Model

Anion exchange is a process in which negatively charged ions are exchanged from a network of ion exchange sites within a microporous or macroporous resin. The resin is usually made up of synthetic polymers. Anion exchange has been used to remove nitrates, sulfates, arsenic and other negatively charged pollutants from water. In the case of arsenic, the solid resin exchanges chloride for the arsenic and other influent anions. The U.S. Environmental Protection Agency (EPA) has selected anion exchange as one of the best available technologies for arsenic removal, with maximum removal percentages around 95 percent (Sorg, 2000).

The work breakdown structure (WBS) model for anion exchange includes standard designs for arsenic and nitrate removal. However, the model can be used to estimate the cost of anion exchange treatment for the removal of other contaminants as well, such as uranium.[6] Users wishing to simulate the use of anion exchange for treatment of other contaminants will need to adjust default inputs (e.g., bed volumes before regeneration, bed depth) and critical design assumptions (e.g., minimum and maximum loading rates). This chapter includes discussion of inputs and assumptions that might require adjustment and these values are highlighted in gold in the model.

3.1 Overview of Anion Exchange Treatment Process

The anion exchange treatment process includes the following components:

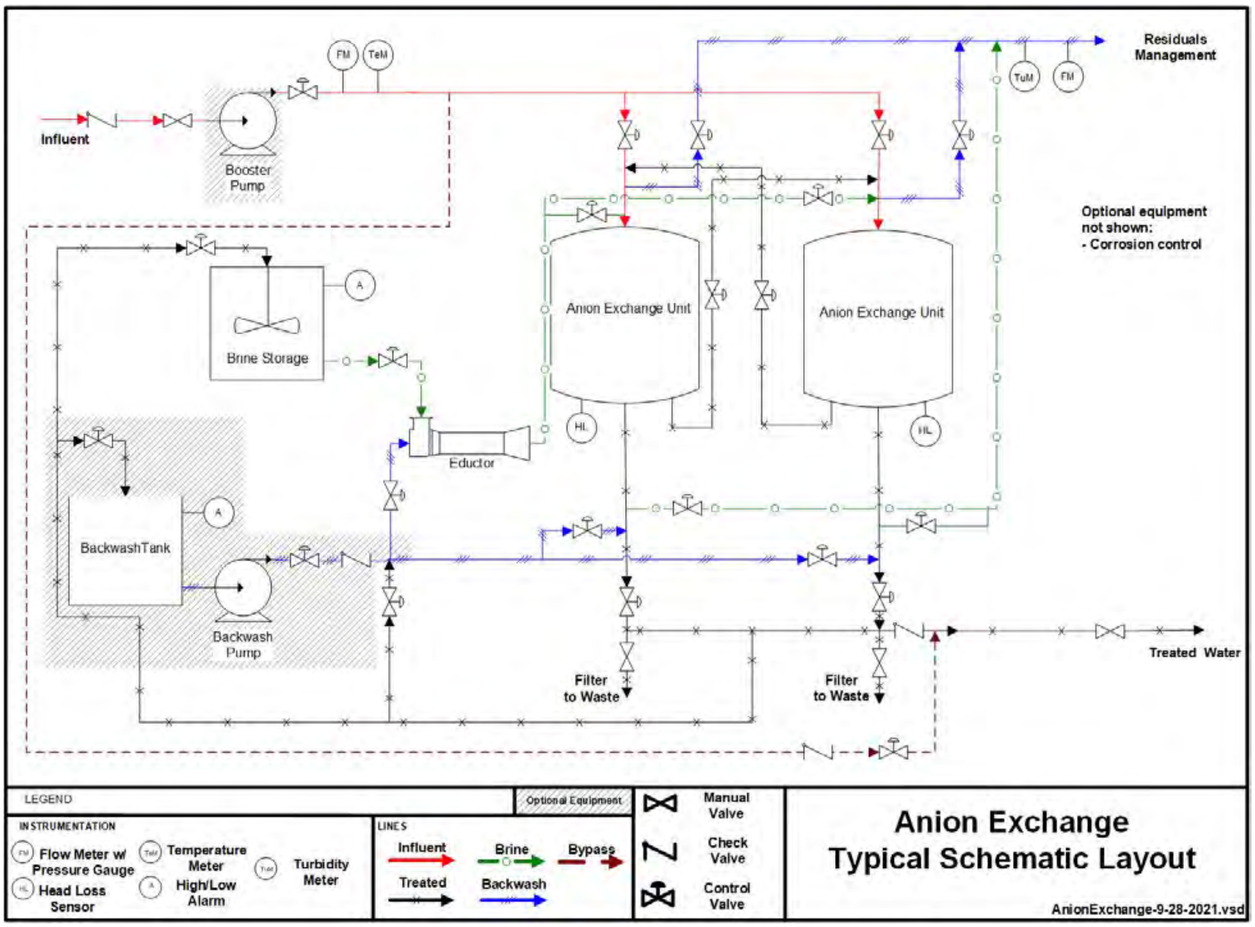
- Booster pumps for influent water
- Pressure vessels that contain the anion resin bed
- Tanks and pumps for backwashing the exchangers
- Tanks, mixers and eductors for delivering the brine used in regenerating the resin
- Associated piping, valves and instrumentation.

The anion exchange process consists of the following steps: service (to exhaustion), backwash and regeneration. In the service step, source water is pumped through the bed, and contaminant ions are "exchanged," or deposited, onto the bed resin until the bed capacity for the anions of the contaminant is exhausted. The backwash step is performed periodically as needed to remove debris from the resin. In the backwash step, the treated water is passed upflow through the resin bed to remove debris (CH2MHill, 1999; Clifford et al., 1997 and 1998). Regeneration of the beds consists of three steps. First, chloride brine is passed through the resin bed to exchange the ions from the resins with chloride. Second, the resin is "slow rinsed" by passing treated water downflow through the bed to displace the brine from the bed. Some designers prefer counter-flow designs in which the brine and slow rinse are passed upflow. Finally, a fast rinse with water is necessary to remove the remaining traces of brine from the resin bed before the unit is returned to service (CH2MHill, 1999; Clifford et al., 1997 and 1998).

[6] For ion exchange removal of perchlorate, EPA has developed a separate WBS model, discussed in detail in Chapter 7. Users interested in estimating costs for ion exchange removal of perchlorate should use that model instead of the anion exchange model discussed here.

Exhibit 3-1 provides a schematic drawing for anion exchange. The schematic shows a system designed to allow operation with vessels in series. A system designed for operation with vessels in parallel, which is the default for arsenic or nitrate removal, would not require piping between the two anion exchange units. See below under "Number of Vessels in Series" for further discussion of parallel and series operation. Anion exchange systems can be either custom-engineered designs or package plants. Package plants typically include all primary process components mounted on a skid that is pre-assembled in a factory and transported to the site. A default assumption in the model is that systems with design flow less than 1 million gallons per day (MGD) use package plants. Section 3.3 provides a description of cost adjustments for small package systems.

Exhibit 3-1. Typical Schematic Layout for Anion Exchange



The specific ion exchange resin selected is of particular importance in the design of an anion exchange system. There are many ion exchange resins available. When choosing a resin for use in a given application, the operating capacity, total exchange capacity and expansion volume of the resin need to be considered. The operating capacity is based on the influent composition, service rate and degree of regeneration. The total exchange capacity is the theoretical capacity of the resin and the operating capacity is the actual useful capacity of the resin (Clifford, 1999).

Most significantly, each ion exchange resin has a unique selectivity value that is provided by the resin supplier. Strong base resins are the preferred resins for anion exchange, and salt-regenerated strong base anion resins are better for removal of arsenic and nitrate.

3.1.1 Arsenic Treatment

Generally, the selectivity of the strong base resins used for arsenic removal is as follows: sulfate is preferred over arsenate, and arsenate is preferred over arsenite. The adsorption preference of ions in the resin is important because if an ion is preferred over arsenic, that ion could displace the arsenate ions previously sorbed by the resin. This results in higher levels of arsenic in the product water than were in the feed water, also referred to as chromatographic peaking. Chromatographic peaking can be avoided by monitoring the bed and regenerating it prior to arsenic reaching its breakthrough peak.

In addition, because arsenate is preferred over arsenite, the speciation of the arsenic in the influent water can have an impact on the effectiveness of anion exchange. If influent arsenic is in the form of arsenite, oxidation to arsenate will be required for anion exchange to be effective. The WBS anion exchange model assumes treatment for arsenic in the arsenate form and does not include pre-oxidation or other pre-treatment. To account for the cost of pre-oxidation or other pre-treatment, EPA is developing separate WBS models that generate costs for the pre-oxidation/pre-treatment steps. For example, the chlorine gas, hypochlorite, chlorine dioxide and permanganate addition models are capable of estimating the cost of pre-oxidation using these technologies. In generating national costs, EPA would add costs from the separate pre-treatment models to costs from the anion exchange model for scenarios that incorporate pre-oxidation or pre-treatment.

Anion exchange run time lengths are dependent on the presence of total dissolved solids (TDS) and negatively charged particles, especially sulfates. Sulfate concentration tends to be lower in surface waters than in groundwaters. Anion exchange for arsenic removal requires influent water with TDS less than 500 parts per million (ppm) and sulfate less than 100 ppm. The number of bed volumes that will can be treated before regeneration is based on the concentration of the primary anion that will be exchanged. In the case of arsenic, sulfate ions are selected by the resin first, so the number of bed volumes treated is based on the concentration of sulfate, not on the operating capacity of the resin for arsenic. If nitrate is present in the influent water, the system can experience chromatographic peaking of nitrate, depending on the resin selected and the nitrate concentration. Water with high iron concentrations also reduces the removal efficiency of arsenic. Contaminants, biological organisms and suspended solids may clog the bed, resulting in reduced arsenic removal efficiency.

EPA's standard designs for arsenic in the WBS anion exchange model assume the following water quality:

- Arsenic 50 micrograms per liter, primarily in the arsenate form, either because arsenic occurs naturally in this form or because pre-oxidation has been employed (see the discussion above about incorporating the cost of pre-oxidation using separate WBS models)
- Influent sulfate 50 ppm

- Concentrations of other influent contaminants (e.g., TDS, nitrates) low enough to not impair removal efficiency.

3.1.2 Nitrate Treatment

Anion exchange removal of nitrate can be accomplished using standard strong base resins. However, because standard strong base resins prefer sulfate to nitrate, their nitrate capacity can be limited when sulfate is high. Furthermore, if the resins are run past a certain breakthrough point, sulfate can begin to displace the nitrate on the resin, resulting in chromatographic peaking of nitrate (Dimotsis and McGarvey, 1995).

Therefore, resin manufacturers have developed specialized nitrate-selective resins with an increased affinity for nitrate over sulfate. In addition to their greater nitrate capacity in the presence of high sulfate, the literature suggests that these resins are less sensitive to the presence of dissolved organic matter (Song et al., 2013). They also remain effective in the presence of competing species such as chloride and bicarbonate (Samatya et al., 2006).

Some manufacturers suggest that nitrate-selective resins are appropriate when sulfate is greater than 25 to 50 percent of the total of sulfate plus nitrate when both are measured as calcium carbonate (Dimotsis and McGarvey, 1995; DeSilva, 2003). The choice, however, is also sensitive to the relative cost of each type of resin. Given current resin prices and the water quality assumptions below, EPA's standard designs for nitrate in the WBS anion exchange model assume the use of nitrate-selective resin. They assume the following water quality:

- Nitrate 90 milligrams per liter (mg/L) as nitrate, equivalent to 20.3 mg/L as nitrogen and 72.6 mg/L as calcium carbonate
- Influent sulfate 30 to 60 mg/L as sulfate, equivalent to 31.2 to 62.4 mg/L as calcium carbonate and, therefore, approximately 30 to 45 percent of the total of nitrate and sulfate as calcium carbonate
- Concentrations of other influent contaminants (e.g., bicarbonate, TDS) low enough to not impair removal efficiency.

3.2 Input Sheet

The input sheet accepts the user-defined design parameters that determine fundamental process requirements. The user can indicate system size and select basic equipment characteristics such as bed depth and vessel geometry. Key design considerations that the user identifies on this sheet are described in greater detail below and include the following:

- Contaminant (e.g., arsenic, nitrate)
- Design and average flow (see Section 2.3)
- Resin type
- Influent contaminant concentration
- Bed volumes before regeneration
- Number of vessels in series (i.e., parallel or series operation)
- Theoretical total empty bed contact time (EBCT)
- Bed depth and pressure vessel dimensions and geometry
- Brine delivery method

- Residuals management
- Number of booster pumps (optional)
- Number of redundant vessels (optional)
- Treated water corrosion control (optional)
- Backwash pumping (optional)
- Backwash storage (optional)
- Component level (optional, see Section 2.3)
- System automation (optional, see Section 2.3 and below)
- Include buildings; heating, ventilating and air conditioning (HVAC) and land? (optional, see Section 2.3).

Exhibit 3-2 summarizes the units and constraints (i.e., Excel validation criteria) for each of these inputs, along with conditions under which the model generates warnings. The sections below describe each input in greater detail.

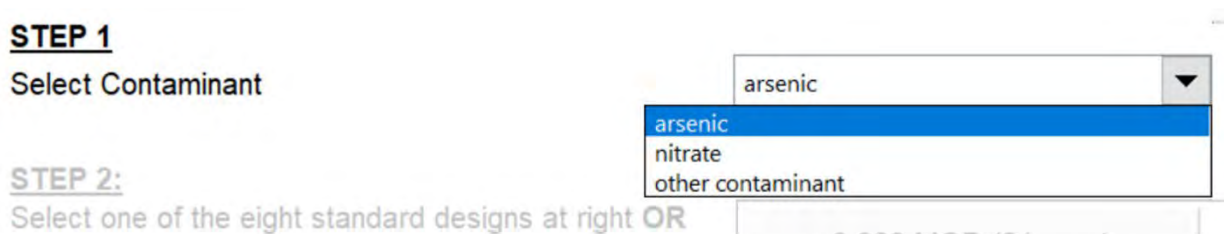
Exhibit 3-2. Anion Exchange Model Input Constraints and Warnings

Input	Units	Constraints	Warning Conditions
Select Contaminant	Pick list	Pick list	None
Design flow	MGD or gpm	Greater than 0	Blank
Average flow	MGD or gpm	Greater than 0	Blank, greater than design flow or less than 0.1 times design flow
Select anion resin type	Pick list	Pick list	Blank
Influent concentration	mg/L	Greater than 0	Blank
Select method for determining bed life	Pick list	Pick list	Blank
Influent sulfate concentration (if calculation based on sulfate)	ppm	Greater than 0	Blank or input results in negative number of bed volumes
1st Freundlich constant (Kf) (if calculation from Freundlich isotherm)	mg/g	Greater than 0	Blank
2nd Freundlich constant (1/n) (if calculation from Freundlich isotherm)	dimensionless	Greater than 0	Blank
Influent concentration (if calculation from Freundlich isotherm)	mg/L	Greater than 0	Blank or not equal to influent concentration entered under contaminant removal input type, if entering influent and treated water concentrations
Breakthrough concentration (if calculation from Freundlich isotherm)	mg/L	Greater than 0	Blank
Number of bed volumes before regeneration (if input type is manual entry)	bed volumes	Greater than 0	Blank
Minimum number of vessels in series (i.e., parallel or series operation)	1 for parallel, 2 or more for series	Integer greater than 0	Blank
Theoretical Total Empty Bed Contact Time (EBCT)	minutes	Greater than 0	Blank

Input	Units	Constraints	Warning Conditions
Vessel size inputs			Additional warnings if vessel volume is insufficient for bed expansion or loading rate is outside of minimum and maximum constraints
Bed depth	feet	Greater than 0	Blank, outside of minimum and maximum constraints or greater than twice vessel diameter
Vessel geometry	Pick list	Pick list	Blank
Height (straight) or Length (straight)	feet	Greater than 0	Blank or outside of minimum and maximum constraints
Diameter	feet	Greater than 0	Blank or outside of minimum and maximum constraints
Brine delivery method	Pick list	Pick list	Blank
Discharge option for spent brine	Pick list	Pick list	Blank
Holding tank for spent brine	Pick list	Pick list	Blank
Characteristics of spent resin	Pick list	Pick list	Blank
Characteristics of holding tank or evaporation pond solids	Pick list	Pick list	Blank
Number of booster pumps (optional)	pumps	Integer greater than or equal to 0	Pump flow is greater than maximum for which prices are available
Number of redundant vessels to be added (optional)	units	Integer greater than or equal to 0	None
Treated water corrosion control? (optional)	Yes/No/Blank	Yes/No/Blank	None
Backwash pumping (optional)	Pick list	Pick list	None
Backwash storage (optional)	Pick list	Pick list	None
Component level (optional)	Pick list	Pick list	None
System automation (optional)	Pick list	Pick list	None
Include buildings? (optional)	Yes/No/Blank	Yes/No/Blank	None
Include HVAC? (optional)	Yes/No/Blank	Yes/No/Blank	None
Include land? (optional)	Yes/No/Blank	Yes/No/Blank	None

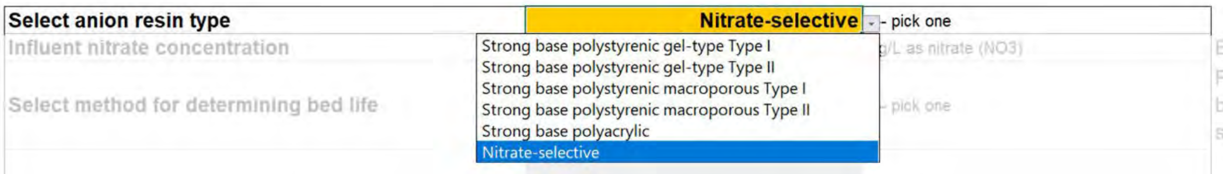
gpm = gallons per minute; MGD = million gallons per day; mg/g = milligrams per gram; mg/L = milligrams per liter; ppm = parts per million

Contaminant



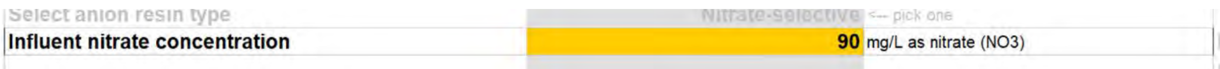
The WBS model for anion exchange includes a "drop-down" list box that allows the user to select among standard designs for removal of different contaminants (specifically, arsenic or nitrate). This box is located at the top of the input sheet, above the standard design buttons. The user should verify that the selection shown in this box is correct before populating the other design input values. The user can change the contaminant modeled by picking a different selection from the list. After doing so, the user should then repopulate the input sheet with values appropriate for the new contaminant by clicking one of the standard design buttons or manually adjusting inputs and clicking the "Generate Results" button (see Section 2.3 for further discussion of each of these methods).

Resin Type



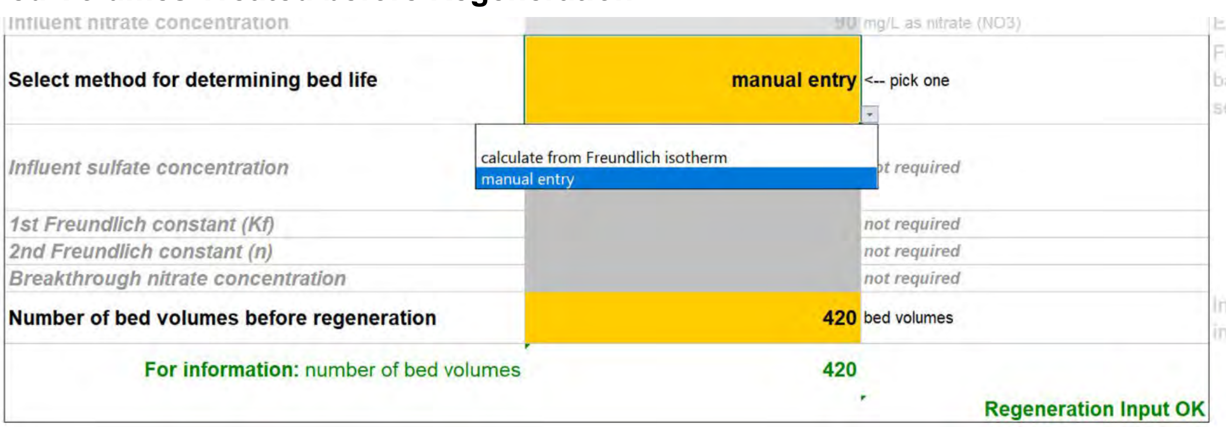
As discussed above, the type of resin employed is a key factor in the design of an anion exchange system. The input sheet requires the user to select the type of resin to be employed. The model standard designs for arsenic assume the use of a polystyrenic gel-type Type II strong base resin, the preferred resin for this purpose. As discussed above, the model standard designs for nitrate assume the use of a nitrate-selective resin, based on the water quality assumptions and current resin prices.

Influent Contaminant Concentration



The input sheet requires the user to document the influent concentration of the selected contaminant (arsenic or nitrate). The model uses this value primarily to calculate residuals characteristics. When the user selects the Freundlich isotherm method for determining bed life (see below), the model also uses this influent concentration in the calculation of bed volumes treated before regeneration.

Bed Volumes Treated before Regeneration



In general, anion exchange beds can be run from 300 to 3,000 bed volumes before regeneration is necessary. The input sheet allows the user to select a method for determining the bed life of the anion exchange resin from among three options:

- Calculating bed life based on influent sulfate (applicable only to arsenic removal using polystyrenic gel-type Type II resin)

- Calculating bed life using the Freundlich isotherm method
- Specifying bed life directly in bed volumes.

When anion exchange is used for arsenic removal, sulfate concentration in the influent water is an important factor in determining the number of bed volumes before regeneration (CH2MHill, 1999; Clifford et al., 1997 and 1998). As the sulfate concentration in the source water increases, the number of bed volumes that can be treated decreases (CH2MHill, 1999; Clifford et al., 1997 and 1998). Therefore, when arsenic is the contaminant selected, the model can estimate bed life based on influent sulfate. Under this method, the user must enter an influent sulfate concentration in ppm. The model then uses an equation, based on the influent sulfate concentration, to determine the number of bed volumes before regeneration (see Section 3.5 for more information on this equation). The input sheet displays the results of this calculation, which assumes the system is designed for arsenic removal using a polystyrene strong base resin (Type II). This calculation will not be valid for treatment of contaminants other than arsenic, for other resin types or for influent water with significant levels of competitors or interferents other than sulfate. In such scenarios, the user should use one of the other methods for determining bed life.

The Freundlich isotherm method (described in **Exhibit 3-3**) relies on theoretical calculations that predict the adsorptive capacity of the resin for a given contaminant. It does not account for factors such as fouling, the presence of other competing contaminants and resin losses. Therefore, it may result in high estimates of bed life. Also, the availability of data for making this theoretical calculation does not negate or replace the need for a pilot study. A pilot study should be conducted to test the efficacy of anion exchange treatment onsite prior to investing in full-scale treatment units. Therefore, users should make use of the theoretical method only in the absence of site-specific pilot, for initial assessment of bed life and suitability of anion exchange for treatment. When the user elects to use the Freundlich isotherm method, the input sheet displays the calculated bed life for reference.

The model standard designs for arsenic calculate bed life based on an influent sulfate concentration of 50 ppm. The model standard designs for nitrate specify a bed life of 420 bed volumes directly. This assumption is based on data from Clifford and Liu (1993), in which the authors tested nitrate-selective resin with water quality conditions similar to those assumed in the model (see above).

Exhibit 3-3. Freundlich Isotherm Method for Bed Life Estimation

Bed life can be estimated theoretically using a Freundlich isotherm, which is an empirical relationship used to predict the capacity of ion exchange resin for a given contaminant at a given treated water contaminant concentration. The Freundlich isotherm is expressed using the following equation:

$$X / M = K_f C_e^{1/n}$$

Where:
X = mass of contaminant absorbed
M = mass of resin
C_e = treated water concentration
K_f and n are the isotherm constants

In a Freundlich isotherm curve, the log X/M is plotted against the log C_e. The isotherm curve can provide a design estimate for the life of the resin. Each type of resin has its own isotherm curve and breakpoint characteristics for identical contaminants. The isotherm can predict the maximum possible resin capacity and best attainable water quality for a given water and a particular resin. Therefore, in theory, the isotherm constants may be used to help predict the service life of the bed and to aid in the design of an anion exchange system. However, the equation provides at best, a very rough estimate of bed life when applied to columnar operation. Increasing bed depth, increasing empty bed contact time and/or running vessels in a series operation mode can improve treated water water quality and anion exchange efficiency.

There are a number of limitations to the Freundlich isotherm model. First, the model is only applicable to batch adsorber systems where sufficient time is provided to allow the system to reach equilibrium. Therefore, estimates of carbon life using the Freundlich isotherm constants should be used for continuous treatment processes only when no better estimate is available. Second, isotherm data are based on bench-scale tests. Traditionally, it has been very difficult to accurately predict adsorption capacities for full-scale, dynamic, multi-component column applications using bench-scale equilibrium (isotherm) tests for single components. There are issues in accurately measuring isotherms at drinking water concentrations (1 microgram per liter and below for some contaminants). Third, measuring isotherms assumes that the disappearance of the contaminant is due only to anion exchange. Controls are needed to be sure other mechanisms (volatilization, adsorption on the container surface, biodegradation) are not responsible for decreases in concentration. Finally, single constituent isotherms have not been effective in predicting the effect of interaction between multiple constituents.

Number of Vessels in Series (Parallel or Series Operation)

Anion exchangers can be set in series or in parallel. Therefore, the input sheet requires the user to select the number of vessels in series. Entering one vessel in series results in a parallel configuration, while entering two vessels in series results in a series configuration. If the user selects a system with two vessels in series, the model automatically increases the number of valves per vessel to allow for interconnecting piping. Systems set in parallel are generally used to increase throughput. In a parallel configuration, one or more vessels are in use, while other vessels are being regenerated or are on standby (Clifford, 1999). For contaminants that are difficult to remove, a treatment train consisting of a number of vessels in series can be effective to achieve a greater capacity. In such designs, the first vessel in each train is a roughing vessel and the second is a polishing vessel. Another potential system configuration involves two primary vessels set in parallel, with treated water from both vessels directed to a single polisher vessel. The model is not directly capable of simulating this configuration. Users, however, can estimate the cost of such a configuration by selecting parallel operation and adding redundant vessels equal to one-half the number of primary vessels. Series operation is rarely required for arsenic or nitrate removal. Therefore, the model standard designs assume parallel operation (i.e., one vessel in series).

Theoretical Total Empty Bed Contact Time

Theoretical total empty bed contact time (EBCT)	**2**	minutes
For information: EBCT per Vessel	2	minutes

Empty bed contact time (EBCT) is defined as the volume of resin, including voids, divided by the flow rate. The EBCT for anion exchange usually ranges between 1.5 and 7 minutes. In any case, EBCT should be determined based on a pilot study or previous experience with anion exchange systems for similar influent waters. The input sheet requires the user to enter the appropriate EBCT for the design in minutes. For systems in a series configuration, this value is the *total* EBCT of each treatment train (i.e., with two vessels in series, the EBCT of each vessel would be half the value entered). The model shows the EBCT per vessel to clarify this point. The model standard designs use an EBCT of 2.0 minutes.

Bed Depth and Pressure Vessel Dimensions and Geometry

The next four inputs may be entered manually, or calculated with Auto Size button

AutoSize	**Bed depth**	**2.9**	feet
	Vessel geometry	**upright**	<-- pick one
	Height (straight)	**5**	feet
	Diameter	**5.5**	feet
	For information:		

The input sheet requires the user to enter the desired bed depth of the anion resin bed and the geometry of the pressure vessel to be used. Geometry options are upright cylinders for small to medium sized systems and horizontally laid long cylinders for very large systems. For either configuration, the user needs to input the straight height or length of the vessel and the diameter of the vessel.

Bed depths for anion exchange typically range between 2.5 and 6 feet. For preliminary design, sources of a reasonable bed depth include the designer's past experience, manufacturer recommended bed depth and published literature. The model also requires that bed depth is less than twice the vessel diameter. The model standard designs use bed depths that meet this constraint and are within the typical range.

For upright (i.e., vertical) vessels, commercial units typically are available from 5 to 12 feet in height and from 5 to 12 feet in diameter. The input sheet will display warning signs if the dimensions of the selected vessel are outside the boundaries specified on the critical design assumptions sheet. These boundaries include loading rates, which are discussed in more detail in Section 3.3, and transportation limitations. For large treatment plants, on-site assembly of tanks might be an option to overcome transportation limitations. To allow this option, the user should increase the maximum dimensions permitted on the critical design assumptions sheet.

Autosize Routine

To aid users, the model includes a button labeled "Autosize." This button activates a computer-aided design routine that attempts to find a design that meets all relevant design constraints for a given design and average flow and minimizes annualized cost. Using the autosize routine, the model will automatically select bed depth, geometry and dimensions that meet all constraints, thus reducing trial and error by users, particularly for systems with design flows other than the eight standard sizes provided on the input sheet. Note that all other inputs must be complete before using the autosize routine. For standard designs, EPA used the autosize routine to select dimensions meeting all required constraints.

Brine Delivery Method

Brine delivery method	**brine mixing tanks**	<-- pick one
Discharge option for spent brine	brine mixing tanks salt saturator	pick one

The input sheet provides the user with two methods for delivering brine to the anion exchange beds. The options are to use either brine mixing tanks or salt saturators. Salt saturators store large quantities of salt in beds and use automated controls to pass water through the salt beds and produce saturated brine. Mixing tanks add and mix salt to fixed quantities of water to create brine. The model standard designs assume the use of brine mixing tanks.

Residuals Management

Discharge option for spent brine	**POTW**	<-- pick one
Holding tank for spent brine	**no holding tank**	<--pick one
Characteristics of spent resin	**non-hazardous**	<-- pick one
Characteristics of holding tank solids		*not required*
		Residuals Input OK

Anion exchange systems generate two primary residuals streams: spent regenerant brine (including backwash water) and spent resin. The standard designs in the anion exchange model generate spent brine on an intermittent basis. The anion exchange model, however, also allows for the potential for continuous generation of spent brine. Under certain conditions, systems can generate spent brine on a continuous basis because regeneration must occur continuously (i.e., at least one vessel requires regeneration at any given time). Although it is regenerated, ion exchange resin will eventually reach the end of its useful life. Therefore, spent resin is generated on an intermittent basis.

The input sheet requires the user to choose from among several options for management of each of these residuals streams. **Exhibit 3-4** shows the management options available for spent brine.

Exhibit 3-4. Management Options for Spent Brine

Options for Stage 1 of Management	Options for Stage 2 of Management
Holding tank with or without coagulant addition (for flow equalization and suspended solids removal)*	Direct discharge to surface water** Discharge to POTW Hazardous waste disposal
No holding tank	Direct discharge to surface water** Discharge to POTW Evaporation pond*** Septic system****

* May result in generation of secondary residuals (holding tank settled solids).
** Likely to be feasible only if an ocean outfall is available.
*** Results in generation of secondary residuals (evaporation pond solids).
**** Can result in generation of secondary residuals (septic tank solids).

The management options shown in **Exhibit 3-4** include the option for a holding tank. The purpose of the holding tank is to equalize the rate of flow at which residuals are released or discharged. Flow equalization can be necessary, for example, to prevent instantaneous flow from overwhelming the capacity of a publicly owned treatment works (POTW). The use of a holding tank can result in the generation of a secondary residuals stream, in the form of solids that settle from the spent regenerant during the holding period. When a holding tank is used, the model includes the option to add a coagulant to promote the settling of these solids and reduce suspended solids levels in the holding tank effluent. As a default, the model assumes coagulant addition is not employed. The user can change this option on the critical design assumptions sheet.

Exhibit 3-4 also includes the option for an evaporation pond. Given the potentially large quantities of spent brine, this management method might be appropriate when the residual is non-hazardous, particularly for facilities in dry climates. The required area for an evaporation pond depends on local climate. After selecting an evaporation pond, the user should carefully review the climatic parameters on the critical design assumptions sheet. For more information, see Appendix C. Furthermore, to ensure that heating, cooling and standby power costs are computed consistently, the user should review the climatic parameters in the operating and maintenance (O&M) and indirect assumptions sheets. Appendix E and Appendix D contain information on these parameters. The use of an evaporation pond results in the generation of a secondary residuals stream, in the form of evaporation pond solids.

A holding tank would not be required with an evaporation pond, because the design of the pond would provide sufficient capacity to handle instantaneous flow. A holding tank also would not be required with a septic system, since the septic tank itself serves as a holding tank. The model always includes a holding tank when hazardous waste disposal is required for spent brine, to store the waste for shipment.

Exhibit 3-4 does not include the option for recycling spent brine to the head of the treatment plant (i.e., combining the spent brine with influent water to be treated). Because spent brine is laden with contaminants removed from the ion exchange resin, this option is not likely to be feasible for this residuals stream. Under certain circumstances, however, spent brine can be recycled for reuse in more than one regeneration cycle. The user can enable this option on the critical design assumptions sheet (see Section 3.3).

Management options available for spent resin include the following:

- Disposal as non-hazardous solid waste
- Disposal as hazardous waste
- Disposal as radioactive waste
- Disposal as radioactive and hazardous waste.

The same options are available for secondary solid residuals (e.g., holding tank solids), when generated. Users can also select land application, instead of landfilling, for non-hazardous secondary residuals by changing an option on the critical design assumptions sheet. Appendix C discusses this option in more detail.

The solid residual management options do not include disposal in an on-site facility. This option would be economically viable only for facilities with an existing on-site landfill—a factor that is highly site-specific. For such facilities, the cost of this option would be less than that for off-site disposal, because it would involve much lower transportation costs. Therefore, the off-site disposal options included provide a conservative cost estimate for these facilities.

For spent brine, the standard designs assume the use of a holding tank for large systems (1 MGD or greater design flow). The standard designs assume discharge to a POTW for the second stage of spent brine management for all systems. For spent resin and holding tank solids, the standard designs assume non-hazardous waste landfill disposal.

Number of Booster Pumps

Number of booster pumps		pumps
For information: # of booster pumps	2	pumps

Review of actual as-built designs for small systems using various technologies (U.S. EPA, 2004) shows that these systems often can operate without additional booster pumps by using existing supply pump pressure. Therefore, the model assumes zero booster pumps for small systems (less than 1 MGD design flow). For larger systems, the model calculates the number of pumps using a method that attempts to minimize the number of pumps, while still accommodating variations in flow and providing redundancy to account for possible equipment failure. The model includes an optional input that allows the user to change these default calculations by specifying the number of pumps required to operate the treatment system. If the user enters zero, the model excludes booster pumps from the design and cost estimate. The model standard designs leave this input blank, excluding booster pumps for small systems (less than 1 MGD design flow) and accepting the default calculations for larger systems.

Number of Redundant Vessels

Number of redundant vessels to be added		units
For information: Redundant vessels	1	

This optional input controls the model’s calculation for the number of redundant vessels. At a minimum, based on the Technology Design Panel recommendations, there should be at least one redundant vessel in an anion exchange system. An exception would be small systems designed with multiple vessels required to treat the maximum design flow (either more than one parallel treatment train or a single line with multiple vessels in series). In such systems, the average daily flow is low enough, relative to the design flow, that the multiple vessel design provides sufficient redundancy without additional vessels. The system can operate at reduced, but greater than average, flow, even while one vessel is off-line for regeneration or resin replacement. Thus, the number of redundant vessels can be zero for certain small systems having at least two vessels.

The model assumes that redundant vessels (and other redundant items of equipment) are used during downtime periods for other vessels and are swapped into operation intermittently, with other vessels then becoming standby. For this reason, the model's O&M estimate includes labor for operating valves and reading instruments associated with redundant vessels.

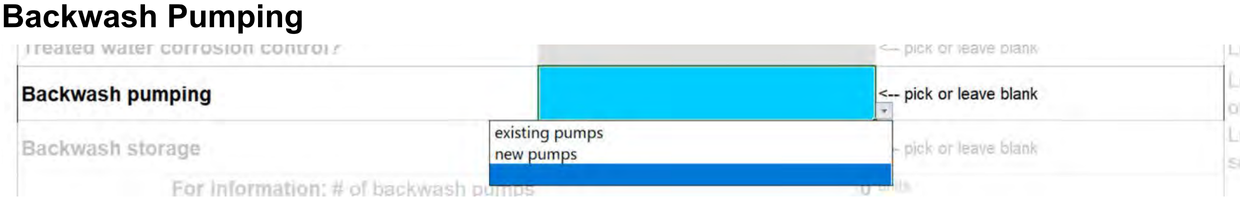
The input sheet allows the user to specify the number of redundant vessels. If the user leaves this optional input blank for a large system (1 MGD or greater design flow), the model calculates the number of redundant vessels based on a redundancy frequency specified in the critical design assumptions sheet. If the user leaves this optional input blank for a small system (less than 1 MGD design flow), the model does not add redundant vessels, unless the design selected by the user results in a single operational vessel. If the design does use only a single operational vessel, the model adds one redundant vessel. The standard designs leave this input blank, resulting in the following redundancy results:

- No redundant vessels for small systems (less than 1 MGD design flow), except in cases where the design results in only one operating vessel
- One vessel every four treatment trains for larger systems (1 MGD design flow or greater).

Treated Water Corrosion Control

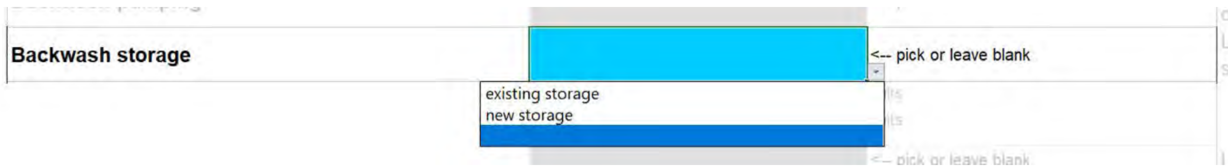
Anion exchange treatment can lower the pH of the treated water. Therefore, the model includes an optional input that allows the user to include equipment for adding sodium hydroxide to raise the pH of the water following treatment. The model standard designs do not include post-treatment corrosion control.

Backwash Pumping



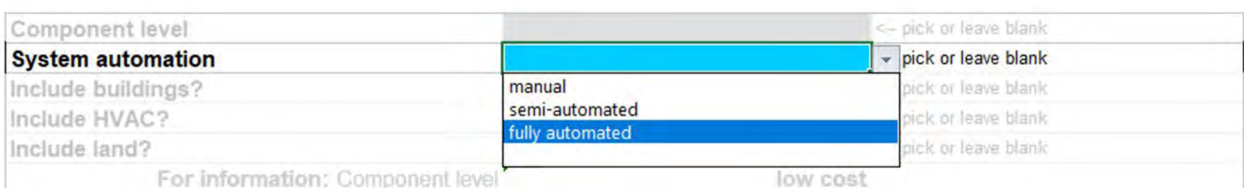
The backwash process can require new pumps or use existing pumps (either influent supply pumps or treated water pumps). The practicality of using existing pumps can vary on a site-specific basis, depending on the performance characteristics of the existing pumps and the differences in head required between normal operation and during backwash. By default, the model assumes existing pumps are sufficient for backwash for small systems (less than 1 MGD design flow), but includes the costs of new backwash pumps for larger systems. The model includes an optional input that allows the user to change these default assumptions by explicitly selecting “existing pumps” or “new pumps.” If the “existing pumps” option is selected, the costs of backwash pumps will be excluded from the output sheet. If “new pumps” is selected, these costs will be included. The standard designs leave this input blank, thereby assuming the use of existing pumps for small systems (less than 1 MGD design flow), but including the costs of backwash pumps for larger systems.

Backwash Storage



Backwash tanks may not be required on most installations, particularly for large systems that have treated water storage capacity. The model assumes that systems with design flow less than 1 MGD do not require backwash tanks because the quantity of backwash water required is low. The model also assumes that systems of 10 MGD and larger design flow do not require backwash tanks because existing storage capacity is sufficient. The model includes backwash tanks for intermediate-sized systems. The model includes an optional input that allows the user to change these default assumptions by explicitly selecting “existing storage” or “new storage.” If the “existing storage” option is selected, the costs of backwash tanks will be excluded from the output sheet. If “new storage” is selected, these costs will be included. The standard designs leave this input blank, thereby including the costs of backwash tanks for intermediate-sized systems (1 MGD to less than 10 MGD design flow) only.

System Automation



The system automation optional input in the anion exchange model functions as described in Section 2.3. However, because of the need for frequent regeneration, the model standard designs specify fully automated systems, instead of leaving the system automation input blank.

3.3 Model Assumptions Sheets

There are three sheets that contain assumptions needed to facilitate process design: the critical design assumptions sheet, the O&M assumptions sheet and the indirect assumptions sheet. These sheets contain a variety of structural and chemical engineering parameters used in the engineering design sheets. They also interact with the input sheet to determine if the user inputs violate good engineering practices. For example, if a user selects a pressure vessel diameter that generates a surface loading rate that is too high or low, a warning message will appear on the input sheet. The warning message will advise the user to adjust vessel dimensions or bed depth to achieve a surface loading rate within generally recommended engineering practices.

There are more than 100 critical design assumptions in the model that cover process, O&M and indirect cost parameters. Key critical design assumptions include surface loading rate, bed expansion, backwash assumptions, regeneration assumptions, resin life, annual resin loss, bypass percentage and assumptions applicable to package plants. The following sections provide descriptions and default values for these assumptions. Any assumption value can be modified, as needed.

Surface Loading Rate

Loading rate is the velocity of flow through the resin bed measured in units of flow rate per unit area (e.g., gallons per minute per square foot or gpm/ft^2). The surface area of the treatment pressure vessels must be selected to maintain loading rates within reasonable bounds. Typical minimum loading rates for anion exchange systems are 1 to 7.5 gpm/ft^2. The model assumes a minimum loading rate of 4 gpm/ft^2 and a maximum loading rate of 16 gpm/ft^2.

Bed Expansion

Vessel height must account for bed expansion during backwash. Bed expansion values should be taken from resin vendor catalogues and verified in pilot studies. The model assumes bed expansion of 50 percent.

Backwash Assumptions

Backwash of anion exchange beds typically is accomplished by passing water through the bed at a rate of 1 to 5 gpm/ft^2 for 10 to 15 minutes. The model assumes 3 gpm/ft^2 for 12 minutes.

Regeneration Assumptions

Regeneration occurs by passing chloride brine through the resin bed to exchange the ions from the resins with chloride. Regenerant may be used 25 times or more if a 1 molar (M) chloride solution is added to provide adequate levels of chloride for regeneration (Clifford et al, 1997 and 1998; U.S. EPA, 2000; Clifford et al., 2003). Another study suggests the use of a regenerant of at least a 0.5 M solution to minimize potential of accumulation of other ions such as nitrate and sulfate on the resin (CH2MHill, 1999; Clifford et al., 1997 and 1998). With chloride resins, sodium chloride solution typically is the regenerant. The amount of salt necessary to regenerate the resin is dependent on the resin capacity. Only a few bed volumes are required for regeneration and rinsing because arsenic is a divalent ion.

The model includes the following regeneration assumptions:

- Brine dose of 8 pounds per cubic foot
- Regenerant brine concentration of 0.5 pounds per gallon (reflecting a concentration of approximately 6 percent)
- Regenerant loading rate of 0.8 gallons per minute per cubic foot
- No regenerant reuse
- Slow rinse with two bed volumes of water
- Fast rinse with five bed volumes of water.

Resin Life and Annual Resin Loss

Although the ion exchange resin is regenerated, the resin bed will eventually reach the end of its useful life and require replacement. The model assumes a resin useful life of 7 years. Also, during operation of an anion exchange system, some resin can be lost over time through natural attrition. Therefore, the model assumes that systems balance the resin loss by adding new resin to the bed. The model also assumes the lost resin ends up in the spent backwash residuals and includes the resin loss in the calculation of suspended solids in the spent backwash. The model assumes an annual resin loss rate of 4.5 percent.

Bypass Percentage

Because anion exchange treatment can remove contaminants to very low levels, systems may choose to treat only a portion of their production flow, using a smaller treatment system and blending treated water with raw water while still achieving treatment targets. The bypass percentage is that portion of production flow that goes untreated. If bypass is used, the model designs the treatment system to treat a flow equal to (100 percent minus bypass percentage) multiplied by design flow and adds bypass piping and associated valves to the components included on the output sheet. The model assumes no bypass, but the user can incorporate bypass by entering a percentage of bypass flow on the critical design assumptions sheet.

Package Systems

The model handles package systems by costing all individual equipment line items (e.g., vessels, interconnecting piping and valves, instrumentation and system controls) in the same manner as custom-engineered systems. This approach is based on vendor practices of partially engineering these types of package plants for specific systems (e.g., selecting vessel size to meet flow and treatment criteria). For small systems (less than 1 MGD design flow), the model applies a variant set of design inputs and assumptions that are intended to simulate the use of a package plant. Also included are assumptions that reflect the smaller capacity and reduced complexity of the treatment systems. These design modifications typically reduce the size and cost of the treatment system. Some are adjustable on the input sheet or the critical design assumptions sheets, while others are in the engineering design formulae. **Exhibit 3-5** shows the modifications used in the model for small systems.

Exhibit 3-5. Variant Design Inputs and Assumptions for Small Systems

Small System Design Modification	Explanation	Model Location
Reduced spacing between vessels and other equipment	This assumption simulates skid placement of treatment vessels (and of pumps, if included in the design), resulting in reduced system footprint and, therefore, reduced costs for interconnecting piping, building structures, certain indirect costs and O&M.	Design equations on the pumps, pipes and structure sheet
No redundant vessels (but a minimum of two operating vessels)	Small systems typically do not include redundant treatment vessels because they are designed to operate at reduced capacity during the brief periods when one vessel is not operating (e.g., during backwash).	Input sheet
Reduced instrumentation requirements	Instrumentation required for small systems is limited to flow meters, high/low alarms, sampling ports and online nitrate analyzers (for nitrate treatment only).	Critical design assumptions sheet
Simplified system controls for automated systems	Package plants, when automated, typically are controlled by a single, pre-programmed operator interface unit mounted on the skid. Therefore, for small systems, the model uses this type of operator interface only and excludes the multiple programmable logic controllers, PC workstations, printers, operator interface software and plant intelligence software included for large, automated, custom-engineered systems.	Component selection logic in the output sheet and WBS cost database
No booster pumps	Small systems result in limited head loss and typically do not require additional booster pumps.	Input sheet
No backwash pumps or tanks	Small systems typically use existing pumps and water supplies, and do not require separate backwash pumps or backwash water storage.	Input sheet
Reduced concrete pad thickness	Small capacity systems require less structural support.	Critical design assumptions sheet
Reduced indirect costs	Package plants require less effort to design and install. Therefore, the model reduces or eliminates certain indirect costs (e.g., mobilization/demobilization, construction management) for small package plants (see Appendix D for complete details).	Indirect assumptions sheet

3.4 Vessel Constraints Sheet

The vessel constraints sheet contains calculations that utilize the user-defined parameters from the input sheet and the boundary values from the critical design assumption sheet to determine the validity of the input values. This sheet also determines the number of vessels required and the quantity of resin needed, given the input values selected by user.

3.5 Regeneration and Backwash Sheet

As discussed above, anion exchange beds require both backwashing to remove debris and regeneration to restore exchange capacity. The regeneration and backwash sheet calculates the anion exchange bed life using the method specified on the input sheet (based on influent sulfate for arsenic removal, using Freundlich isotherm data or specified directly in bed volumes). For arsenic removal using polystyrenic gel-type Type II resin, when the user chooses the option to calculate the number of bed volumes before regeneration based on the influent sulfate concentration, this sheet uses the following best fit equation from Chen et al. (1999):

$$BV = -606 * \mathrm{Ln}(x) + 3150$$

where:

- BV is bed volumes before regeneration
- x is sulfate concentration in mg/L.

For the influent sulfate concentration (50 ppm) assumed in the model standard designs for arsenic, the calculation results in 779 bed volumes before regeneration.

This sheet also calculates the quantity of brine (sodium chloride) needed for regeneration and the water volume needed for regular backwashing and the slow rinse and fast rinse steps of regeneration. Using these values, the sheet calculates the backwash and brine storage tank (or salt saturator) volumes, pumping requirements and backwash and regeneration downtime. It also calculates the number and size of mixers for brine tanks and eductors for delivering the brine to the system.

3.6 pH Adjustment Sheet

If the user selects post-treatment corrosion control, the pH adjustment sheet calculates the quantity of sodium hydroxide needed. It also calculates the number and size of tanks required for storage of the chemical. The model includes separate day tanks, in addition to the primary bulk storage tanks, are required if daily sodium hydroxide usage at design flow exceeds the number of gallons specified on the critical design assumptions sheet. To provide secondary containment for sodium hydroxide, this sheet also includes calculations for concrete curbing around the storage area and chemical resistant coating for the curbing and the underlying concrete pad.

3.7 Pumps, Pipe and Structure Sheet

Other elements of the technology for which the size and cost need to be determined include pumps and piping. The pumps, pipe and structure sheet performs the required calculations to determine the number and size (in terms of flow capacity) of the following pumps:

- Booster pumps
- Backwash pumps (if required)
- Corrosion control metering pumps (if required).

This sheet uses the input values for flow and water quality parameters, as well as the pertinent parameters detailed on the critical design assumption sheet, to determine the number of pumps needed, including redundant units. Pump sizing depends on the maximum corresponding flow rate. For example, booster pumps are sized based on the system design flow and backwash pumps are sized based on the total backwash flow. The sizes of corrosion control (sodium hydroxide) metering pumps vary based on the calculations performed on the pH adjustment sheet. As discussed in Section 2.3, the sizing of all pumps incorporates a safety factor, which is specified on the critical design assumptions sheet.

This sheet also performs calculations for the following pipes:

- Influent and treated water piping
- Process piping
- Backwash piping
- Brine/regeneration piping
- Bypass piping (if a bypass percentage is specified)
- Coagulant addition piping (if residuals coagulant addition is specified on the critical design assumptions sheet)
- Caustic piping (if corrosion control is required).

The size (diameter) of pipes is determined using a pipe flow look-up table that is part of the WBS cost database. The pipe diameter selection method assumes a reasonable head loss and flow velocity, as documented in **Exhibit 2-8**. These design assumptions may result in some over sizing of pipes, which means the costs for pipes may be conservative (i.e., err on the high side).

The flow used to determine influent and treated water pipe size is the design flow. The diameter of interconnecting process piping uses the same pipe flow chart, after splitting the inflow by the number of parallel treatment trains. A similar approach is used in determining the size and capacity of brine, backwash, bypass and caustic piping. The length of these pipes is determined using the assumptions documented in **Exhibit 2-10**, which are designed to account for the cost of fittings.

This sheet also calculates the housing area for this technology based on the footprint of the technology components and the space criteria specified on the critical design assumption sheet. The space requirements for vessels, pumps, tanks and service space are based on manufacturer specification, “to scale” drawings and the experience of engineers. The amount of additional concrete needed to support heavy equipment, such as pumps and vessels, is calculated using the footprint of the vessels and pumps.

For smaller space requirements (less than a square footage specified on the critical design assumptions sheet), the model assumes a single building containing all process equipment. For larger requirements, the model assumes two buildings, one containing the anion exchange vessels and the other containing all other equipment. The number of buildings affects the total land required and energy costs for heating, ventilating and cooling.

3.8 Instrumentation and Control Sheet

The instrumentation and control sheet calculates requirements for valves, instrumentation (e.g., flow meters) and automated system controls. The number of valves and instruments is based on the number of process components (e.g. number of treatment trains) and assumptions from the critical design assumptions sheet (e.g., x number of valves per treatment train). The assumptions correspond to the general schematic layout for this technology shown in **Exhibit 3-1**. Sizing of valves corresponds to the size of the appropriate pipe determined on the pumps, pipes and structure sheet. Appendix A describes the method used in the WBS models to estimate the number and type of system control components.

3.9 Residuals Management Sheet

The residuals management sheet estimates the volume and mass of residuals, their characteristics and the capital and O&M requirements for residuals management, based on the management options selected on the input sheet and the approach outlined in Appendix C. Depending on the management options chosen, specific items of capital equipment for residuals can include:

- Holding tanks
- Pumps
- Evaporation ponds (including excavation and lining)
- Septic tanks and drain field components
- Coagulant feed and mixing equipment
- Valves, piping and instrumentation.

Specific O&M requirements associated with residuals can include:

- Residuals pump materials and energy[7]
- POTW discharge fees
- Coagulant usage
- Spent resin transportation and disposal costs
- Spent brine transportation and disposal costs (when hazardous waste disposal is required)
- Secondary residuals (holding tank solids, septic tank solids or evaporation pond solids) transportation and disposal costs.

3.10 O&M and HVAC Sheets

The O&M and HVAC calculations in the model cover two sheets: the O&M sheet (annual labor, materials and energy usage) and the HVAC sheet (HVAC capacity requirements). The O&M sheet derives annual O&M requirements for anion exchange treatment based on the engineering design, O&M critical design assumptions and input values. It determines the following O&M requirements based on the approach outlined in Section 2.4 and Appendix E:

- Operator labor for system operation and maintenance
- Managerial and clerical labor
- Booster pump maintenance materials and operating energy
- Building and HVAC maintenance materials
- Energy for building lighting and HVAC.

In addition, the O&M sheet adds the following technology-specific O&M requirements:

- Chemical usage (sodium chloride for brine, sodium hydroxide for corrosion control)
- Replacement resin, both natural attrition replacement and periodic complete replacement; note that spent resin disposal is calculated on the residuals management sheet
- Operating energy for backwash pumps

[7] Labor associated with residuals pumps is calculated on the O&M sheet.

- Operator labor and materials for backwash pump maintenance (if regeneration occurs weekly or more frequently)
- Operator labor for resin changeouts
- Operator labor for regeneration.

The O&M sheet determines annual sodium chloride use based on the regeneration requirements calculated on the regeneration and backwash sheet. It determines annual sodium hydroxide use (if required) based on the outputs of the pH adjustment sheet.

Because anion exchange systems are regenerated frequently, the associated pumping facilities can entail significant energy consumption and can require significant maintenance. Therefore, the model includes backwash pump operating energy among its O&M costs. When regeneration occurs weekly or more frequently, the model also explicitly includes labor and materials for maintaining the backwash pumps.

For manual and semi-automated systems, regeneration requires constant operator attention. Therefore, the model assumes labor equal to the actual time to accomplish regeneration for these systems. For automated systems, the model assumes 10 minutes per regeneration event to verify that the automated regeneration cycle is initiated and operating properly. The user can change this latter assumption on the O&M assumptions sheet.

3.11 Indirect Sheet

As stated in Section 2.4, indirect capital costs are costs that are not directly related to the treatment technology used or the amount or quality of the finished water, but that are associated with the construction and installation of a treatment technology and water intake structures. The indirect sheet derives capital costs for the following components of indirect cost:

- Construction management and general contractor overhead
- Standby power
- Geotechnical
- Site work
- Yard piping.

Appendix D contains detailed information on the derivation of these and other indirect costs. This sheet also contains calculations to estimate permit costs.

3.12 Output Sheet

The output sheet contains the list of components identified for anion exchange based on the WBS approach. For each component, the output sheet provides information on size (e.g., tank capacity or pipe diameter) and quantity, as well as estimated capital cost and estimated useful life. The output sheet also contains cost estimates for indirect costs (e.g., mobilization and demobilization, site work and yard piping), add-on costs (for permitting, pilot testing and land) and O&M costs. These estimates are described generally in Section 2.4 and in more detail in Appendix D (indirect costs) and Appendix E (O&M costs). Finally, the output sheet combines the total capital cost, system useful life and annual O&M cost to estimate total annualized cost, as discussed in Section 2.4. Sections 2.1 and 2.3 provide further details about the output sheet.

As discussed in Section 2.4, the output sheet shows model results to the nearest $1, but this precision is not meant to imply that the results are accurate to $1. The anion exchange model underwent peer review in 2005, during an early stage of its development. One peer reviewer responded that resulting cost estimates were in the range of budget estimates (+30 to -15 percent). The other two reviewers thought anion exchange estimates were order of magnitude estimates (+50 to -30 percent), with an emphasis on the estimates being high. The anion exchange model has since undergone extensive revision in response to the peer review. Users are encouraged to review all documentation, modify inputs and assumptions as appropriate to their specific purpose, and form their own informed opinions about the accuracy and suitability of the results shown on the output sheet.

3.13 Ancillary and Reference Model Components

The model contains several ancillary sheets: index, standard inputs, autosize, cost equations and lookup tables. The index is a hyperlinked list of user-adjustable inputs and assumptions that can assist the user in finding these inputs and assumptions, should they wish to change them. The standard inputs worksheet documents the inputs used in the standard designs. Advanced users can adjust these standard inputs, if desired. The model uses the autosize sheet when performing the iterative calculations required when the user clicks the "Autosize" button on the input sheet. The cost equations sheet uses the component-level cost curve equations from the WBS cost database to generate unit costs on an item-by-item basis. The lookup tables sheet is for internal model use in populating the drop-down boxes on the model input sheet.

The anion exchange model also includes a reference sheet containing information on Freundlich isotherms for nitrate removal (comparable data are not available for arsenic). As discussed in Section 3.2, the user may refer to the information in this reference sheet in determining how to adjust inputs.

3.14 List of Abbreviations and Symbols in this Chapter

EBCT	empty bed contact time
EPA	U.S. Environmental Protection Agency
gpm/ft^2	gallons per minute per square foot
HVAC	heating, ventilating and air conditioning
M	molar
MGD	million gallons per day
mg/L	milligrams per liter
O&M	operating and maintenance
POTW	publicly owned treatment works
ppm	parts per million
TDS	total dissolved solids
WBS	work breakdown structure

3.15 References

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Appendix A. Valves, Instrumentation and System Controls

A.1 Valves in the WBS Models

There are many types of valves used to control water and chemical flow rates, pressure and direction in a water treatment plant. Valves can be distinguished by function, mode of operation, materials of construction, size (i.e., diameter), design or shape and connection method. For purposes of estimating valve costs, the most important of these distinctions are function, mode of operation, size and materials of construction. Therefore, the work breakdown structure (WBS) models group valves according to these four distinctions. The WBS models identify valve size explicitly, using the same methodology used to size pipes. The WBS models also explicitly identify materials of construction. The output sheet of each model includes line item costs for valves of each material (plastic, stainless steel and cast iron), so that the user can observe variations in cost among materials.

To distinguish by function and mode of operation, the WBS models use a generic nomenclature. The WBS models identify valves as one of the following:

- Check valves
- Manual valves
- Motor/air-operated valves.

Check valves are those that serve the function of backflow prevention. They generally do not vary significantly in mode of operation or design/shape.

The other two categories of valves serve the function of flow control and are distinguished by their mode of operation (i.e., whether they are manual or automated). An example of a valve that must be a manual valve is an emergency shut-off valve that, in an extreme event such as complete power failure, can be shut off by an operator. Manual valves can vary in design according to their specific opening/closing method (e.g., hand wheel or chain). Automated valves (identified in the WBS models as motor/air operated) can be motor-operated valves, air-operated valves or solenoid valves. Solenoid valves are electrically operated on/off control valves. Motor-operated valves open and close more slowly than solenoid valves. This action reduces likelihood of a water hammer. While the different opening/closing methods for manual and automated valves have various advantages and disadvantages, cost differences among designs are relatively small and the WBS unit costs do not distinguish between them at this level of detail. The key cost difference is whether the valves are automated or manual, because of the cost of the motor, air actuator or solenoid.

A.2 Instrumentation for Process Measurements

Each of the models includes the cost of various instruments that perform process measurements. Most of these measurement devices are categorized into the following groups:

- *Hydraulic measurement instruments and control devices*. Hydraulic measurement instruments include: flow meters, pressure gauges, head loss sensors and water level meters/alarms. Hydraulic control devices include: pump control, motor control and valve control.

- *Water quality measurement and control devices*. These include water quality parameter measurement devices, such as pH meters, oxidation-reduction potential (ORP) sensors, temperature meters, turbidity meters and sampling devices and ports.

The WBS models determine instrumentation requirements for each technology based on review of the schematic flow diagram for the appropriate technology, along with certain general assumptions that are applied to all of the technologies. **Exhibit A-1** documents the general assumptions about instrumentation that are applied in the WBS models. Slightly different assumptions hold when a model is intended as an add-on to an existing process (e.g., acid feed) rather than a complete process (e.g., anion exchange).

Exhibit A-1. General Design Assumptions for Instrumentation

Instrument Type	Assumption
Chlorine analyzers	Varies by technology; for chlorine and hypochlorite disinfection, 1 per treatment train to monitor residual
Conductivity meters	Varies by technology
Dissolved oxygen analyzers	Varies by technology
Drive controllers	1 per each pump (including booster, backwash and chemical metering pumps) or other motorized item of equipment (e.g., mixers, blowers) in fully automated systems
Electric enclosures	Only for technologies with significant electric-powered equipment outside a building structure
Flow meters	Varies by technology; usually 1 for the influent or treated water line and 1 for backwash discharge. Some technologies also include flow meters on process lines.
Head loss sensors	Continuous level sensors. 1 per process vessel for technologies with pressure vessels. Some technologies omit head loss sensors for systems with design flows less than 1 million gallons per day.
High/low alarms	1 per backwash tank and 1 per chemical storage tank
Level switch/alarms	1 per process basin; 2 per contact tank for chemical disinfection technologies. Technologies with chemical cleaning use 1 or 2 per chemical tank in the cleaning system.
ORP sensors	Varies by technology
Particle meters	Varies by technology
pH meters	1 each for the influent and treated water lines for systems with pH adjustment, plus others on a technology-specific basis
Pressure transducers	Included in the cost of flow meter assemblies for venturi and orifice plate meters
Sampling ports	Varies by technology; usually 1 per process vessel, plus 1 each for the influent line, treated water line and discharge side of the backwash line for complete process models. Others are included on a technology-specific basis.
Total dissolved solids monitors	Varies by technology
Temperature meters	Varies by technology; often 1 for the influent and/or treated water lines, except for add-on models. Some technologies omit temperature meters for systems with design flows less than 1 million gallons per day.
Total organic carbon analyzers	Varies by technology
Turbidity meters	Varies by technology

Several types of flow meters can appear in the model output: propeller, venturi, orifice plate and magnetic flow meters. In general, the choice of meter depends on the cost level and design flow of the system, although some technologies require particular types of flow meters for specific purposes. For smaller and/or low-cost systems, the preference order in the models will have propeller flow meters as a first choice; for intermediate systems, venturi flow meters top the preference order; and for larger and/or high-cost systems, the top preference is magnetic flow meters. In all cases, the component buildup will display the price for all available types of flow meters at a given size, so that a user can assess the cost impact of different types.

The critical design assumptions sheet of each model incorporates these general assumptions. Therefore, the user can adjust instrumentation assumptions on a technology-specific basis.

Individual technologies—in particular, aeration technologies and chlorine and hypochlorite disinfection—have additional or differing instrumentation requirements.

A.3 Control Systems

Automated control systems comprise the hardware and software used to monitor and control a treatment process. There are two general types of systems: programmable logic controls (PLCs) and/or remote telemetry units (RTUs). PLCs are stand-alone microprocessor-based control systems that can be programmed to monitor and control process equipment. RTUs were originally developed to communicate with systems from remote, outdoor locations. Newer RTU models can provide full equipment control through remote operator interface (AWWA, 2001). Because the WBS cost models (except for the nontreatment model) pertain to centralized treatment facilities, the assumptions reflect the control of all system components using a PLC system; RTUs are generally more appropriate for remote communications.

PLC hardware consists of a rack-mounted system with plug-in slots for the input and output (I/O) modules, which provide connections for the instruments and equipment, and one or more central processing unit (CPU) modules, which process the monitoring data inputs and control command outputs. The PLC equipment requires a power supply unit to operate the PLC data and command processing functions. In addition, an uninterruptible power supply (UPS) will protect the PLC system from undesired features such as outages and surges that can adversely affect the performance of the PLC unit. A system operator can monitor and operate with the PLC using either a computer or an operator interface unit, which is a panel mounted on the PLC enclosure. These units can be as simple as 2-line light-emitting diode text panels or as advanced as full color touch panels. The WBS models have default assumptions that PLC systems for smaller drinking water systems will be operated using an advanced, fully-functional operator interface unit after the control system installer has programmed the PLC. Larger systems will include an operator interface unit with more limited functionality and use at least one computer workstation with PLC programming software and printers to accomplish more advanced control functions from a central location. Large systems also include plant intelligence software to assist operation of the extensive control system.

The PLC system design in the WBS models depends on the design of the treatment system, which dictates the total number and type of I/O connections. The PLC system receives input signals from and transmits output signals to ports on instruments and equipment controllers. The I/O signals may be discrete or analog, depending on the type of equipment generating or receiving the signals. Discrete signals indicate which of two conditions apply such as whether a switch is on or off. Analog signals indicate a value along a predefined range such as temperature or rate of flow. **Exhibit A-2** identifies the assumptions used in the WBS models to determine the total number of I/O connections required for the PLC system.

Exhibit A-2. I/O Port Requirements for Instrumentation and Control

Instrument Type	Inputs to and Outputs from PLC System
Alarm (level switch/alarm, high/low alarm or low alarm)	1 input and 1 output—discrete
Chlorine analyzer	1 input—analog
Conductivity meter	1 input—analog
Dissolved oxygen analyzer	1 input—analog
Drive controller	3 inputs (1 for the auto switch position, 1 for the run status signal and 1 for overload or fault signal) and 1 output—discrete
Flow meter	1 input—analog Venturi and orifice plate meters also include inputs and outputs for the associated pressure transducer (below)
Head loss sensor	1 input—discrete
Motor/air-operated valve	1 input and 1 output—analog
ORP sensor	1 input—analog
Particle meter	1 input—analog
pH meter	1 input—analog
Pressure transducer	1 input—analog
Sampling port	1 input—discrete
Total dissolved solids monitor	1 input—discrete
Temperature meter	1 input—analog
Total organic carbon analyzer	1 input—analog
Turbidity meter	1 input—analog

The degree of automated control at a treatment facility can range from none to a fully automated control system that can monitor and control the hydraulic regime at the plant, the chemicals addition system, the power system and the communication system. To reflect potential ranges in treatment costs, the WBS models can provide equipment and operator labor cost outputs for three degrees of control:

- Fully automated control with safety overrides
- Semi-automated control where instruments provide data and information to the control station, but operators manually activate valves and mechanical equipment (e.g., this option removes outputs from the PLC system and removes automated drive controllers from mechanical equipment)
- Fully manual control where operators collect data directly from the instruments and manually activate valves and mechanical equipment.

Users can select among these three control schemes using the system automation input in each WBS model (see Section 2.3). **Exhibit A-3** shows the general design assumptions about control equipment used for each control scheme in the WBS models. The paragraphs below provide additional information regarding the equipment components and calculations.

Exhibit A-3. General Design Assumptions for System Controls

Item of Control Equipment	Small System (<1 MGD)	Medium System (1–10 MGD)	Large System (>10 MGD)	WBS Assumption
PLC Rack/Power Supply	A,S	A,S	A,S	1 base and expansion bases as needed for I/O (see text)
CPU	A,S	A,S	A,S	2 per system[1]
I/O Discrete Output Module	A	A	A	1 for every 32 outputs[2]
I/O Discrete Input Module	A,S	A,S	A,S	1 for every 32 inputs[2]
I/O Combination Analog Module	A,S	A,S	A,S	1 for every 12 inputs (for A and S) and outputs (for A only)[3]
Ethernet Module	A,S	A,S	A,S	2 per system[1]
Base Expansion Module	A,S	A,S	A,S	1 per expansion base
Base Expansion Controller Module	A,S	A,S	A,S	1 per expansion base
UPS	A,S	A,S	A,S	1 per system
Operator Interface Unit – limited functionality	NA	A,S	A,S	2 per system[1] (see text)
Operator Interface Unit – advanced, fully functional	A,S	NA	NA	2 per system[1] (see text)
Computer Workstations	NA	A,S	A,S	1 per operator
Printers	NA	A,S	A,S	1 per 4 workstations
PLC Programming Software	NA	A,S	A,S	1 per workstation
Operator Interface Software	A,S	NA	NA	1 per system
PLC Data Collection Software	NA	A,S	A,S	1 per workstation
Plant Intelligence Software	NA	A,S	A,S	1 per workstation

A = included in a fully automated system; S = included in a semi-automated system; NA = not applicable for this design size
Notes: Fully manual systems do not include system controls
1. Includes one to provide redundancy
2. Discrete input and output modules can have fewer I/O connections, but price differences are small. To keep the equipment requirement calculation tractable, the WBS models use a 32-connection module, which will slightly overstate cost when fewer connection points are needed on the last module.
3. A combination module accommodates 8 inputs and 4 outputs. This 2-to-1 ratio is generally consistent with the ratio of analog inputs-to-outputs in the WBS models for a fully automated system.

The primary PLC system is a rack and power supply (i.e., a "base") with nine slots for control modules.[8] The CPU module requires one slot. An ethernet module necessary for PLC programming requires a second slot, leaving seven for I/O modules. If additional I/O slots are needed to accommodate instruments and equipment, then up to four additional expansion bases can be added, giving the single CPU the capacity to run up to 8,192 I/O connections. Each expansion base has nine module slots and is linked to the CPU module on the primary base.

The total number of PLC racks and power supplies include the primary rack and any expansion racks. The calculation for the total number of racks must take into account the module slots that will be occupied by all types of modules including the CPU module, the ethernet module and expansion base controller modules. Each expansion rack requires a base expansion controller module, which occupies one of the module slots on the expansion rack, leaving eight slots for

[8] Bases with fewer slots are also available, but cost differences across base sizes are small. To keep the equipment requirement calculation tractable, the WBS models use a 9-slot base, which will slightly overstate cost when fewer slots are needed.

I/O modules. Each expansion rack also requires a base expansion module, which is attached to the outside of the rack and, therefore, does not require a module slot. The following calculations illustrate how the WBS models calculate total PLC racks:

> IF (*plc_cpu* + *plc_ethernet* + *plc_discrete_input* + *plc_discrete_output* + *plc_combination_analog)* ≤ *9*
> THEN *plc_rack* = 1*, plc_base_expansion* = 0*, plc_ base_expansion_controller* = 0
>
> IF (*plc_cpu* + *plc_ethernet* + *plc_discrete_input* + *plc_discrete_output* + *plc_combination_analog)* > *9* AND ≤ 17
> THEN *plc_rack* = 2*, plc_base_expansion* = 1*, plc_ base_expansion_controller* = 1
>
> IF (*plc_cpu* + *plc_ethernet* + *plc_discrete_input* + *plc_discrete_output* + *plc_combination_analog)* > *17* AND ≤ 25
> THEN *plc_rack* = 3*, plc_base_expansion* = 2*, plc_ base_expansion_controller* = 2
>
> IF (*plc_cpu* + *plc_ethernet* + *plc_discrete_input* + *plc_discrete_output* + *plc_combination_analog)* > 25 AND ≤ 33
> THEN *plc_rack* = 4*, plc_base_expansion* = 3*, plc_ base_expansion_controller* = 3
>
> IF (*plc_cpu* + *plc_ethernet* + *plc_discrete_input* + *plc_discrete_output* + *plc_combination_analog)* > 36 AND ≤ 41
> THEN *plc_rack* = 5*, plc_base_expansion* = 4*, plc_ base_expansion_controller* = 4

A.4 List of Abbreviations and Symbols in this Appendix

CPU	central processing unit
I/O	input and output
ORP	oxidation-reduction potential
PLCs	programmable logic controls
RTUs	remote telemetry units
UPS	uninterruptible power supply
WBS	work breakdown structure

A.5 References

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Appendix B. Building Construction Costs

B.1 Introduction

The work breakdown structure (WBS) cost database incorporates building costs from three sources: RSMeans *2020 Square Foot Costs* (RSMeans, 2020), Saylor *2020 Commercial Square Foot Building Costs* (Saylor, 2020) and the Craftsman 2020 National Building Cost Estimator (NCBE) software model (described in Craftsman, 2020). Each of these sources enables a user to create a cost estimate by combining costs for different elements of a building—for example, the foundation, exterior walls or light fixtures.

For each source, the WBS cost database includes three sets of options to represent low, medium and high building design and material qualities. Section B.2 provides descriptions of the relevant options for each source within these categories, as well as the options selected for each of the three building types used in the WBS models. The WBS models cost heating and cooling systems as individual capital cost line items separate from the building construction costs. Therefore, the building costs discussed here exclude heating and cooling systems.

For each of the three types of building, EPA used the three sources described here to develop cost buildups for 24 building sizes ranging from 500 to 200,000 square feet and tabulated costs for each of the models. The resulting costs from each model are included in the WBS cost database. The database escalates these costs from 2020 dollars using the Engineering News-Record Building Cost Index (ENR, 2020) and averages them following the same procedure as for other components, as described in Chapter 2. The WBS models use these costs to estimate costs per square foot for buildings larger than 500 square feet (ft^2).

EPA also developed a fourth building type that applies only to structures smaller than 500 ft^2—essentially a shed with steel walls and a roof. This additional building type allows the WBS models to use, for very small systems, building costs that reflect very inexpensive building construction methods and materials. For this type of building, EPA used the Craftsman NCBE model to estimate costs for a low-profile steel building. However, the WBS models do not use this building type for chlorine storage buildings because chlorine gas use necessitates a non-corrodible building material and special ventilation requirements. Thus, for chlorine storage buildings smaller than 500 ft^2, the WBS models use the same unit costs as for larger buildings.

B.2 Buildup Options and Building Quality Selections

EPA developed building cost estimates using comparable assumptions across data sources: the Craftsman NBCE model, building costs from RSMeans *2020 Square Foot Costs* and Saylor *2020 Commercial Square Foot Building Costs*. Each source provides unit costs for different building types and construction qualities.

The Craftsman NBCE model is a software model that generates building cost estimates based on user input (i.e., building size and quality of building features and fixtures). Given the variation in unit costs for components by size, it appears to function as a parametric model. The costs in the NBCE model are based on data obtained from U.S. government building cost surveys.

The RSMeans and Saylor manuals contain unit costs, usually in dollars per square foot, for various building components (e.g., exterior walls, floor structure or roof structure). The costs are based on data obtained from the construction industry and independent research of construction costs. By combining unit costs across components, one can build up a total building unit cost. The approach is essentially a WBS cost approach where most components are priced on the basis of building area, with little or no variation in the cost per unit area as building size increases. For example, the RSMeans unit cost for a foundation slab varies with the thickness of the slab (EPA chose thicker slabs for higher quality buildings), but not with the building size. Notable exceptions are the cost of exterior walls and roof structures. Exterior wall cost in dollars per ft^2 declines as building size increases because the ratio of exterior wall linear footage to square footage declines. For roof structures, EPA chose roof spans based on the length of a side of the building (assumed square). For building side lengths greater than 70 feet, EPA included support columns to give a maximum roof span of 70 feet. Larger buildings, therefore, may have somewhat more expensive superstructures on a per-square-foot basis, since they may have a wider roof span or support columns.

EPA chose inputs to the NBCE model and chose components from the RSMeans and Saylor manuals to reflect the different levels of building quality used in the WBS models (high, medium, low and very small low quality).

Based on the NBCE industrial building quality classifications, EPA determined that the NBCE Class 1&2 (best/good quality), Class 3 (average quality) and Class 4 (low quality) reflected WBS high, medium and low quality buildings, respectively. EPA used the NBCE low-profile steel building for very small low quality buildings.

The RSMeans and Saylor manuals do not contain building types that are closely comparable to the very small low quality building. Therefore, there are no RSMeans or Saylor costs for this type of structure. RSMeans and Saylor building cost estimates were "built" by selecting specific building elements of differing quality for each type of building from the assemblies sections of their respective manuals.

From each source, EPA obtained cost estimates for the following building areas in square feet: 500; 1,000; 2,000; 3,000; 4,000; 5,000; 7,500; 8,000; 10,000; 12,000; 15,000; 18,000; 20,000; 24,000; 25,000; 30,000; 36,000; 42,000; 48,000; 50,000; 54,000; 60,000; 100,000 and 200,000. The resulting costs do not include costs for site improvements (e.g., land, landscaping, parking and utilities), permits, furnishings and production equipment, homeland security responses or contingency allowance.

The RSMeans and Saylor costs include installation costs as well as overhead and profit for the contractors installing the building components, but do not include architectural fees or general contractor markup for general conditions, overhead and profit (RSMeans, 2020; Saylor, 2020). According to Craftsman (Ogershok, 2009), the NBCE model's costs do not include installing contractor markup directly, but do include a markup of 30 percent for the general contractor, which they assume to also cover the installing contractor's markup. Since the Craftsman costs were generally lower than those from Means or Saylor and since the installing contractor's markup in Means and Saylor is usually 30 percent or more, EPA assumed that the 30 percent markup in the Craftsman costs was passed along directly to the installing contractor and further markup would be required for the general contractor. Architectural fees and the general contractor's markup are included in the WBS model indirect cost output, as described in Appendix D.

Each source has a different set of options. They can be grouped into six categories:

- Substructure
- Superstructure
- Exterior closure
- Interior finish
- Mechanical services, excluding heating and cooling
- Electrical services.

B.2.1 Substructure

Building substructure was selected using application scenarios for each of the three quality options. For low quality buildings, EPA assumed an average industrial use scenario. For medium quality buildings, EPA assumed a heavy industrial use scenario. For higher quality buildings, EPA assumed a heavy industrial with live loads use scenario. EPA assumed light foot traffic for the very small (less than 500 ft^2) buildings (other than those used to store chlorine gas).

Exhibit B-1 shows the detailed choices that EPA made for each of the three sources.

Exhibit B-1. Substructure Selections for NBCE, RSMeans and Saylor

Building Variable	Lower Quality Building	Medium Quality Building	Higher Quality Building	Very Small Lower Quality Building
Craftsman NBCE	*Foundation*: reinforced concrete pads under pilasters. *Floor*: 6" rock base, 4" concrete with reinforcing mesh.	*Foundation*: continuous reinforced concrete. *Floor*: 6" rock base, 5" concrete with reinforcing mesh or bars.	*Foundation*: continuous reinforced concrete. *Floor*: 6" rock base, 6" concrete with reinforcing mesh or bars.	*Foundations* as required for normal soil conditions; a 4" concrete floor with reinforcing mesh and a 2" sand fill.
RSMeans	*Foundation*: poured concrete; strip and spread footings. *Slab*: 4" reinforced, industrial concrete with vapor barrier and granular base. Site preparation for slab and trench for foundation wall and footing. 4' foundation wall.	*Foundation*: poured concrete; strip and spread footings. *Slab*: 5" reinforced, heavy industrial concrete with vapor barrier and granular base. Site preparation for slab and trench for foundation wall and footing. 4' foundation wall.	*Foundation*: poured concrete; strip and spread footings. *Slab*: 6" reinforced, heavy industrial concrete with vapor barrier and granular base. Site preparation for slab and trench for foundation wall and footing. 4' foundation wall.	not applicable
Saylor	*Foundation*: concrete strip and spread footings, 4' foundation wall. *Slab on grade*: reinforced concrete, vapor barrier, 4" thick, on 4' sand or gravel base.	*Foundation*: concrete strip and spread footings, 4' foundation wall. *Slab on grade*: reinforced concrete, vapor barrier, 5" thick, on 4' sand or gravel base.	*Foundation*: concrete strip and spread footings, 4' foundation wall. *Slab on grade*: reinforced concrete, vapor barrier, 6" thick, on 4' sand or gravel base.	not applicable

' = feet; " = inches

B.2.2 Superstructure

EPA assumed the same quality of superstructure for each of the three quality options—metal deck and open web steel joists, supported by columns and exterior walls. However, the superstructure support column spans range up to 70 feet, depending upon building size. To establish the column span, EPA computed the length of a building side, assuming the building to be square. For buildings with side lengths larger than 70 feet, EPA included support columns in a square grid to provide a roof span of 70 feet or less, assuming that the roof would also be supported on the exterior walls. For instance, a 10,000 ft^2 building (100 feet on a side) would have one support column in the center, with a 50 foot roof span. A 30,000 ft^2 building (173 feet on a side) would have four support columns at 58 foot intervals. Since the sources included roof spans in increments of 10 feet, EPA rounded up to a 60 foot roof span for this building. EPA used a steel building quality superstructure for the very small (less than 500 ft^2) buildings (other than those used to store chlorine gas).

Exhibit B-2 displays the superstructure options that EPA selected for each source.

Exhibit B-2. Superstructure Selections for NBCE, RSMeans and Saylor

Building Variable	Lower Quality Building	Medium Quality Building	Higher Quality Building	Very Small Lower Quality Building
Craftsman NBCE	*Roof structure*: glu-lams wood or steel trusses on steel intermediate columns, short span. *Roof cover*: panelized roof system, ½" plywood sheathing, 4-ply built-up roof. 10 ft^2 of skylight per 2,500 ft^2 of floor area (1-2'x 4'skylight 40' to 50' o.c.).	*Roof structure*: glu-lams wood or steel trusses on steel intermediate columns, short span. *Roof cover*: panelized roof system, ½" plywood sheathing, 4-ply built-up roof. 24 ft^2 of skylight per 2,500 ft^2 of floor area (1-4'x 6' skylight 40' to 50' o.c.).	*Roof structure*: glu-lams wood or steel trusses on steel intermediate columns, span exceeds 70'. *Roof cover*: panelized roof system, ½" plywood sheathing, 4-ply built-up roof. 32 ft^2 of skylight per 2,500 ft^2 of floor area (1-4'x 8' skylight 40' to 50' o.c.).	Steel roof purlins 4½ to 5½ feet on centers, 26-gauge galvanized steel on roof
RSMeans	*Roof*: 1.5" galvanized metal deck, open web steel joists, joist girders, on columns and walls; total load = 60-65 lbs/ft^2. Column spacing chosen to give a maximum span of 70', with the building assumed square. Steel columns. *Roof cover*: Built-up tar and gravel roof covering with flashing, perlite/EPS composite insulation. Roof hatches with curb.	Same as lower quality	Same as lower quality	not applicable
Saylor	*Roof*: metal deck, open web steel joists, on columns and walls. Wide flange steel columns, steel beams and girders. Column spacing chosen to give a maximum span of 70', with the building assumed square. *Roof cover*: built-up tar and gravel.	Same as lower quality	Same as lower quality	not applicable

' = feet; " = inches; EPS = expanded polystyrene; o.c. = on center

B.2.3 Exterior Closure

EPA used different building exterior qualities to estimate unit costs that vary by exterior material. EPA selected reinforced concrete block exteriors for the lower quality buildings, reinforced tilt-up concrete panel exteriors for the medium quality buildings[9] and brick-faced, reinforced cavity/composition wall exteriors for the higher quality buildings. EPA used corrugated metal exteriors for the very small lower quality structures (smaller than 500 ft^2).

A cavity wall (e.g., masonry) is a wall in which the inner and outer wythes are separated by an air space, but tied together with wires or metal stays. A composition wall is a wall combining different materials to work as a single unit. A tilt-up wall is a method of concrete construction in which wall sections are cast horizontally at a location adjacent to their eventual position and tilted into place after removal of forms.

Exhibit B-3 shows the exterior closure options that EPA selected for each model.

Exhibit B-3. Exterior Closure Selections for NBCE, RSMeans and Saylor

Building Variable	Lower Quality Building	Medium Quality Building	Higher Quality Building	Very Small Lower Quality Building
Craftsman NBCE	8” reinforced concrete block or brick, unpainted. (Same for both lower and medium quality.)	8” reinforced concrete block or brick, unpainted. (Same for both lower and medium quality.)	8” reinforced concrete block or brick with pilasters 20’ on centers, painted sides and rear exterior, front wall brick veneer	Steel frames/bents set 20’ to 24’ on centers, steel wall girts 3½’ to 4½’ on centers, post and beam type end wall frames, 26-gauge galvanized steel on ends and sides
RSMeans	Concrete block, reinforced, regular weight, hollow, 4x8x16’, 2,000 psi	Tilt-up concrete panels, broom finish, 5½” thick, 3,000 psi	Brick face composite wall-double wythe: utility brick, concrete block backup masonry, 8” thick, perlite core fill.	not applicable
Saylor	Concrete block, 4x8x16’, reinforced	Tilt-up concrete panel, 6" thick, no pilasters.	Brick cavity wall, reinforced, 10" thick.	not applicable

‘ = feet; “ = inches; psi = pounds per square inch

B.2.4 Interior Finish

Choices of interior finish reflect the quality and duty of the interior construction materials such as floor coverings, wall coverings and ceilings. EPA selected functional, minimally attractive interior finishes for the lower quality buildings and more functional and attractive interiors for medium and higher quality buildings. EPA also selected functional, unattractive interior finishes for the very small (less than 500 ft^2) buildings (other than those used to store chlorine gas).

Exhibit B-4 shows the interior finish options that EPA selected for each source.

[9] Tilt-up concrete panel exteriors were selected in the RSMeans and Saylor cost estimation buildups. Tilt-up concrete panels were not an exterior option in the Craftsman NBCE cost estimation model; therefore, reinforced concrete block exterior was selected in the Craftsman NBCE cost estimation model for medium quality buildings.

Exhibit B-4. Interior Finish Selections for NBCE, RSMeans and Saylor

Building Variable	Lower Quality Building	Medium Quality Building	Higher Quality Building	Very Small Lower Quality Building
Craftsman NBCE	Concrete floors. Rest rooms: unfinished wallboard partitions and 2 low cost fixtures.	Concrete floors. Rest rooms: painted gypsum wallboard partitions and 2 average fixtures.	Concrete floors. Rest rooms: enameled gypsum wallboard partitions, 3 good fixtures, vinyl asbestos tile floors.	Minimal quality, minimal duty, functional, unattractive
RSMeans	One minimal quality 2-fixture restroom per 5,000 ft^2 building area. Unpainted walls. Concrete floors. Fiberglass ceiling board on exposed grid system covering 10 percent of building area.	One minimal quality 2-fixture restroom per 5,000 ft^2 building area. Painted walls. Vinyl composition tile floors covering 10 percent of building area. Fiberglass ceiling board on exposed grid system covering 10 percent of building area.	One high quality 3-fixture restroom per 5,000 ft^2 building area. Acrylic glazed walls. Vinyl composition tile floors covering 10 percent of building area. Fiberglass ceiling board on exposed grid system covering 10 percent of building area.	not applicable
Saylor	One restroom per 5,000 ft^2 building area, with 2 economy fixtures, baked enamel partitions. Unpainted walls. Concrete floors. Ceiling: 5/8" gypsum board on metal frame, covering 10 percent of building area.	One restroom per 5,000 ft^2 building area, with 2 standard fixtures, baked enamel partitions. Painted walls. Vinyl composition floor covering 10 percent of building area. Ceiling: 5/8" gypsum board on metal frame, covering 10 percent of building area.	One restroom per 5,000 ft^2 building area, with 3 standard fixtures, baked enamel partitions. Painted walls. Vinyl composition floor covering 10 percent of building area. Ceiling: 5/8" gypsum board on metal frame, covering 10 percent of building area.	not applicable

' = feet; " = inches

B.2.5 Mechanical Services

Mechanical services include fire protection, plumbing, heating, ventilation and cooling. The WBS models cost heating and cooling systems as individual capital cost line items separate from the building construction costs, so the mechanical services included in the building costs are limited to fire protection, plumbing and ventilation. EPA assumed no sprinkler systems for the lower quality buildings and normal hazard wet sprinkler systems for medium and higher quality buildings. EPA also assumed no sprinkler systems for the very small (less than 500 ft^2) buildings (other than those used to store chlorine gas).

Exhibit B-5 shows the mechanical services options that EPA selected for each source.

Exhibit B-5. Mechanical Services Selections NBCE, RSMeans and Saylor

Building Variable	Lower Quality Building	Medium Quality Building	Higher Quality Building	Very Small Lower Quality Building
Craftsman NBCE	No sprinklers. 1 small rotary vent per 2,500 ft^2 of floor area.	Sprinklers. 1 medium rotary vent per 2,500 ft^2 of floor area. (Same for both medium and higher quality.)	Sprinklers. 1 medium rotary vent per 2,500 ft^2 of floor area. (Same for both medium and higher quality.)	Minimal quality, minimal duty, functional, no sprinklers
RSMeans	Gas-fired water heater. No sprinklers.	Gas-fired water heater. Wet pipe sprinkler system. (Same for both medium and higher quality.)	Gas-fired water heater. Wet pipe sprinkler system. (Same for both medium and higher quality.)	not applicable
Saylor	Gas-fired water heater (1 per 5,000 ft^2), 50 gallon, 100 GPH. No sprinklers.	Gas-fired water heater (1 per 5,000 ft^2), 50 gallon, 100 GPH. Exposed wet sprinkler system, normal hazard. (Same for both medium and higher quality.)	Gas-fired water heater (1 per 5,000 ft^2), 50 gallon, 100 GPH. Exposed wet sprinkler system, normal hazard. (Same for both medium and higher quality.)	not applicable

‘ = feet; “ = inches; GPH = gallons per hour

B.2.6 Electrical Services

EPA included the cost of light fixtures and convenience power, along with associated wiring and conduits. EPA selected inexpensive lighting fixtures that provide minimal lighting and a minimal number of wall switches and receptacles for the lower quality buildings and selected increasingly expensive lighting fixtures that provide bright lighting and an increased number of wall switches and receptacles for the medium and higher quality buildings. EPA also selected minimal lighting fixtures for the very small (less than 500 ft^2) buildings (other than those used to store chlorine gas).

EPA did not include electrical feed, switchgear, motor control centers, etc. in building costs. These costs are likely to vary significantly by technology for buildings of the same size and quality; for example, a mid-sized reverse osmosis system and a small packaged conventional filtration system might occupy roughly the same footprint in similar buildings, but the reverse osmosis system will likely have much greater power requirements. It is therefore not appropriate to base these costs on the building’s area or quality. These costs are included in the indirect cost buildup based on a percentage of process cost, as described in Appendix D.

Exhibit B-6 shows the electrical services options that EPA selected for each source.

Exhibit B-6. Electrical Services Selections for NBCE, RSMeans and Saylor

Building Variable	Lower Quality Building	Medium Quality Building	Higher Quality Building	Very Small Lower Quality Building
Craftsman NBCE	*Lighting*: low cost incandescent fixtures, 20'x30' spacing	*Lighting*: low cost single tube fluorescent fixtures 20'x20' spacing	*Lighting*: 4" single tube fluorescent fixtures 10'x12' spacing	Minimal quality, minimal duty, basic wiring and minimal lighting fixtures
RSMeans	*Lighting*: Incandescent fixtures recess mounted, type A: 1 W/ft², 8 FC. 6 lighting fixtures, 1 wall switch and 2.5 receptacles per 1,000 ft². 1 W miscellaneous power.	*Lighting*: Fluorescent fixtures recess mounted in ceiling: T-12, 40 W lamps, 2 W/ft², 40 FC. 10 lighting fixtures, 2.5 wall switches and 5 receptacles per 1,000 ft². 1.5 W miscellaneous power.	*Lighting*: Fluorescent fixtures recess mounted in ceiling: T-12, 40 W lamps, 4 W/ft², 80 FC. 20 lighting fixtures, 5 wall switches and 10 receptacles per 1,000 ft². 3 W miscellaneous power.	not applicable
Saylor	*Lighting*: Incandescent fixtures, surface mounted, 100 W, commercial grade, 10 per 1,000 ft² for 1 W/ft² total. 1 commercial grade single-pole switch and 2.5 commercial-grade duplex receptacles per 1,000 ft². In slab/PVC conduit and wire for 60 A current, length assumed equal to building perimeter for a square building.	*Lighting*: Fluorescent fixtures, recessed, 2 13 W bulbs each, 16 per 1,000 ft² for 2 W/ft² total. 2.5 commercial grade single-pole switches and 5 commercial-grade duplex receptacles per 1,000 ft². EMT conduit and wire for 60 A current, length assumed equal to building perimeter for a square building.	*Lighting*: Fluorescent fixtures, recessed, 2 13 W bulbs each, 31 per 1,000 ft² for 4 W/ft² total. 5 commercial grade single-pole switches and 10 commercial-grade duplex receptacles per 1,000 ft². RGS conduit and wire for 60 A current, length assumed equal to building perimeter for a square building.	not applicable

' = feet; " = inches; A = amp; EMT = electrical metallic tubing; FC = foot candles; PVC = polyvinyl chloride; RGS = rigid galvanized steel; W = watt

B.3 List of Abbreviations and Symbols in this Appendix

EPA	U.S. Environmental Protection Agency
ft^2	square feet
NBCE	National Building Cost Estimator
WBS	work breakdown structure

B.4 References

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Appendix C. Residuals Management Costs

C.1 Introduction

The purpose of this appendix is to outline the approach used to estimate costs for managing the residuals generated by different drinking water treatment technologies. The work breakdown structure (WBS) model for each treatment technology includes its own residuals cost estimate. Each model allows the user to choose from different residual management options that reflect the methods most likely to be used for the drinking water treatment technology being modeled. Based on the residuals management option selected, each model identifies the specific component equipment and operating and maintenance (O&M) requirements and generates costs using the WBS approach based on engineering design. Costs for residuals management equipment appear as line items in the model output, as is the case for other WBS elements. The residuals management design also affects indirect costs, land costs and building costs.

The residuals management options available in each model are specific to the technology being modeled, driven by the types of residuals generated, their quantity, the frequency of generation (e.g., intermittent versus continuous) and their characteristics. There are, however, similarities among groups of technologies that generate similar residuals. **Exhibit C-1**, below, lists the technology groups, the residuals generated and the frequency of generation.

The technology-specific chapters of this report identify the residuals management options available in each model. Because many of the options are similar within (or even across) technology groups, this appendix describes the methodology and assumptions used for each option in a single location, rather than repeating the information in each technology chapter. The residuals management options that may be included in a given model include the following:

- Holding tanks (with or without coagulant addition)
- Direct discharge to surface water
- Discharge to a publicly owned treatment works (POTW)
- Recycle to treatment plant headworks
- Evaporation ponds
- Septic system
- Off-site disposal (non-hazardous, hazardous, radioactive or hazardous and radioactive)
- Land application
- Liquid hazardous waste disposal
- Deep well injection
- Off-gas treatment.

Section C.2, below, describes general design methods and assumptions common across residuals management options. With two exceptions, subsequent sections describe each of the above options. Deep well injection is included as an option only in the reverse osmosis/nanofiltration model and, therefore, is discussed in detail in the chapter relating to that model. Off-gas treatment is relevant only to aeration technologies and, therefore, is discussed in detail in chapters relating to aeration models (e.g., packed tower aeration, multi-stage bubble aeration).

Exhibit C-1. Technologies and Residuals Generated

Residuals Generated	Type of residual	Generation Frequency	Technologies
Spent regenerant or brine[1]	Liquid	Intermittent or continuous	Adsorptive Media, Anion Exchange, Cation Exchange
Spent backwash	Liquid	Intermittent	Adsorptive Media, Anion Exchange, Biologically Active Filtration, Biological Treatment, Cation Exchange, Greensand Filtration, Granular Activated Carbon
Spent media or resin	Solid	Intermittent	Adsorptive Media, Anion Exchange, Biologically Active Filtration, Biological Treatment, Cation Exchange, Greensand Filtration, Granular Activated Carbon
Membrane concentrate	Liquid	Continuous	Reverse Osmosis/Nanofiltration
Spent backwash/tank drain and crossflow	Liquid	Intermittent	Low-pressure Membranes (Microfiltration/Ultrafiltration)
Cleaning waste	Liquid	Intermittent	Reverse Osmosis/Nanofiltration, Low-pressure Membranes (Microfiltration/Ultrafiltration)
Spent membrane modules/elements	Solid	Intermittent	Reverse Osmosis/Nanofiltration, Low-pressure Membranes (Microfiltration/Ultrafiltration)
Used cartridge filters	Solid	Intermittent	Reverse Osmosis/Nanofiltration
Off-gas	Gas	Continuous	Packed Tower Aeration, Multi-stage Bubble Aeration, Diffuse Aeration, Tray Aeration
Spent lamps, ballasts and intensity sensors	Solid	Intermittent	Ultraviolet Disinfection, Ultraviolet Advanced Oxidation

The chlorine gas, hypochlorite, chlorine dioxide, chloramine, nontreatment, ozone, permanganate addition, phosphate feed, caustic feed and acid feed models are not shown because no process residuals are generated.
Note:
1. Generated when the technology is used with media regeneration, rather than on a throw away basis.

C.2 General Assumptions

Some of the general assumptions used in developing the costs for management of residuals are listed below:

- For intermittently generated liquid residuals (e.g., filter backwash), the models calculate residuals quantities based on the volume of a single generation event (e.g., backwashing one vessel) and assuming a staggered schedule between generation events (e.g., if vessels must be backwashed every 48 hours and there are two vessels in operation, the facility will backwash vessel one at 0 and 48 hours and backwash vessel two at 24 and 72 hours).
- For intermittently generated liquid residuals, flow rates depend on whether flow equalization is used (e.g., through the use of holding tanks, as described in Section C.3).
- Without flow equalization, the maximum residuals flow rate for intermittently generated liquid residuals is *single generation event volume/event duration*.
- With flow equalization, the models assume residuals are released continuously during the time between generation events. Therefore, the maximum residuals flow rate for intermittently generated liquid residuals is *(single generation event volume/time between events) x capacity factor*. The variable, *capacity factor*, is present to account for less than perfect staggering between generation events. The models assume *capacity factor* equals

2, but the user can change this assumption on the critical design assumptions sheet of each model.

- The models size residuals piping, valves and other downstream equipment based on the *maximum* flow rates calculated as described above for intermittently generated liquid residuals and on the *maximum* continuous flow rate determined by the engineering models for continuously generated liquid residuals.
- The models assume the length of interconnecting piping between treatment process equipment and residuals management equipment is equal to 1 times the overall system building layout length. Like the pipe length assumptions documented in **Exhibit 2-10**, this assumption is designed to account for the cost of fittings.
- With a few exceptions (noted in the individual model chapters), the models assume an *additional* 40 feet of piping is required for liquid residuals to reach their ultimate destination (e.g., the discharge point, head of the treatment plant or evaporation pond). Except when this piping is used to recycle the residual, the models assume this piping is buried and, therefore, include the cost of excavation, bedding, thrust blocks, backfill and compaction for the additional pipe length. The user can change the assumption about the length of the additional residuals piping on critical design assumptions sheet of each model.
- The models generally assume that total suspended solids (TSS) in the influent water are completely removed during treatment and accumulate in the residuals generated. This assumption provides a conservative (high) estimate of the TSS concentration in the residuals. Assumptions about the concentration of TSS in the influent water vary on a technology-by-technology basis, but the user can change the assumption on the critical design assumptions sheet of each model.

C.3 Holding Tanks

The purpose of a holding tank is to equalize the rate of flow at which residuals are released or discharged. A holding tank may be desirable for intermittently generated liquid residuals that ultimately are recycled to the treatment plant headworks or discharged to a POTW. The instantaneous flow of intermittently generated liquid residuals (e.g., filter backwash) during a generation event can be quite high. The use of a holding tank allows the discharge of these residuals over the time between generation events, so that the ultimate flow is lower, but more continuous. When residuals such as filter backwash are recycled to the head of a treatment plant, recommended engineering practice is that the recycle stream should be no more than 5 percent to 10 percent of total system flow (U.S. EPA, 2002; U.S. EPA, 1996). Flow equalization through the use of a holding tank may be necessary to meet this generally recommended engineering practice. It also may be reasonable to include a holding tank for other discharge options (e.g., to prevent instantaneous flow from overwhelming the capacity of a POTW).

When holding tanks are used for intermittently generated liquid residuals, the models determine the capacity required as follows: *single generation event volume x capacity factor*. This capacity factor is the same variable discussed in Section C.2 and is intended to account for less than perfect staggering between generation events.

Holding tanks can also be desirable for certain continuously generated liquid residuals (e.g., membrane reject) to accommodate variations in flow that occur as influent flow varies. In this case, the models determine the capacity required based on a desired detention time. The user can change this detention time on the critical design assumptions sheet of the appropriate models.

When holding tanks are included, residuals pumps are required to move residuals from the holding tank to their ultimate destination. The models size these pumps based on maximum residuals flow rate, as discussed in Section C.2. The models also include maintenance labor, materials and energy for these pumps in the O&M calculations using the same approach described for booster pumps in Appendix E.

When holding tanks are used, they can result in the generation of secondary residuals in the form of solids that settle in the holding tank. The models also allow for the addition of coagulant to the holding tank to increase the percentage of TSS removed. Users can model this option by changing the appropriate triggering variable on the critical design assumptions sheet of each model. When the coagulant addition option is chosen, users also can choose the coagulant used. Options available (specified on the critical design assumptions sheet) are polymers, ferric chloride or both ferric chloride and polymers.

By default, holding tanks can be constructed of plastic, fiberglass or steel or they can be open concrete basins. When the coagulant addition option is chosen, however, the models automatically assume the tanks will be open concrete basins, to allow for easier solids cleanout. The models also size the tanks so that a minimum settling time is achieved. When coagulant addition is chosen, the models also add other required equipment, specifically mixers and dry feeders or metering pumps.

The following are the model assumptions relevant to solids generation and coagulant addition:

- Without coagulant addition, most models assume that 25 percent of the TSS present in the residuals is removed in a holding tank[10]
- With coagulant addition, this assumption increases to 50 percent
- With coagulant addition, the holding tanks must provide a minimum settling time of 90 minutes
- Coagulant dose is 10 milligrams per liter
- Coagulant sludge production factor is 1 pounds of sludge per pound of polymers added and 0.99 pounds of sludge per pound of ferric chloride added
- Holding tank solid density is 25 pounds per cubic foot
- Holding tank solids are removed when the solids accumulation reaches 10 percent of tank capacity.

The user can change each of these assumptions on the critical design assumptions sheet of the individual models.

[10] Exceptions are models, such as anion exchange, that assume low influent solids or include pretreatment filtration to remove influent solids. These models assume no settling in the holding tank without coagulant addition, because of the low solids content present (or remaining) in the water being treated.

C.4 Direct Discharge to Surface Water

Some liquid residuals may be amenable to direct discharge to surface water. Such discharges require a National Pollutant Discharge Elimination System permit, the costs of which are included in the add-on costs line item for permits. The only items of capital equipment required for direct discharges are piping and valves, although the models will include pumps if holding tanks are used in conjunction with direct discharge (see Section C.3, above).

C.5 Discharge to POTW

Discharge to a POTW is another possible management option for liquid residuals. The discharge should meet certain pretreatment requirements and must not overwhelm the capacity of the POTW. The only items of capital equipment required for POTW discharges are piping and valves, although the models will include pumps if holding tanks are used in conjunction with POTW discharge (see Section C.3, above).

Discharge to a POTW, however, entails certain charges that are included in the O&M costs of each model when this discharge option is included. POTW rate structures vary nationwide, but the most common types of charges are the following:

- Flat fees (e.g., dollars per month).
- Volume-based fees (e.g., dollars per 1,000 gallons discharged).
- TSS-based fees (e.g., dollars per pound of TSS in the discharge if over a certain TSS concentration). For this fee type, the models assume that the POTW TSS discharge limit over which a fee is imposed to be 250 parts per million (which is the most common limit for cities with a limit on TSS).

Individual POTW rate structures can reflect a combination of one or more of these fee types. To model POTW charges in a way that is nationally representative, the models include all three fee types and calculate them based on unit charges that represent the average for each fee type based on data from AWWA (2013). The user can change these average unit charges in the data extracted from the central WBS cost database. Alternatively, the user can model a specific type of POTW rate structure by selecting the appropriate option on the critical design assumptions sheet of each model. The user can indicate which fee types to include (e.g., flat fee only). The model will then use "typical" unit charges for the selected fee type(s). These "typical" unit charges, which can be changed in the data extracted from the WBS cost database, reflect the average including only cities that use that specific fee type (i.e., the average not counting zeros).

C.6 Recycle to Treatment Plant Headworks

Certain liquid residuals can be recycled to the treatment plant headworks provided the system complies with the backwash recycling rule and the practice does not negatively impact finished water quality. The recommended engineering practice is that the recycle stream should be no more than 5 to 10 percent of total system flow (U.S. EPA, 2002; U.S. EPA, 1996). The only items of capital equipment required for recycling are piping and valves, although a holding tank (and, therefore, pumps) also would be necessary in most cases to meet the recommendation.

C.7 Evaporation Ponds

When large quantities of liquid residuals are generated (e.g., spent brine from ion exchange), an evaporation pond can be an appropriate management method, particularly for facilities in dry climates. Holding tanks are never necessary with an evaporation pond, even for designs with intermittent generation frequency, because the design of the pond would provide sufficient capacity to handle instantaneous flow. A minimum of two cells is recommended to ensure availability of storage space during cleaning, maintenance or emergency conditions (U.S. EPA, 1987).

When evaporation ponds are selected, the models include the following evaporation pond capital expenses: excavation, backfill, lining and dike construction. Also, when evaporation ponds are selected, the models always include the cost of a geotechnical investigation (see Appendix D). These items are in addition to the pipes and valves required to deliver residuals to the pond. The models make the following assumptions to design evaporation ponds:

- Arid climate with annual average precipitation of 70 centimeters per year (cm/yr)
- Average annual pan evaporation rate is 180 cm/yr
- Evaporation ratio (which takes into account conversion of pan to lake evaporation rate and the effect of salinity) of 0.7
- 180 days of storage with no net evaporation
- Evaporation pond safety factor (which accounts for years with below average evaporation) of 1.1
- Maximum evaporation pond cell area of 5 acres.

The user can change each of these assumptions on the critical design assumptions sheet in each model that includes the evaporation pond option. If evaporation ponds are selected, the user should also review the other climate-based assumptions included in the model (e.g., the heating and cooling requirements on the O&M assumptions sheet) to determine that they are sufficiently consistent with the assumption of an arid climate that is implicit in the selection of evaporation ponds as a residuals management method.

The use of an evaporation pond results in the generation of a secondary residual stream in the form of evaporation pond solids. The models calculate the accumulation of evaporation pond solids by including all suspended *and* dissolved solids present in the residuals. The models assume evaporation pond solids removal frequency of once per year. Users can change this latter assumption on the critical design assumption sheet of the appropriate models.

C.8 Septic System

Based on comments from peer reviewers, discharge to an in-ground septic tank and drain field (a septic system) might be an option for some liquid residuals with intermittent generation in small systems using certain technologies (e.g., adsorptive media, anion exchange). Users selecting this option should evaluate whether the characteristics of the residuals are appropriate for this type of discharge. Holding tanks are never necessary with septic systems because the design of the septic tank would provide sufficient capacity to handle instantaneous flow.

When a septic system is selected, the models include the following capital expenses:

- Septic tanks
- Excavation for septic tanks
- Distribution boxes
- Distribution pipe (perforated polyvinyl chloride)
- Drain field trench excavation
- Drain field gravel.

These items are in addition to the pipes and valves required to deliver residuals to the septic tank. Also, when a septic system is selected, the models always include the cost of a geotechnical investigation (see Appendix D). The models make the following assumptions to design septic systems:

- Minimum septic tank discharge time of 2 days
- Minimum septic tank volume of 1,000 gallons
- Maximum septic tank volume of 100,000 gallons
- Septic tank volume safety factor of 150 percent
- Long-term acceptance rate (a value, based on soil type, used by states/localities to determine the minimum drain field infiltration area) of 0.5 gallons per day per square foot
- Septic drain field trench width of 4 feet
- Septic drain field trench depth of 4 feet
- Septic drain field trench gravel depth below distribution pipe of 1 foot
- A minimum of two septic drain field trenches
- A maximum septic drain field trench length of 100 feet
- 8 feet between drain field trenches
- Septic drain field trench total gravel depth of 28 inches, based on 1 foot below and 1 foot above the distribution pipe and a 4 inch pipe diameter
- Septic drain field buffer distance of 10 feet
- Septic tank overexcavation depth of 1 foot above and to each side of the tank
- A maximum of 7 distribution pipe connections per distribution box
- Septic system distribution pipe diameter of 4 inches.

These assumptions are based on values typically found in state and local regulations for septic systems. The user can change each of these assumptions on the critical design assumptions sheet of each model that includes the septic system option. The use of a septic system results in the generation of a secondary residual stream in the form of septic tank solids. The models calculate the accumulation and disposal cost for these solids using the same assumptions used for holding tank solids (except that addition of coagulant is not included for septic systems).

C.9 Off-Site Disposal

For solid residuals, including secondary residuals like holding tank solids or evaporation pond solids, most of the models offer two options: disposal in a hazardous or non-hazardous off-site landfill. The models do not include disposal in an on-site landfill as an option. This option would be economically viable only for facilities with an existing on-site landfill—a factor that is highly site-specific. For these facilities, the cost of this option would be less than that for off-site disposal, because it would involve much lower transportation costs. Therefore, the off-site disposal options available in the models provide a conservative cost estimate for these facilities.

For certain solid residuals, many of the models also offer two additional options: off-site disposal as a radioactive waste or off-site disposal as a hazardous and radioactive waste. The radioactive waste disposal options assume that the residuals are classified as low-level radioactive wastes (LLRW), instead of technologically-enhanced, naturally-occurring radioactive materials (TENORM). In some cases, TENORM is accepted at traditional non-hazardous or hazardous waste disposal facility. In such cases, disposal costs would be lower than those at specialized radioactive waste disposal sites. Therefore, the LLRW disposal costs assumed in the models provide a conservative cost estimate for cases where residuals might be classified instead as TENORM.

The models calculate annual disposal costs for non-hazardous solid residuals as follows:

Annual disposal costs = Disposal costs + Transportation costs

where:

Disposal costs = quantity of solids per disposal event (in tons per event) x disposal frequency (in events per year) x unit cost for non–hazardous waste disposal (in dollars per ton)

Transportation costs = quantity of solids per disposal event (in tons per event) x disposal frequency (in events per year) x distance to disposal site (in miles) x unit cost for non–hazardous waste transportation (in dollars per ton per mile).

The disposal costs for hazardous, radioactive and hazardous radioactive solid residuals are calculated in a similar fashion. For transportation costs, however, there is a minimum charge per shipment applied. If transportation costs calculated based on dollars per ton per mile are less than this minimum, the models calculate transportation costs based on this minimum.

The following are the model assumptions relevant to off-site landfill disposal:

- 10 miles to the nearest non-hazardous waste disposal site
- 200 miles to the nearest hazardous waste disposal site
- 700 miles to the nearest radioactive or hazardous radioactive waste disposal site
- Maximum waste shipment size of 18 tons.

The user can change each of these assumptions on the critical design assumptions sheet of each model.

C.10 Land Application

When secondary solids (e.g., holding tank solids, evaporation pond solids) are non-hazardous, most models provide the option of assuming land application instead of landfill disposal. Users can select this option on the critical design assumptions sheet. When land application is chosen, the models assume that transportation and disposal costs for the secondary solids are zero, although they still include the operator labor costs associated with managing the secondary solids.

C.11 Liquid Hazardous Waste Disposal

In some site-specific cases, the only viable option for certain liquid residuals (e.g., anion exchange brine) might be off-site disposal as a hazardous waste. When this option is chosen, the models automatically include a holding tank, which is required to store the residuals for shipment. Any solids that settle in the holding tank also are assumed to require hazardous waste disposal.

The models calculate costs for the liquid hazardous waste disposal option similarly to the off-site hazardous waste landfill option (e.g., disposal cost + transportation cost, with a minimum charge per shipment), except that unit costs are different. These unit costs are specific to off-site liquid hazardous waste disposal, instead of off-site hazardous waste solids landfilling, and expressed in dollars per gallon or dollars per gallon per mile. The models assume the maximum liquid hazardous waste shipment size is 6,000 gallons.

C.12 List of Abbreviations and Symbols in this Appendix

cm/yr	centimeters per year
LLRW	low-level radioactive waste
O&M	operating and maintenance
POTW	publicly owned treatment works
TENORM	technologically-enhanced, naturally-occurring radioactive materials
TSS	total suspended solids
WBS	work breakdown structure

C.13 References

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Appendix D. Indirect Capital Costs

D.1 Introduction

Indirect capital costs are costs that are not directly related to the treatment technology used or the amount or quality of the treated water produced, but are associated with the construction and installation of a treatment technology and appurtenant water intake structures. These costs represent some of the expenditures required in order to get a technology or the treated water production process up and running. They include indirect material costs (such as yard piping and wiring), indirect labor costs (such as process engineering) and indirect burden expenses (such as administrative costs).

Indirect capital costs included in the work breakdown structure (WBS) models include the following:

- Mobilization and demobilization
- Architectural fees for treatment building
- Equipment delivery, equipment installation and contractor overhead and profit
- Site work
- Yard piping
- Geotechnical
- Standby power
- Electrical infrastructure
- Instrumentation and control
- Process engineering
- Contingency
- Miscellaneous allowance
- Legal, fiscal and administrative
- Sales tax
- Financing during construction
- Construction management and general contractor overhead
- City index.

The following sections describe each of these indirect cost elements in more detail, address their effect on capital costs and explain the reasoning behind including them as an additional indirect capital cost allowance or contingency.

D.2 Mobilization and Demobilization

Mobilization and demobilization costs are costs incurred by the contractor to assemble crews and equipment onsite and to dismantle semi-permanent and temporary construction facilities once the job is completed. The types of equipment that may be needed include: backhoes, bulldozers, front-end loaders, self-propelled scrapers, pavers, pavement rollers, sheeps-foot rollers, rubber tire rollers, cranes, temporary generators, trucks (e.g., water and fuel trucks) and trailers. In some construction contracts, mobilization costs also include performance bonds and insurance.

To estimate mobilization and demobilization costs in the absence of site-specific data, the WBS models use a multiplication factor of 2 to 5 percent. The models apply this multiplication factor to direct process costs, building costs and the physical portions of indirect capital costs (site work, yard piping, geotechnical, standby power, electrical, instrumentation and control and miscellaneous). Examples of mobilization and demobilization percentages include:

- Buckeye, Arizona Water System Infrastructure Improvements (multiple projects) Mobilization/Demobilization/Bonds/Insurance = 5 percent (Scoutten, Inc., 2009)
- City of New Port Richey Maytum Water Treatment Plant Modifications, Mobilization/Demobilization (limit included in bid instructions) = 4 percent (Tampa Bay Water, 2006)
- Alton Water Works Mobilization = 1 percent (AWWC, 1999)
- Fairfax Water Authority New Intake, Mobilization = 4.6 percent, Demobilization = 1.8 percent, Total = 6.4 percent (FWA, 2003)
- Fairfax Water Authority Trunk Sewer Project Mobilization = 5 percent (FWA, 2003)
- Forest Park Water Treatment Plant, Chalfont, PA = 0.26 percent (Allis, 2005).

The last example, for the Forest Park treatment plant, applied to a retrofit of an existing conventional filtration facility with a membrane system. The project involved modifications to existing buildings and treatment basins and the construction of one new building. Since the project involved less new construction than a greenfield project, the mobilization cost may be lower than it otherwise would be.

Mobilization/demobilization costs tend to be proportionately higher for smaller projects because of fixed costs that are the same regardless of project size. For example, if construction requires use of a large crane, then the mobilization/demobilization cost will be the same regardless of whether it is onsite for a long time to complete a large construction project or a short time to complete a small project. Therefore, small projects will most likely have mobilization/demobilization percentages in the higher end of the range and larger projects will tend to have values in the lower end of the range. The default values in the WBS models reflect this type of variation. For small systems with a design flow less than 1 million gallons per day (MGD), the default mobilization/demobilization factor is 5 percent. For medium systems (design flows between 1 MGD and 10 MGD), the default factor is 4 percent and for large systems (design flows above 10 MGD), the default factor is 2 percent. The models make an exception in the case of small systems that use pre-engineered package treatment plants. Because these package plants typically are skid-mounted, they require only a short time to install onsite and should use a minimum of heavy equipment in the process. Therefore, the models assume a mobilization/demobilization factor of 0 percent for small, pre-engineered package systems. The user can change this assumption on the indirect assumptions sheet of each model.

Because the installation costs in the models include rental of equipment for installation (see Section D.4.2), there may be some redundancy between the default mobilization and demobilization costs and the installation costs (which are included in the model unit costs). The extent of this redundancy is difficult to determine, but is a potential source of conservatism in model cost estimates (i.e., the potential redundancy would tend to make model cost results higher).

D.3 Architectural Fees for Treatment Building

The architectural fees for the treatment building include the costs of designing the structure and preparing technical drawings. By convention, the architectural fee also includes the fees for structural, electrical and mechanical engineering associated with the treatment building (RSMeans, 2013). Furthermore, the architectural fees include the costs of preparing final drawings and the tender document package. The building costs in the WBS cost database (see Appendix B) do not include architectural fees, so the fees are added as an indirect cost. The models apply the architectural percentage only to treatment building costs, not to other process costs.

The WBS models use architectural fees from RSMeans (2013), based upon the direct cost of the building, as shown in **Exhibit D-1**. The models make an exception in the case of small systems with a design flow of less than 1 MGD. Because they are typically housed in small, prefabricated buildings that require a minimum of design and engineering, the models assume no architectural fee for these small systems. The user can change this assumption on the indirect assumptions sheet of each model.

Exhibit D-1. Architectural Fees

Building Direct Cost Range	Architectural Fee[a]
<$250,000	9.0%
$250,000 to $500,000	8.0%
$500,000 to $1,000,000	7.0%
$1,000,000 to $5,000,000	6.2%
$5,000,000 to $10,000,000	5.3%
$10,000,000 to $50,000,000	4.9%
>$50,000,000	4.5%

a. The architectural fee is a percentage of the direct cost for buildings. It includes a structural engineering fee, as well as mechanical and electrical engineering fees that are associated with the building.

Source: RSMeans (2013), reference table R011110-10.

D.4 Equipment Delivery, Equipment Installation and Contractor Overhead and Profit

The equipment unit cost estimates in the WBS database include the cost of equipment delivery, equipment installation and contractor overhead and profit (O&P). Because these costs are included in the direct or process costs, the default value of this multiplier in the WBS models is 0 percent. If the user has site-specific or technology-specific data that show delivery, installation or O&P costs outside of typical ranges, the user can change this factor on the indirect assumptions sheet of each model to better account for actual installation costs.

The sources of unit cost quotes include manufacturers, vendors, published construction cost data reference books and peer-reviewed literature. Price quotes for an item vary across sources because of inherent price variability or product quality differences that are not relevant to overall performance. The U.S. Environmental Protection Agency (EPA) addressed this source of price variability by including quotes from multiple vendors in the WBS cost database; the unit costs used in the WBS models are simple averages across vendor quotes. Differences also arise because vendors include different information in price quotes. For example, prices obtained from RSMeans (2013) include all components needed for installed process costs (i.e., delivered equipment, installation and O&P costs). Quotes from other sources may not include installation costs, contractor O&P or transportation costs. Thus, before EPA calculated average costs, all prices needed to be adjusted to the same installed cost basis. EPA converted costs to this basis by adding transportation, installation and O&P costs where they were missing from the original unit price estimates.

D.4.1 Equipment Delivery

Incorporating delivery costs in unit costs that will be used for a national cost analysis is challenging because of variability in the methods used to assess transportation costs. For example, transportation costs can be based on a cost per mile, a cost per unit of weight, a cost per unit of volume, a cost per region or within a radius or a proportion of sales price. EPA developed standardized transportation cost multipliers that vary by equipment type and size. The type of multiplier selected for each equipment category is based on a likely method of transportation.

For tanks, vessels and towers, EPA applied transportation costs that are scaled to equipment volume units (e.g., gallons). These costs are based on quotes for shipping from several vendors for tanks of varying volumes and materials. For steel tanks, the costs range from a minimum of $600 for tanks of 1,000 gallons or less to a maximum of $9,000 for tanks of 280,000 gallons or greater. For plastic/fiberglass tanks, the costs range from a minimum of $120 for tanks of 1,000 gallons or less to a maximum of $2,800 for tanks of 50,000 gallons or greater.

To estimate transportation costs for pipe, EPA calculated delivery costs per linear foot of pipe using vendor delivery cost estimates and linear feet/truck load estimates. EPA obtained a vendor delivery estimate of $1,000 for a truckload of steel pipe. Information obtained from vendors was used to estimate the number of linear feet of each size pipe that could fit in a truckload.

For valves, pumps, blowers and mixers, EPA developed transportation cost estimates based on equipment weight and costs for “less than a load” (LTL) shipments obtained from vendors. The estimates assume an average delivery distance of 100 miles. For shipping cost estimation purposes, average weights were assumed for the small, medium and large sizes of valves, pumps, blowers and mixers. The assigned weights (which are based on the actual weights of valves, pumps, blowers and mixers for which EPA received vendor quotes) are as follows:

- Small steel valves ~ 30 pounds
- Medium steel valves ~ 80 pounds
- Large steel valves ~ 400 pounds
- Small pumps / blowers ~ 100 pounds
- Medium pumps / blowers ~ 300 pounds
- Large pumps / blowers ~ 600 pounds
- Small mixers ~ 50 pounds
- Medium mixers ~ 100 pounds
- Large mixers ~ 400 pounds.

Since the density of 304 stainless steel is approximately 5.6 times greater than the density of polyvinyl chloride, the following weights were assigned to plastic valves:

- Small plastic valve ~ 5 pounds
- Medium plastic valves ~ 15 pounds
- Large plastic valves ~ 70 pounds.

Exhibit D-2 provides the weight categories and LTL costs for valves, pumps, blowers and mixers, along with a complete summary of transportation cost methods for all categories of equipment.

EPA assumed a 2.5 percent markup on instrumentation, based on typical shipping charges from two vendors for large orders ($600 to greater than $4000). For system control components, EPA assumed no transportation costs, because the vendors contacted did not charge for shipping on large orders (greater than $49 to greater than $300). EPA assumed a 5 percent markup on miscellaneous equipment and filter components for membrane systems. Transportation costs for chemicals, resins and filter media are averages of delivery costs obtained from vendors.

D.4.2 Installation, Overhead and Profit

EPA incorporated installation and O&P costs using multipliers derived from RSMeans (2013) cost data. RSMeans provides complete installed cost estimates for the unit costs in its database. The following cost components are reported for each unit cost:

- Bare material costs, including delivery
- Installation labor, materials and any rental cost for installation equipment
- Overhead for installing contractor (i.e., labor and business overhead costs)
- Profit for installing contractor (i.e., a 10 percent rate of profit charged on materials, installation and overhead costs).

These component cost data provide enough information to calculate adjustment factors that can be applied to price quotes that exclude installation and O&P costs. By dividing total unit cost, which includes all components, by bare material cost including delivery, EPA obtained adjustment factors for several types of equipment in the WBS cost database. For example, if the bare material cost, including delivery, for an item of equipment is $1.00 and the total unit cost is $1.78, then the adjustment factor is 1.78. When unit costs obtained for the database did not include installation, overhead and profit (as is typical when obtaining costs from manufacturers), EPA applied these adjustment factors to escalate the unit costs so that they represented the full installed cost. For example, if a manufacturer's price for a 20,000 gallon steel tank was $25,000, EPA would first add delivery cost ($1,000 per 10,000 gallons capacity, as described in Section D.4.1), resulting in a cost with delivery of $27,000. EPA would then multiply that cost by the appropriate adjustment factor (for instance, 1.17) to obtain a complete unit cost—that is, the total unit cost in this example would be ($25,000 + $2,000) × 1.17 = $31,500.

Most of the installation and O&P multipliers in the WBS cost database fall between 1.03 and 1.73, with an average around 1.36.

Exhibit D-2. Transportation Cost Estimation Methods

Equipment Category	Transportation Costs (year 2020 dollars)
Vessels, Tanks, Towers – steel	Varies by tank volume in gallons, from a minimum of $600 for tanks of 1.000 gallons or less to a maximum of $9,000 for tanks of 280,000 gallons and greater
Vessels, Tanks, Towers – plastic/fiberglass	Varies by tank volume in gallons, from a minimum of $120 for tanks of 1,000 gallons or less to a maximum of $2,800 for tanks of 50,000 gallons and greater
Pipes	Varies by pipe diameter and material of construction. Plastic pipes: range is $0.37 to $208 per 100 linear feet. Iron and steel pipes: range is $32.68 to $494 per 100 linear feet.
Valves-steel/iron Weight Class 60 LTL rate = $189.13 per 100 lb	Small valves: $57 (1" to 4" diameter) Medium valves: $151 (5" to 9" diameter) Large valves: $757 (>9" diameter)
Valves-plastic Weight Class 70 – plastics LTL rate = $189.13 per 100 lb	Small valves: $9 (1" to 3" diameter) Medium valves: $28 (4" to 6" diameter) Large valves: $132 (>6" diameter)
Pumps and blowers Weight Class 85 LTL rate = $48.81 to $189.13 per 100 lb depending on total weight	Small units: $189 (0 to 50 gpm) Medium units: $595 (51 to 300 gpm) Large units: $1,757 (>300 gpm)
Mixers Weight Class 85 LTL rate = $48.81 to $189.13 per 100 lb depending on total weight	Small mixers: $95 (includes mounted and portable mixers) Medium mixers: $189 (includes inline and static mixers) Large mixers: $978 (includes turbine, rapid, flocculant, impeller mixers)
Instrumentation	2.5% of equipment cost
System Controls	None
Miscellaneous Equipment	5% of equipment cost
RO/NF and MF/UF Skids and Equipment	5% of equipment cost
Chemicals, Resins and Filter Media	$0.26 per lb for hazardous materials $0. 32 per lb for filter media and resins $0.22 per lb for 150 lb chlorine cylinders $0.29 per lb for 1 ton chlorine cylinders $0.07 per lb for all other chemicals

lb = pound; gpm = gallons per minute; " = inch; RO/NF = reverse osmosis/nanofiltration; MF/UF = microfiltration/ultrafiltration

D.5 Site Work

Every construction site requires a certain amount of site preparation and finish work. Site work costs include site preparation, excavation and backfilling, temporary and permanent road construction, retaining wall construction, final grading, landscaping, parking lots, fencing, storm water control structures, yard structures, site cleanup, waste disposal and utilities.

Estimating the site work cost based on a factor applied to the direct capital cost is an approach commonly used when detailed information about the site plan is not known. Under this approach, site work costs are typically estimated between 5 and 15 percent of the direct capital costs, depending on project size and scope.

Site work costs vary directly with the land area requirement. The WBS models generate land area estimates, which allows the models to use an alternative cost estimation approach based on total project land area instead of total project costs. RSMeans (2013) provides an analysis of actual reported project and component costs for different types of construction. Of the many building categories reported in the summary database, the “factory” category best fits the scope of construction associated with drinking water treatment plants. Therefore, the models use the national average median project cost for site work at factories from RSMeans (2013). The WBS cost database automatically updates this unit cost to current year dollars using the Engineering News-Record (ENR) Building Cost Index (see Chapter 2). The models compute a site work cost based on this unit cost and the total project land area, excluding land used for residuals holding lagoons and evaporation ponds. Since the models include the cost of excavation and backfill for these facilities, there is no need to include them in the site work calculations.

EPA believes that using an approach based on land area instead of direct process costs provides a better estimate of site work costs because the unit costs from RSMeans (2013) are primarily based on quantities of area and earthwork volume. Furthermore, this approach is less sensitive to cost fluctuations caused by high cost equipment—the site work cost for a 0.5-acre project site will be the same regardless of whether the treatment building houses chemical addition or a membrane filtration process. This is particularly important because expensive, advanced treatment technologies often have smaller footprints than lower-cost, conventional technologies such as conventional filtration. Basing site work costs on process costs will tend to overstate site work costs for such advanced technologies.

Although the default site work cost in the WBS models reflects a median value, the user can enter a different rate in the data extracted from the WBS cost database based on site-specific conditions. A higher cost factor should be entered for projects where the site conditions may require higher-than-average site work costs (e.g., a site with steep terrain that may require retaining walls). Conversely, a lower rate should be entered for projects where the site conditions may require lower-than-average site work costs (e.g., a site where little grading is needed and where requirements for infrastructure and other site improvement are minimal or where portions are already in-place).

D.6 Yard Piping

Yard piping costs reflect the costs to install piping for untreated, partially treated and treated water to and from the site, between new treatment plant buildings or between existing and new treatment units. It does not include piping of treatment residuals to a residuals treatment system, to disposal in a sewer or to a direct discharge connection; those costs are included as explicit capital cost line items in the relevant WBS technology models, as discussed in Appendix C.

Yard piping costs include the following components:

- Trench excavation, backfill and pipe bedding
- Piping from the boundary of the building buffer zone to and from the building inlet and building outlet and in between buildings that house water treatment components
- Optionally, piping from the water source to the property boundary and piping from the property boundary to the distribution system connection

- Thrust blocks.

The sections below describe each of these components.

D.6.1 Trench Excavation, Backfill and Pipe Bedding

Costs of pipe contained in the WBS cost database are installed costs for aboveground pipes within the treatment facility. Yard piping generally is installed below ground. Therefore, yard piping entails additional costs. These costs include trench excavation costs, bedding costs, backfill costs and thrust block costs (discussed in Section D.6.3).

Technology land area requirements are calculated on a basis of starting with a square building with the required footprint and adding a non-fire buffer (10 feet) on three sides of each building and a fire buffer (40 feet) on the fourth side. The general configuration assumption is that the fire buffer will be located along the front side and the distance between buildings will be two times the non-fire buffer distance (20 feet) and, therefore, yard piping will not cross the fire buffer area. Thus, the minimum initial trench length is 20 feet (10 feet at inlet and 10 feet at outlet) for a system with one building or 30 feet (20 feet inlet and outlet and 10 feet between buildings) for a system with two buildings. Since the inlet and outlet piping may not always line up and may extend inside the building perimeter, an offset distance is added to the 10 foot buffer distance based on the building size. The offset distance is assumed to be ¼ the length of one side of the building footprint (based on square root of total building footprint).

The models assume yard piping will be buried with the top of the pipe set at or below the local frost depth. Where frost depth is less than 30 inches, a minimum depth of 30 inches is assumed to provide a protective cover. The default frost depth is 38 inches and corresponds to the frost depth in St. Louis. Users can change the frost depth on the indirect assumptions sheet of each model based, for example, on the climate data for a selected city in the climate database (AFCCC, 2000). Trench depth also incorporates the pipe diameter and the bedding depth, which the models assume to be 6 inches below the bottom of the pipe. This default value is sufficient to approximate bedding requirements for large size pipes laid in soils where bedding is necessary. The user has the option of changing the default value on the indirect assumptions sheet of each model.

Trench width is equal to the pipe diameter plus 1 foot on either side. Trench volume is based on the calculated trench length times the trench cross-sectional area, which incorporates trench width and depth and assumes sloped trench sides, with an angle of 45 degrees (expressed in radians on the indirect assumptions sheet). Excavation and backfill costs are based on total trench volume plus thrust block volume and the unit cost for excavation and backfill. Although backfill quantities are generally smaller than excavation quantities, they are assumed to be the same in the WBS models. This approach is assumed to cover to the cost of backfill and the cost of spreading or hauling excess soil off site. Pipe bedding volume accounts for the bedding depth, incorporating additional volume to account for the sloped sides of the trench and the assumption that the bedding covers 25 percent of the pipe diameter. The user can change this latter assumption on the indirect assumptions sheet of each model.

D.6.2 Piping

The basic assumptions for yard piping from the boundary of building buffer zone to and from the building inlet and building outlet and in between buildings are:

- Pipe length will be equal to trench length plus two times the trench depth.
- Pipe costs will be based on an equivalent pipe length, which will include an additional length to account for cost of fittings (e.g., elbows). The equivalent length will be equal to two times the pipe length, using the same factor used for process piping within the buildings (see Section 2.4).
- Yard piping costs do not include valves.
- Piping materials, diameter and unit cost are the same as those selected in the treatment model for inlet and outlet piping within the building.

In addition, the indirect assumptions sheet in each model contains an optional assumption for the length of yard piping from the water source and another optional assumption for the desired length of yard piping to the distribution system. Therefore, if the technology is not the initial step in the treatment train, the default value length of pipe from the water source should be 0 feet, because there is already a pipe from the water source to the existing facility. Similarly, if the technology is not the last technology in the treatment train, then the default value should be 0 feet. As a default, these assumptions are set to zero.

D.6.3 Thrust Blocks

Yard piping costs include concrete thrust blocks to hold small pipe elbows and other fittings in place. The basis of the thrust block volume calculation is thrust force in pounds. The models derive thrust force using a lookup table based on pipe diameter. Users can modify the thrust force assumptions by editing the engineering lookup table extracted from the WBS cost database. The values in the lookup table assume a pipe test pressure of 150 pounds per square inch and a pipe elbow angle of 90 degrees and account for block weight. Although both vertical and horizontal elbows are expected in every pipe-laying job, the thrust block calculations assume horizontal thrust blocks.

Using the data from the thrust force lookup table, the models calculate bearing surface area based on a conservative approach found in U.S. Army Corps of Engineers guidance (U.S. ACOE, 1992). The calculation is:

$$\text{Area} = 1.5*T/(\text{Soil Density}*Kp*\text{Depth}*R)$$

where:

1.5 is a safety factor, which is typical for thrust block design

T is the thrust force required, derived as discussed above

Soil Density is the minimum soil bulk density, which the models assume is 1.55 grams per cubic centimeter (97 pounds per cubic foot) consistent with loamy sand, which is also on the lower end of the range for sandy soils (1.5–1.8) and the upper end of the range for silty clay (1.4–1.5) (MN NRSC, 2003)

Kp is the coefficient of passive pressure, which the models assume to be 3, based on an internal angle of friction of the soil (phi) of 30 degrees

Depth is the depth to bottom of the block, which the models calculate based on trench depth and pipe diameter

R is a reduction factor of 0.467, based on phi of 30 degrees and a vertical bearing surface (CADOT, 2001, Figure 8).

Users can adjust soil density, Kp and R on the indirect assumption sheet of each model. Note that this approach is conservative in that it considers only the bearing force of the vertical surface, which is perpendicular to the thrust force, and ignores the frictional force exerted on the bottom surface of the block. Use of deeper trench depths will result in lower thrust block costs.

D.7 Geotechnical Investigation

Construction cost estimates generally include a geotechnical allowance to provide for investigation of subsurface conditions. Subsurface conditions can affect the foundation design and construction technique. For example, a high groundwater table or soft substrate may require special construction techniques such as piles and dewatering. Thus, the actual costs of addressing subsurface conditions are site specific and can vary considerably. In addition, where a system is adding treatment technology to a site with existing structures and, therefore, the site already has an existing geotechnical investigation, additional geotechnical investigation may not be required. To account for these variations, the models include assumptions that allow the user to select whether geotechnical investigation costs should be included for low, medium and high cost estimates. The default values for these assumptions include geotechnical costs only for high-cost systems. However, the models always include geotechnical costs (regardless of the value selected for these assumptions) when certain components are included in the technology design, such as septic systems, evaporation ponds or below-grade structures like basins.

Geotechnical investigations can be as simple as digging trenches or test pits to determine the soil conditions underlying small, lightweight structures. For larger, heavier structures, site investigations generally involve drilling boreholes to extract samples of rock or soil for further study. Cost estimates in the WBS models reflect either test pit costs or borehole costs, depending on the building footprint size. For footprints of 2,000 ft^2 or smaller, the WBS models have costs based on hand digging test pits. All larger structures have costs based on the costs of drilling boreholes. The following sections describe the method for estimating costs for each approach.

D.7.1 Borehole Cost Analysis

The cost analysis for drilling boreholes includes preparation activities (e.g., staking the field) and actual drilling. Thus, a key cost driver is the number of boreholes needed. An additional factor is the required drilling depth.

For a large industrial building, a borehole should be drilled at the expected location for each column foundation and at locations where concentrated loads are expected to occur such as under tanks and heavy equipment. The models assume four boreholes is reasonable for structures in the range of 2,000 to 4,000 ft^2. For larger structures, the models assume an additional borehole for every 1,000 ft^2 in additional space. Thus, the requirement for structures in the range of 4,001 to 5,000 ft^2 is five boreholes. This approach is based on the assumption that column footings are spaced approximately 32 feet apart.

Drilling depth depends on a structure's weight and existing knowledge of subsurface conditions. Nevertheless, a rough criterion used to develop WBS cost estimates is that boreholes should penetrate at least 1.5 times the width of the footings below the lowest portion of the footing (Krynine and Judd, 1957). The lowest portion of the footing must be below the frost line, which ranges from almost 0 feet to more than 5 feet in the continental United States. The WBS models assume a frost line depth of 38 inches, an additional safety depth of 22 inches and a footing width of 3 feet to obtain a minimum borehole depth of approximately 10 feet (5 feet + 1.5 x 3 feet).

EPA selected three different boring depths to represent a range of geologic conditions and building bearing loads. A boring depth of 10 feet applies to relatively light structures in areas where the soil conditions are predictable without any expectation of deeper strata that exhibit poor shear strength. A boring depth of 25 feet applies to moderately heavy structures in areas where subsurface conditions are less well defined, but no severe conditions are expected and where underground structures, such as basins, as deep as 20 feet need to be constructed. Similarly, a boring depth of 50 feet deep applies to heavy structures in areas where extreme or unknown subsurface conditions (such as strata with poor shear strength) may exist.

EPA developed cost estimates based on cost data for drilling activities that use a truck-mounted, 2.5-inch auger with casing and sampling from RSMeans (2013). **Exhibit D-3** identifies the cost elements included in borehole drilling. The WBS cost database automatically updates the unit costs for these elements to current year dollars using the ENR Construction Cost Index (see Chapter 2). Costs are applied based on the selected borehole depth and total structure area rounded up to the nearest thousand ft^2.

Exhibit D-3. Cost Elements Included in Borehole Drilling

Item
• Borings, initial field stake out and determination of elevations
• Borings, drawings showing boring details
• Borings, report and recommendations from professional engineer
• Borings, mobilization and demobilization, minimum
• Borings, drill rig and crew with truck mounted auger (output 55 feet/day)
• Borings, cased borings in earth, with samples, 2.5-inch diameter.

Source: RSMeans, 2013, 02 32 13.10-0200.

D.7.2 Test Pit Cost Analysis

For smaller, less expensive buildings, boreholes are less cost effective compared to test pits or trenches that can be dug by hand or by using earth moving equipment if it is already available at the site. Because geotechnical investigations may precede site work, excavating equipment may be available to dig test pits. Therefore, for small buildings, the models use hand-dug test pits as the basis for costs. The models assume one pit for buildings up to 1,000 ft^2 and two pits for buildings of 1,001 to 2,000 ft^2.

Pit widths range from 4 feet by 4 feet to 6 feet by 8 feet (Krynine and Judd, 1957). Because this test method is limited to small buildings, the models assume pits that are 4 feet by 4 feet wide. Pit depth of 7 feet is based on a footing width of 2 feet and a frost depth of 5 feet (5 feet + 1.5 x 2 feet). The unit excavation and backfill costs are based on data from RSMeans (2013) for hand dug pits in heavy soil. The cost of surveying and the soil sample evaluation report and recommendation from a Professional Engineer are assumed to be the same as for borings.

D.8 Standby Power

A new treatment facility sometimes requires a standby power source that can produce enough energy to operate the facility in the event of an electricity outage. Thus, the power rating or capacity of the standby generator should be sufficient to power critical operating components at the rated maximum flow capacity of the equipment (i.e., the design flow). Critical components in a treatment plant include pumps, lighting and ventilation. In addition, standby power can be required to provide space heating (if an electrical resistance heater or heat pump is used) and/or cooling in the event of a power outage. As a default, the WBS models do not include heating or cooling in their estimate of standby power requirements. The user can change the assumptions about inclusion of heating and/or cooling in standby power on the indirect assumptions sheet of each model.[11]

Also as a default, the models do not include standby power at all for small systems with a design flow of less than 1 MGD. These small systems typically operate for only a few hours each day, placing water in storage for use during the rest of the day. This operating procedure means small systems can handle short term power outages simply by postponing their operating hours, without the need for standby power systems. The user can change the assumption about including standby power for small systems on the indirect assumptions sheet of each model.

The generation capacity requirement for critical systems is based on the maximum daily load, which is the potential energy demand to meet production at the design flow rate. Since the energy requirements calculated in the models are based on continuous operation (24 hours/day and 365 days/year), the maximum power requirement in kilowatts (KW) can be estimated using the following equation:

$$\text{Power requirement for critical operating components (KW)} = \\ [\text{annual power use by critical operating components (MWh/yr)} / 365\ (\text{day/yr}) / 24\ (\text{hr/day})] * 1{,}000\ (\text{KW/MW})$$

where:

hr = hours
MW = megawatt
MWh/yr = megawatt hours per year
yr = years

Standby power costs primarily comprise equipment purchase (e.g., a generator) and installation. Additional costs include fuel purchase and storage. Annual fuel costs for standby power generation are hard to estimate or predict, given the unpredictable nature of using the standby power generator. Typical standby generators consist of diesel engine powered generators

[11] Note that if the assumption about including heating in standby power is changed, heating requirements will only be included in standby power if an electrical resistance heater or heat pump is used, because the other heating options (e.g., natural gas heat) do not use electricity.

(NREL, 2003). Installation costs include provisions for a foundation, fuel storage and louvered housings for larger systems. For the diesel generators typically used for standby power, EPA used installed unit costs from RSMeans (2009a). The WBS cost database automatically updates these unit costs to current year dollars using the Producer Price Index from the Bureau of Labor Statistics for motors, generators and motor generator sets (see Chapter 2). The models multiply the appropriate unit cost, which users can change by modifying the data extracted from the WBS cost database, by the calculated standby power requirement in KW, after applying a minimum requirement of 1.5 KW (based on the smallest available standby power generator).

D.9 Electrical

The electrical cost allowance in a construction cost estimate will primarily account for electric wiring inside structures, such as wiring for motors, duct banks, motor control centers, relays and lighting. The unit costs for buildings in the WBS models (see Appendix B) already incorporate general building electrical, such as building wiring and lighting fixtures and electrical engineering associated with those components. In addition, certain electrical costs (motor/drive controllers, variable frequency drives and switches) are included in direct costs for system controls and pumps. Technologies with significant process equipment located outside include an electrical enclosure as an explicit line item. Thus, the indirect cost electrical allowance only accounts for additional electrical equipment associated with the treatment facility, including outdoor lighting, yard wiring, switchgear, transformers and miscellaneous wiring. Yard wiring consists primarily of the infrastructure that connects a new treatment facility to the power grid and, if necessary, converts voltage.

Typical electrical percentages include:

- Building electrical as a percentage of building cost = 7.7 to 13.0 percent, depending on building size and quality (Association for the Advancement of Cost Engineering International [AACEI] building cost model results)
- Seymour, Indiana electrical costs as a percentage of non-electrical process costs = 12.1 percent (AWWC, 2001a)
- St. Joseph, Missouri electrical costs as a percentage of non-electrical process costs = 8.7 percent (AWWC, 2001b).

Based on these data, the electrical percentage in the WBS models is 10 percent as a default. Users can change this assumption on the indirect assumptions sheet of each model.

D.10 Instrumentation and Control

Instrumentation and control (I&C) costs include a facility control system and software to operate the system. The WBS models include detailed process cost estimates for instrumentation and control, as described in Appendix A. Therefore, the default value for I&C on the indirect assumptions sheet is 0 percent. This line item remains among the indirect costs on the output sheet of each model, however, to allow the user to incorporate any site-specific or technology-specific data that cannot be accommodated by altering the I&C design assumptions in the WBS models.

D.11 Process Engineering

Process engineering costs include treatment process engineering, unit operation construction supervision, travel, system start-up engineering, operating and maintenance manual development and production of record drawings. Process engineering as a percent of installed process capital cost ranges from 5 to 20 percent. For example, Brayton Point Power Plant Water Works process engineering costs were estimated at 8 percent of installed capital costs (Stone and Webster, 2001).

The ratio of process engineering to installed process capital cost varies based on system size and the complexity of the treatment process. In particular, engineering cost as a percentage of process cost tends to decrease as the size of the treatment plant increases. The default values in the WBS models reflect this pattern: 8, 12 and 20 percent for large, medium and small systems, respectively. The WBS models apply these percentages to installed process costs, but not building costs, because structural, mechanical and electrical engineering fees are included in the architectural fee (Section D.3).

The process engineering percentages at 13 EPA demonstration sites for low-flow packaged systems ranged from 20 to 80 percent, with a mean of 36 percent (U.S. EPA, 2004). These percentages, however, also include permitting and administrative costs. Because these costs are separate line items in the WBS models, these percentages overstate stand-alone process engineering costs. Furthermore, engineering costs can be higher for technologies in the demonstration phase than for those in wide use. Therefore, EPA retained its assumption of 20 percent process engineering cost for small systems.

D.12 Contingency Cost

Contingency cost reflects the degree of risk that management assigns to a project. This cost should reflect the statistical probability of additional project costs because of uncertainties and unlikely or unforeseen events (AACEI, 1996). These unforeseeable additional costs to the project occur because of changes in design, materials, construction methods and/or project schedule. Contingency reflects a judgment by project management or bidders to account for unforeseeable costs, thereby avoiding cost overruns. Contingency costs are included as part of a construction contract allowing the contractor to be paid extra upon authorization of design and construction changes by the project engineer (AACEI, 1996).

The risk of additional unforeseen costs associated with construction projects tends to vary with project size and complexity. Therefore, EPA developed contingency factors using both project size (i.e., total direct cost) and complexity (i.e., the technology being modeled) as input variables. Ideally, a contingency cost estimate is based on statistical data or experience from similar projects. By their nature, however, contingency costs are site specific and difficult to predict; two estimators may recommend different contingency budgets for the same project (Burger, 2003). EPA examined recommended contingency values, tabulated by project size, from an economic analysis of water services (GeoEconomics Associates Inc., 2002). The recommendations are presented in **Exhibit D-4**. These contingency rates, which range from 2 to 10 percent, are applied to the base costs (i.e., direct costs) to derive contingency cost. These rates apply to projects of low to average complexity. Water treatment construction projects typically fall into this category, depending on the technology being installed.

Exhibit D-4. Recommended Contingency Rates from an Economic Analysis of Water Services

Project Base (Direct) Cost	Contingency as a Percent of Base Costs
Up to $100,000	10%
$100,000 to $500,000	8%
$500,000 to $1,500,000	6%
$1,500,000 to $3,000,000	4%
Over $3,000,000	2%

Source: GeoEconomics Associates Inc. (2002)

The WBS models would ideally include only the part of a contingency budget that is actually spent, rather than the total amount budgeted. EPA therefore considered a Construction Industry Institute (2001) study, which included both budget estimates and actual spending for contingency in a series of heavy construction projects. **Exhibit D-5** presents the relevant results. The factors are expressed as a percentage of the total budget, rather than direct costs. These projects are not limited to water treatment systems and include a variety of heavy construction projects. The data in **Exhibit D-5** show that, with the exception of very large projects (those with total project costs of over $100 million), the contingency cost tends to decrease as project size increased. The average contingency factor decreases from 6 to 4 percent before increasing to 7 percent for very large projects. Such very large projects are generally beyond the size of projects that can be modeled using the WBS models. **Exhibit D-5** also shows that unforeseen problems during construction tend to account for a higher share of contingency cost than design or procurement problems.

Exhibit D-5. Average Contingency Costs in Budgets for Heavy Industrial Projects

Project Size	Total Cost Budget	Contingency Budget Estimate	Contingency (% of budget)	Final Project Cost	Contingency Costs Incurred by Project Phase (Design / Procurement / Construction)	Contingency Incurred / Budgeted
<$15	8.09	0.46	6%	$7.76	0.34 (0.04 / 0.10 / 0.20)	74%
$15–$50	30.22	1.55	5%	$29.51	1.15 (0.20 / 0.30 / 0.65)	74%
$50–$100	70.70	3.09	4%	$68.19	2.24 (0.25 / 0.83 / 1.16)	72%
>$100	214.02	15.56	7%	$206.50	13.63 (2.00 / 4.24 / 7.39)	87%

All costs are in millions of dollars. Incurred contingency costs exclude excludes three phases: Project Planning Phase, Demolition and Start Up.
Source: CII (2001)

The contingency factors in **Exhibit D-5** are higher than the recommended values in **Exhibit D-4**. Because **Exhibit D-5** data is empirical and the basis for the estimates in **Exhibit D-4** is not clear, EPA based its contingency factors in the WBS models primarily on the values in **Exhibit D-5**, but incorporated additional price categories below $15 million with contingency factors above 6 percent. To create the contingency factors, EPA first converted the figures in **Exhibit D-5**, which are expressed as percentages of a total budget, to markups. For instance, if the contingency budget is 7 percent of a total budget, it represents a markup of 7 / (100 - 7) percent = 7.5 percent. EPA modified the markups by a factor of 0.77, which is the average ratio of incurred to budgeted contingency costs in **Exhibit D-5**. **Exhibit D-6** presents the resulting base contingency factors. These represent the contingency or risk prior to consideration of technology complexity.

Exhibit D-6. WBS Model Contingency Factors Prior to Consideration of Technology Complexity

Project Direct Cost Range	Base Contingency Factor
<$500,000	6.7%
$500,000 to $3,000,000	5.8%
$3,000,000 to $15,000,000	4.9%*
$15,000,000 to $50,000,000	4.1%*
$50,000,000 to $100,000,000	3.2%*
>$100,000,000	5.8%*

* Percentages based on CII-Benchmarking & Metrics Analysis Results (CII, 2001).

While there are techniques and computer programs designed to estimate contingency factors for large projects based on construction activity risk simulation, the engineering costing literature and the example projects EPA reviewed do not provide specific quantitative guidance regarding the effect of project complexity on contingency costs. Nevertheless, the anecdotal evidence suggests that risks (and, therefore, contingency costs) increase when project complexity increases.

Among the WBS technologies, project complexity depends on the type of technology employed and the general degree of experience with the technology as it will be applied. Well-established technologies, which have a depth of construction and technology installation and operational history under a variety of conditions, are expected to have low risk with respect to unforeseen problems during construction and installation. Recently developed technologies or ones that have had limited application to a variety of water quality conditions and project sizes (or to the conditions at the project in question) are expected to have a higher degree of risk.

To account for differences in contingency values associated with technology type and project complexity, EPA identified four categories of project complexity and assigned multipliers that the models use to adjust the contingency factors (up or down) from **Exhibit D-6**:

- Low complexity = base contingency factor x 0.5
- Average complexity = base contingency factor x 1.0
- High complexity = base contingency factor x 1.5
- Very high complexity = base contingency factor x 2.0.

Thus, for each technology, the applied contingency factor combines the effects of project size and technology complexity to obtain the project specific contingency factor. EPA assigned a project complexity category to each WBS technology based on general knowledge and the application history of the technology to drinking water treatment. **Exhibit D-7** shows this default complexity category assignment. The user can change these values on the indirect assumptions sheet of each model if specific knowledge of the technology and its expected performance under the site-specific conditions warrant such a change.

The WBS models assume that contingency costs are incurred only in high cost scenarios (see Section 2.3). For low and medium cost estimates, the models assume construction is completed with a minimum of unforeseen site-specific costs and, therefore, that none of the contingency budget is incurred. Users can change this assumption on the indirect assumptions sheet of each model.

Exhibit D-7. WBS Default Complexity Factors by Technology

Technology	Risk Level Assigned to Technology	Default Complexity Factor
Acid Feed	Low	0.5
Cation Exchange	Low	0.5
Caustic Feed	Low	0.5
Chloramine	Low	0.5
Nontreatment Options	Low	0.5
Phosphate Feed	Low	0.5
Permanganate Addition	Low	0.5
Granular Activated Carbon	Average	1
Chlorine Gas	Average	1
Diffuse Aeration	Average	1
Packed Tower Aeration	Average	1
Adsorptive Media	High	1.5
Anion Exchange	High	1.5
Biological Treatment	High	1.5
Biologically Active Filtration	High	1.5
Chlorine Dioxide	High	1.5
Low-pressure Membranes (Microfiltration/Ultrafiltration)	High	1.5
Greensand Filtration	High	1.5
Hypochlorite	High	1.5
Multi-stage Bubble Aeration	High	1.5
Ozone	High	1.5
Reverse Osmosis/Nanofiltration	High	1.5
Tray Aeration	High	1.5
Ultraviolet Advanced Oxidation Processes	Very high	2
Ultraviolet Disinfection	Very high	2

D.13 Miscellaneous Allowance

In a cost estimate for a construction project, an allowance may be included for conditions or events that the estimator can anticipate, but whose cost is not known with any degree of certainty. If, for example, the site is expected to have contaminated soil that may require remediation, the allowance will incorporate the resulting costs. An allowance differs from a contingency cost, which provides contract coverage for unpredictable conditions. The allowance funds account for anticipated additional costs that should become apparent at a later stage of the project (for example, upon completion of the site investigation activities and the detailed engineering design). Much of this cost is associated with knowledge of site-related conditions.

In a national average cost estimate such as the one that the WBS models generate, it is not possible to allow for the specific conditions associated with any given site. However, the models include an allowance line item to simulate an average effect due to such conditions. The line also accounts for the level of detail in the WBS design, since the models do not include all minor process components.

The WBS models assume a miscellaneous allowance of 10 percent as a default. Since the allowance addresses a modeling uncertainty, there is little guidance available from the cost estimation literature. Instead, the assumption must be validated by comparing WBS output to actual water treatment facility construction costs. Users can change the miscellaneous allowance on the indirect assumptions sheet of each model.

D.14 Legal, Fiscal and Administrative

This category includes project management, accounting and administrative activities related to the project, excluding permitting. The cost can range from 2 to 5 percent of the process cost. In the WBS models, this category is considered to account for administrative costs that the purchaser incurs in the course of procurement. These costs are distinct from the construction management fee, which is included as a separate indirect cost (Section D.17). The WBS models use a default value of 2 percent. Users can change this assumption on the indirect assumptions sheet of each model.

D.15 Sales Tax

Water treatment plant projects may be exempt from the sales tax, particularly those constructed with public funds. The default value in the WBS models is 0 percent, which reflects the status of taxes in social cost analysis. Taxes are considered a transfer payment and not an actual social cost, which is based on the concept of opportunity cost. Transfer payments are not included in social cost analysis, so a default value of 0 percent is appropriate for social cost analysis. The WBS models include a sales tax line item among indirect costs because the models can also be used for private cost analysis (e.g., for a specific utility), which includes transfer payments. Users can enter a sales tax percentage on the indirect assumptions sheet of each model in cases where consideration of transfer payments is appropriate.

D.16 Financing During Construction

Engineering cost estimates include interest for financing of the project. Drinking water systems can obtain financing through various sources including Drinking Water State Revolving Funds (DWSRF), public-sector financing, private-sector borrowing or equity instruments. **Exhibit D-8** shows interest rates for drinking water treatment projects derived from the EPA 2006 Community Water Systems Survey. The default value in the WBS models is 5 percent, which is toward the higher end of the range of financing costs for public and private systems, and implicitly assumes 1 year of financing during construction. For small systems with design flow less than 1 MGD, the models assume 0 percent financing during construction, implicitly accounting for the very short construction time required for these systems. Users can change the assumptions for both large and small systems on the indirect assumptions sheet of each model.

Exhibit D-8. Average Interest Rates for Capital Funds

System Ownership Type	Lender	Average Interest Rate (All System Sizes)	Range of Average Interest Rates
Public	DWSRF	2.3	1.0 – 3.5
Public	Other Public Sector	3.5	0.5 – 4.4
Public	Private Sector	4.6	4.2 – 5.0
Public	Other	3.9	0.0 – 4.9
Private	DWSRF	5.6	0.8 – 6.2
Private	Other Public Sector	4.4	3.1 – 5.5
Private	Private Sector	6.5	4.3 – 7.7
Private	Other	5.9	0.0 – 10.0
All Systems	DWSRF	2.6	1.0 – 4.3
All Systems	Other Public Sector	3.8	1.9 – 4.5
All Systems	Private Sector	5.2	4.3 – 5.5
All Systems	Other	4.3	0.0 – 10.0
All Systems	All Lenders	Data not available	0.0 – 10.0

DWSRF = Drinking Water State Revolving Funds

D.17 Construction Management and General Contractor Overhead

As discussed in Section D.4.2, the component costs in the WBS cost database include the cost of installation, including O&P for the installing contractor. However, the installation cost does not cover the cost of insurance, performance bonds, job supervision or other costs associated with the general contractor. The WBS models account for these costs by combining costs and fees for the following items:

- Builder's risk insurance
- Performance bonds
- Construction management.

Builder's risk insurance is casualty insurance for the project during construction and may cover various risks, such as vandalism, fire, theft or natural disasters. According to RSMeans (2009c), a national average rate is 0.34 percent of the project cost. EPA adopted this assumption for the WBS models. Users can adjust this rate on the indirect assumptions sheet of each model.

Performance bonds compensate the owner for losses due to contractor failure to complete work according to specifications. RSMeans (2006) estimates the costs based on the total direct cost of the project, as described in **Exhibit D-9**.

Exhibit D-9. Cost of Performance Bonds

Project Direct Cost Range	Performance Bond Cost
<$100,000	2.5%
$100,000 to $500,000	$2,500 plus 1.5% of the amount over $100,000
$500,000 to $2,500,000	$8,500 plus 1.0% of the amount over $500,000
$2,500,000 to $5,000,000	$28,500 plus 0.75% of the amount over $2,500,000
$5,000,000 to $7,500,000	$47,250 plus 0.70% of the amount over $5,000,000
>$7,500,000	$64,750 plus 0.60% of the amount over $7,500,000

Source: RSMeans (2006), reference table R013113-80.

The construction management fee covers the cost of job supervision, an on-site office, main office overhead and profit. Various sources provide individual estimates for these items, but the WBS models roll them into a construction management fee to reflect a cost structure that the owner might see. RSMeans (2009c) provides a table of typical construction management rates for jobs of various sizes. EPA adapted those rates to develop those shown in **Exhibit D-10**.

Exhibit D-10. Construction Management Fees

Project Direct Cost Range	Construction Management Fee
<$100,000	10%
$100,000 to $250,000	9%
$250,000 to $1,000,000	6%
$1,000,000 to $5,000,000	5%
$5,000,000 to $10,000,000	4%
>$10,000,000	3.2%[a]

a. The reference quotes a fee range of 2.5% to 4% for a $50 million project. The WBS models assume an intermediate rate for projects over $10 million.

Source: RSMeans (2009c), division 01 11 31.20.

The indirect line item for construction management and general contractor overhead sums all of these costs. The costs can be omitted individually on the indirect assumptions sheet of each model, either by an assumption that directly controls inclusion or exclusion or by setting the appropriate percentage to zero. For example, in the case of small systems that use pre-engineered package treatment plants, the models exclude the construction management fee portion by default and include only the performance bond and builder's risk insurance. Because package plants typically are skid-mounted and assembled offsite, they typically do not require a general contractor to supervise their installation. Instead, their installation is managed by a single entity, often the vendor that supplied the package.

D.18 City Index

This indirect cost accounts for city-specific and regional variability in materials and construction costs. The city index factor included in the WBS models is expressed as a decimal number, assuming a national average of 1.0. The default value in the WBS models is set to the national average of 1.0, which is appropriate for estimating national compliance costs. Users wishing to adjust estimated costs to be more reflective of potential costs in specific geographic locations can change the city index value on the output sheet. For example, to estimate costs for a city where construction costs are 90 percent of the national average, the user would change the city index to 0.9. One source for region- or location-specific adjustment factors is RSMeans (2013), which publishes average construction cost indices for various three-digit zip code locations.

D.19 List of Abbreviations and Symbols in this Appendix

DWSRF	Drinking Water State Revolving Funds
EPA	U.S. Environmental Protection Agency
ENR	Engineering News-Record
ft^2	square feet
I&C	instrumentation and control
KW	kilowatt
LTL	less than a load
MGD	million gallons per day
O&P	overhead and profit
WBS	work breakdown structure

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Appendix E. General Assumptions for Operating and Maintenance Costs

E.1 Introduction

The work breakdown structure (WBS) models calculate operating and maintenance (O&M) costs independently for each treatment technology. Nevertheless, there are several general assumptions and estimation functions that are common to the O&M estimates across the treatment models. This appendix describes those assumptions and functions. Any O&M cost element that is technology-specific is included in the chapter describing that technology in the main document.

The O&M costs estimated in the WBS models primarily include annual expenses for:

- Labor to operate and maintain the new treatment equipment
- Chemicals required by the treatment
- Materials needed to carry out maintenance (including small tools)
- Energy.

Costs for commercial liability insurance, inspection fees, domestic waste disposal, property insurance and other miscellaneous expenditures that are not directly related to the operation of the technology are included in the WBS models by applying a miscellaneous allowance to the total annual O&M costs. This calculation uses the same miscellaneous allowance percentage that is applied to capital costs as an indirect line item (see Appendix D). Users can change this percentage on the indirect assumptions sheet of each model.

The WBS models calculate O&M costs based on the inputs provided by the user on the input sheet and values specified on the O&M assumptions sheet. These inputs include system size, raw and finished water quality parameters and other factors that affect operation requirements such as an option in the activated alumina model to regenerate media or operate on a throw away basis. The design equations and assumptions incorporated in the O&M sheets are described below.

Despite provisions for user inputs, there are several factors that can affect site-specific O&M costs in ways that are not readily reflected in the WBS outputs. These include:

- Operator expertise
- Equipment quality, design, installation and degree of automation
- Environmental conditions (e.g., changes in raw water quality over time).

Some O&M costs components, such as energy for pumping water or chemicals for treatment, are well defined and readily estimated using an engineering cost approach. Other O&M cost drivers, however, depend on multiple factors that are difficult to quantify and, therefore, represent a challenge for estimating costs. For example, the required level of effort to operate or maintain a technology depends on the level of complexity and sophistication of the installed technology, the size of the treatment system, the professional level or education and training of the operator and state and local regulations for process staffing.

To complicate matters further, there are trade-offs between system capital costs and O&M costs. Higher cost equipment may require less intensive maintenance or less hands-on operation. For example, using mixers and tanks to prepare brine solution for regenerating an anion exchanger might reduce equipment costs compared to using salt saturators. However, salt saturators require less labor to use and potentially reduce the need for a salt storage facility. Also high quality, highly automated systems can significantly reduce labor requirements, but increase capital costs. The U.S. Environmental Protection Agency (EPA) included some adjustments to O&M costs in the WBS models to account for some types of savings, which are described below.

E.2 Labor Costs

The WBS models calculate the annual hours of O&M labor in the following categories:

- Operator labor for operation and maintenance of process equipment
- Operator labor for building maintenance
- Managerial and clerical labor.

The WBS model labor hour estimates are intended to be incremental. That is, they only include labor associated with the new treatment system components.

E.2.1 Operator Labor for Operation and Maintenance of Process Equipment

System operation includes the following primary tasks:

- Collecting data from process instruments and recording system operating parameters
- Preventative maintenance and calibration of process instruments
- Verifying the proper operation of pumps, valves and other equipment and controlling the treatment process by adjusting this equipment
- Preventative maintenance of pumps, valves and other equipment
- Inspection and maintenance of chemical supplies
- Visual inspection of the treatment facility and system components
- Other, technology-specific tasks (e.g., managing regeneration, backwash or media replacement).

Labor required for these tasks is sensitive to the level of system automation. As discussed in Section 2.3 and Appendix A, the user has the option to choose from three levels of automation: manual, semi-automated and fully automated. The assumptions about labor required for each task vary depending on the level of automation selected, as shown in **Exhibit E-1** and discussed below. Users can change these assumptions, if desired, on the O&M assumptions sheet of each model.

EPA compared model results using these assumptions with annual labor hours reported for 12 different water treatment facilities. Most of the resulting model estimates were within +50 percent to -30 percent of the annual labor hours reported for the sample facilities.

Exhibit E-1. Operator Labor Assumptions for Three Levels of Automation

Task	Manual	Semi-automated	Automated
Record system operating parameters from process instruments (includes routine sampling)	5 minutes per day per instrument	5 minutes per day	5 minutes per day
Preventative maintenance and calibration of process instruments	10 minutes per month per instrument	10 minutes per month per instrument	10 minutes per month per instrument
Verify and adjust pump operating parameters	5 minutes per day per pump	5 minutes per day per pump	None
Preventative maintenance of pumps	30.25 hours per year per pump	30.25 hours per year per pump	30.25 hours per year per pump
Verify and adjust valve positions	5 minutes per week per valve	5 minutes per week per valve	None
Preventative maintenance and inspection of valves	5 minutes per year per valve	5 minutes per year per valve	5 minutes per year per valve
Visual inspection of facility	1 minute per day per 100 square feet of facility	1 minute per day per 100 square feet of facility	1 minute per day per 100 square feet of facility
Inspect and maintain chemical supplies	120 minutes per month per chemical supply tank	120 minutes per month per chemical supply tank	120 minutes per month per chemical supply tank

Collecting Data from Process Instruments and Recording System Operating Parameters

For manual systems, the models assume 5 minutes per day per instrument associated with day-to-day operation of the treatment process (e.g., flow meter, head loss sensor). Instruments associated with intermittent processes (e.g., backwash flow meters) are not included in this estimate, because observation of these instruments is included the operator labor associated with managing the intermittent process. In semi-automated and automated systems, the control system handles the task of collecting information from the various process instruments, so operator labor is reduced to 5 minutes per day to keep a record of operating parameters.

Preventative Maintenance and Calibration of Process Instruments

Regardless of the level of automation, the models assume 5 minutes per month for each instrument, including those associated with intermittent processes. While some instruments (e.g., chlorine residual analyzers) may require calibration more frequently than monthly, others (e.g., head loss sensors) will require limited, less frequent maintenance. Therefore, the models use 10 minutes per month as an average across the various types of instruments.

Verify and Adjust Pump Operating Parameters

For manual and semi-automated systems, the models assume 5 minutes per day per pump, including metering pumps associated with continuous chemical feed processes. Pumps associated with intermittent processes (e.g., backwash pumps) are not included in this estimate, because operation of these pumps is included the operator labor associated with managing the intermittent process. In automated systems, the control system handles this task, so no additional operator labor is required.

Preventative Maintenance of Pumps

Regardless of level of automation, the models assume 30.25 hours per year for large, frequently operated pumps (e.g., booster pumps). This estimate does not include small chemical metering pumps, but does include backwash pumps when these are operated more frequently than weekly. The estimate of 30.25 hours per year is based on a list of recommended pump maintenance activities from a vendor, combined with an independent engineering estimate of hours required for each activity, as shown in **Exhibit E-2**.

Exhibit E-2. Pump Maintenance Activities

Task	Interval	Estimated Minutes/Task	Estimated Hours/Year
Check bearing temperature	Monthly	5	1
Changing lubricant/ adjusting power level	Monthly	30	6
Disassemble for inspection, reassemble	Monthly	60	12
Check oil	Quarterly	10	0.67
Check lubricated bearings for saponification	Quarterly	10	0.67
Removal of bearings and replace, reassemble	Quarterly	60	4
Check packing and replace if necessary, reassemble	6 months	60	2
Vibration readings	6 months	10	0.33
Remove casing and inspect pump	Annual	120	2
If parts are worn, replace	Annual	varies	covered by pump materials percentage and pump useful life
Clean deposits and/ or scaling	Annual	60	1
Clean out stuffing box piping	Annual	30	0.5
Measure and record suction and discharge pipe head	Annual	5	0.08
Total All Tasks	Annual	1,815	30.25

Verify and Adjust Valve Positions

For manual and semi-automated systems, the models assume 5 minutes per week per valve on the main process line. In automated systems, the control system handles this task, so no additional operator labor is required.

Preventative Maintenance and Inspection of Valves

Regardless of level of automation, the models assume 5 minutes per year per valve on the main process line.

Visual Inspection of Facility

Regardless of level of automation, the models assume 1 minute per week per 100 square feet (ft^2) of treatment system floor plan to conduct visual inspection of the overall process. This daily inspection is in addition to inspection conducted as part of routine operation and maintenance of major operational components (instruments, pumps and valves), as discussed above.

Inspect and Maintain Chemical Supplies

The models assume that chemical supplies, whether they are associated with continuous addition or intermittent use, require additional attention beyond that included in daily visual inspection. In particular, they also require labor associated with receiving chemical shipments. Regardless of level of automation, the models assume 120 minutes per month for each chemical storage tank. Although counted on the basis of the number of tanks, this estimate is intended to cover all components associated with the chemical supply system (e.g., checking pipes and valves for leaks and inspecting and maintaining small metering pumps).

Technology-Specific Tasks

Many of the technologies include activities in addition to day-to-day operation that may require operator attention, depending on the level of automation (e.g., intermittent regeneration, backwash or media replacement). Where this is the case, the technology chapters in the main document describe the specific assumptions required to calculate operator labor.

E.2.2 Labor for Building Maintenance

The WBS models include a building maintenance cost based on the building area (i.e., using a unit cost in dollars per square foot per year). EPA developed this cost based on two sources: Whitestone Research (2009) and RSMeans (2013). Specifically, EPA selected a list of appropriate building maintenance repair and repair tasks from those listed in the two sources. The selected tasks include those associated with preventative maintenance, small repairs and major repairs. EPA estimated a frequency for each task by averaging the frequency recommended in each of the two sources. **Exhibit E-3** identifies the tasks included in the maintenance and repair buildup. The models include maintenance and repair tasks for heating and cooling systems only for buildings with the relevant systems. To avoid double-counting, the task list does not include tasks in the following categories:

- Maintenance of treatment system components that are already explicitly considered in the models' maintenance labor and materials costs (e.g., pumps, valves, instruments)
- Full replacement of items that are explicitly given a useful life in the models (e.g., piping, heating and cooling systems)
- Repair tasks with a lower frequency than the useful life assumed in the models for the related WBS line item (e.g., skylight replacement has a recommended frequency of 40 years, whereas the models assume a useful life for the entire building of 37 to 40 years).

For the buildup, EPA assumed a baseline building area of 4,000 ft^2 and building components corresponding to a medium-quality building (see the assumptions in Appendix B). EPA estimated costs for each task using data from RSMeans (2013) and assuming that preventative maintenance and minor repairs would be conducted using in-house labor, while major repairs would be conducted using outside contractors. These costs include both labor and materials.

Because repair needs do not follow a strict schedule, EPA annualized costs with no discount rate—that is, a $100 task with a typical frequency of 5 years is assigned an annual cost of $20.

Labor accounts for most of the cost for the maintenance and repair tasks. Further, the Building Cost Index and Construction Cost Index, the only two cost indices in the WBS cost database that combine labor and material costs, do not include the costs of materials that are likely to be used in building maintenance. The WBS cost database therefore uses the Employment Cost Index to escalate the building maintenance costs to current year dollars.

Exhibit E-3. Building Maintenance and Repair Tasks

- Minor repairs and refinishing for concrete floors
- Repairs and waterproofing for exterior concrete block walls
- Repairs and refinishing for doors
- Roofing debris removal and inspections
- Minor repairs and replacement for roofing membranes and flashing
- Repairs to skylights
- Repairs and refinishing for interior concrete block walls
- Repairs and refinishing for drywall
- Office painting
- Vinyl tile flooring replacement
- Repairs, refinishing and replacement for acoustic tile ceilings
- Preventive maintenance, repairs and replacement for lavatories and lavatory fixtures
- Water heater preventive maintenance, cleaning and servicing, overhauls and replacement
- Repairs to pipe joints and fittings
- Cleaning of drains
- Maintenance, repair and replacement of gutters
- Repair and replacement of fans
- Inspection and replacement of sprinkler systems
- Maintenance, inspection, repair and replacement of electrical systems including switchgear, receptacles, wiring devices, voice/data outlets and structure ground
- Replacement of lamps, ballasts and lighting fixtures
- Standby generator maintenance and inspection
- Preventive maintenance of computers

E.2.3 Managerial and Administrative Labor

The models contain an assumption that managerial and administrative support levels for a new treatment plant are equal to 10 percent of the total operator hours for system operation and maintenance. This estimate is not intended to represent total administrative and managerial time at a drinking water system, because total time includes many tasks unrelated to operating a new treatment train. It only represents incremental time needed to provide administrative support for the new treatment plant, e.g., processing supply orders. It also does not include labor time associated with recordkeeping and reporting burden estimates that EPA must estimate and report independently to comply with Paperwork Reduction Act requirements. Users can change the 10 percent assumption for either or both of managerial and administrative labor on the O&M assumptions sheet of each model.

E.2.4 Labor Unit Costs

To estimate the cost of the labor calculated in each of the categories above, the models multiply labor hours by unit costs from the WBS cost database. These unit costs reflect average loaded wage rates for applicable labor categories (i.e. technical, managerial and administrative) and vary across system size. The WBS cost database uses the Employment Cost Index to escalate the rates to current year dollars. Users can change the wage rates, if desired, in the data extracted from the WBS cost database.

E.3 Chemicals

Each of the WBS models calculates annual chemical usage (in pounds or gallons per year) on a technology-specific basis. The technology chapters in the main document describe these calculations. In some models, these calculations also reflect the selected option for regeneration or disposal of spent chemicals. Annual chemical costs equal the product of the annual chemical requirements and the unit chemical costs in the WBS cost database.

E.4 Materials

The WBS models calculate the annual cost of materials in the following categories:

- Materials for maintenance of booster or influent pumps
- Materials for maintenance and operation of other, technology-specific equipment
- Replacement of technology-specific equipment that occurs on an annual basis
- Materials for building maintenance.

Pumps are operated continuously (or nearly continuously) and require preventive and routine maintenance. Pumps are common to all the technologies. Each of the models assumes the annual cost of materials for pumps is equal to 1 percent of their pre-installation capital cost to account for consumable supplies and small parts requiring frequent replacement. This assumption is based on input from the technology experts who reviewed the WBS models and commented that the initial assumption of 5 percent was too high. Users can change this assumption on the O&M assumptions sheet of each model. Although accidents or improper operation can result in a need for major repairs that increase maintenance materials costs beyond 1 percent, the models do not include these types of costs.

Some of the technologies include other equipment that may require significant maintenance (e.g., the blowers in the packed tower aeration and multi-stage bubble aeration technologies). The models for these technologies include annual costs for maintenance materials. The technology chapters in this document describe the specific calculations. In general, these calculations are based a percentage of the pre-installation capital cost of the equipment.

Some of the technologies also include equipment components (e.g., membrane filter cartridges) that require frequent replacement. Rather than treat these components as frequently replaced capital items, the models handle the replacement costs in the O&M sheet. The replacement cost calculations are based on assumptions about replacement frequency and unit costs from the WBS component cost database. The specific calculations are in the technology sections of the main document.

The WBS models compute a cost for building maintenance that combines labor and materials. The cost is discussed in Section E.2.2.

E.5 Energy

All of the WBS models calculate the annual cost of energy in the following categories:

- Energy for operation of booster or influent pumps
- Energy for operation of other, technology-specific items of equipment
- Energy for lighting
- Energy for ventilation
- Energy for cooling
- Energy for heating.

E.5.1 Energy for Pumps and Other Equipment

Booster or influent pumps are equipment common to all the technologies. Because these pumps are operated continuously (or nearly continuously), they can represent significant energy consumption. Therefore, each of the WBS models calculates pump operating horsepower based on average flow, pump head and pump efficiency. The models then convert this operating horsepower to megawatt-hours/year assuming continuous operation. To calculate annual cost, the models then multiply the annual power requirement by the unit cost for electricity contained in the WBS component cost database.

Some of the technologies include other equipment that consumes significant quantities of energy (e.g., blowers, backwash pumps, mixers). For those technologies, the model also calculates the energy for such equipment explicitly. The technology chapters in the main document describe the specific energy calculations. In general, those calculations are similar to the energy calculation for pumps.

E.5.2 Energy for Lighting

The models calculate annual lighting requirements based on the building square footage estimate and the quality level of the building (see Appendix B). The building capital costs in the WBS cost database include the cost of light fixtures for the following light requirements:

- Sheds and low quality buildings, 0.3 watts/hour/ft^2 of building area
- Mid quality buildings, 0.6 watts/hour/ft^2 of building area
- High quality buildings, 1.2 watts/hour/ft^2 of building area.

Multiplying the appropriate light requirement by 8.8 results in an energy usage rate in kilowatt hours per ft^2 per year. This conversion is based on operation of the lights 24 hours per day, 365 days per year. EPA evaluated these assumptions by calculating the granular activated carbon contactor, pipe gallery and furnace area lighting requirements at the Richard Miller Water Treatment Plant in Cincinnati, Ohio. For this facility, the lighting requirements are 1.5, 1.0 and 0.8 watts per hour per ft^2 for the contactor, pipe gallery and regeneration areas, respectively, with a weighted average of 1.0 watt per hour per ft^2, which is between the mid and high quality values that EPA uses in the models. Users can change the lighting requirement for each level of building quality on the O&M assumptions sheet of each model.

Because many systems are not lit during times an operator is not present, the models reduce lighting energy requirements when a full-time operator presence is not required (possible for small systems for many technologies) using the following factor (with a maximum of 1 to account for large systems that might require more than one full-time operator):

Operator hours per year/ (24*365).

E.5.3 Energy for Ventilation

The models calculate ventilation requirements based on the assumptions shown in **Exhibit E-4**. The technology experts who reviewed the assumptions for the WBS models confirmed the reasonableness of these assumptions, although one expert commented that the air change rate for pumps could be lower for systems in a northern climate. The WBS models continue to use the value shown, however, because it is believed to be more reasonable for a national average estimate and results in a more conservative (i.e., higher) estimate of ventilation energy consumption. All of the models use these same assumptions with the exception of chlorination, which has special ventilation requirements as described in that technology section. Users can change the ventilation assumptions, if desired, on the O&M assumptions sheet of each WBS technology model.

Exhibit E-4. Assumptions for Calculating Ventilation Requirements

Variable	Value used
Ventilation air change rate for contactor areas	3 air changes/hour
Ventilation air change rate for pump areas	20 air changes/hour
Ventilation air change rate for chemical storage areas	2 air changes/hour
Ventilation air change rate for offices	2 air changes/hour
Pressure drop across ventilation fans	0.25 pounds/ ft^2
Number of days with mechanical ventilation for small systems (less than 1 MGD)	90 days/year
Number of days with mechanical ventilation for medium systems (1 to 10 MGD)	120 days/year
Number of days with mechanical ventilation for large systems (greater than 10 MGD)	185 days/year

MGD = million gallons per day

The models first use the air change rate assumptions to calculate an overall weighted average air change rate for each building based on the equipment present in that building. The models then use this weighted average air change rate for each building in the following formula:

$$\text{Ventilation energy (kWh/yr)} = DAYS \times 24 \times 0.746 \times P_{drop} \times FP \times H \times A_{changes} / 33{,}000$$

where:

DAYS = days per year with mechanical ventilation

P_{drop} = pressure drop across ventilation fans (pounds/ft^2)

FP = building footprint (ft^2)
H = building height (feet)
$A_{changes}$ = weighted average air change rate for the building (air changes/hour)

E.5.4 Energy for Heating and Cooling

The models calculate heating and cooling requirements based on the assumptions shown in **Exhibit E-5**. Users can change these assumptions, if desired, on the O&M assumptions sheet of each WBS technology model. These assumptions are described in greater detail below.

R-values are a measure of the effective resistance to heat flow of an insulating barrier such as a building envelope. The R-values assumed in the models (20 for walls, 49 for ceilings) are based on minimum requirements from the 2021 International Energy Conservation Code for commercial buildings in the majority of climate zones, assuming construction materials consistent with those used to develop the unit building costs (see Appendix B) (ICC, 2021). The user can change these values to reflect higher efficiency construction materials. In doing so, however, the user should also examine the unit building costs extracted from the WBS cost database to determine if they are consistent with the use of such construction materials.

Exhibit E-5. Assumptions for Calculating Heating and Cooling Requirements

Variable	Value used
R-value for walls	20 hour - ft^2 - ^oF /BTU
R-value for ceilings	49 hour - ft^2 - ^oF /BTU
Annual heating degree days	4,260 degree days
Annual cooling degree days	1,415 degree days
Heating ventilation/infiltration load	168,679 BTU/cfm
Cooling ventilation/infiltration load	51,771 BTU/cfm
Electric resistance heating efficiency	98%
Heat pump heating coefficient of performance	3.3
Natural gas non-condensing furnace efficiency	85%
Natural gas condensing furnace efficiency	90%
Standard oil furnace efficiency	82%
Mid-efficiency oil furnace efficiency	90%
Air conditioning energy efficiency ratio	11.8 BTU/Whr
Heat pump cooling energy efficiency ratio	11.8 BTU/Whr

BTU = British thermal unit; cfm = cubic feet per minute; Whr = watt hour

Annual heating and cooling degree days are based on data from the U.S. Energy Information Administration (U.S. EIA, 2021). Specifically, the values used in the models (4,260 heating degree days and 1,415 cooling degree days) are the national average of regional, population-weighted data. EPA derived the heating and cooling ventilation/infiltration load values from data in the Air Force Combat Climatology Center Engineering Weather Data Version 1.0 (U.S. Air Force, 2000). Specifically, EPA selected climate data for 21 cities distributed geographically throughout the United States and calculated total annual heating and cooling losses. The values used in the WBS models (168,679 BTU/cfm heating load and 51,771 BTU/cfm cooling load) are those for the city (St. Louis) that represents the median total annual heating and cooling loss from among the 21 cities. In combination, the degree day and ventilation/infiltration load values used in the models are intended to represent a climate that produces a nationally representative total heating and cooling requirement. The user can change these values to represent a specific different climate. In doing so, however, the user should select values for the heating and cooling measures, respectively, that are consistent with one another (i.e., reflective of a realistic climate).

The remaining values in the exhibit are related to the efficiency and performance of heating and air conditioning equipment. Electric resistance heating efficiency is based on information from the U.S. Department of Energy (U.S. DOE, 1997) in combination with guidance from Rosen (2021). The heat pump heating coefficient of performance is based on requirements from the Federal Energy Management Program, assuming a heat pump that is air-cooled and in the 135,000 to less than 240,000 BTU per hour category (U.S. DOE, 2021). The four furnace efficiency assumptions consider minimum efficiencies as outlined in Title 42 of the U.S. Code Chapter 77, Subchapter III: Improving Energy Efficiency, as well as trends and definitions from the Appliance Standards Awareness Project (ASAP, 2021). EPA derived the air conditioning and heat pump cooling energy efficiency ratios by converting the minimum Seasonal Energy Efficiency Ratios for single-package units outlined in 10 CFR 430.32 to approximate energy efficiency ratios using the formula outlined in Engebrecht and Hendron (2010). The user can modify these values, as desired, to reflect the use of more or less efficient equipment.

The WBS models use the assumptions in **Exhibit E-5**, along with estimated building dimensions, to calculate total annual heating and cooling losses. The models consider both conductance losses and ventilation/infiltration losses. The models calculate conductance losses for each building using the following formulae:

$$\text{Conductance heating loss} = 4 \times S \times H \times H_{DD} \times 24 / R_{wall} + FP \times H_{DD} \times 24 / R_{ceiling}$$
$$\text{Conductance cooling loss} = 4 \times S \times H \times C_{DD} \times 24 / R_{wall} + FP \times C_{DD} \times 24 / R_{ceiling}$$

where:

S = length of building side in feet (assumed to equal the square root of the building footprint)
H = building height (feet)
H_{DD} = annual heating degree-days
C_{DD} = annual cooling degree-days
FP = building footprint (ft^2)
R_{wall} = R-value for walls
$R_{ceiling}$ = R-value for ceiling.

The equations above represent the total heat transfer in British thermal units (BTU)/year through all four walls and the ceiling of each building. The models assume heat transfer through the building floor is negligible.

To calculate ventilation and infiltration losses, the models first calculate the air exchange rate in cubic feet per minute (cfm) for each building using the following formula:

$$\text{Air exchange rate (cfm)} = FP \times H \times A_{changes} / 60$$

where:

H = building height (feet)
FP = building footprint (ft^2)
$A_{changes}$ = weighted average air change rate for the building (air changes/hour, as described above in the section on ventilation)

Note that, unlike the calculation for ventilation energy use, this calculation does not incorporate assumptions about the frequency of mechanical ventilation. This is because heating and cooling losses occur regardless of whether ventilation is achieved by mechanical or natural means.

The models then apply the air exchange rate calculated above to determine ventilation and infiltration losses (in BTU/year) for each building using the following formulae:

$$\text{Heating ventilation and infiltration heat loss} = CFM \times H_{VIload}$$
$$\text{Cooling ventilation and infiltration heat loss} = CFM \times C_{VIload}$$

where:

CFM = air exchange rate (cfm, as calculated above)
H_{VIload} = heating ventilation/infiltration load (in BTU/cfm)
C_{VIload} = cooling ventilation/infiltration load (in BTU/cfm)

The models then sum conductance losses and ventilation/infiltration losses to determine total annual heating and cooling requirements for each building. For cooling, the models add cooling required to compensate for the waste heat generated by pumps (and other technology-specific mechanical equipment).

The models then calculate heating and cooling energy consumption for each of several options using these requirements, BTU values for the appropriate fuel (i.e., electricity, natural gas or oil) and the efficiency factors shown in **Exhibit E-5**. For heating, the options are electric resistance heating, electric heat pump, natural gas condensing or non-condensing furnace and standard or mid-efficiency oil furnace. For cooling, the options are conventional air conditioning and electric heat pump.

The models determine whether to include heating and cooling costs (both capital and O&M) based on building size, system design flow and user input for component level (see Section 2.3), as shown in **Exhibit E-6**. Users can change these assumptions on the indirect assumptions sheet of each model. When heating and/or cooling are included, the models choose among the heating and cooling system options based on the total annualized cost of each option (annual energy cost, plus capital cost of the system annualized as discussed in Section 2.4). The models select the option with the lowest annualized cost for inclusion in the system capital costs and add the corresponding annual energy cost to O&M costs.

Exhibit E-6. WBS Model Assumptions Regarding Inclusion of Heating and Cooling

Building Square Footage	Component Cost Level Selected	System Design Flow: Less than 1 MGD	System Design Flow: 1 to 10 MGD	System Design Flow: 10 MGD or greater
500 or greater	Low	Neither	Heating Only	Heating and Cooling
500 or greater	Medium	Heating Only	Heating and Cooling	Heating and Cooling
500 or greater	High	Heating and Cooling	Heating and Cooling	Heating and Cooling
Less than 500	Low or Medium	Neither	Neither	Heating Only
Less than 500	High	Heating Only	Heating Only	Heating Only

MGD = million gallons per day

E.5.5 Energy Unit Costs

To estimate the cost of the energy consumption calculated in each of the categories above, the models use unit costs from the WBS component cost database. These unit costs represent national averages for each fuel (electricity, natural gas and diesel) obtained from the U.S. Department of Energy's Energy Information Administration. Because energy costs are highly variable, users can change these energy unit costs, if desired, in the data extracted from the WBS cost database.

E.6 List of Abbreviations and Symbols in this Appendix

BTU	British thermal unit
cfm	cubic feet per minute
EPA	U.S. Environmental Protection Agency
ft^2	square feet
kWh	kilowatt hour
MGD	million gallons per day
O&M	operating and maintenance
U.S. DOE	U.S. Department of Energy
WBS	work breakdown structure
Whr	watt hour

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Attachment 24: Form 10K February 2024

SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, D.C. 20549

FORM 10-K

(Mark One)
☒ **Annual Report pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934 for the fiscal year ended December 31, 2023 or**
☐ **Transition report pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934 for the transition period from to**

Commission File Number	Registrant, State of Incorporation Address, Zip Code and Telephone Number	IRS Employer Identification No.
001-14431	**American States Water Company** Incorporated in California 630 E. Foothill Boulevard, San Dimas CA 91773-1212 (909) 394-3600	95-4676679

Securities registered pursuant to Section 12(b) of the Act:

Title of Each Class	Trading Symbol	Name of Each Exchange on Which Registered
Common Shares	AWR	New York Stock Exchange

Securities registered pursuant to Section 12(g) of the Act: None

Commission File Number	Registrant, State of Incorporation Address, Zip Code and Telephone Number	IRS Employer Identification No.
001-12008	**Golden State Water Company** Incorporated in California 630 E. Foothill Boulevard, San Dimas CA 91773-1212 (909) 394-3600	95-1243678

Securities registered pursuant to Section 12(b) of the Act:

Title of Each Class	Trading Symbol	Name of Each Exchange on Which Registered
None	None	None

Securities registered pursuant to Section 12(g) of the Act: **None**

Indicate by check mark if the Registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act.

American States Water Company	Yes	☒	No	☐
Golden State Water Company	Yes	☐	No	☒

Indicate by check mark if the Registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act.

American States Water Company	Yes	☐	No	☒
Golden State Water Company	Yes	☐	No	☒

Indicate by check mark whether Registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that Registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days.

American States Water Company	Yes	☒	No	☐
Golden State Water Company	Yes	☒	No	☐

Indicate by check mark whether Registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§ 232.405 of this chapter) during the preceding 12 months (or such shorter period that the Registrant was required to submit such files).

American States Water Company	Yes	☒	No	☐
Golden State Water Company	Yes	☒	No	☐

Indicate by check mark whether the Registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company or an emerging growth company. See the definitions of "large accelerated filer," "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act.

American States Water Company

Large accelerated filer	☒	Accelerated filer	☐	Non-accelerated filer	☐	Smaller reporting company	☐	Emerging growth company	☐

Golden States Water Company

Large accelerated filer	☐	Accelerated filer	☐	Non-accelerated filer	☒	Smaller reporting company	☐	Emerging growth company	☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act.
American States Water Company ☐
Golden State Water Company ☐

Indicate by check mark whether the Registrant has filed a report on and attestation to its management's assessment of the effectiveness of its internal control over financial reporting under Section 404(b) of the Sarbanes-Oxley Act (15 U.S.C. 7262(b)) by the registered public accounting firm that prepared or issued its audit report.
American States Water Company ☒
Golden State Water Company ☐

If securities are registered pursuant to Section 12(b) of the Act, indicate by check mark whether the financial statements of the Registrant included in the filing reflect the correction of an error to previously issued financial statements.
American States Water Company ☐
Golden State Water Company ☐

Indicate by check mark whether any of those error corrections are restatements that required a recovery analysis of incentive-based compensation received by any of the Registrant's executive officers during the relevant recovery period pursuant to §240.10D-1(b).
American States Water Company ☐
Golden State Water Company ☐

Indicate by check mark whether the Registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act)

American States Water Company	Yes	☐	No	☒
Golden State Water Company	Yes	☐	No	☒

The aggregate market value of all voting and non-voting common shares, no par value, of American States Water ("Common Shares") held by non-affiliates of American States Water Company was approximately $3,189,000,557 on June 30, 2023, the last business day of the Registrant's most recently completed second fiscal quarter, based on the closing price per Common Share of American States Water Company as traded on the New York Stock Exchange. As of February 20, 2024, the number of Common Shares of American States Water Company outstanding was 36,988,764. As of that same date, American States Water Company owned all 171 outstanding Common Shares of Golden State Water Company. The aggregate market value of all voting stock held by non-affiliates of Golden State Water Company was zero on June 30, 2023.

Golden State Water Company meets the conditions set forth in General Instruction I(1)(a) and (b) of Form 10-K and is therefore filing this Form, in part, with the reduced disclosure format for Golden State Water Company.

Documents Incorporated by Reference:

Portions of the Proxy Statement of American States Water Company will be subsequently filed with the Securities and Exchange Commission as to Part III, Item Nos. 10, 11, 13 and 14 and portions of Item 12, in each case as specifically referenced herein.

AMERICAN STATES WATER COMPANY
and
GOLDEN STATE WATER COMPANY

FORM 10-K

INDEX

GLOSSARY OF TERMS

The following terms and acronyms used in this Form 10-K are defined below:

Term or Acronym	Definition
50-year contract	ASUS's initial 50-year, firm-fixed-price contracts
AFUDC	Allowance for Funds Used During Construction
Arrearage Program	California Water and Wastewater Arrearage Payment Program
ASC	Accounting Standards Codification
ASU	Accounting Standards Update
ASUS	American States Utility Services, Inc.
AWR	American States Water Company
BRRAM	Base Revenue Requirement Adjustment Mechanism
BSUS	Bay State Utility Services LLC
BVES	Bear Valley Electric Service, Inc.
CCPA	California Consumer Privacy Act
CEMA	Catastrophic Emergency Memorandum Account
COC	Cost of Capital
CPUC	California Public Utilities Commission
CWA	California Water Association
DCAA	Defense Contract Auditing Agency
DCMA	Defense Contract Management Agency
DDW	Division of Drinking Water
DRP	Common Share Purchase and Dividend Reinvestment Plan
EBITDA	Earnings Before Income Taxes, Depreciation and Amortization
ECUS	Emerald Coast Utility Services, Inc.
EPA	Economic Price Adjustment
EPS	Earnings Per Share
ERISA	Employee Retirement Income Security Act of 1974, as amended
Exchange Act	Securities Exchange Act of 1934, as amended
Extended Arrearage Program	New Extended Water and Wastewater Arrearage Program
FBWS	Fort Bliss Water Services Company
FRUS	Fort Riley Utility Services, Inc.
FTB	California Franchise Tax Board
GAAP	Generally Accepted Accounting Principles in the United States of America
GHG	Greenhouse Gas
gpcd	Gallons Per Capita Per Day
GSWC	Golden State Water Company
IRS	Internal Revenue Service
IOWU	Investor-Owned Water Utility
JBCC	Joint Base Cape Cod
kv	Kilovolt
MAF	Million Acre-Feet
MCBA	Modified Cost Balancing Account
MCL	Maximum Contamination Level
Moody's	Moody's Investors Service
MWD	Metropolitan Water District of Southern California
MWh	Megawatt-Hour
NYSE	New York Stock Exchange
ODUS	Old Dominion Utility Services, Inc.
OEIS	Office of Energy Infrastructure Safety

ONUS	Old North Utility Services, Inc.
PCAOB	Public Company Accounting Oversight Board
PFAS	Perfluoroalkyl Substances
PFBS	Perfluorobutane Sulfonic Acid
PFHxS	Perfluorohexane Sulfonic Acid
PFOA	Perfluorooctanoic Acid
PFOS	perfluorooctanesulfonic acid
ppb	Parts Per Billion
ppt	Parts Per Trillion
PRUS	Patuxent River Utility Services LLC
PSUS	Palmetto State Utility Services, Inc.
Public Advocates	Public Advocates Office at the CPUC
REA	Request for Equitable Adjustment
REC	Renewable Energy Credit
Registrant	American States Water Company and Golden State Water Company
ROU	Right-of-Use
RPS	Renewables Portfolio Standard
RSU	Restricted Stock Unit
S&P	Standard and Poor's Global Ratings
SB	Senate Bill
SEC	Securities and Exchange Commission
SERP	Supplemental Executive Retirement Plan
SOFR	Secured Overnight Financing Rate
SWP	State Water Project
SWRCB	State Water Resources Control Board
TSR	Total Shareholder Return
TUS	Terrapin Utility Services, Inc.
U.S.	United States
USEPA	United States Environmental Protection Agency
WCCM	Water Cost of Capital Mechanism
WMP	Wildfire Mitigation Plan
WRAM	Water Revenue Adjustment Mechanism

INFORMATION REGARDING FORWARD-LOOKING STATEMENTS

This Form 10-K and the information incorporated by reference into this Form 10-K contain forward-looking statements within the meaning of the Private Securities Litigation Reform Act of 1995. These statements reflect the current views of our senior management with respect to future events and our financial performance. These statements include forward-looking statements with respect to our business and industry in general. Statements that include the words “expect,” “intend,” “believe,” “estimate,” “may,” “can,” “will,” “likely,” “should,” “could,” “anticipate,” “plan” and similar statements of a future or forward-looking nature identify forward-looking statements for purposes of the federal securities laws or otherwise. Forward-looking statements address matters that involve risks and uncertainties. Accordingly, there are or will be important factors that could cause our actual results to differ materially from those indicated in these statements. We believe that these factors include, but are not limited to, the following:

- the impact of laws, regulations and policies of regulatory agencies or the U.S. government applicable to water, wastewater and electric utility operations;
- the ability of GSWC and BVES to recover their respective costs through regulated rates, including increased costs associated with addressing climate change risks, such as drought and wildfires in California, costs incurred in connection with complying with water quality regulations, and increased costs of operation and maintenance due to inflation, supply chain disruptions and increases in interest rates, while facing an increase in customer rate increase opposition and possible reluctance from the CPUC to pass through all such costs to the customers;
- customer dissatisfaction due to rising rates needed to recover the costs of replacing aging infrastructure, address climate change risks, comply with water quality, renewable energy and greenhouse gas regulation;
- all of our contracts for providing services on military bases are provided to the U.S. government under long-term, fixed-price contracts subject to annual economic price adjustments
- all contracts for providing services on military bases may be terminated or suspended at any time by the government;
- ASUS is subject to potential government audits or investigations of its business practices and compliance with government procurement statutes and regulations that could result in fines and penalties;
- GSWC and BVES are subject to potential audit and investigations by the CPUC for failure to comply with regulations applicable to public utilities, including failure to comply with state and federal water quality requirements, wildfire mitigation plans, renewable energy legislation, greenhouse gas regulations and other climate related regulations that could result in fines and penalties;
- we compete with other companies in bidding on providing utility services on military bases which involves estimating costs and potential profits that may not be realized;
- the impact of water quality and wastewater quality regulations on military bases;
- asset or business acquisitions may not yield the anticipated benefits;
- the impact of climate change and extreme weather events, including droughts, storms, high wind events, wildfires, flash flooding and other natural disasters, and the effects they could have on our operations;
- our assets at our regulated utilities are subject to condemnation by municipalities and other governmental subdivisions;
- increases in the costs of obtaining and complying with the terms of franchise agreements;
- damage to our reputation or adverse publicity may lead to increased regulatory oversight or sanctions;
- costs and effects of legal and administrative proceedings, settlements, investigations and claims;
- our ability to control operation and maintenance costs within the amounts that have been approved in rates or estimated in our military base contracts;
- the outbreak of pandemics, such as COVID-19, and other events that may cause region wide, statewide, nationwide or even global disruption, which could impact our businesses, operations, cash flows or financial results;
- the inherent risk of damage to private property and injury to employees and the general public involved in the generation, transmission and distribution of electricity, the handling of hazardous materials and equipment, and being in close proximity to public utility construction and maintenance operations;
- the impact of groundwater contamination and the increasing costs associated with treatment and mitigation;
- risks of incurring losses not covered by insurance or recoverable in rates;

- the adequacy of water supplies due to fluctuations of weather, climate change, and other uncontrollable factors;
- the impact that water conservation efforts may have on GSWC's operations and costs incurred;
- changes in electricity and natural gas prices in California;
- failure to make accurate estimates about financing and accounting matters;
- changes in accounting, public utility, environmental and tax laws and regulations affecting our businesses;
- changes in fair value of investments and other assets;
- the performance of subcontractors engaged to assist us in the performance of contracted services on military bases;
- incomplete or delayed reimbursement from the U.S. government and delays in obtaining decisions from the CPUC on regulated public utility rates that can adversely impact our financial condition and liquidity;
- physical security of our critical assets, personnel and data critical to our business, employees, customers and vendors;
- cybersecurity incidents that could disrupt critical information technology systems, resulting in the loss of financial and other information critical for operations and the breach of confidential information of our customers, employees and vendors;
- our ability to attract, retain, train, motivate, develop, and transition key employees;
- the failure of our employees to maintain required certifications and licenses or to complete required compliance training;
- changes in interest rates and our ability to borrow funds and access bank and capital markets on reasonable terms;
- the impact of inflation and supply chain disruptions on our operational costs and costs of capital that may not be recovered in rates for our regulated utilities and through economic price adjustments for our military bases;
- results of financing efforts, including the ability to obtain financing on favorable terms, which can be affected by various factors, including credit ratings, interest rate fluctuations, compliance with debt covenants and conditions, delays in receiving general rate case decisions from the CPUC, and general market and economic conditions;
- actions by credit rating agencies to downgrade AWR or GSWC's credit ratings or to place those ratings on negative outlook;
- our ability to finance the significant capital expenditures required by our operations, which are increasing;
- volatility in the price of our Common Shares;
- declines in the market prices of equity and fixed-income securities and resultant cash funding requirements for defined benefit pension plans and other post-retirement benefit plans;
- our reliance on cash flow from our subsidiaries to meet our financial obligations and to pay dividends on our Common Shares;
- the geographic concentration of our operations in California; and
- other risks and uncertainties described under the heading "Item 1A. Risk Factors" in this Form 10-K.

Although we believe that the expectations reflected in the forward-looking statements are reasonable based on our current knowledge of our business and operations, we cannot guarantee future results, levels of activity, performance or achievements. If one or more of these or other risks or uncertainties materialize, or if our underlying assumptions prove to be incorrect, actual results may differ materially from what we anticipate. Any forward-looking statements you read in this Form 10-K and the information incorporated herein by reference reflect our views as of their respective dates and are subject to these and other risks, uncertainties and assumptions relating to our operations, results of operations, growth strategy and liquidity. You should not place undue reliance on these forward-looking statements and you should carefully consider all of the factors identified in this Form 10-K and the information incorporated herein by reference that could cause actual results to differ. Forward-looking statements speak only as of the date they are made and except as required by law, AWR expressly disclaims an obligation to publicly update or revise any forward-looking statements, whether as a result of new information, future events or otherwise.

PART I

Item 1. Business

This annual report on Form 10-K is a combined report being filed by two separate Registrants, American States Water Company ("AWR") and Golden State Water Company ("GSWC"). References in this report to "Registrant" are to AWR and GSWC, collectively, unless otherwise specified. GSWC makes no representations as to the information contained in this report relating to AWR and its subsidiaries, other than GSWC.

AWR makes its periodic reports, Form 10-Q and Form 10-K, and current reports, Form 8-K, and amendments to those reports, available free of charge through its website, www.aswater.com, as soon as those reports are electronically filed with or furnished to the Securities and Exchange Commission ("SEC"). Such reports are also available on the SEC's website at www.sec.gov. AWR also makes available free of charge its code of business conduct and ethics, its corporate governance guidelines, its policy for the recoupment of performance-based compensation, its insider trading policy and the charters of its Nominating and Governance Committee, Compensation Committee and Audit and Finance Committee through its website or by calling (877) 463-6297.

Overview

AWR is the parent company of GSWC, Bear Valley Electric Service, Inc. ("BVES") and American States Utility Services, Inc. ("ASUS") (and its wholly-owned subsidiaries: Fort Bliss Water Services Company ("FBWS"), Old Dominion Utility Services, Inc. ("ODUS"), Terrapin Utility Services, Inc. ("TUS"), Palmetto State Utility Services, Inc. ("PSUS"), Old North Utility Services, Inc. ("ONUS"), Emerald Coast Utility Services, Inc. ("ECUS"), Fort Riley Utility Services, Inc. ("FRUS"), Bay State Utility Services LLC ("BSUS"), and Patuxent River Utility Services LLC ("PRUS")).

AWR has three reportable segments: water, electric and contracted services. Within the segments, AWR has three principal business units, water and electric service utility operations conducted through its regulated utilities GSWC and BVES, respectively, and contracted services conducted through ASUS and its subsidiaries.

GSWC is a public water utility engaged in the purchase, production, distribution and sale of water in 10 counties in the state of California. GSWC is regulated by the California Public Utilities Commission ("CPUC"). BVES is a public electric utility that distributes electricity in several San Bernardino County mountain communities in California and is also regulated by the CPUC. Additional information regarding public utility regulation is discussed in Item 7. *"Management's Discussion and Analysis of Financial Condition and Results of Operations"* under the section titled *"Regulatory Matters."*

AWR's regulated utilities served 264,093 water customers and 24,777 electric customers at December 31, 2023, or a total of 288,870 customers, compared with 263,265 water customers and 24,705 electric customers at December 31, 2022, or a total of 287,970 customers. Both GSWC's and BVES's operations exhibit seasonal trends. Although both have diversified customer bases, residential and commercial customers account for the majority of water and electric sales and revenues. Revenues derived from commercial and residential customers accounted for approximately 90% of total water and electric revenues for the years ended December 31, 2023, 2022 and 2021.

ASUS, through its subsidiaries, has contracted with the U.S. government to provide water and/or wastewater services at various military installations. ASUS operates, maintains and performs construction activities (including renewal and replacement capital work) on water and/or wastewater systems at various U.S. military bases pursuant to an initial 50-year, firm-fixed-price contract and additional firm-fixed-price contracts, task order agreements and contracts with third party prime contractors. ASUS has one subsidiary that has entered into a task order agreement with the U.S. government that has a term of 15 years. Each of the contracts with the U.S. government is subject to termination, in whole or in part, prior to the end of its term for convenience of the U.S. government or as a result of default or nonperformance by the ASUS subsidiary performing the contract. The price for each of these contracts is subject to annual economic price adjustments or task order adjustments. The contracts are also subject to modifications for changes in circumstances, changes in laws and regulations, and additions to the contract value for new construction of facilities at the military bases. AWR generally guarantees performance of all of the contracts of ASUS's subsidiaries.

Pursuant to the terms of the 50-year contracts with the U.S. government, the subsidiaries of ASUS operate the following water and wastewater systems:

Subsidiary	Military Base	Type of System	Location
FBWS	Fort Bliss	Water and Wastewater	Texas and New Mexico
ODUS	Fort Gregg-Adams	Wastewater	Virginia
ODUS	Joint-Base Langley Eustis and Joint Expeditionary Base Little Creek-Fort Story	Water and Wastewater	Virginia
TUS	Joint Base Andrews	Water and Wastewater	Maryland
PSUS	Fort Jackson	Water and Wastewater	South Carolina
ONUS	Fort Liberty, Pope Army Airfield and Camp Mackall	Water and Wastewater	North Carolina
ECUS	Eglin Air Force Base	Water and Wastewater	Florida
FRUS	Fort Riley	Water and Wastewater Collection and Treatment	Kansas
PRUS	Naval Air Station Patuxent River	Water and Wastewater	Maryland
BSUS	Joint Base Cape Cod*	Water and Wastewater Collection and Treatment	Massachusetts

*BSUS is the only subsidiary that has entered into a task order agreement serving Joint Base Cape Cod that has a term of 15 years.

Certain financial information for each of AWR's business segments - water distribution, electric distribution, and contracted services - is set forth in Note 17 to the Notes to Consolidated Financial Statements of American States Water Company and its subsidiaries. While AWR's water and electric utility segments are not dependent upon a single or only a few customers, the U.S. government is the primary customer for ASUS's contracted services. ASUS, from time to time, performs work at military bases for other prime contractors of the U.S. government.

Seasonality

The demand for water and electricity varies by season. For instance, there can be a higher level of water consumption during the third quarter of each year when weather in California has been hot and dry. During unusually wet weather, our customers generally use less water. The CPUC has adopted regulatory mechanisms at GSWC that help mitigate fluctuations in revenues due to changes in water consumption by our customers in California, which currently remain in effect.

The demand for electricity in our electric customer service area is greatly affected by winter snow levels. An increase in winter snow levels reduces the use of snow-making machines at ski resorts in the Big Bear area and, as a result, reduces our electric revenues. Likewise, unseasonably warm weather during a skiing season may result in temperatures too high for snow making conditions, which also reduces our electric revenues. The CPUC has adopted regulatory mechanisms for our electric business, which helps mitigate fluctuations in the revenues of our electric business due to changes in the amount of electricity used by BVES's customers.

Environmental Regulations

AWR's subsidiaries are subject to extensive environmental regulations. GSWC is required to comply with safe drinking water requirements, including testing to determine constituents in its water supply and customer notification requirements if certain contaminants exceed maximum levels or advisory levels, and requirements to address issues relating to known contamination. The subsidiaries of ASUS are subject to similar requirements in connection with their water and wastewater operations on military bases. GSWC is also responsible for clean-up and remediation at a plant site that contained an underground storage tank. As mandated by legislation enacted in California, BVES is required to submit wildfire mitigation plans to the CPUC and the Office of Energy Infrastructure Safety ("OEIS") for approvals. California requires electric utilities to prepare plans on constructing, maintaining, and operating their electrical lines and equipment to minimize the risk of catastrophic wildfire.

ASUS's subsidiaries are responsible for ensuring compliance with the reduction and/or removal of all constituents required under its wastewater treatment plant operating permits. ASUS works with state regulators and industry associations for the purpose of staying current with emergent issues and proactively addressing any change in wastewater treatment regulation.

The regulated utilities spent approximately $29.0 million in 2023 and expect to spend approximately $23.5 million in 2024 for capital expenditures on environmental control facilities. During 2023, ASUS performed construction activities (for the benefit of the U.S. government) related to environmental control facilities with a contract value of $4.5 million. ASUS expects to perform construction activities related to environmental control facilities with a contract value of $9.2 million in 2024. In addition, various other capital expenditures at the regulated utilities and construction projects at ASUS are incurred for purposes other than environmental control facilities but may also have some environmental benefits. An environmental control facility is any facility that is reasonably expected to abate, reduce or aid in the prevention, measurement, control of monitoring of noise, air or water pollutants, solid waste, thermal pollution, radiation or other pollutants.

Environmental matters and compliance with such laws and regulations are discussed further in Item 7. *"Management's Discussion and Analysis of Financial Condition and Results of Operations"* under the section titled *"Environmental Matters*."

Climate Change Planning, Risks and Opportunities

Climate change is one area that we focus on as we develop and execute our business strategy and financial planning, both in the short- and long-term and is subject to the oversight of the Board of Directors and senior management. First and foremost, designing and implementing efficient and resilient infrastructure and operational processes not only addresses climate change, but also reduces costs. Our capital investment programs are critical to ensure we can continue delivering reliable, high-quality water, wastewater and electric services without interruption. As a utility company, our operating strategy is dependent on having a reliable infrastructure in place.

The risks posed by climate variability increase the need for us to plan for and address supply resiliency. We address these risks by planning, assessing, mitigating, and investing in our infrastructure for the long-term benefit of our communities. As a provider of an essential product and service, our primary goal is to ensure service is uninterrupted.

GSWC considers the potential impacts of climate change in its water supply portfolio planning and its overall infrastructure replacement plans. We evaluate how water supplies, water quality and water demands may change, and consider mitigation strategies to assist us in being able to deliver water to our customers.

We seek to minimize our greenhouse gas ("GHG") emissions to assist in reducing the effects of climate change. We have studied our GHG emissions levels, set a 2020 baseline, and developed a GHG emissions reduction target of 60% by 2035 from the 2020 baseline. To accomplish this, GSWC and BVES have developed a phased approach, which includes short-, medium- and long-term actions. Our priorities include reductions in energy use and increasing purchases of green energy for our water operations, increasing purchases of green energy for distribution to our electric customers, and reviewing our vehicle fleet needs and electrification. Achievement of this reduction target is contingent on certain external factors, which include the ongoing development of technology.

Water Utility

There are risks to maintaining adequate water quality and/or supply, either from climate variability or other events. They include droughts, changes in weather patterns, natural disasters, wildfires, decisions or actions restricting the use of water from our sources, and/or pumping of groundwater, and contamination or acts of terrorism or vandalism. We consider these potential events in our strategic planning process as we aim to avoid service interruptions and compromised water quality.

Our goal is to maintain adequate and high-quality water supplies. We strive to reach this goal in a number of ways, including monitoring water levels, short- and long-term water supply planning, having a diverse water supply portfolio, developing contingency plans, water efficiency and conservation efforts, and maintaining a strong infrastructure. Additional information on GSWC's water supplies is discussed further in Item 7. *"Management's Discussion and Analysis of Financial Condition and Results of Operation"* under the section titled *"Water Supplies."*

Electric Utility

Climate change has also impacted electric utilities in California due to an increase in wildfires. BVES's compliance with its wildfire mitigation plans have resulted in an increase in capital expenditures for wildfire mitigation projects. BVES will not be able to recover the costs incurred to make capital improvements included in BVES's current wildfire mitigation plans from customers until the CPUC approves recovery of these costs in its next general rate case filing. BVES filed a general rate case application in August 2022, which will determine new electric rates for the years 2023-2026. Power supplies may also become more constrained and more expensive due to regulation of power plants using fossil fuels.

California has established a cap-and-trade program applicable to greenhouse gas emissions. While BVES's power-plant emissions are below the reporting threshold, as a "Covered Entity," BVES has an obligation to file a report with the California Air Resources Board ("CARB") in June of each year under the Greenhouse Gas Mandatory Reporting Regulation. The report will become available publicly in the third quarter of 2024.

The State of California and the CPUC have established renewable energy procurement targets. BVES has entered into a CPUC-approved eleven-year contract for renewable energy credits. Because of this agreement, BVES believes it will comply through at least 2024 with California's renewable energy statutes that address this issue. BVES is pursuing short- and long-term renewable energy contracts to satisfy its requirements related to its resource portfolio for the compliance period covering the years 2021-2024 and beyond.

In 2023, BVES's renewable power represented 41.3% of total retail sales. Renewable energy procurement requirements continue to escalate, reaching 50% by 2026 and 100% carbon free by 2045. BVES has entered into a contract to construct a solar energy project in Big Bear Lake, subject to obtaining CPUC approval and necessary permits. If approved and constructed, the project will provide a source of clean, local energy for BVES's customers.

BVES offers a distributed generation program, which benefits customers who install a solar or wind-generating facility that produces renewable energy. Those customers can receive a bill credit if their monthly renewable energy production exceeds their on-site use. BVES also has a number of customers on its Net Energy Metering Program (NEM), which was the previous renewable energy program. NEM customers can receive a bill credit if their annual renewable energy production exceeds their on-site use. Approximately 5% of the energy consumed by our BVES customers is now generated by customer-owned renewable sources (solar).

BVES is also required to comply with the CPUC's greenhouse gas emission performance standards. Under these standards, BVES must file an annual attestation with the CPUC stating that BVES has no new ownership investment in generation facilities exceeding the emission performance standards and no long-term commitments for generation exceeding the standards. In January 2024, BVES filed an attestation that BVES complied with the standards for 2023. At this time, management cannot estimate the impact, if any, that these regulations may have on future costs over BVES's power plant operations or the cost of BVES's purchased power from third party providers.

Competition

The businesses of GSWC and BVES are substantially free from direct and indirect competition with other public utilities, municipalities and other public agencies within their existing service territories. However, GSWC and BVES may be subject to eminent domain proceedings in which governmental agencies, under state law, may acquire GSWC's water systems or BVES's electric system if doing so is necessary and in the public's interest. GSWC competes with governmental agencies and other investor-owned utilities in connection with offering service to new real estate developments on the basis of financial terms, availability of water and ability to commence providing service on a timely basis. ASUS actively competes for business with other investor-owned utilities, other third-party providers of water and/or wastewater services, and governmental entities primarily on the basis of quality of service and price.

AWR Workforce

AWR and its subsidiaries had a total of 815 employees as of December 31, 2023. GSWC had 506 employees as of December 31, 2023. BVES had 50 employees, of which 18 employees are covered by a collective bargaining agreement with the International Brotherhood of Electrical Workers, which expires in December 2025. At times, GSWC and BVES use temporary and contract workers for a finite period of time and in a limited capacity to continue a project or workflow until they can hire a regular employee. It is also common for those temporary workers to be hired as a regular, full-time employee.

ASUS and its subsidiaries had a total of 259 employees as of December 31, 2023. FBWS, a subsidiary of ASUS, has 14 employees that are covered by a collective bargaining agreement with the International Union of Operating Engineers. This agreement expires in September 2024.

Our businesses require a combination of complex infrastructure, regulatory expertise and customer service. Ongoing development of our talent across the organization to meet critical business needs is a continual focus, and includes (i) building a culture such that high-potential talent is identified and further developed, (ii) creating career paths that not only move up a specialized ladder, but across the organization, and (iii) offering opportunities for employees to accept new challenges through stretch assignments.

Attracting Diverse Qualified Candidates

We understand that strength comes from having a diverse employee population. We strive to hire from our local communities and to have a workforce that is representative, at all job levels, of the communities we serve and from which we recruit. This begins with the recruitment process. We strive to have all aspects of employment, including the decision to hire, promote, discipline, or discharge, be based on merit, competence, performance, and business needs. It is our policy not to discriminate on the basis of race, color, religion, marital status, age, national origin, ancestry, physical or mental disability, medical condition, pregnancy, genetic information, gender, sexual orientation, gender identity or expression, veteran status, or any other status protected under federal, state, or local laws.

Compensation and Benefits

We believe that we pay employees a competitive and fair wage, as benchmarked with other leading companies and the market. Consistent with our principle of valuing personal mastery, we reward employees for improving their skills and capabilities. Our benefits include a defined benefit pension plan for employees hired prior to January 1, 2011, a defined contribution plan for hires or rehires after December 31, 2010, a 401(k) plan, healthcare and insurance benefits, health savings and flexible spending accounts.

Safety and Training

Strong occupational health and safety practices reduce injuries, keep our workforce healthy, and reduce operating costs. A safe workforce translates into better performance company-wide. We work to create a safety-focused culture in which each individual feels personally responsible for their own safety, the safety of their co-workers, as well as the safety of the communities they serve. Safety performance is included as a metric in the officer and manager compensation programs. Employees attend training in various mandated safety programs that are applicable to their area of operations, including training to meet regulatory safety training requirements and requirements of the Department of Transportation. We also provide training to assist in compliance with local, state, and federal environmental laws.

To reinforce our safety efforts and protocols, company-wide safety inspections at GSWC and BVES are conducted with supervisors. The inspection reports are forwarded to management for review, allocation of resources are made (if needed), and corrective actions are taken. ASUS has a dedicated Safety Coordinator located at each military base installation served. The onsite Safety Coordinator is responsible for regulatory compliance, as well as beneficial health and safety monitoring functions.

Learning and Development

Compliance training is required each year, for each employee. Other types of training are offered on an optional basis. Examples of optional programs include ongoing water operations competencies and education, supervisor development, knowledge capture and management, feedback and measurements to show the value of learning solutions, and administrative oversight for various business competencies relative to mandated training and compliance requirements. We pay for approved external business-related seminars and workshops. Certain positions require employees to maintain all of their job-specific certifications, licenses and continuing education credits.

On a regular and ongoing basis, we require all employees to certify that they have reviewed and understand our Code of Conduct as well as our Employee Handbook. We provide harassment and prevention awareness training for all employees.

Succession Planning

On an annual basis, our senior management team completes a roadmap for improving human capital management by developing succession plans with the goal of achieving the most efficient alignment of resources and talent to meet business needs. This includes identifying key succession positions and potential successors for top-level positions, such as Vice Presidents, for the next ten years.

Recruiting, developing and retaining the right talent is key to our long-term success. With approximately 30% of our employees eligible for retirement in the next five years, we are focused on transferring institutional knowledge, continuing succession planning and pursuing recruitment and development strategies to attract qualified talent.

Item 1A. Risk Factors

You should carefully read the risks described below and other information in this Form 10-K in order to understand certain of the risks of our business.

Overview of Risk Factors

We have three business segments, water utility, electric utility and contracted services, each of which are subject to different risks as further discussed below. We are also subject to risks frequently encountered by businesses of our size.

Regulated Water and Electric Utility Operations

GSWC's and BVES's revenues depend substantially on the rates and charges we are permitted to recover from our customers and the timing of that recovery as authorized by the CPUC. Decisions of the CPUC could result in impairment charges and customer refunds, and delays in recovering costs in rates. Some of the factors impacting our ability to obtain rate recovery on a timely basis include opposition to rate increases arising out of increased costs for replacing aging infrastructure and increased costs associated with addressing climate change and weather event risks, such as drought, storms and wildfires in California, costs incurred in connection with complying with water quality regulations, costs incurred in connection with obtaining and complying with franchise agreements with local governmental agencies and costs of obtaining permits from local, state and federal governmental agencies. There may also be increased customer opposition to rate increases due to customer dissatisfaction with conservation rate structures and public safety power shutdowns.

Our water and electric utility services are provided in California. As a result, our financial results are largely subject to political, water supply, labor, utility cost and regulatory risks, economic conditions, natural disasters (which may increase as a result of climate change), and other risks affecting California businesses. Our assets are also subject to condemnation in California.

Contract Services Operations

All of our utility privatization contract services are provided to the U.S. government pursuant to the terms of firm-fixed-price contracts subject to annual economic price adjustments. ASUS may also, from time to time, perform construction services on military bases as a subcontractor or pursuant to task order agreements. These contracts may be terminated or services suspended at any time for convenience of the government. We are subject to penalties for failure to conform or comply with U.S. government regulations and the terms of our contracts, and may be suspended or debarred for such failure to comply. The fees that we may charge are adjusted annually and in response to our requests for equitable adjustments. We have experienced delays in obtaining price and equitable adjustments, as well as delays in being paid by the U.S. government.

We are also responsible for complying with water quality and wastewater quality regulations on military bases.

We compete with other companies in bidding on providing utility services on military bases. We submit bids on new U.S. government contracts for military bases based on estimates of cost and potential profit. Our estimates and judgment are important, for in the event we overpay to obtain a contract, we could incur losses on it.

Other Business Risks

We may be subject to financial losses, penalties and other liabilities if we fail to operate and maintain safe work sites, equipment and facilities, including losses, damages, penalties and other liabilities arising from wildfires, other natural disasters and terrorist activities. We may not be able to recover all these losses from insurance or from ratepayers or may experience delays in obtaining recovery for these losses.

We are also subject to other business risks typical of our business, including:

- Cybersecurity incidents and physical security risks of our infrastructure and data could disrupt our operations and critical systems, increase our expenses, result in liabilities to third parties and damage to our reputation;
- Failure to attract, train, develop and transition key employees with the necessary skills to replace employees who are retiring or otherwise terminate employment or to fill new positions needed to respond to the increase in public utility and environmental regulations;
- Failure to make accurate estimates about financing and accounting matters, and in filing requests for rate increases with the CPUC or requests for price adjustments with the U.S. government or in bids on military base contracts or obtain new task orders from the U.S. government;
- Our ability to finance significant capital expenditures required by our businesses, which could be adversely impacted by general economic and market conditions, delays in receiving decisions from the CPUC on our general rate cases or delays in receiving payment from the U.S. government;

- Volatility in economic conditions such as changes to inflation, short-term interest rate volatility, and other market conditions may adversely impact our financial performance;
- Changes in accounting, public utility, environmental and tax laws and regulations impacting our business;
- Our inability to comply with debt covenants in our debt agreements; and
- Final determination of our income tax liability by the federal and applicable state governments.

As a holding company, AWR is dependent upon dividends from its subsidiaries to pay dividends to its shareholders. The ability of its subsidiaries to pay dividends is dependent upon compliance with state laws governing the payment of dividends and the terms of the debt agreements with the applicable subsidiary.

Climate Change

Climate change has resulted in increased frequency and duration of droughts, potential degradation of water quality, and changes in demand for services. More frequent and extended California drought conditions may cause increased stress on surface water supplies and groundwater basins, as well as allocations of water from the State Water Project and the Colorado River. Wholesale water suppliers may not have adequate supply during extended periods of drought, which may result in increases in prices for water delivered to us. In addition, GSWC could experience an increased use of reclaimed or recycled water by GSWC customers, in lieu of GSWC supplying potable water to these customers. Reclaimed water generally has lower tariff rates than potable water and may be provided by other companies or government entities in GSWC's service territory. Prolonged droughts may also result in state-ordered mandatory or voluntary conservation efforts by customers, changes in customer conservation patterns and imposition of new regulations impacting such things as landscaping and irrigation patterns.

California has established long-term indoor and outdoor water use standards to address the impact of climate change on California water resources. These standards will require all urban water retailers to meet certain water use standards on a system-by-system basis. The extended drought in the Colorado River watershed has resulted in a short-term agreement between Arizona, California and Nevada and the Bureau of Reclamation to reduce the amount of water taken from the Colorado River by 10% over the next three years (through the end of 2026). The impact to GSWC as a result of the short-term agreement is not known at this time.

Drought conditions have contributed to increases in wildfires, which has resulted in new California legislation requiring electric utilities to adopt and implement wildfire mitigation plans. BVES is incurring increased capital expenditures related to the creation and implementation of these plans. We anticipate that the costs of capital improvements necessary to implement this program will continue to increase. BVES is also required to implement a public safety power shut-off program during high wildfire threat conditions. Shut-offs can reduce BVES's liquidity and decrease customer satisfaction. Abnormal weather patterns created by climate change can also impact electricity demand at BVES. The demand for electricity at our electric segment is greatly affected by winter snow levels. An increase in winter snow levels reduces the use of snow-making machines at ski resorts in the Big Bear area and, as a result, also reduces BVES's liquidity. Likewise, unseasonably warm weather during a skiing season may result in temperatures too high for snow making conditions, which also reduces our liquidity.

More extreme weather events which may result in flash flooding, mudslides and high winds which could damage our infrastructure and our customers' and/or suppliers' property as a result of climate change may increase our cost of maintaining our infrastructure, our ability to provide water or electric service and the demand of our services from customers whose property has been damaged. The cost of damage to our infrastructure may be somewhat mitigated if the CPUC permits us to establish a catastrophic emergency memorandum account enabling us to recover the costs incurred. Furthermore, potential future legislative efforts to ban gas powered power plants as a response to climate change may require us to replace our current 8.4 MW natural gas-powered generator before its useful life is completed.

Risks Associated with Regulated Public Utility and Contracted Services Operations

Our businesses are heavily regulated and, as a result, decisions by regulatory agencies or the U.S. government can significantly affect our businesses

GSWC's and BVES's revenues depend substantially on the rates and fees they charge their customers and their ability to recover costs on a timely basis as authorized by the CPUC, including the ability to recover the costs of purchased water, groundwater assessments, electricity, natural gas, chemicals, water treatment, security at water facilities and preventative maintenance and emergency repairs. Any delays by the CPUC in granting rate relief to cover increased operating and capital costs at our public utilities or delays in obtaining approval of our requests at ASUS for economic price or equitable adjustments for contracted services from the U.S. government may adversely affect our year-over-year financial performance, liquidity and cash flows. We may file for interim rates in California in situations where there may be delays in granting final rate relief during a general rate case proceeding. If the CPUC approves lower rates than the interim rates we were permitted to adopt, the

CPUC will require us to refund to customers the difference between the interim rates and the rates approved by the CPUC. Similarly, if the CPUC approves rates that are higher than the interim rates, the CPUC may authorize us to recover the difference between the interim rates and the final rates.

Regulatory decisions affecting GSWC and/or BVES may also impact prospective revenues and earnings, affect the timing of the recognition of revenues and expenses, may overturn past decisions used in determining our revenues and expenses, and could result in impairment charges and customer refunds. Negative decisions made by the CPUC may have an adverse effect on GSWC's or BVES's results of operations, financial position or cash flows and affect the ability of the regulated utilities to recover costs and an appropriate return on the capital investments being made.

On August 27, 2020, the CPUC issued a final decision in the first phase of the CPUC's Order Instituting Rulemaking evaluating the low income ratepayer assistance and affordability objectives contained in the CPUC's 2010 Water Action Plan, addressing the continued use of the Water Revenue Adjustment Mechanism ("WRAM") and the Modified Cost Balancing Account ("MCBA") by California water utilities. These mechanisms implemented in 2008 for the purpose of recovering the costs of water would be discontinued for years after 2024. However, on September 30, 2022, the governor of California signed Senate Bill ("SB") 1469. Effective January 1, 2023, SB 1469 allows Class A water utilities, including GSWC, to continue requesting the use of the WRAM in their next general rate case. With the passage of SB 1469, GSWC has requested the continued use of a full revenue decoupling mechanism, similar to the WRAM, in its next general rate case application filed in August 2023 that will establish new rates for the years 2025 – 2027. GSWC's request to continue using a full revenue decoupling mechanism in its next general rate case will be subject to CPUC approval.

Our regulated utilities' ongoing financial results depend on their ability to recover costs from its customers, including costs such as water or electricity purchased for its customers, through rates charged and billed to its customers as approved by the CPUC. Both GSWC's and BVES's financial results depend on its ability to earn a reasonable return on capital, from its credit facilities, long-term debt and equity as well as the recovery of costs such as operations and maintenance expense that are incurred. Our ability to recover costs and earn a reasonable rate of return can be affected by time lags or delays in receiving approvals on general rate case decisions from the CPUC to authorize recovery of customers' rates and differences between authorized rates and the actual costs incurred, due to increased levels of inflation, which each could adversely impact our financial condition and cash flows.

Management continually evaluates the anticipated recovery of regulatory assets, settlement of liabilities and revenues subject to refund and provides for allowances and reserves as deemed necessary. In the event that our assessment of the probability of recovery or settlement through the ratemaking process is incorrect, we will adjust the associated regulatory asset or liability to reflect the change in our assessment or any regulatory disallowances. A change in our evaluation of the probability over the recovery of regulatory assets including a future disallowance of previously granted regulatory mechanisms, or a regulatory disallowance of all or a portion of our costs could have a material adverse effect on our financial results.

We are also, in some cases, required to estimate future expenses and, in others, we are required to incur the expense before receiving approval to recover the costs. As a result, our revenues and earnings may fluctuate depending on the accuracy of our estimates, the timing of our investments or expenses or other factors. If expenses increase significantly over a short period, we may experience delays in recovery of these expenses and the inability to recover the carrying costs for the expenses, which increases risks of regulatory disallowances or write-offs.

Delays in obtaining approval of general rate cases could adversely impact our liquidity

We have been experiencing increasing delays in obtaining CPUC approval of our general rate cases. As a result, we have previously needed, and may need in the future, to undertake capital improvements described in our rate case filings before we receive CPUC approval to recover these costs in rates. BVES is required to file wildfire mitigation plans with OEIS for regulatory approval by the OEIS and the CPUC and, once approved, for BVES to make the capital improvements described in the wildfire mitigation plan. However, the CPUC does not approve recovery of any of the costs of implementing approved wildfire mitigation plans until it approves the next general rate case filed by BVES after the approval of the wildfire mitigation plans. As a result, there may be a delay in recovering costs associated with capital improvements required to be made by wildfire mitigation plans, and the CPUC may not approve all costs incurred in connection with the implementation of these plans that are incurred prior to obtaining CPUC approval of these costs in a general rate case.

Changes in laws, regulations and policies of regulatory agencies can significantly affect our business

Regulatory agencies may also change their rules and policies, which may adversely affect our profitability and cash flows. We are subject to regulations under U.S. federal and state regulations and policies including from the CPUC, Federal Energy Regulatory Commission and other regulatory agencies. Regulations and laws affect almost all aspects of our businesses and changes to such regulations are continuous and ongoing. There can be no assurance that laws, regulations and policies of regulatory agencies will not be changed in ways that will not materially impact our results of operations, financial position or cash flows.

Changes in policies of the U.S. government may adversely affect one or more of ASUS's subsidiaries. In certain circumstances, the U.S. government may be unwilling or unable to appropriate funds to pay costs mandated by changes in rules and policies of federal or state regulatory agencies. The U.S. government may disagree with the increases that we request and may delay approval of requests for equitable adjustment or economic price adjustments, which could adversely affect our anticipated rates of return at our contracted services business.

We may also be subject to fines or penalties if a regulatory agency or the U.S. government determine that we have failed to comply with laws, regulations or orders applicable to our businesses, unless we successfully appeal such an adverse determination. Regulatory agencies may disallow recovery of certain costs if they determine they may no longer be recovered in rates, or if audit findings determine that we have failed to comply with our policies and procedures for procurement or other practices.

Our assets at our regulated utilities are subject to condemnation

Municipalities and other governmental subdivisions may, in certain circumstances, seek to acquire certain of our assets through eminent domain proceedings. It is generally our practice to contest these proceedings, which may be costly and may temporarily divert the attention of management from the operation of our business. If a municipality or other governmental subdivision succeeds in acquiring our assets, there is a risk that we will not receive adequate compensation for the assets taken or be able to recover all charges associated with the condemnation of such assets. In addition, we would no longer be entitled to any portion of the revenues generated from the use of such assets.

Our costs of obtaining and complying with the terms of franchise agreements are increasing

Cities and counties in which GSWC and BVES operate have granted them franchises to construct, maintain and use pipes, wires and appurtenances in or along public streets and rights of way. The costs of obtaining, renewing and complying with the terms of these franchise agreements have been increasing as cities and counties attempt to regulate our operations within the boundaries of the city or unincorporated areas of the counties in which we operate. Our regulated utilities may also be required from time to time to relocate existing infrastructure in order to accommodate local infrastructure improvement projects. Cities and counties have also been imposing new fees on our operations, including pipeline abandonment fees and road-cut or other types of capital improvement fees. At the same time, there is increasing opposition from consumer groups to rate increases that may be necessary to compensate GSWC and BVES for the increased costs of regulation by local governments. These trends may adversely affect our ability to recover in rates the costs of providing water and electric services and to efficiently manage capital expenditures and operating and maintenance expenses within CPUC-authorized levels.

We have also experienced instances of increased costs and delays in obtaining permits that we need in order to install, maintain, repair, and replace some of our aging water and electric utility infrastructure and upgrades needed to comply with changes in laws and regulations or otherwise necessary to harden our infrastructure as a result of drought, wildfires and increases in the frequency and duration of more extreme weather events due to climate change.

Our liquidity and earnings may be adversely affected by maintenance costs at our regulated utilities

Some of our infrastructure in California is aging. We have experienced leaks and mechanical problems in some of these older systems. In addition, infrastructure maintenance expenses are affected by labor and material costs, inflationary changes impacting such costs, supply chain disruptions and more stringent environmental regulations. Our electrical systems have also required upgrades due to aging and new wildfire safety and other compliance requirements. While we spend significant amounts on maintenance each year, these costs can increase substantially and unexpectedly. There could be an increase in infrastructure damage if California experiences more extreme weather events resulting in damage to our property.

We include estimated increases in maintenance costs for future years in each water and electric general rate case filed by GSWC and BVES, respectively, for possible recovery. To the extent that these estimates understate our actual costs, we may be unable to recover all maintenance costs in rates.

Adverse publicity and reputational risks can lead to increased regulatory oversight or sanctions

As a utility company, we have a large customer base and are therefore, subject to public criticism regarding, among other things, the quality and reliability of our water and electricity services, and the accuracy, timeliness and format of bills that are provided to our customers for such services. Adverse publicity and negative customer sentiment may cause regulatory authorities, including the CPUC, and other governing bodies to view us unfavorably and cause us to be susceptible to increased oversight and more stringent regulations and economic requirements.

Risks Associated with Health, Safety and Liability Matters

Our liquidity and earnings may be adversely affected by wildfires

It is possible that wildfires may occur more frequently, be of longer duration or impact larger areas as a result of drought-damaged plants and trees, lower humidity or higher winds that may occur as result of changing weather patterns. Our liquidity, earnings and operations may be materially adversely affected by wildfires. We may be required to (i) incur greater costs to relocate lines or increase our trimming of trees and other plants near our electric facilities to avoid wildfires, (ii) make significant additional capital expenditures to fund the projects in BVES's wildfire and safety mitigation plans, and (iii) bear the costs of damages to property or injuries to the public if it is determined that our power lines or other electrical equipment was a cause of such damages or injuries. In addition, wildfires may result in reduced demand if structures are destroyed or unusable following a wildfire and may adversely affect our ability to provide water or electric service in our service areas due to public safety power shutdowns or any of our water or electric utility infrastructure is damaged by a wildfire.

Losses by insurance companies resulting from wildfires in California have caused insurance coverage for wildfire risks to become more expensive and coverage could become unavailable on reasonable terms, and our insurance may be inadequate to recover all our losses incurred in a wildfire. We might not be allowed to recover in our rates any increased costs of wildfire insurance or the costs of any uninsured wildfire losses.

Electric utilities in California are authorized to shut off power for public safety reasons, such as during periods of extreme fire hazard, if the utility reasonably believes that there is an imminent and significant risk that strong winds may topple power lines or cause vegetation to come into contact with power lines leading to increased risk of fire. Shut-offs can reduce BVES's liquidity and decrease customer satisfaction.

These shut-offs can also adversely affect GSWC's water utility operations if the electric utilities that provide electric service to GSWC's water operations shut off power lines that deliver electricity to GSWC's water plant and equipment, thereby adversely affecting its ability to provide water service to its customers.

We may, in certain circumstances, be held strictly liable for damages to property caused by our equipment even if we are not negligent

Utilities in California may be held strictly liable, in certain circumstances, for damages caused by their property, such as mains, fire hydrants, power lines and other equipment, even though they were not negligent in the operation and maintenance of that property, under a doctrine known as inverse condemnation. Our liquidity, earnings and operations may be adversely affected if we are unable to recover the costs of paying claims for damages caused by the non-negligent operation and maintenance of our property from customers or through insurance.

We may be subject to financial losses, penalties and other liabilities if we fail to maintain safe work sites, equipment or facilities

Our safety record is critical to our reputation. We maintain health and safety standards to protect our employees, customers, vendors and the public. Although we aim to comply with such health and safety standards, it is unlikely that we will be able to avoid all accidents or other events resulting in damage to property or the public.

Our business sites, including construction and maintenance sites, often put our employees and others in close proximity with large pieces of equipment, moving vehicles, pressurized water, chemicals and other regulated materials. On many sites, we are responsible for safety and, accordingly, must implement safety procedures. If we fail in any respect to implement such procedures or if the procedures we implement are ineffective or are not followed by our employees or others, our employees and others may be injured or die. Unsafe work sites also have the potential to increase our operating costs. Any of the foregoing could result in financial losses, which could have a material adverse impact on our business, financial condition, and results of operations.

Our operations involve the handling and storage of hazardous chemicals that, if improperly handled, stored or disposed of, could subject us to penalties or other liabilities. We are also subject to regulations dealing with occupational health and safety. Although we maintain functional employee groups whose primary purpose is to ensure that we implement effective health, safety, and environmental work procedures throughout our organization, including construction sites and maintenance sites, a failure to comply with such regulations in any respect could subject us to liability.

The generation, transmission and distribution of electricity are dangerous and involve inherent risks of damage to private property and injury to employees and the general public

Electricity is dangerous for employees and the general public should they come in contact with electrical current or equipment, including through downed power lines, sparking during high-wind events or equipment malfunctions. Injuries and property damage caused by such events may subject BVES to significant liabilities that may not be covered or fully covered by insurance. Additionally, the CPUC has delegated to its staff the authority to issue citations, which carry a fine of $50,000 per-violation per day, to electric utilities subject to its jurisdiction for violations of safety rules found in statutes, regulations, and the General Orders of the CPUC.

We may sustain losses that exceed or are excluded from our insurance coverage or for which we are not insured

We are, from time to time, parties to legal or regulatory proceedings. These proceedings may pertain to regulatory investigations, employment matters or other disputes. Management periodically reviews its assessment of the probable outcome of these proceedings, the costs and expenses reasonably expected to be incurred, and the availability and extent of insurance coverage. On the basis of this review, management establishes reserves for such matters. We may, however, from time to time be required to pay fines, penalties or damages that exceed our insurance coverage and/or reserves if our estimate of the probable outcome of such proceedings proves to be inaccurate.

We maintain insurance coverage as part of our overall legal and risk management strategy to minimize our potential liabilities. Generally, our insurance policies cover property, workers' compensation, general liability, automobile liability, and other risks. Insurance coverage may not cover certain claims involving punitive damages. Each policy includes deductibles or self-insured retentions and policy limits for covered claims. Our insurance policies also contain exclusions and other limitations that may not cover our potential liabilities. Furthermore, due to insurance market conditions resulting in tighter underwriting and increased premiums along with reductions in capacity, we have experienced increased costs and difficulties in obtaining certain insurance coverages, particularly along the general liability, umbrella and cyber insurance lines. We may experience further increased insurance costs and/or coverage reductions in future years. As a result, we may sustain losses that exceed or that are excluded from our insurance coverage or for which we are not insured.

Uninsured losses and increases in the cost of insurance may not be recoverable or fully recoverable in customer rates. A loss which is not insured or not fully insured or cannot be recovered in customer rates could materially affect our financial condition and results of operations.

We operate in areas subject to natural disasters

We operate in areas that are prone to earthquakes, fires, mudslides, hurricanes, tornadoes, high winds, storms, flooding or other natural disasters. While we maintain insurance policies to help reduce our financial exposure, a significant seismic event in southern California, where our regulated water and electric operations are concentrated, wildfires or other natural disasters in any of the areas that we serve could adversely impact our ability to deliver water and electricity or provide wastewater service, and adversely affect our costs of operations. Any losses not covered by insurance could have an adverse effect on the results of operations, financial position, cash flows and reputation of our regulated utilities. In addition, such events may cause increases to the cost of the applicable insurance. With respect to GSWC and BVES, the CPUC has historically allowed utilities to establish a catastrophic emergency memorandum account ("CEMA") to potentially recover incremental costs not covered in rates caused by catastrophic emergency events. With respect to ASUS's subsidiaries, costs associated with responding to natural disasters have been recoverable through requests for equitable adjustment.

Our operations may be the target of terrorist activities

Terrorists could seek to disrupt service to our customers by targeting our assets through physical or cyber events. We also may be prevented from providing water and/or wastewater services at the military bases we serve in times of military crisis affecting these bases. We have invested in additional security for facilities throughout our regulated service areas to mitigate the risks of terrorist activities. In addition, we continue to increase our investment in information technology to monitor and address cyber threats and attempted cyber-attacks, and to improve our posture in addressing security vulnerabilities.

Water Quality Regulatory Risks

Our costs involved in maintaining water quality and complying with environmental regulation have increased and are expected to continue to increase

Capital and operating costs at GSWC may increase substantially as a result of increases in environmental regulation arising from increases in the cost of upgrading and building new water treatment plants, disposing of residuals from our water treatment plants, handling and storing hazardous chemicals, compliance-monitoring activities and securing alternative supplies when necessary. GSWC may be able to recover these costs from customers through the ratemaking process. We may also be able to recover a portion of these costs from certain third parties under settlement and contractual arrangements. Our capital and operating costs may also increase as a result of changes in laboratory detection capabilities and drinking water notification levels, response levels, and maximum contaminant levels for certain substances, such as perfluoroalkyl substances ("PFAS") used to make certain fabrics and other materials, certain fire suppression agents and used in various industrial processes. Additional information regarding the regulation of PFAS in drinking water is provided in Item 7. "*Management's Discussion and Analysis of Financial Condition and Results of Operations*" under the heading "*Environmental Matters*."

Our operating costs may increase as a result of groundwater contamination

Our operations can be impacted by groundwater contamination in certain service territories. Historically, we have taken a number of steps to address contamination, including the removal of wells from service, decreasing the amount of groundwater pumped from wells in order to facilitate remediation of plumes of contaminated water, constructing water treatment facilities and securing alternative sources of supply from other areas not affected by the contamination. In emergency situations, we have supplied our customers with bottled water until the emergency situation has been resolved.

Our ability to recover these types of costs depends upon a variety of factors, including approval of rate increases, the willingness of potentially responsible parties to settle litigation and otherwise address the contamination, and the extent and magnitude of the contamination. We may recover costs from certain third parties that may be responsible, or potentially responsible, for groundwater contamination. However, we often experience delays in obtaining recovery of these costs and incur additional costs associated with seeking recovery from responsible or potentially responsible parties, which may adversely impact our liquidity. In some events, we may be unable to recover all of these costs from third parties due to the inability to identify the potentially responsible parties, the lack of financial resources of responsible parties or the high litigation costs associated with obtaining recovery from responsible or potentially responsible parties.

We can give no assurance regarding the adequacy of any such recovery to offset the costs associated with contamination or the cost of recovery of any legal costs. To date, the CPUC has permitted us to establish memorandum accounts for potential recovery of these types of costs when they have arisen.

Management believes that rate recovery, proper insurance coverage and reserves are in place to appropriately manage these types of contamination issues. However, such issues, if ultimately resolved unfavorably to us, could, in the aggregate, have a material adverse effect on our results of operations and financial condition.

Water Supply Risks

The adequacy of our water supplies depends upon weather and a variety of other uncontrollable factors

The adequacy of our water supplies varies from year to year depending upon a variety of factors, including:

- rainfall, basin replenishment, flood control, snowpack levels in California and the West, reservoir levels and availability of reservoir storage;
- availability of Colorado River water and imported water from the State Water Project;
- the amount of usable water stored in reservoirs and groundwater basins;
- the amount of water used by our customers and others;
- water quality;
- legal limitations on production, diversion, storage, conveyance and use; and
- climate change.

California drought conditions in recent years and historically and changes in weather patterns have caused an increased stress on surface water supplies and groundwater basins. In addition, low or no allocations of water from the State Water Project and court-ordered pumping restrictions on water obtained from the Sacramento-San Joaquin Delta decrease or eliminate the amount of water that the Metropolitan Water District of Southern California (“MWD”) and other state water contractors are able to import from northern California.

We have implemented tiered rates and other practices, as appropriate, in order to encourage water conservation. We have also implemented programs to assist customers in complying with water usage reductions. Over the long term, we are acting to secure additional supplies, which may include supplies from desalination and increased use of reclaimed water, where appropriate and feasible. We cannot predict the extent to which these efforts to reduce stress on our water supplies will be successful or sustainable, or the extent to which these efforts will enable us to continue to satisfy all of the water needs of our customers. Water shortages at GSWC may:

- adversely affect our supply mix, for instance, by causing increased reliance upon more expensive water sources;
- adversely affect our operating costs, for instance, by increasing the cost of producing water from more highly contaminated aquifers or requiring us to transport water over longer distances, truck water to water systems or adopt other emergency measures to enable us to continue to provide water service to our customers;
- result in an increase in our capital expenditures over the long term, for example, by requiring future construction of pipelines to connect to alternative sources of supply, new wells to replace those that are no longer in service or are otherwise inadequate to meet the needs of our customers, and other facilities to conserve or reclaim water;
- adversely affect the volume of water sold as a result of such factors as mandatory or voluntary conservation efforts by customers, changes in customer conservation patterns, recycling of water by customers and imposition of new regulations impacting such things as landscaping and irrigation patterns;

- adversely affect aesthetic water quality if we are unable to flush our water systems as frequently due to water shortages or drought restrictions; and
- result in customer dissatisfaction and harm to our reputation if water service is reduced, interrupted or otherwise adversely affected as a result of drought, water contamination or other causes.

Our liquidity may be adversely affected by changes in water supply costs

We obtain our water supplies for GSWC from a variety of sources, which vary among our water systems. Certain systems obtain all of their supply from water that is pumped from aquifers within our service areas; some systems purchase all of their supply from wholesale suppliers; some systems obtain their supply from treating surface water sources; and other systems obtain their supply from a combination of wells, surface water sources and/or wholesale suppliers. The cost of obtaining these supplies varies, and overall costs can be impacted as use within a system varies from time to time. As a result, our cost of providing, distributing and treating water for our customers' use can vary significantly.

Furthermore, imported water wholesalers, such as MWD, may not always have an adequate supply of water to sell to us. Wholesale water suppliers may increase their prices for water delivered to us based on factors that affect their operating costs. Purchased water rate increases are beyond our control.

Since 2008, GSWC has implemented a modified supply cost balancing account, the MCBA, to track and recover costs from supply mix changes and rate changes by wholesale suppliers, as authorized by the CPUC. However, cash flows from operations can be significantly affected since much of the balance we recognize in the MCBA is collected from or refunded to customers primarily through surcharges or surcredits, respectively, generally over twelve- to twenty-four-months. Beginning 2025, the MCBA will be discontinued and no longer be available to recover costs from supply mix changes and rate changes by wholesale suppliers. However, as SB 1469 was passed in 2022, GSWC and other Class A water utilities are allowed to continue to request the MCBA in future general rate case applications. GSWC has requested for the continued use of a full supply cost balancing account, similar to the MCBA, in its next general rate case application filed in August 2023. GSWC's request to continue using a full supply cost balancing account in its next general rate case will be subject to CPUC approval.

Our liquidity and earnings may be adversely affected by our conservation efforts

Our water utility business is heavily dependent upon revenue generated from rates charged to our customers based on the volume of water used. The rates we charge for water are regulated by the CPUC and may not be adequately adjusted to reflect changes in demand. Declining usage also negatively impacts our long-term operating revenues if we are unable to secure rate increases or if growth in the customer base does not occur to the extent necessary to offset per-customer usage decline.

Conservation by all customer classes at GSWC is a top priority. However, customer conservation will result in lower volumes of water sold. We may experience a decline in per-customer water usage due to factors such as:

- conservation efforts to reduce costs;
- drought conditions resulting in additional water conservation;
- the use of more efficient household fixtures and appliances by customers to save water;
- voluntary or mandatory changes in landscaping and irrigation patterns;
- recycling of water by our customers; and
- mandated water-use restrictions.

These types of changes may result in permanent decreases in demand even if our water supplies are sufficient to meet higher levels of demand after a drought ends. In addition, governmental restrictions on water usage during drought conditions may result in a decreased demand for water, even if our sources of supply are sufficient to serve our customers during such drought conditions. California has established long-term indoor and outdoor water use standards to address the impact of climate change on California water resources and mandate water conservation requirements on all Californians. These standards will require all urban water retailers to meet certain water use standards on a system-by-system basis.

Since 2008, we have implemented the CPUC-approved WRAM at GSWC, which has the effect of stabilizing revenues at the adopted level thereby reducing the potential adverse earnings impact of our customers' conservation efforts. However, cash flows from operations can be significantly affected since much of the balance we recognize in the WRAM account is collected from or refunded to customers generally over twelve-, eighteen- or twenty-four-month periods.

Electric Segment Operations Risks

Our electric segment operates in a high wildfire risk area

Drought conditions in recent years and historically as well as shifting weather patterns in California as a result of climate change have created dry vegetation and higher risks of wildfire in California. Severe wildfires can pose a material risk for BVES in the event of the occurrence of a wildfire. There is no assurance that losses incurred through a wildfire event will not exceed the coverage limits of BVES's insurance coverage. Any losses not fully insured by BVES's insurance coverage may not be approved by the CPUC for future cost recovery.

BVES is required to adopt and implement a wildfire mitigation plan that is submitted periodically to, and subject to the approval of, the CPUC. In December 2023, the CPUC ratified BVES's 2023-2025 wildfire mitigation plan which was also approved by the Office of Energy Infrastructure Safety in the fourth quarter of 2023. The recovery of costs incurred to implement this plan are not approved by the CPUC at the time of its approval of the wildfire mitigation plan but will only be approved by the CPUC in a subsequent general rate case. We anticipate that the costs of capital improvements necessary to implement this program will increase substantially.

BVES is also required to implement a public safety power shut-off program during high wildfire threat conditions. The CPUC may assess penalties if BVES shuts-down power to its customers and the CPUC determines that the shutdown was not reasonably necessary in the circumstances. As a result of shutting-down power to its customers, BVES's cash flows may be negatively affected due to a reduction in electricity sold. However, BVES has implemented a CPUC-approved revenue decoupling mechanism that mitigates the impact of customer usage fluctuations to earnings.

BVES has also obtained a safety certificate, which must be renewed annually by the CPUC. Even with an approved safety certificate, BVES could be found liable for deaths, injuries and property damage if BVES's electric equipment is found to have caused a catastrophic wildfire and it is determined by the CPUC that BVES did not act reasonably in operating and maintaining its equipment. BVES may not be able to recover the costs of all liabilities from such a wildfire from insurance or from ratepayers.

Our liquidity may be adversely affected by increases in electricity and natural gas prices in California

We purchase most of the electric energy sold to customers in our electric customer service area from others under purchased power contracts. In addition to purchased power contracts, we purchase additional energy from the spot market to meet peak demand and following the expiration of purchased power contracts if there are delays in obtaining CPUC authorization of new purchase power contracts. We may sell surplus power to the spot market during times of reduced energy demand. As a result, our cash flow may be affected by increases in spot market prices of electricity purchased and decreases in spot market prices for electricity sold. However, BVES has implemented a CPUC-approved supply-cost balancing account to mitigate the impact to earnings from fluctuations in supply costs.

Unexpected generator downtime at our 8.4 megawatt natural-gas-fueled generator or a failure to perform by any of the counterparties to our electric and natural gas purchase contracts could further increase our exposure to fluctuating natural gas and electricity prices.

Changes in electricity prices also affect the unrealized gains and losses on our block forward purchased power contracts that qualify as derivative instruments since we adjust the asset or liability on these contracts to reflect the fair market value of the contracts at the end of each month. The CPUC has authorized us to establish a memorandum account to track the changes in the fair market value of our purchased power contracts. As a result, unrealized gains and losses on these types of purchased power contracts do not impact earnings.

We may not be able to procure sufficient renewable energy resources to comply with CPUC rules

We are required to procure a portion of our electricity for BVES from renewable energy resources to meet the CPUC's renewable procurement requirements. We have agreements with third parties to purchase renewable energy credits, which enables us to meet these requirements through 2024. The next RPS compliance period is years 2025-2027. In the event that the third parties fail to perform in accordance with the terms of the agreement, we may not be able to obtain sufficient resources to meet the renewable procurement requirements. We may be subject to fines and penalties by the CPUC if it determines that we are not in compliance with the renewable resource procurement rules.

Utility Privatization Contract Risks

Our contracts for servicing military bases create certain risks that are different from our public utility operations

We have entered into contracts to provide water and/or wastewater services at military bases primarily pursuant to initial 50-year, firm-fixed-priced contracts, additional firm-fixed-price contracts and task order contracts, subject to termination, in whole or in part, for the convenience of the U.S. government. We also from time to time enter into contracts with third party prime contractors on military bases. The U.S. government may stop work under the terms of one or more of these contracts, not provide additional task orders, delay performance of our obligations under the contracts, or modify the contracts at its convenience.

Our contract pricing is based on a number of assumptions, including assumptions about the condition and amount of infrastructure at the military bases, prices and availability of labor, equipment and materials. We may be unable to recover all costs if any of these assumptions are inaccurate or if all costs incurred in connection with performing the work were not considered. Our contracts are also subject to annual economic price adjustments, adjustments as task orders are issued or other changes permitted by the terms of the contracts. Prices are also subject to equitable adjustment based upon changes in circumstances, laws or regulations and service-requirement changes to the extent provided in each of the contracts.

We are required to record all costs under our military base contracts as they are incurred. As a result, we may record losses associated with unanticipated conditions that result in higher than estimated costs, higher than anticipated infrastructure levels, and required emergency work at the time such expenses occur. We recognize additional revenue for such work as, and to the extent that, our economic price adjustments and/or requests for equitable adjustments are approved. Delays in obtaining approval of economic price adjustments and/or equitable adjustments can negatively impact our results of operations and cash flows.

Certain payments under these contracts are subject to appropriations by Congress. We may experience delays in receiving payment or delays in price adjustments due to canceled or delayed appropriations specific to our projects, reductions in government spending for the military generally or military-base operations specifically or other delays in Congress approving appropriations. Appropriations and the timing of payment may be influenced by, among other things, the state of the economy, competing political priorities, budget constraints, the timing and amount of tax receipts, government shutdowns and the overall level of government expenditures.

We may experience delays in receiving payments for services rendered in military bases due to delays in Congressional appropriation bills or other factors affecting the available funds to pay contractors.

Our contracts for the construction of infrastructure improvements on military bases create risks that are different from those of our public utility operations and maintenance activities

We have entered into contract modifications with the U.S. government and agreements with third parties for the construction of new water and/or wastewater infrastructure at the military bases on which we operate. Most of these contracts are firm-fixed-price contracts. Under firm-fixed-price contracts, we will benefit from cost savings, but are generally unable (except for changes in scope or circumstances approved by the U.S. government or third party) to recover any cost overruns to the approved contract price. Under most circumstances, the U.S. government or third party has approved increased-cost change orders due to changes in scope of work performed.

We generally recognize contract revenues from these types of contracts over time using input methods to measure progress towards satisfying a performance obligation. The measurement of performance over time is based on cost incurred relative to total estimated costs, or the physical completion of the construction projects. The earnings or losses recognized on individual contracts are based on periodic estimates of contract revenues, costs and profitability as these construction projects progress.

We establish prices for these types of firm-fixed-price contracts and the overall contract taken as a whole, based, in part, on cost estimates that are subject to a number of assumptions, including assumptions regarding future economic conditions. If these estimates prove inaccurate or circumstances change, cost overruns could have a material adverse effect on our contracted business operations and results of operations.

We may be adversely affected by disputes with the U.S. government regarding our performance of contracted services on military bases

Entering into contracts with the U.S. government subjects us to a number of operational and compliance risks over our performance of contracted services on military bases. We are periodically audited or reviewed by the Defense Contract Auditing Agency ("DCAA"), the Defense Contract Management Agency ("DCMA"), the Department of Labor, the Defense Logistics Agency Energy, and/or the Department of Justice for compliance with federal acquisition regulations, cost-accounting standards and other laws, regulations and standards that are not applicable to the operations of GSWC or BVES. During the course of these audits/reviews, the U.S. government may question our incurred project costs or the manner in which we have accounted for such costs and recommend to our U.S. government administrative contracting officer that such costs be disallowed. If there is a dispute with the U.S. government regarding performance under these contracts or the amounts owed to us, the U.S. government may delay, reject or withhold payment, delay price adjustments or assert its right to offset damages against amounts owed to us. If we are unable to collect amounts owed to us on a timely basis or the U.S. government asserts its offset rights, profits and cash flows could be adversely affected.

Moreover, we are subject to potential government investigations of our business practices and compliance with government procurement statutes and security regulations. If we are charged with wrongdoing as a result of an investigation, or if we fail to comply with the terms of one or more of our U.S. government contracts, other agreements with the U.S. government or U.S. government statutes and regulations, our existing contracts could be terminated or we could be suspended or barred from future U.S. government contracts for a period of time, and be subject to possible damages, fines and penalties as well as damage to our reputation in the water and wastewater industry, which could have a material adverse effect on our results of operations and cash flows.

We depend, to some extent, upon subcontractors to assist us in the performance of contracted services on military bases

We rely, to some extent, on subcontractors to assist us in the operation and maintenance of the water and wastewater systems at military bases. The failure of any of these subcontractors to perform services for us in accordance with the terms of our contracts with the U.S. government could result in the termination of our contract to provide water and/or wastewater services at the affected base(s), and/or a loss of revenues, or increases in costs, to correct a subcontractor's performance failures.

We are also required to make a good faith effort to achieve our small business subcontracting plan goals pursuant to U.S. government regulations. If we fail to use good faith efforts to meet these goals, the U.S. government may assess damages against us at the end of the contract. The U.S. government has the right to offset claimed damages against any amounts owed to us.

We also rely on third-party manufacturers, as well as third-party subcontractors, to complete our construction projects. To the extent that we cannot engage subcontractors or acquire equipment or materials, our ability to complete a project in a timely fashion or at a profit may be impaired. If the amount of costs we incur for these projects exceeds the amount we have estimated in our bids, we could experience reduced profits or losses in the performance of these contracts. In addition, if a subcontractor or manufacturer is unable to deliver its services, equipment or materials according to the negotiated terms for any reason, including the deterioration of its financial condition, we may be required to purchase the services, equipment or materials from another source at a higher price. This may reduce the profit to be realized or result in a loss on a project for which the services, equipment or materials were needed.

If subcontractors fail to perform services to be provided to us or fail to provide us with the proper equipment or materials, we may be penalized for their failure to perform; however, our contracts with subcontractors include certain protective provisions, which may include the assessment of liquidated damages. We also mitigate these risks by requiring our subcontractors, as appropriate, to obtain performance bonds and to compensate us for any penalties we may be required to pay as a result of their failure to perform.

We may not be fully reimbursed for all of our construction costs or may only receive payment on a delayed basis

Unlike GSWC and BVES, who recover their capital investments from customers over the life of the assets through annual depreciation and earn a return on such investments through the ratemaking process, ASUS is reimbursed for the cost of ongoing renewal and replacement construction projects plus a profit through the collection of a monthly cash stream under each of the 50-year contracts with the U.S. government. ASUS also receives funding from the U.S. government for initial and other new construction projects at the military bases it serves that, in many cases, are outside the scope of contracts with the U.S. government and are granted through firm-fixed contract modifications. ASUS's subsidiaries expect to continue incurring significant construction costs. Reimbursement by the U.S government for these construction costs may not be fully reimbursable if the costs incurred are greater than the amounts estimated and approved by the U.S. government, or payments may be delayed awaiting government funding and processing, which could significantly affect our cash flows from operations.

Other Contracted Services Segment Risks

Risks associated with wastewater systems are different from those of our water distribution operations

The wastewater-collection-system operations of our ASUS subsidiaries providing wastewater services on military bases are subject to substantial regulation and involve significant environmental risks. If collection, treatment or disposal systems fail, overflow or do not operate properly, untreated wastewater or other contaminants could spill onto nearby properties or into nearby streams and rivers, causing damage to persons or property, injury to aquatic life and economic damages. The cost of addressing such damages may not be recoverable. This risk is most acute during periods of substantial rainfall or flooding, which are common causes of sewer overflows and system failures. These risks may be increased as a result of an increase in the duration and frequency of storms due to climate change. Liabilities resulting from such damage could adversely and materially affect our business, results of operations and financial condition. In the event that we are deemed liable for any damage caused by overflows, our losses may not be recoverable under our contracts with the U.S. government or covered by insurance policies. We may also find it difficult to secure insurance for this business in the future at acceptable rates.

We may have responsibility for water quality at the military bases we serve

While it is the responsibility of the U.S. government to provide the source of water supply to meet ASUS's subsidiaries water distribution system requirements under their contracts with the U.S. government, the ASUS's subsidiaries, as the water system permit holders for most of the bases they serve, are responsible for ensuring the continued compliance of the provided source of supply with all federal, state and local regulations. We believe, however, that the terms of the contracts between ASUS's subsidiaries and the U.S. government provide the opportunity for us to recover costs incurred in the treatment or remediation of any quality issue that arises from the source of water supply.

Our earnings may be affected, to some extent, by weather during different seasons

Seasonal weather conditions, such as hurricanes, heavy rainfall or significant winter storms, occasionally cause temporary office closures and/or result in temporary halts to construction activity at military bases. To the extent that our construction activities are impeded by these events, we will experience a delay in recognizing revenues from these construction projects.

We continue to incur costs associated with the expansion of our military base contract activities

We continue to incur additional costs in connection with the expansion of our contract operations associated with the preparation of bids for new contract operations on prospective and existing military bases. Our ability to recover these costs and to earn a profit on our contract operations will depend upon the extent to which we are successful in obtaining new contracts and recovering these costs and other costs from new contract revenues.

We face intense competition for new military base contracts

An important part of our growth strategy is the expansion of our contracted services business through new contract awards to serve additional military bases for the U.S. government. ASUS competes with other investor-owned utilities, municipalities, and other entities for these contracts.

Additionally, the U.S. government periodically reviews the cost and overall effectiveness of the military privatization program. Should these reviews prompt a decision to curtail or eliminate the issuance of solicitations for future military base contract awards, the potential for growth in this segment could be negatively impacted.

Information Technology Risk Factors

We must successfully maintain and/or upgrade our information technology systems as we are increasingly dependent on the continuous and reliable operation of these systems

We rely on various information technology systems to manage our operations. Such systems require periodic modifications, upgrades and/or replacement, which subject us to inherent costs and risks, including potential disruption of our internal control structure, substantial capital expenditures, additional administrative and operating expenses, retention of sufficiently skilled personnel to implement and operate the new systems, and other risks and costs of delays or difficulties in transitioning to new systems or of integrating new systems into our current systems. In addition, the difficulties with implementing new technology systems may cause disruptions in our business operations and have an adverse effect on our business and operations, if not anticipated and appropriately mitigated.

We rely on our computer, information and communications technology systems in connection with the operation of our business, especially with respect to customer service and billing, accounting and the monitoring and operation of our treatment, storage and pumping facilities. Our computer and communications systems and operations could be damaged or interrupted by weather, natural disasters, telecommunications failures, cyberattacks or acts of war or terrorism or similar events or disruptions. Any of these or other events could cause system interruption, delays and loss of critical data, delay or prevent operations or delay in notification of system failures or emergencies and adversely affect our financial results and could result in liabilities not covered by insurance or recoverable in rates for misappropriation of assets or sensitive information, corruption of data and the impact of operational disruptions on our customers.

Cybersecurity incidents could disrupt our internal operations, and any such disruption could increase our expenses, damage our reputation and adversely affect our stock price

There continues to be an increasing number of cyberattacks on companies around the world, which have caused operational failures or compromised sensitive corporate or customer data. These attacks have occurred over the internet, through malware, viruses or attachments to e-mails, or through persons inside the organization or with access to systems inside the organization and may be heightened with the increased use and prevalence of artificial intelligence. Although we do not believe that our systems are at a materially greater risk of cybersecurity attacks than other similar organizations, our information technology systems remain at risk to damage or interruption from the following among other types of cybersecurity risks:

- Supply Chain Attacks;

- Malicious Software;
- Credential Loss or Theft;
- Supervisory Control and Data Acquisition System Takeover;
- Equipment Theft;
- Ransomware;
- Actions of Employees (Intentional or Accidental);
- Phishing Attacks;
- Identity-Based Attacks; and
- Denial-of-Service Attacks.

We believe a breach of customer personally identifiable information is one of the most significant financial risks to us as the costs incurred could exceed the amount of our cybersecurity insurance coverage and these costs may increase if we fail to comply with federal and state privacy regulations such as the California Consumer Privacy Act ("CCPA"), a state statute that became effective January 1, 2020, which enhances the privacy rights and consumer protections for California residents. Among other things, the CCPA establishes statutory damages for victims of data security breaches, and provides additional rights for consumers to obtain their data from any business that has their personally identifying information. Any actual or perceived failure to comply with the CCPA could lead to investigations, claims, and proceedings by governmental entities and private parties, damages for breach, and other significant costs, penalties, and other liabilities, as well as harm to our reputation.

We have implemented security measures and will continue to devote significant resources to improve our security posture to address any security vulnerabilities in an effort to prevent cyberattacks. Despite our efforts, due to the evolving nature of cyberattacks and vulnerabilities, we cannot be assured that a cyberattack will not cause water, wastewater or electric system problems, disrupt service to our customers, compromise important data or systems or result in unintended release of customer or employee information. Moreover, if a security breach affects our systems or results in the unauthorized release of sensitive data, our reputation could be materially damaged. We may not discover any security breach and loss of information for a significant period of time after the security breach. We could also be exposed to a risk of loss or litigation and possible liability. Pursuant to U.S. government regulations regarding cybersecurity of government contractors, we might be subject to fines, penalties or other actions, including debarment, with respect to current contracts or with respect to future contract opportunities.

We maintain cybersecurity insurance to provide coverage for a portion of the losses and damages that may result from a security breach, but such insurance is subject to a number of exclusions and may not cover the total loss caused by a breach. Other costs associated with cyber incidents may not be covered by insurance or recoverable in rates. The market for cybersecurity insurance continues to evolve and may affect the future availability of cyber insurance at reasonable rates.

Human Capital Management Risks

Failure to attract, retain, train, motivate, develop and transition key employees could adversely affect our business

In order to be successful, we must attract, retain, train, motivate, and develop key employees, including those in managerial, operational, financial, regulatory, business-development and information-technology support positions. Our regulated business and contracted services operations are complex. Attracting and retaining high quality staff allows us to minimize the cost of providing quality service. In order to attract and retain key employees in a competitive marketplace, we must provide a competitive compensation package and be able to effectively recruit qualified candidates. This is especially challenging for us since approximately 30% of our employees will be eligible to retire in the next five years. The failure to successfully hire key employees or the loss of a material number of key employees could have a significant impact on the quality of our operations in the short term. Further, changes in our management team may be disruptive to our business, and any failure to successfully transition key new hires or promoted employees could adversely affect our business and results of operations.

Failure of our employees to maintain required certifications and licenses or to complete required compliance training could adversely impact our ability to operate and maintain our utility systems and provide services to our customers

Many of our employees must have specialized certifications and licenses in order to perform their duties and periodically complete required compliance training. Our business could be adversely affected if our employees do not maintain their certifications and licenses or we are unable to attract employees with the necessary certifications and licenses.

Other Business Risk Factors

The accuracy of our judgments and estimates about financial and accounting matters will impact our operating results and financial condition

The quality and accuracy of estimates and judgments used have an impact on our operating results and financial condition. If our estimates are not accurate, we will be required to make an adjustment in a future period. We make certain estimates and judgments in preparing our financial statements regarding, among others:

- timing of recovering WRAM, MCBA and BRRAM regulatory assets;
- amounts to set aside for uncollectible accounts receivable, inventory obsolescence and uninsured losses;
- our legal exposure and the appropriate accrual for claims, including general liability and workers' compensation claims;
- future costs and assumptions for pensions and other post-retirement benefits;
- regulatory recovery of deferred items; and
- possible tax uncertainties.

Market conditions and demographic changes may adversely impact the value of our benefit plan assets and liabilities

Market factors can affect assumptions we use in determining funding requirements with respect to our pension and other post-retirement benefit plans. For example, a relatively modest change in our assumptions regarding discount rates can materially affect our calculation of funding requirements. To the extent that market data compels us to reduce the discount rate used in our assumptions, our benefit obligations could materially increase, which could adversely affect our financial position and cash flows. Further, changes in demographics, such as increases in life expectancy assumptions may also increase the funding requirements of our obligations related to our pension and other post-retirement benefit plans.

Market conditions also affect the values of the assets that are held in trusts to satisfy significant future obligations under our pension and other post-retirement benefit plans. These assets are subject to market fluctuations, which may cause investment returns to fall below our projected rates of return. A decline in the market value of our pension and other post-retirement benefit plan assets will increase the funding requirements under these plans if future returns on these assets are insufficient to offset the decline in value. Future increases in pension and other post-retirement costs as a result of the reduced value of plan assets may not be fully recoverable in rates, and our results of operations and financial position could be negatively affected. These risks are mitigated to some extent by the two-way pension balancing accounts authorized by the CPUC, which permits us to track differences between forecasted annual pension expense adopted in water and electric rates and actual pension expenses for future recovery or refund to customers.

Our business requires significant capital expenditures and our inability to access the capital or financial markets could affect our ability to meet our liquidity needs and long-term commitments, which could adversely impact our operations and financial results

The utility business is capital intensive. We spend significant sums of money for additions to, or replacement of, our property, plant and equipment at our water and electric regulated utilities. We obtain funds for these capital projects from operations, contributions by developers and others, and refundable advances from developers (which are repaid over a period of time). We periodically borrow money or issue equity or debt securities for these purposes. In addition, we have revolving credit facilities that are used for capital expenditure programs with our utilities and operations. We cannot provide assurance that these sources will continue to be adequate or that the cost of funds will remain at levels permitting us to earn a reasonable rate of return.

As our capital investment program continues to increase, coupled with the elimination of bonus depreciation for regulated utilities due to tax reform, we will need access to external financing more often, which increases our exposure to market conditions. In addition to cash flow from operations, we rely primarily on our credit facilities and long-term debt to satisfy our liquidity needs. We also may from time to time issue Common Shares to support our capital investment program. Changes in market conditions, including events beyond our control such as recent increases to interest rates, could limit our ability to access capital on terms favorable to us or at all, including obtaining credit facilities with the borrowing capacities needed as well as issuing equity or debt securities. As a result, the amount of capital available may not be sufficient to meet all our liquidity needs at a reasonable cost at all of our subsidiaries.

Payment of our debt may be accelerated if we fail to comply with restrictive covenants in our debt agreements

Our failure to comply with restrictive covenants in our debt agreements could result in an event of default. If the default is not cured or waived, we may be required to repay or refinance the debt before it becomes due. Even if we are able to obtain waivers from our creditors, we may only be able to do so on unfavorable terms. Our ability to comply with the financial covenants in our debt agreements may be adversely affected by delays in obtaining CPUC approval of our general rate case filings.

The price of our Common Shares may be volatile and may be affected by market conditions beyond our control

The trading price of our Common Shares may fluctuate in the future because of the volatility of the stock market and a variety of other factors, many of which are beyond our control. Factors that could cause fluctuations in the trading price of our Common Shares include: changes in interest rates; regulatory developments, decisions and delays; general economic conditions and trends; price and volume fluctuations in the overall stock market; actual or anticipated changes or fluctuations in our results of operations; actual or anticipated changes in the expectations of investors or securities analysts; actual or anticipated developments in other utilities' businesses or the competitive landscape generally; litigation involving us or our industry; major catastrophic events, or sales of large blocks of our stock.

AWR is a holding company that depends on cash flow from its subsidiaries to meet its financial obligations and to pay dividends on its Common Shares

As a holding company, our subsidiaries conduct substantially all operations and our only significant assets are investments in our subsidiaries. This means that we are dependent on distributions of funds from our subsidiaries to meet our debt service obligations and to pay dividends on our Common Shares.

Our subsidiaries are separate and distinct legal entities and generally have no obligation to pay any amounts due on AWR's credit facility. Our subsidiaries only pay dividends if and when declared by the respective subsidiary board. Moreover, GSWC and BVES are obligated to give first priority to their own capital requirements and to maintain capital structures consistent with those determined to be reasonable by the CPUC in its most recent decisions on capital structure for both GSWC and BVES in order for customers to not be adversely affected by the holding company structure. Furthermore, our right to receive cash or other assets in the unlikely event of liquidation or reorganization of any of our subsidiaries is generally subject to the prior claims of creditors of that subsidiary. If we are unable to obtain funds from a subsidiary in a timely manner, we may be unable to meet our financial obligations, make additional investments or pay dividends.

The final determination of our income tax liability may be materially different from our income tax provision

Significant judgment is required in determining our provision for income taxes. Our calculation of the provision for income taxes is subject to our interpretation of applicable tax laws in the jurisdictions in which we file. In addition, our income tax returns are subject to periodic examination by the Internal Revenue Service and other taxing authorities.

Although we believe our income tax estimates are appropriate, there is no assurance that the final determination of our current taxes payable will not be materially different, either higher or lower, from the amounts reflected in our financial statements. In the event we are assessed additional income taxes, our financial condition and cash flows could be adversely affected.

Our operations are geographically concentrated in California

Although we operate water and wastewater facilities in a number of states under our contracted services business, our regulated water and electric operations are concentrated in California, particularly Southern California. As a result, our financial results are largely subject to political, water supply, labor, utility cost and regulatory risks, economic conditions, natural disasters (which may increase as a result of climate change) and other risks affecting California. Our financial results may also be impacted by population growth or decline in our service areas.

Item 1B. Unresolved Staff Comments

None.

Item 1C. Cybersecurity

Cyberattacks represent a threat to water, wastewater and electric utility systems. There have also been increasing threats to the information that companies maintain that have resulted in unauthorized disclosure of private customer, employee, director and corporate financial information.

Threats can come from many sources, including, but not limited to, ransomware, malicious software, credential loss or theft, supervisory control and data acquisition ("SCADA") system takeover, equipment theft, supply chain attacks, phishing attacks, identity-based attacks, denial-of-service attacks or the actions of employees either intentional or accidental. Ransomware whereby hackers take control of a company's systems and/or data has been identified as the most significant threat to Registrant's critical infrastructure systems and is getting harder to detect and encrypted files are becoming harder to recover. Threat actors using ransomware have also increased their use of data, not only for direct ransom and data destruction, but also to release the data to the public. Registrant believes a breach of customer personally identifiable information is one of the most significant financial risks to it as the costs incurred could exceed the amount of its cybersecurity insurance coverage.

Nevertheless, in order to continue meeting Registrant's technological business needs and as more vendors build solutions in the cloud, Registrant expects to further expand its use of cloud-computing environments. As such, Registrant expects risks from cyberattacks and data breaches to increase due to the growth of its technological footprint in the cloud environments.

Registrant expects to continue to increase its investment in information technology to monitor and address cyber threats and attempted cyber-attacks, and to improve its posture in addressing security vulnerabilities. In addition, Registrant has dedicated employees with cybersecurity technical expertise and also leverages outside cybersecurity firms. Registrant has adopted multi-layered safeguards and educational measures to protect its operations, assets and digital information. Registrant conducts mandatory quarterly cybersecurity training for all employees. Registrant also conducts specialized training for ASUS employees annually on protecting certain types of information relating to the work ASUS and its subsidiaries do with the U.S. government to comply with U.S. government contracting requirements. In addition, Registrant conducts periodic and unannounced phishing tests with all employees and vulnerability assessment and penetration tests.

Registrant has adopted a cybersecurity incident response policy, plan and set of specific instructions, which are annually reviewed by the IT cybersecurity team members. Registrant is also taking actions intended to strengthen its cybersecurity posture and to improve its cybersecurity incident response plans and operating procedures. Despite the actions Registrant has taken and is taking and the fact that, to its knowledge, it has yet to experience a cybersecurity incident, there can be no assurance that Registrant will not experience a cybersecurity incident.

Risk management, oversight and response

Cyber risk management is an ongoing iterative process that requires continuous identification, assessment and management of possible cyber threats and has become a vital part of Registrant's overall risk management efforts. Registrant's cybersecurity team assesses ongoing cybersecurity threats and vulnerabilities to prioritize and implement mitigation factors and defense to help contain and combat identified risks.

To ensure threat and vulnerability information is up-to-date, the cybersecurity team subscribes to multiple national and state-level threat and vulnerability information disclosure services, both general-purpose and industry-specific in nature. Updates from these sources include general information delivered on a daily basis and more threat-specific information delivered as required. Tools are in place within Registrant's environment to monitor for anomalous behavior and provide alerting and, in some cases, automated responses to threats. Registrant's cybersecurity team meets regularly with product vendors for these tools to ensure optimal configurations are in place to protect its environment.

To determine the risk to Registrant's systems, it engages in a continuous vulnerability management lifecycle process to identify and remediate vulnerable systems and system configurations. In this regard, Registrant leverages the National Institute of Standards and Technologies cybersecurity framework. To supplement Registrant's internal process, the cybersecurity team regularly contracts consultants to assess system configurations, both passively through exercises such as configuration review and actively through penetration testing, and response procedures, such as tabletop exercises, to identify areas for improvement. In addition, Registrant supplements its day-to-day operations with around the clock identification, assessment and mitigation of cyber risks with third-party security services as well. Registrant is working on implementing across AWR and its subsidiaries a comprehensive, risk-based approach to identify and oversee cybersecurity risks presented by third parties, including vendors, service providers and other external users of its systems and data, as well as the systems of third parties that could adversely impact Registrant's business in the event of a cybersecurity incident affecting those third-party systems.

Cybersecurity updates are provided periodically to Registrant's senior management, including its CEO, CFO and senior vice presidents of Registrant's operations, and to the senior management of Registrant's subsidiaries. Cybersecurity risk management extends beyond Registrant's and its subsidiaries' senior management teams. Registrant's Board of Directors ("the Board") oversees enterprise risk management, or ERM, performed under the direction of Registrant's senior management team. Cybersecurity updates, including recent findings, changes to processes or personnel changes, are provided to the ERM liaison to the Board, who is a member of the Board, and to the full Board on a quarterly basis or more frequently if needed. Cybersecurity is one component of an overall ERM framework that involves Registrant's Board. The Board satisfies its oversight responsibility by obtaining information from the ERM liaison and senior management of Registrant, with input from the senior management of Registrant's subsidiaries as necessary. On a quarterly basis, Registrant's senior management will discuss the implementation status of plans to mitigate cybersecurity risks with the ERM liaison. The ERM liaison and Registrant's senior management will then provide a report to the full Board regarding the critical cybersecurity risks discussed, mitigation plans and implementation of the ERM program that addresses cybersecurity risks.

In addition, Registrant's plans require members of its senior management, such as its CEO and CFO, as well as members of management from its, and its subsidiaries', Operations, Information Technology, Human Capital Management, Accounting and Legal teams participate in Registrant's Cybersecurity Incident Response Team ("CIRT") to be kept current on all aspects related to a cyber-attack, if a cybersecurity incident were to occur.

Responses to cyber-attacks are fast-moving and dynamic and would require an assessment of actual or potential damage performed by Registrant's cybersecurity team. If a cyber-attack were to occur, continuous engagement, communication and collaboration between Registrant's cybersecurity team and members of its CIRT as well as third parties would likely be necessary in order to gather accurate and complete information, perform a comprehensive evaluation and assessment of the cyber-attack, manage and contain the cybersecurity threat, and develop and execute a remediation and recovery plan. Members of its CIRT team would work together to determine whether a cybersecurity breach is material and required to be reported to the Board and publicly under applicable law.

To ensure that members of Registrant's Board are informed of material cyber-attacks, Registrant's CFO and IT Director have been designated as key members of management that will provide current updates to Registrant's ERM liaison and the Board. The communication will include but not be limited to, the nature and status of the cyber-attack and Registrant's plan to contain and mitigate the cyber threat and ultimately the remediation and recovery plan to return to “business as usual” state. Registrant's CFO has over 15 years overseeing the Company's risk management area. Registrant's IT Director has over 25 years in Information Technology designing, implementing and supporting various cybersecurity and technical solutions, along with ensuring compliance with multiple cybersecurity regulations.

Cybersecurity threats, including as a result of any previous cybersecurity incidents, have not materially affected and are not reasonably likely to materially affect Registrant, including its business strategy, results of operations or financial condition. However, the risk of cybersecurity threats could be significant if the cyber-attack disrupts Registrant's critical operations, service or financial systems. See “Information Technology Risk Factors” under Item 1A. In addition, any unauthorized access to sensitive information or data breaches could be detrimental to Registrant's operations, critical corporate information and reputation and relationships with its customers, vendors, employees, directors and could negatively affect the future of contract awards at ASUS and could result in a termination of one or more of its existing contracts or the assessment of penalties. The cost of responding to a cyber-attack could be significant depending on the severity of the cyber-attack and could go beyond financial costs as operations and services provided by Registrant could be delayed and coordinated resources in response could be significant. Registrant could also be assessed penalties if it is determined that applicable data privacy laws have been violated.

Item 2. Properties

Water Properties

As of December 31, 2023, GSWC's physical properties consisted of water transmission and distribution systems, which included 2,878 miles of pipeline together with services, meters and fire hydrants, and approximately 450 parcels of land generally less than 1 acre each, on which are located wells, pumping plants, reservoirs and other water utility facilities, including five surface water treatment plants. GSWC also has franchises, easements and other rights of way for the purpose of accessing wells and tanks and constructing and using pipes and appurtenances for transmitting and distributing water. All of GSWC's properties are located in California.

As of December 31, 2023, GSWC owned 239 wells, of which 167 are active with an aggregate production capacity of approximately 164 million gallons per day. GSWC has 59 connections to the water distribution facilities of the MWD, and other municipal water agencies. GSWC's storage reservoirs and tanks have an aggregate capacity of approximately 119 million gallons. GSWC owns no dams. The following table provides, in greater detail, information regarding the water utility plant of GSWC:

Pumps		Distribution Facilities			Reservoirs	
Well	Booster	Mains*	Services	Hydrants	Tanks	Capacity*
239	387	2,878	264,097	26,852	145	119 (1)

* Reservoir capacity is measured in millions of gallons. Mains are in miles.

(1) GSWC has additional capacity in its Bay Point system, through an exclusive capacity right to use 4.4 million gallons per day from a treatment plant owned by Contra Costa Water District. GSWC also has additional reservoir capacity through an exclusive right-to-use all of one 8 million gallon reservoir, one-half of another 8 million gallon reservoir, and one-half of a treatment plant's capacity, all owned by Three Valleys Municipal Water District.

Electric Properties

BVES's properties are located in the Big Bear area of San Bernardino County, California. As of December 31, 2023, BVES owned and operated approximately 87.8 miles of overhead 34.5 kilovolt (kv) sub-transmission lines (17.43 circuit miles are insulated), 6.49 miles of underground 34.5 kv sub-transmission lines, 493.41 miles of overhead 4.16 kv or 2.4 kv distribution lines (36.2 circuit miles are insulated), 114.22 miles of underground cable, 13 sub-stations and a natural gas-fueled 8.4 MW peaking generation facility. BVES also has franchises, easements and other rights of way for the purpose of constructing and using poles, wires and other appurtenances for transmitting electricity.

Adjudicated and Other Water Rights

GSWC owns groundwater and surface water rights in California. Groundwater rights are further subject to classification as either adjudicated or unadjudicated rights. Adjudicated rights have been established through comprehensive litigation in the courts, and the annual extraction quantities and use of the adjudicated rights are often subject to the provisions of the judgment for that particular groundwater basin. Additionally, as a result of the adjudication, many of these groundwater basins are managed by a watermaster that is charged with enforcing the provisions of the judgment, which may include determining operating safe yields based on the water supply conditions of the groundwater basin.

GSWC actively manages its adjudicated groundwater rights portfolio with the goal of optimizing and making this source of supply sustainable. Unadjudicated rights are subject to further regulation by the State Water Resources Control Board ("SWRCB") and the California Department of Water Resources. Surface water rights are quantified and managed by the SWRCB, unless the surface water rights originated prior to 1914. As of December 31, 2023, GSWC had adjudicated groundwater rights and surface water rights of 69,409 and 11,335 acre-feet per year, respectively. GSWC also has a number of unadjudicated groundwater rights, which have not been quantified, but are typically measured by historical usage.

Office Buildings

GSWC owns its general headquarters facility in San Dimas, California. GSWC also owns and leases customer service offices and office space throughout California. BVES owns office space in California. ASUS leases office facilities in Virginia and North Carolina, and owns service centers in Florida, Maryland, South Carolina, Virginia, Texas, North Carolina and Kansas.

Mortgage and Other Liens

As of December 31, 2023, neither AWR, GSWC, BVES, ASUS, nor any of its subsidiaries, had any mortgage debt or liens securing indebtedness outstanding. Under the terms of certain debt instruments, AWR, GSWC and BVES are prohibited from issuing any secured debt, without providing equal and ratable security to the holders of this existing debt.

Condemnation of Properties

The laws of the state of California provide for the acquisition of public utility property by governmental agencies through their power of eminent domain, also known as condemnation, where doing so constitutes a more necessary use. In addition, these laws provide that the owner of utility property (i) may contest whether the condemnation is actually necessary, and (ii) is entitled to receive the fair market value of its property if the property is ultimately taken.

Item 3. Legal Proceedings

Registrant is subject to ordinary routine litigation incidental to its business, some of which may include claims for compensatory and punitive damages. Management believes that rate recovery, proper insurance coverage and reserves are in place to insure against, among other things, property, general liability, employment, and workers' compensation claims incurred in the ordinary course of business. Insurance coverage may not cover certain claims involving punitive damages.

Item 4. Mine Safety Disclosure

Not applicable.

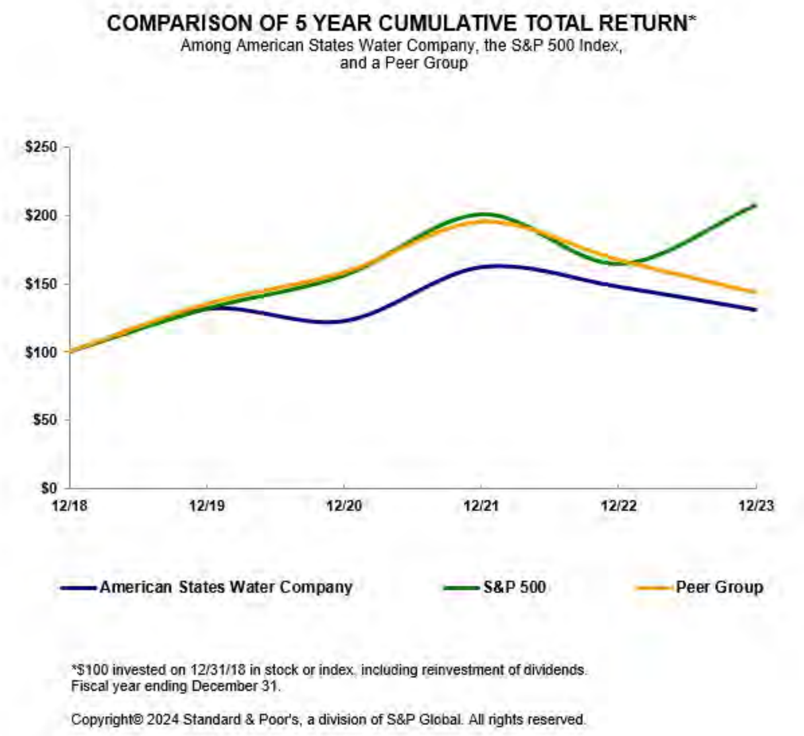
PART II

Item 5. Market for Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities

Stock Performance Graph

The graph below compares the cumulative 5-Year total return of American States Water Company's Common Shares with the cumulative total returns of the S&P 500 index and a customized peer group of seven water utilities that includes: American Water Works Company Inc., Essential Utilities Inc., Artesian Resources Corporation, California Water Service Group, Middlesex Water Co., York Water Co. and SJW Group. In accordance with SEC guidance, the returns of the seven utilities included in the peer group are weighted according to their respective market capitalizations.

An investment of $100 (with reinvestment of all dividends) is assumed to have been made in our Common Shares, and in the common stock in the index and in the peer group on December 31, 2018. Relative performance is tracked through December 31, 2023.



	12/2018	12/2019	12/2020	12/2021	12/2022	12/2023
American States Water Company	**$ 100.00**	**$ 131.19**	**$ 122.32**	**$ 161.78**	**$ 147.31**	**$ 130.43**
S&P 500	**$ 100.00**	**$ 131.49**	**$ 155.68**	**$ 200.37**	**$ 164.08**	**$ 207.21**
Peer Group	**$ 100.00**	**$ 134.93**	**$ 157.90**	**$ 194.95**	**$ 166.87**	**$ 142.93**

The stock price performance included in this graph is not necessarily indicative of future stock price performance.

Market Information Relating to Common Shares

Common Shares of American States Water Company are traded on the New York Stock Exchange ("NYSE") under the symbol "AWR."

GSWC is a wholly-owned subsidiary of AWR. As a result, there is no public trading market in its common shares.

Approximate Number of Holders of Common Shares

As of February 20, 2024, there were 1,854 holders of record of the 36,988,764 outstanding Common Shares of American States Water Company. AWR owns all of the outstanding common shares of GSWC, BVES and ASUS. ASUS owns all of the outstanding stock of its subsidiaries.

Frequency and Amount of Any Dividends Declared and Dividend Restrictions

For the last two years, AWR has paid dividends on its Common Shares on or about March 1, June 1, September 1 and December 1. The following table lists the amounts of dividends paid on Common Shares of American States Water Company:

	2023	2022
First Quarter	$ 0.3975	$ 0.3650
Second Quarter	$ 0.3975	$ 0.3650
Third Quarter	$ 0.4300	$ 0.3975
Fourth Quarter	$ 0.4300	$ 0.3975
Total	$ 1.6550	$ 1.5250

AWR's ability to pay dividends is subject to the requirement in its revolving credit facility to maintain compliance with all covenants described in *Note 9 Bank Debt* included in Part II, Item 8, in the *Notes to Consolidated Financial Statements*. GSWC is prohibited under the terms of its senior notes from paying dividends if, after giving effect to the dividend, its total indebtedness to capitalization ratio (as defined) would be more than 0.6667-to-1. GSWC would have to issue additional debt of $716.3 million to invoke this covenant as of December 31, 2023.

Under California law, AWR, GSWC, BVES and ASUS are each permitted to distribute dividends to its shareholders and repurchase its shares so long as the Board of Directors determines, in good faith, that either: (i) the value of the corporation's assets equals or exceeds the sum of its total liabilities immediately after the dividend, or (ii) its retained earnings equals or exceeds the amount of the distribution.

Under the least restrictive of the California tests, approximately $776.1 million was available to pay dividends to AWR's common shareholders and repurchase shares from AWR's common shareholders at December 31, 2023. Approximately $703.8 million was available for GSWC to pay dividends to AWR at December 31, 2023, and approximately $72.3 million was available for BVES to pay dividends to AWR at December 31, 2023. BVES has a separate revolving credit facility, and its ability to pay dividends is subject to the requirement in the credit agreement to maintain compliance with all covenants described in *Note 9 Bank Debt*.

ASUS's ability to pay dividends to AWR is dependent upon the ability of each of its subsidiaries to pay dividends to ASUS under applicable state law as well as ASUS's ability to pay dividends under California law.

AWR paid $61.2 million in dividends to shareholders for the year ended December 31, 2023, as compared to $56.4 million for the year ended December 31, 2022. GSWC paid dividends of $55.4 million and $27.0 million to AWR in 2023 and 2022, respectively. BVES did not pay dividends to AWR in 2023 and paid dividends of $14.7 million to AWR in 2022. ASUS paid dividends of $16.0 million and $14.7 million to AWR in 2023 and 2022, respectively.

Other Information

The shareholders of AWR have approved the material features of all equity-compensation plans under which AWR directly issues equity securities. AWR did not issue any unregistered equity securities during 2023.

The following table provides information about AWR repurchases of its Common Shares during the fourth quarter of 2023:

Period	Total Number of Shares Purchased		Average Price Paid per Share	Total Number of Shares Purchased as Part of Publicly Announced Plans or Programs (1)	Maximum Number of Shares That May Yet Be Purchased under the Plans or Programs (1)(3)
October 1 - 31, 2023	468		$ 77.22	—	—
November 1 - 30, 2023	203		$ 80.11	—	—
December 1 - 31, 2023	3,086		$ 79.55	—	—
Total	3,757	(2)	$ 79.29	—	

(1) None of the Common Shares were repurchased pursuant to any publicly announced stock repurchase program.

(2) Of these amounts, zero Common Shares were acquired on the open market for employees pursuant to the 401(k) plan. The remainder of the shares were acquired on the open market for participants in the DRP.

(3) Neither the 401(k) plan nor the Common Share Purchase and DRP contains a maximum number of Common Shares that may be purchased in the open market.

Item 6. (Reserved)

Item 7. Management's Discussion and Analysis of Financial Condition and Results of Operations

The following discussion and analysis provides information on AWR's consolidated operations and assets, and includes specific references to AWR's individual segments and its subsidiaries (GSWC, BVES, and ASUS and its subsidiaries), and AWR (parent) where applicable.

Included in the following analysis is a discussion of Registrant's operations in terms of earnings per share by business segment and AWR (parent), which equals each business segment's earnings divided by AWR's weighted average number of diluted Common Shares. The gains and losses generated on the investments held to fund one of the Company's retirement plans during the years ended December 31, 2023 and 2022 have been excluded when communicating the results to help facilitate comparisons of AWR's performance from period to period. In addition, both the impact of retroactive rates related to the full year 2022 recorded during the year ended December 31, 2023 resulting from the final decision on the water general rate case, and the impact from the estimates of revenues subject to refund recorded in 2022 and changes to estimates recorded in 2023 following the receipt of a final cost of capital decision in June 2023 have been excluded when communicating AWR's consolidated and water segment results for the years ended December 31, 2023 and 2022 to help facilitate comparisons of the Company's performance from period to period.

All of the measures discussed above are derived from consolidated financial information of Registrant, but are not presented in our financial statements that are prepared in accordance with Generally Accepted Accounting Principles in the United States ("GAAP"). These items constitute "non-GAAP financial measures" under Securities and Exchange Commission rules, which supplement our GAAP disclosures but should not be considered as an alternative to the respective GAAP measures. Furthermore, the non-GAAP financial measures may not be comparable to similarly titled non-GAAP financial measures of other registrants.

AWR uses earnings per share by business segment, a non-GAAP financial measure, as an important measure in evaluating its operating results and believes it provides investors with clarity surrounding the performance of its segments. AWR reviews this measurement regularly and compares it to historical periods and to its operating budget. A reconciliation to AWR's consolidated diluted earnings per share prepared in accordance with GAAP is included in the discussion under the section titled "*Summary Results by Segment*."

Overview

Factors affecting our financial performance are summarized under the Overview section in *Item 1. Business* and *Item 1A. Risk Factors*.

Water and Electric Segments:

GSWC's and BVES's revenues, operating income, and cash flows are earned primarily through delivering potable water to homes and businesses in California and electricity in the Big Bear area of San Bernardino County, California, respectively. Rates charged to GSWC and BVES customers are authorized by the CPUC. These rates are intended to allow recovery of operating costs and a reasonable rate of return on invested capital. GSWC and BVES plan to continue seeking additional rate increases in future years from the CPUC to recover operating and supply costs, and receive reasonable returns on invested capital. Capital expenditures in future years at GSWC and BVES are expected to remain at substantially higher levels than depreciation expense. When necessary, GSWC and BVES may obtain funds from external sources in the capital markets and through bank borrowings.

General Rate Case Filings and Other Matters:

Water General Rate Case for the years 2025–2027:

On August 14, 2023, GSWC filed a general rate case application for all its water regions and the general office. This general rate case will determine new water rates for the years 2025 – 2027. Among other things, GSWC requested capital budgets of approximately $611.4 million for the three-year capital cycle. GSWC also requested the continuation of mechanisms to accommodate fully decoupled revenues and sales, and track differences between recorded and CPUC-authorized supply-related expenses. In an August 2020 decision, the CPUC discontinued the use of the WRAM and the MCBA by water utilities, which GSWC implemented in 2008, but would be discontinued for GSWC after 2024. However, on September 30, 2022, the governor of California signed Senate Bill ("SB") 1469 and effective January 1, 2023, SB 1469 allows Class A water utilities, including GSWC, to continue requesting the use of a revenue decoupling mechanism in their next general rate case. With the passage of SB 1469, GSWC's request to continue using a revenue decoupling mechanism will be subject to CPUC approval. As of the filing date of this Form 10-K, a proposed decision in the water general rate case is scheduled for the fourth quarter of 2024, with new rates to become effective January 1, 2025.

Water General Rate Case for years 2022 - 2024:

On June 29, 2023, the CPUC adopted a final decision in GSWC's general rate case application for all its water regions and its general office that determined new water rates for the years 2022–2024 retroactive to January 1, 2022. Among other things, the final decision (i) adopted the full settlement agreement between GSWC and the Public Advocates Office at the CPUC ("Public Advocates") that resolved all issues related to the 2022 annual revenue requirement in the general rate case application and authorized GSWC to invest approximately $404.8 million in capital infrastructure over the three-year capital cycle (excluding advice letter projects), and (ii) allowed for additional increases in adopted revenues for 2023 and 2024 subject to an earnings test and inflationary index values at the time of filing for implementation of the new rates. The impact of retroactive rates for the full year of 2022 as well as second-year rate increases for 2023 have been reflected in the results of operations for the year ended December 31, 2023.

As a result of receiving the final decision that approved the settlement agreement in its entirety, the net impact of retroactive new rates for the full year of 2022 was $0.38 per share and has been reflected in the year ended December 31, 2023 results, which consisted primarily of the increase in 2022's annual revenue requirement (excluding advice letter projects) that, among other things, incorporated an increase in supply costs, and which combined is a net increase of approximately $0.40 per share; partially offset by the approval of new operating expense levels related to 2022 that resulted in an increase in recorded depreciation expense of approximately $790,000, or $0.02 per share, resulting from updated composite depreciation rates adopted in the final decision, and which are reflected in the 2022 adopted revenue requirement.

The second-year rate increases for 2023, which were retroactive to January 1, 2023, have also been reflected in the year ended December 31, 2023 results. Excluding the impact of retroactive rates for 2022 discussed above, there was an increase in recorded water operating revenues of $48.1 million largely as a result of the second-year rate increases for 2023 that, among other things, incorporated the increase in recorded supply costs of $10.0 million, which combined is an increase of $0.74 per share. Upon receiving the final decision, GSWC filed for the implementation of new 2023 rate increases that went into effect on July 31, 2023. Due to the delay in finalizing the water general rate case, water revenues billed to customers for the year ended December 31, 2022 and for the period from January 1, 2023 to July 30, 2023 were based on 2021 adopted rates. In October 2023, GSWC also filed with the CPUC to recover all retroactive rate amounts accumulated in memorandum accounts for the full 2022 year and for 2023 through July 30, 2023. Surcharges were implemented to recover the cumulative retroactive rate differences over 36 months. As of December 31, 2023, there is an aggregate cumulative balance of $52.8 million in CPUC-approved general rate case memorandum accounts that have been recognized as regulatory assets with a corresponding increase in water revenues.

Cost of Capital ("COC") Proceedings:

2024 COC Application:

Investor-owned water utilities serving California are required to file their cost of capital applications on a triennial basis. GSWC's next cost of capital application was scheduled to be filed on May 1, 2024 effective for the years 2025 - 2027. However, GSWC, along with three other Class A investor-owned water utilities in California, filed a joint request with the CPUC to defer the filing deadline of the next cost of capital applications by one year, which was approved on February 2, 2024. The joint request asked that the utilities keep the cost of capital currently authorized for 2024 in effect through 2025, and file new cost of capital applications by May 1, 2025 to set the cost of debt, return on equity and capital structure starting January 1, 2026. GSWC's current authorized rate of return on rate base is 7.93% effective January 1, 2024, which will continue in effect through December 31, 2025. Additionally, GSWC's Water Cost of Capital Adjustment Mechanism ("WCCM") will remain active through the one year deferral period.

2021 COC Application:

GSWC filed its last cost of capital application with the CPUC in May 2021. On June 29, 2023, the CPUC adopted a final decision that, among other things, (i) adopted GSWC's requested capital structure of 57% equity and 43% debt; (ii) adopted a cost of debt of 5.1% for GSWC as compared to 6.6% previously authorized; (iii) adopted a return on equity of 8.85% for GSWC as compared to 8.9% previously authorized; (iv) allowed for the continuation of the WCCM through December 31, 2024; and (v) adopted the new cost of capital for the three-year period commencing January 1, 2022 through December 31, 2024. Based on the final decision issued in June 2023, all adjustments to rates are prospective and not retroactive. GSWC filed an advice letter that implemented the new cost of capital effective July 31, 2023.

Following the receipt of the final decision in the cost of capital proceeding, management updated its analysis and reassessed the accounting estimates recorded to date related to GSWC's lower cost of debt. Accordingly, during the second quarter of 2023, GSWC recorded a change in estimate that resulted in an increase to water revenues in the amount of $6.4 million, or approximately $0.13 per share, as a result of reversing its regulatory liability for revenues subject to refund that it had recorded during 2022.

The WCCM adjusts the return on equity and rate of return on rate base between the three-year cost of capital proceedings only if there is a positive or negative change of more than 100 basis points in the average of the Moody's Aa utility bond rate as measured over the period October 1 through September 30. If there is a positive or negative change of more than

100 basis points, the return on equity is adjusted by one half of the difference. For the period from October 1, 2021 through September 30, 2022, the Moody's Aa utility bond rate increased by 102.8 basis points from the benchmark, which triggered the WCCM adjustment. GSWC recognized revenues for the period from January 1 through July 30, 2023 and all of 2022 based on the previously authorized return of equity of 8.9% that had also been billed to water customers through the same period. On June 30, 2023, GSWC filed an advice letter to establish the WCCM for 2023, which increased GSWC's 8.85% adopted return on equity in the decision to 9.36% effective July 31, 2023. Additionally, for the period from October 1, 2022 through September 30, 2023, the Moody's Aa utility bond rate increased by 139.7 basis points from the benchmark, which triggered another WCCM adjustment. On October 12, 2023, GSWC filed an advice letter to establish the WCCM for 2024, which has been approved by the CPUC and increased GSWC's 9.36% adopted return on equity to 10.06% effective January 1, 2024.

Final Decision in the First Phase of the Low-Income Affordability Rulemaking:

In August 2020, the CPUC issued a final decision in the first phase of the CPUC's Order Instituting Rulemaking evaluating the low income ratepayer assistance and affordability objectives contained in the CPUC's 2010 Water Action Plan. This decision also addressed other issues, including mandating discontinuance of the WRAM and the MCBA. The MCBA is a full-cost balancing account used to track the difference between adopted and actual water supply costs (including the effects of changes in both rates and volume). Based on the final decision, any general rate case application filed by GSWC and the other California water utilities after August 27, 2020 may not include a proposal to continue the use of the WRAM or MCBA, but may instead include a proposal to use a limited price adjustment mechanism and an incremental supply cost balancing account. The discontinuation of the WRAM and MCBA for GSWC would be effective for years after 2024. However, on September 30, 2022, the governor of California signed Senate Bill ("SB") 1469. Effective January 1, 2023, SB 1469 allows Class A water utilities, including GSWC, to continue requesting the use of a full revenue decoupling mechanism in their general rate case. With the passage of SB 1469, GSWC was able to request the continued use of a full revenue decoupling mechanism, similar to the WRAM in its general rate case application filed on August 14, 2023 that establishes new rates for the years 2025 – 2027. GSWC's request to continue using a full revenue decoupling mechanism in its general rate case is subject to CPUC approval. Since its implementation in 2008, the WRAM and MCBA have helped mitigate fluctuations in GSWC's earnings due to changes in water consumption by its customers or changes in water supply mix. Replacing them with mechanisms recommended in the final decision will likely result in more volatility in GSWC's future earnings and could result in less than, or more than, full recovery of its authorized revenue and supply costs.

In October 2020, GSWC, three other investor-owned water utilities ("IOWUs") operating in California, and the California Water Association ("CWA") filed applications with the CPUC for rehearing on the discontinuation of the WRAM and MCBA, which the CPUC denied in September 2021. GSWC, the three other IOWUs and CWA each separately filed a petition with the California Supreme Court to review the CPUC's decision revoking prior authorization of the WRAM and MCBA. In May 2022, the Court granted the petition for writ of review. The Court ordered GSWC, along with the other IOWUs and CWA, to file opening briefs, which were filed on September 1, 2022. The CPUC's answer to the opening briefs was originally due by November 15, 2022 and reply briefs were due by December 15, 2022. However, as a result of SB 1469, in October 2022 the CPUC filed a motion to dismiss the IOWUs and CWA's petition with the Court, and also requested that the Court suspend the proceeding schedule until it rules on the motion to dismiss. The Court granted the CPUC's request to suspend the proceeding schedule. In November 2022, the Supreme Court denied the CPUC's motion to dismiss and established a new proceeding schedule whereby the CPUC filed their answer brief on December 9, 2022 and the IOWUs filed their reply brief on January 13, 2023. At this time, management cannot predict the final outcome of this matter.

Electric General Rate Case for the years 2023–2026:

On August 30, 2022, BVES filed a general rate case application that will determine new electric rates for the years 2023 – 2026. In February 2023, a scoping memo and ruling that set the final schedule and scope of issues in BVES's general rate case proceeding was issued by the CPUC. Electric revenues billed to customers for 2023 were based on 2022 adopted rates and will remain in effect until finalization of the pending general rate case application. On December 15, 2022, the CPUC approved a decision for BVES to establish a general rate case memorandum account that makes the new 2023 rates effective and retroactive to January 1, 2023. When a decision is issued in the electric general rate case, cumulative adjustments will be recorded at that time.

Among other things, BVES requested (i) capital budgets of approximately $62.0 million for the four-year rate cycle, and another $6.2 million for a large line replacement capital project to be filed for revenue recovery through an advice letter when the project is completed, and (ii) a capital structure for BVES of 61.8% equity and 38.2% debt, a return on equity of 11.25%, an embedded cost of debt of 5.51%, and a return on rate base of 9.05%. Included in the general rate case application is a request for recovery of all capital expenditures and other incremental costs incurred over the last few years in connection with BVES's wildfire mitigation plans that are currently not included in customer rates. These costs will be subject to review by the CPUC during the general rate case proceeding.

Contracted Services Segment:

ASUS’s revenues, operating income and cash flows are earned by providing water and/or wastewater services, including operation and maintenance services and construction of facilities for the water and/or wastewater systems at various military installations, pursuant to an initial 50-year, firm-fixed-price contract, additional firm-fixed-price contracts, task order agreements and subcontracts with third party prime contractors on military bases. Currently, ASUS has one subsidiary that has entered into a task order agreement with the U.S. government that has a term of 15 years. The contract price for each of the contracts and recurring task order agreements is subject to annual economic price adjustments. Additional revenues generated by contract operations are primarily dependent on annual economic price adjustments, and new construction activities under contract modifications with the U.S. government or agreements with other third-party prime contractors. ASUS’s subsidiaries continue to enter into U.S. government-awarded contract modifications and agreements with third-party prime contractors for new construction projects at the military bases served.

During 2023, excluding the first task order of Joint Base Cape Cod (“JBCC”) and the new contract for Naval Air Station Patuxent River, ASUS was awarded approximately $24.1 million in new construction projects for completion beginning in 2023 through 2026. Earnings and cash flows from modifications to the initial 50-year contracts, additional contracts thereafter with the U.S. government and agreements with third-party prime contractors for additional construction projects may or may not continue in future periods.

On August 15, 2023, ASUS was awarded a new 50-year contract by the U.S. government to operate, maintain, and provide construction management services for the water distribution and wastewater collection and treatment facilities at Naval Air Station Patuxent River, a United States Navy air station located in Maryland. The initial firm-fixed-price value of the contract is estimated at $349 million over a 50-year period and is subject to annual economic price adjustments. This initial value is also subject to adjustment based on the results of a joint inventory of assets to be performed during the transition period and will be finalized during the first year of operations.

On September 29, 2023, ASUS was awarded a new 15-year contract by the U.S. government, that is different than ASUS's other existing 50-year contracts, to operate, maintain, and provide construction management services for the water distribution and wastewater collection and treatment facilities at JBCC located in Massachusetts. Under this contract, ASUS will have the opportunity to perform work at JBCC through the periodic issuance of task orders by the U.S. government for up to a maximum initial firm-fixed-price value of $45.0 million over a 15-year period, subject to adjustments as task orders are issued. In September 2023, the first task order was issued with a value of $2.3 million to perform an evaluation, construction and transition services that are scheduled for completion in 2024.

Entering into contracts with the U.S. government subjects ASUS to potential government audits or investigations of its business practices and compliance with government procurement statutes and regulations. ASUS had been under a civil government investigation over bidding and estimating practices used in certain capital upgrade projects. In July 2023, ASUS and the U.S. government entered into an agreement that settles civil and monetary claims by the U.S. government. This settlement did not have a material impact on Registrant’s financial statements.

Summary Results by Segment

The table below sets forth a comparison of the diluted earnings per share by business segment and for the parent company:

	Diluted Earnings per Share – Year Ended 12/31/2023	Diluted Earnings per Share – Year Ended 12/31/2022	CHANGE
Water	$ 2.77	$ 1.45	$ 1.32
Electric	0.20	0.24	(0.04)
Contracted services	0.50	0.46	0.04
AWR (parent)	(0.10)	(0.04)	(0.06)
Consolidated diluted earnings per share, as recorded (GAAP)	3.36	2.11	1.25
Adjustments to GAAP measure:			
Impact of retroactive rates related to the full year of 2022 from the final decision in the water general rate case*	(0.38)	—	(0.38)
Impact related to the final cost of capital decision*	(0.13)	0.13	(0.26)
Consolidated diluted earnings per share, as adjusted (Non-GAAP)*	$ 2.85	$ 2.24	$ 0.61
Water diluted earnings per share, as adjusted (Non-GAAP)*	$ 2.26	$ 1.58	$ 0.68

Note: Certain amounts in the table above may not foot or crossfoot due to rounding.

* All adjustments to recorded diluted earnings per share relate to the water segment. The water segment's adjusted earnings for 2023 exclude the impact of retroactive rates related to the full year of 2022 resulting from the final CPUC decision in the general rate case previously discussed, and for 2023 and 2022 they exclude the impact of changes in estimates resulting from revenues subject to refund related to the cost of capital proceeding, both shown separately in the table above.

For the year ended December 31, 2023, AWR's recorded consolidated diluted earnings were $3.36 per share, as compared to $2.11 per share for 2022, an increase of $1.25 per share, which includes: (i) the impact of retroactive new rates related to the full 2022 year of $0.38 per share as a result of receiving a final decision in the water general rate case as previously discussed and shown separately in the table above, and (ii) a net favorable variance of $0.26 per share, also shown separately in the table above, related to the impact of the final cost of capital decision that resulted in the reversal during 2023 of revenues subject to refund of $6.4 million, or $0.13 per share, due to a change in estimate from what had been recorded during 2022. Excluding these items from both periods, for the year ended December 31, 2023 and 2022, adjusted consolidated diluted earnings were $2.85 per share and $2.24 per share, respectively, an adjusted increase of $0.61 per share. Also, included in the results for 2023 were gains totaling $5.0 million, or approximately $0.10 per share, on investments held to fund one of the Company's retirement plans, as compared to losses of $5.2 million, or approximately $0.10 per share, for 2022, both due to financial market conditions.

Excluding the gains and losses on the retirement plan investments from both periods, the impact of retroactive rates recorded in 2023 related to the full year of 2022, and the impact of changes in estimates from the cost of capital proceeding from both periods, adjusted consolidated diluted earnings for the year of 2023 would be $2.75 per share as compared to adjusted diluted earnings of $2.34 per share for 2022, an adjusted increase of $0.41 per share or a 17.5% increase, largely due to new 2023 water rates approved in GSWC's final decision in its general rate case proceeding.

The following is a computation and reconciliation of diluted earnings per share from the measure of operating income by business segment as disclosed in Note 17 to the Consolidated Financial Statements, to AWR's consolidated fully diluted earnings per common share for the year ended December 31, 2023 and 2022:

	Water		Electric		Contracted Services		AWR (Parent)		Consolidated (GAAP)	
In 000's except per share amounts	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**
Operating income (Note 17)	$ 159,177	$ 92,455	$ 11,196	$ 11,740	$ 26,151	$ 22,449	$ 216	$ (8)	$ 196,740	$ 126,636
Other (income) and expense	20,780	22,339	2,202	425	1,446	(273)	5,792	2,085	30,220	24,576
Income tax expense (benefit)	35,689	16,346	1,515	2,439	6,109	5,476	(1,714)	(597)	41,599	23,664
Net income (loss)	$ 102,708	$ 53,770	$ 7,479	$ 8,876	$ 18,596	$ 17,246	$ (3,862)	$ (1,496)	$ 124,921	$ 78,396
Weighted Average Number of Diluted Shares	37,077	37,039	37,077	37,039	37,077	37,039	37,077	37,039	37,077	37,039
Diluted earnings per share	$ 2.77	$ 1.45	$ 0.20	$ 0.24	$ 0.50	$ 0.46	$ (0.10)	$ (0.04)	$ 3.36	$ 2.11

Note: Certain amounts in the table above may not foot or crossfoot due to rounding.

Water Segment:

For the year ended December 31, 2023, recorded diluted earnings from the water utility segment were $2.77 per share, as compared to $1.45 per share for 2022, an increase of $1.32 per share, which includes: (i) the impact of retroactive new rates related to the full 2022 year of $0.38 per share (shown separately in the Summary Results by Segment table above), (ii) a net favorable variance of $0.26 per share (shown separately in the Summary Results by Segment table above) from the impact of the final cost of capital decision that resulted in the reversal of $6.4 million, or $0.13 per share, due to a change in estimate from what had been recorded during 2022, and (iii) a net favorable variance of $0.20 per share from gains totaling $5.0 million, or $0.10 per share, recorded during 2023 on investments held to fund a retirement plan, as compared to losses of $5.2 million, or $0.10 per share, recorded in 2022.

Excluding the gains and losses on the retirement plan investments from both periods, the impact of retroactive rates recorded in 2023 related to the full year of 2022, and the impact of changes in estimates from the cost of capital proceeding from both periods, adjusted diluted earnings for 2023 at the water segment were $2.16 per share as compared to adjusted diluted earnings of $1.68 per share for 2022, an adjusted net increase at the water segment of $0.48 per share, or a 28.6% increase, due primarily to the following items:

- An increase in the water operating revenues of $48.1 million largely as a result of the second-year rate increases for 2023 that are retroactive to January 1, 2023 and have been reflected in the results for the year ended December 31, 2023, partially offset by the impact of the prospective change in the new cost of capital effective July 31, 2023. GSWC filed for the implementation of new 2023 rates upon receiving the final decisions in June 2023 in both its general rate case and cost of capital proceedings. The increase in water revenues during 2023 represents the difference from the 2023 second-year rate increases and the 2021 adopted rates in place and recorded during 2022.
- An increase in water supply costs of $10.0 million, which consist of purchased water, purchased power for pumping, groundwater production assessments and changes in the water supply cost balancing accounts. Adopted supply costs for the year of 2023 were based on 2023 authorized amounts approved in the final CPUC decision in the water general rate case as compared to 2021 authorized amounts in place during 2022. Actual water supply costs are tracked and passed through to customers on a dollar-for-dollar basis by way of the CPUC-approved water supply cost balancing accounts. The increase in water supply costs results in a corresponding increase in water operating revenues and has no net impact on the water segment’s profitability.
- An overall increase in operating expenses of $3.4 million (excluding supply costs), which negatively impacted earnings and was mainly due to increases in (i) overall labor costs and other employee-related benefits, (ii) administrative and general expenses resulting from higher legal and other outside-services costs, (iii) depreciation and amortization expenses resulting from additions to utility plant and higher composite depreciation rates based on a revised depreciation study approved in the water general rate case, and (iv) franchise fees resulting from higher water revenues. These increases were partially offset by a decrease in water treatment costs, and bad debt expense as a result of additional state relief funds expected to be received for unpaid water bills accumulated during the COVID-19 pandemic period.
- An overall increase in interest expense (net of interest and other income) of $4.8 million resulting primarily from an increase in interest rates, as well as an overall increase in total borrowing levels to support, among other things, the capital expenditure programs at GSWC; partially offset by higher interest income earned on regulatory assets bearing interest at the current 90-day commercial-paper rate, which increased compared to 2022’s rates, as well as an increase in the level of regulatory assets recorded resulting, in large part, from the decision on the water general rate case that had been delayed.
- An overall increase in other expense (net of other income) of $4.6 million due largely to a net increase in the non-service cost components related to GSWC’s benefit plans resulting from changes in actuarial assumptions recorded during the year ended December 31, 2023 as compared to 2022. However, as a result of GSWC’s two-way pension balancing accounts authorized by the CPUC, changes in total net periodic benefit costs related to the pension plan have no material impact to earnings, which accounts for the majority of the increase in non-service costs.
- Changes in certain flowed-through income taxes and permanent items included in GSWC’s income tax expense for the twelve months ended December 31, 2023 as compared to the same period in 2022 that unfavorably impacted the water segment's earnings. As a regulated utility, GSWC treats certain temporary differences as being flowed-through in computing its income tax expense consistent with the income tax method used in its CPUC-jurisdiction rate making. Changes in the magnitude of flowed-through items either increase or decrease tax expense, thereby affecting diluted earnings per share.

Electric Segment:

Diluted earnings from the electric utility segment decreased $0.04 per share for the year ended December 31, 2023 as compared to 2022, largely resulting from not having new rates in 2023 while awaiting the processing of the pending electric general rate case that will set new rates for 2023 – 2026, while also experiencing continued increases in overall operating expenses and interest costs, partially offset by favorable changes in certain flowed-through income taxes. When a decision is issued in the electric general rate case, new rates are expected to be retroactive to January 1, 2023 and cumulative adjustments will be recorded at that time.

Contracted Services Segment:

Diluted earnings from the contracted services segment increased $0.04 per share for the year ended December 31, 2023 as compared to 2022, largely due to an increase in management fee revenues resulting from the resolution of various economic price adjustments and an increase in construction activity, partially offset by higher overall operating expenses (excluding construction expenses) and interest costs as compared to 2022.

AWR (Parent):

For the year ended December 31, 2023, the diluted loss from AWR (parent) increased $0.06 per share compared to 2022 due primarily to an increase in interest expense resulting from higher short-term interest rates and higher borrowings made under AWR's revolving credit facility, as well as changes in state unitary taxes.

The following discussion and analysis for the years ended December 31, 2023 and 2022 provide information on AWR's consolidated operations and assets and, where necessary, includes specific references to AWR's individual segments and subsidiaries: GSWC, BVES and ASUS and its subsidiaries.

Consolidated Results of Operations — Years Ended December 31, 2023 and 2022 (amounts in thousands, except per share amounts):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
OPERATING REVENUES				
Water	$ 433,473	$ 340,602	$ 92,871	27.3 %
Electric	41,832	39,986	1,846	4.6 %
Contracted services	120,394	110,940	9,454	8.5 %
Total operating revenues	595,699	491,528	104,171	21.2 %
OPERATING EXPENSES				
Water purchased	72,864	75,939	(3,075)	-4.0 %
Power purchased for pumping	12,829	11,861	968	8.2 %
Groundwater production assessment	20,850	19,071	1,779	9.3 %
Power purchased for resale	13,275	15,039	(1,764)	-11.7 %
Supply cost balancing accounts	12,118	(12,000)	24,118	-201.0 %
Other operation	40,271	38,095	2,176	5.7 %
Administrative and general	88,273	86,190	2,083	2.4 %
Depreciation and amortization	42,403	41,315	1,088	2.6 %
Maintenance	14,218	13,392	826	6.2 %
Property and other taxes	24,046	22,894	1,152	5.0 %
ASUS construction	57,912	53,171	4,741	8.9 %
Gain on sale of assets	(100)	(75)	(25)	33.3 %
Total operating expenses	398,959	364,892	34,067	9.3 %
OPERATING INCOME	196,740	126,636	70,104	55.4 %
OTHER INCOME AND EXPENSES				
Interest expense	(42,762)	(27,027)	(15,735)	58.2 %
Interest income	7,416	2,326	5,090	218.8 %
Other, net	5,126	125	5,001	*
	(30,220)	(24,576)	(5,644)	23.0 %
INCOME FROM OPERATIONS BEFORE INCOME TAX EXPENSE	166,520	102,060	64,460	63.2 %
Income tax expense	41,599	23,664	17,935	75.8 %
NET INCOME	$ 124,921	$ 78,396	$ 46,525	59.3 %
Basic earnings per Common Share	$ 3.37	$ 2.12	$ 1.25	59.0 %
Fully diluted earnings per Common Share	$ 3.36	$ 2.11	$ 1.25	59.2 %

* not meaningful

Operating Revenues

General

GSWC and BVES rely upon approvals by the CPUC of rate increases to recover operating expenses and to provide for a return on invested and borrowed capital used to fund utility plant. ASUS relies on economic price and equitable adjustments by the U.S. government in order to recover operating expenses and provide a profit margin for ASUS. Current operating revenues and earnings may be negatively impacted if ASUS's subsidiaries do not receive adequate price adjustments in a timely manner. ASUS's earnings are also impacted by the level of construction projects at its subsidiaries, which may or may not continue at current levels in future periods.

Water

For the year ended December 31, 2023, revenues from water operations increased by $92.9 million to $433.5 million, compared to 2022. The increase in water revenues was largely because of the adoption in June 2023 of a final decision in the water general rate case that included the impact of retroactive rates associated with the increase in 2022's annual revenue requirement (excluding advice letter projects), as well as the second-year rate increases for 2023, partially offset by the impact of the prospective change in the new cost of capital effective July 31, 2023. In addition, because of receiving a final decision in the cost of capital proceeding in June 2023, in which the CPUC made adjustments to rates prospective, GSWC recorded a change in estimate that resulted in an increase to water revenues in 2023 totaling $6.4 million as a result of reversing its regulatory liability for revenues subject to refund that it had recorded during 2022.

Billed water consumption for the year ended December 31, 2023 was lower by 7.8% compared to 2022 due primarily to overall above average rainfall in California during the year of 2023 compared to 2022. Currently, changes in consumption generally do not have a significant impact on recorded revenues due to the CPUC-approved WRAM that is in place in all but one small rate-making area. GSWC records the difference between what it bills its water customers and that which is authorized by the CPUC in the WRAM accounts as regulatory assets or liabilities.

Electric

Electric revenues for the year ended December 31, 2023 increased $1.8 million to $41.8 million due, in large part, to the final decision adopted in the water general rate case proceeding that updates the costs allocated from the general corporate office to the electric segment. The final decision authorizes an increase in the allocation ratio to the electric segment. The increase in general corporate office expenses allocated to the electric segment also includes a corresponding and offsetting increase in adopted electric revenues as provided in BVES's last general rate case proceeding, resulting in no impact to earnings. There was also an increase in electric revenues from an advice letter filing related to a completed capital project.

Electric usage for the year ended December 31, 2023 was lower by 2.9% compared to 2022. Due to the CPUC-approved Base Revenue Requirement Adjustment Mechanism, which adjusts certain revenues to adopted levels authorized by the CPUC, changes in usage do not have a significant impact on earnings.

Contracted Services

Revenues from contracted services are composed of construction revenues (including renewal and replacements) and management fees for operating and maintaining the water and/or wastewater systems at various military bases. For the year ended December 31, 2023, revenues from contracted services increased $9.5 million to $120.4 million as compared to $110.9 million for 2022. The increase was largely due to higher construction activity and an increase in management fee revenue from annual economic price adjustments as compared to 2022.

ASUS's subsidiaries continue to enter into U.S. government-awarded contract modifications and agreements with third-party prime contractors for new construction projects at the military bases served. During 2023, excluding the first task order of JBCC and the new contract for Naval Air Station Patuxent River, ASUS was awarded approximately $24.1 million in new construction projects for completion in 2023 through 2026. Earnings and cash flows from modifications to the initial 50-year contracts and additional contracts with the U.S. government and agreements with third-party prime contractors for additional construction projects may or may not continue in future periods.

Operating Expenses:

Supply Costs

Total supply costs at the regulated utilities comprise the largest segment of total consolidated operating expenses. Supply costs accounted for 33.1% and 30.1% of total operating expenses for the years ended December 31, 2023 and 2022, respectively.

Water segment supply costs

Two of the principal factors affecting water supply costs are the amount of water produced and the source of the water. Generally, the variable cost of producing water from wells is less than the cost of water purchased from wholesale suppliers. The overall actual percentages for purchased water for the years ended December 31, 2023 and 2022 were 43% and 45%, as compared to the adopted percentages of 41% and 34% for 2023 and 2022. The higher actual percentage of purchased water as compared to adopted resulted from a higher volume of purchased water costs due to several wells being out of service.

Under the current CPUC-approved MCBA, GSWC tracks adopted and actual expense levels for purchased water, power purchased for pumping and pump taxes. GSWC records the variances (which include the effects of changes in both rate and volume) between adopted and actual purchased water, purchased power and pump tax expenses as a regulatory asset or liability. GSWC recovers from, or refunds to, customers the amount of such variances. GSWC tracks these variances individually for each water ratemaking area.

Supply costs for the water segment consist of purchased water, purchased power for pumping, groundwater production assessments and changes in the water supply cost balancing accounts. For the years ended December 31, 2023 and 2022, water supply costs consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water purchased	$ 72,864	$ 75,939	$ (3,075)	-4.0 %
Power purchased for pumping	12,829	11,861	968	8.2 %
Groundwater production assessment	20,850	19,071	1,779	9.3 %
Water supply cost balancing accounts *	13,839	(8,643)	22,482	-260.1 %
Total water supply costs	$ 120,382	$ 98,228	$ 22,154	22.6 %

* The sum of water and electric supply-cost balancing accounts are shown on AWR's Consolidated Statements of Income and totaled $12.1 million and $(12.0) million for 2023 and 2022, respectively.

Purchased water costs for the year ended December 31, 2023 decreased to $72.9 million as compared to $75.9 million for 2022 primarily due to decreases in water consumption and production that were driven by overall above-average rainfall in 2023 and from overall improvements in drought conditions in 2023 as compared to 2022, partially offset by increases in wholesale water costs. The increase in power purchased for pumping was due to increases in electricity provider rates. Groundwater production assessments increased due to increases in pump tax rates during 2023 as compared to 2022.

For the year ended December 31, 2023, the water supply cost balancing account had a $13.8 million over-collection as compared to an $8.6 million under-collection in 2022. The change in water supply cost balancing accounts was primarily due to updated adopted supply costs from the final decision in the water general rate case proceeding received in June 2023. This increase includes the full year impact of 2022 to reflect newly adopted supply costs retroactive to January 1, 2022, with a corresponding and offsetting increase in adopted water revenues, resulting in no impact to earnings.

Electric segment supply costs

Supply costs for the electric segment consist primarily of purchased power for resale, the cost of natural gas used by BVES's generating unit, the cost of renewable energy credits and changes in the electric supply cost balancing account. For the years ended December 31, 2023 and 2022, electric supply costs consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Power purchased for resale	$ 13,275	$ 15,039	$ (1,764)	-11.7 %
Electric supply cost balancing account *	(1,721)	(3,357)	1,636	-48.7 %
Total electric supply costs	$ 11,554	$ 11,682	$ (128)	-1.1 %

* The sum of water and electric supply-cost balancing accounts are shown on AWR's Consolidated Statements of Income and totaled $12.1 million and $(12.0) million for 2023 and 2022, respectively.

For the year ended December 31, 2023, the cost of power purchased for resale to BVES's customers decreased to $13.3 million as compared to $15.0 million for 2022 primarily due to a decrease in customer usage and lower average price per megawatt-hour ("MWh"). The average price per MWh, including fixed costs, decreased to $79.80 per MWh in 2023 from $97.89 per MWh in 2022. The lower customer usage resulted in a lower under-collection of $1.7 million recorded in the electric supply balancing account in 2023 when compared to an under-collection of $3.4 million during 2022.

Other Operation

The primary components of other operation expenses include payroll costs, materials and supplies, chemicals and water treatment costs, and outside service costs of operating the regulated water and electric systems, including the costs associated with transmission and distribution, pumping, water quality, meter reading, billing, and operations of district offices. Registrant's contracted services operations incur many of the same types of expenses. For the years ended December 31, 2023 and 2022, other operation expenses by business segment consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 29,064	$ 28,117	$ 947	3.4 %
Electric Services	4,057	3,311	746	22.5 %
Contracted Services	7,150	6,667	483	7.2 %
Total other operation	$ 40,271	$ 38,095	$ 2,176	5.7 %

For the year ended December 31, 2023, the increase in other operation expenses at the water segment was due primarily to higher operation-related labor, transportation and outside-service costs, partially offset by lower water treatment costs and bad debt expense. As a result of receiving the final decision in the water general rate case, the increase at the water segment also included a cumulative depreciation adjustment for 2022 of $212,000 on GSWC's transportation equipment, which is recorded in other operation expenses.

The increases at the electric and contracted services segments were due primarily to higher operation-related labor and outside-services costs.

Administrative and General

Administrative and general expenses include payroll related to administrative and general functions, all employee-related benefits, insurance expenses, outside legal and consulting fees, regulatory utility commission expenses, expenses associated with being a public company and general corporate expenses charged to expense accounts. For the years ended December 31, 2023 and 2022, administrative and general expenses by business segment, including AWR (parent), consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 59,313	$ 58,358	$ 955	1.6 %
Electric Services	8,745	7,901	844	10.7 %
Contracted Services	20,431	19,923	508	2.5 %
AWR (parent)	(216)	8	(224)	*
Total administrative and general	$ 88,273	$ 86,190	$ 2,083	2.4 %

* not meaningful

Administrative and general expenses increased at the water segment due, in large part, to an increase in legal and other outside-service costs, labor and employee-related expenses, partially offset by a decrease in the service cost component of GSWC's defined-benefit pension plan. Due to GSWC's two-way pension balancing accounts authorized by the CPUC, changes in total net periodic benefit costs related to the pension plan have no material impact to earnings. In addition, there was a reduction of approximately $447,000 to reflect the final decision in the water general rate case that authorized the one-time recovery of previously incurred administrative and general expenses that were being tracked in CPUC-authorized memorandum accounts.

Administrative and general expenses increased at the electric segment due, in part, to an increase in labor costs and a higher allocation of costs from the general corporate office because of the updated allocation ratio authorized in the final decision on the water general rate case. The increase in general corporate office expenses allocated to the electric segment also includes a corresponding and offsetting increase in adopted electric revenues, resulting in no impact on earnings.

Administrative and general expenses increased at the contracted services segment due to an increase in outside service, labor, and employee-related benefit costs.

Administrative and general expenses at AWR (parent) during the year ended December 31, 2023 reflect the reversal of a previous accrual for a matter that was favorably resolved.

Depreciation and Amortization

For the years ended December 31, 2023 and 2022, depreciation and amortization expense by segment consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 35,886	$ 34,805	$ 1,081	3.1 %
Electric Services	3,256	2,792	464	16.6 %
Contracted Services	3,261	3,718	(457)	-12.3 %
Total depreciation and amortization	$ 42,403	$ 41,315	$ 1,088	2.6 %

The water general rate case final decision approved an overall higher composite depreciation rates based on a revised depreciation study. The increase in composite depreciation rates increases the adopted water revenue requirement, with a corresponding increase in adopted depreciation expense, resulting in no impact to net earnings. The overall increase in depreciation and amortization expenses at the water segment included the retroactive impact for the full year of 2022 of $576,000. In addition, the increase to depreciation and amortization expense was also attributed to additions to utility plant and other fixed assets at both regulated utilities.

Maintenance

For the years ended December 31, 2023 and 2022, maintenance expense by segment consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 9,906	$ 9,559	$ 347	3.6 %
Electric Services	924	723	201	27.8 %
Contracted Services	3,388	3,110	278	8.9 %
Total maintenance	$ 14,218	$ 13,392	$ 826	6.2 %

Maintenance expense increased at each of the business segments due to higher planned and unplanned maintenance activities as compared to the same period in 2022.

Property and Other Taxes

For the years ended December 31, 2023 and 2022, property and other taxes by segment, consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 19,845	$ 19,080	$ 765	4.0 %
Electric Services	2,100	1,837	263	14.3 %
Contracted Services	2,101	1,977	124	6.3 %
Total property and other taxes	$ 24,046	$ 22,894	$ 1,152	5.0 %

Property and other taxes increased at the water segment primarily due to an increase in franchise fees resulting from higher water revenues, partially offset by favorable property tax adjustments resulting from changes in property tax assessments for certain counties. In addition, there was an increase in property taxes at the electric segment resulting from an increase in capital additions and higher assessed values, and an increase in gross receipts taxes at the contracted services segment from higher construction activity.

ASUS Construction

For the year ended December 31, 2023, construction expenses for contracted services were $57.9 million, increasing by $4.7 million compared to 2022 primarily due to an increase in construction activity as compared to 2022.

Interest Expense

For the years ended December 31, 2023 and 2022, interest expense by segment, including AWR (parent), consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 31,283	$ 22,742	$ 8,541	37.6 %
Electric Services	3,298	1,225	2,073	169.2 %
Contracted Services	2,127	743	1,384	186.3 %
AWR (parent)	6,054	2,317	3,737	161.3 %
Total interest expense	$ 42,762	$ 27,027	$ 15,735	58.2 %

AWR's borrowings consist of bank notes under revolving credit facilities, while GSWC and BVES borrowings consist of revolving credit facilities and long-term debt issuances. Consolidated interest expense increased as compared to 2022 resulting from an overall increase in total borrowing levels to support, among other things, the capital expenditures programs at the regulated utilities, as well as overall increases in average interest rates both short- and long-term. On January 13, 2023, GSWC issued $130.0 million unsecured notes in a private placement consisting of $100.0 million in aggregate notes at a coupon rate of 5.12% due January 31, 2033, and $30.0 million in aggregate notes at a coupon rate of 5.22% due January 31, 2038. Also, in April 2022, BVES issued $35.0 million in unsecured notes in a private placement consisting of 10 and 15 year term notes bearing interest at 4.548% and 4.949%, respectively.

Interest Income

For the years ended December 31, 2023 and 2022, interest income by business segment, including AWR (parent), consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 5,557	$ 1,083	$ 4,474	*
Electric Services	1,060	394	666	169.0 %
Contracted Services	806	875	(69)	-7.9 %
AWR (parent)	(7)	(26)	19	-73.1 %
Total interest income	$ 7,416	$ 2,326	$ 5,090	218.8 %

* not meaningful

The overall increase in interest income was due primarily to higher interest income earned on regulatory assets at the regulated utilities bearing interest at the current 90-day commercial-paper rates, which have increased since 2022, as well as an overall increase in regulatory assets recorded as a result of the final decision in the water general rate case, partially offset by lower interest income recognized on certain construction projects at the contracted services segment as compared to 2022.

Other Income and (Expense), net

For the years ended December 31, 2023 and 2022, other income and (expense) by business segment, including AWR (parent), consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 4,946	$ (680)	$ 5,626	*
Electric Services	36	406	(370)	-91.1 %
Contracted Services	(125)	141	(266)	-188.7 %
AWR (parent)	269	258	11	4.3 %
Total interest income	$ 5,126	$ 125	$ 5,001	*

* not meaningful

For the year ended December 31, 2023, other income (net of other expense) increased mostly because of gains of $5.0 million recorded on investments held to fund one of the Company's retirement plans, as compared to losses of $5.2 million incurred in 2022, both due to financial market conditions. This was partially offset by an increase in the non-service cost components of net periodic benefit costs related to the Company's defined-benefit pension plan and other retirement benefits. However, as a result of GSWC's and BVES's two-way pension balancing accounts authorized by the CPUC, changes in total net periodic benefit costs related to the pension plan have no material impact to earnings.

Income Tax Expense

For the years ended December 31, 2023 and 2022, income tax expense by segment, including AWR (parent), consisted of the following amounts (in thousands):

	Year Ended 12/31/2023	Year Ended 12/31/2022	$ CHANGE	% CHANGE
Water Services	$ 35,689	$ 16,346	$ 19,343	118.3 %
Electric Services	1,515	2,439	(924)	-37.9 %
Contracted Services	6,109	5,476	633	11.6 %
AWR (parent)	(1,714)	(597)	(1,117)	187.1 %
Total income tax expense	$ 41,599	$ 23,664	$ 17,935	75.8 %

Consolidated income tax expense for the year ended December 31, 2023 increased by $17.9 million primarily due to an increase in pretax income as compared to 2022. AWR's ETRs were 25.0% and 23.2% for the years ended December 31, 2023 and 2022, respectively. GSWC's ETR was 25.8% for the year ended December 31, 2023 as compared to 23.3% for 2022. The increase in GSWC's ETR was also primarily due to the effect of the increase in its pretax income. The increase in AWR (parent)'s tax benefit was primarily due to an increase in pretax loss resulting from higher interest expense, as well as changes in state unitary taxes.

Information comparing the consolidated results of operations for fiscal years 2022 and 2021 can be found under Item 7, Management's Discussion and Analysis under the headings *"Summary Results by Segment"* and *"Consolidated Results of Operations-Years Ended December 31, 2022 and 2021"* in AWR's Annual Report on Form 10-K for the fiscal year ended December 31, 2022 filed with the SEC.

Critical Accounting Policies and Estimates

Critical accounting policies and estimates are those that are important to the portrayal of AWR's financial condition, results of operations and cash flows, and require the most difficult, subjective or complex judgments of AWR's management. The need to make estimates about the effect of items that are uncertain is what makes these judgments difficult, subjective and/or complex. Management makes subjective judgments about the accounting and regulatory treatment of many items. The following are accounting policies and estimates that are critical to the financial statements of AWR. For more information regarding the significant accounting policies of Registrant, see Note 1 of "*Notes to Financial Statements*" included in Part II, Item 8, in Financial Statements and Supplementary Data.

Accounting for Rate Regulation — Because GSWC and BVES operate extensively in regulated businesses, they are subject to the authoritative guidance for accounting for the effects of certain types of regulation. Application of this guidance requires accounting for certain transactions in accordance with regulations adopted by the regulatory commissions of the states in which rate-regulated operations are conducted. Utility companies defer costs and credits on the balance sheet as regulatory assets and liabilities when it is probable that those costs and credits will be recognized in the ratemaking process in a period different from the period in which they would have been reflected in income by an unregulated company. These deferred regulatory assets and liabilities are then reflected in the income statement in the period in which the same amounts are reflected in the rates charged for service.

Regulation and the effects of regulatory accounting have the most significant impact on the financial statements of GSWC and BVES. When either files for adjustments to rates, the capital assets, operating costs and other matters are subject to review, and disallowances may occur. In the event that a portion of either GSWC's or BVES's operations are no longer subject to the accounting guidance for the effects of certain types of regulation, they are required to write-off related regulatory assets that are not specifically recoverable and determine if other assets might be impaired. If the CPUC determines that a portion of either GSWC's or BVES's assets are not recoverable in customer rates, management is required to determine if it has suffered an asset impairment that would require a write-down in the asset valuation. Management continually evaluates the anticipated recovery, settlement or refund of regulatory assets, liabilities, and revenues subject to refund and provides for allowances and/or reserves that it believes to be necessary. In the event that management's assessment as to the probability of the inclusion in the ratemaking process is incorrect, the associated regulatory asset or liability will be adjusted to reflect the change in assessment or the impact of regulatory approval of rates. Reviews by the CPUC may also result in additional regulatory liabilities to refund previously collected revenues to customers if the CPUC disallows costs included in the ratemaking process.

Registrant also reviews its utility plant in-service for possible impairment in accordance with accounting guidance for regulated entities for abandonments and disallowances of plant costs.

Revenue Recognition — GSWC and BVES record water and electric utility operating revenues when the service is provided to customers. Operating revenues include unbilled revenues that are earned (i.e., the service has been provided) but not billed by the end of each accounting period. Unbilled revenues are calculated based on the number of days and total usage from each customer's most recent billing record that was billed prior to the end of the accounting period and is used to estimate unbilled consumption as of the year-end reporting period. Unbilled revenues are recorded for both monthly and bi-monthly customers.

In 2008, the CPUC granted GSWC the authority to implement revenue decoupling mechanisms through the adoption of the WRAM. With the adoption of this alternative revenue program, GSWC adjusts revenues in the WRAM for the difference between what is billed to its water customers and that which is authorized by the CPUC. GSWC's request to continue using a revenue decoupling mechanism, similar to the WRAM, in its next general rate case is subject to CPUC approval. The CPUC also granted BVES a revenue decoupling mechanism through the BRRAM. BVES adjusts revenues in the BRRAM for the difference between what is billed to its electric customers and that which is authorized by the CPUC.

As required by the accounting guidance for alternative revenue programs, GSWC and BVES are required to collect their WRAM and BRRAM balances, respectively, within 24 months following the year in which they are recorded. The CPUC has set the recovery period for under-collected balances that are up to 15% of adopted annual revenues at 18 months or less. For net WRAM under-collected balances greater than 15%, the recovery period is 19 to 36 months. As a result of the accounting guidance and CPUC-adopted recovery periods, Registrant must estimate if any WRAM and BRRAM revenues will be collected beyond the 24-month period. This can affect the timing of when such revenues are recognized.

ASUS's firm-fixed-price contracts with the U.S. government are considered service concession arrangements under ASC 853 *Service Concession Arrangements*. Accordingly, the services under these contracts are accounted for under Topic 606 *Revenue from Contracts with Customers* and the water and/or wastewater systems are not recorded as Property, Plant and Equipment on AWR's consolidated balance sheet. Revenues for ASUS's operations and maintenance contracts are recognized when services have been rendered to the U.S. government pursuant to the initial 50-year contract and additional contracts thereafter. Revenues from construction activities are recognized as performance obligations are satisfied. Performance obligations related to firm-fixed-price contracts are satisfied over time as the ASUS's performance typically creates or enhances an asset that the U.S. government controls. ASUS recognizes revenue on its firm-fixed-price contracts as performance obligations are satisfied and control of the promised good and/or service is transferred to the U.S. government by measuring the progress toward complete satisfaction of the performance obligation(s) using an input method. Revenues for construction activities are recognized over time, with progress toward completion measured based on the input method using costs incurred relative to the total estimated costs (cost-to-cost method). Due to the nature of these construction projects, ASUS has determined the cost-to-cost input measurement to be the best method to measure progress towards satisfying its construction contract performance obligations, as compared to using an output measurement such as units produced. Changes in job performance, job conditions, change orders and estimated profitability, including those arising from any contract penalty provisions, and final contract settlements may result in revisions to costs and income, and are recognized in the period in which the revisions are determined. Unbilled receivables from the U.S. government represent amounts to be billed for construction work completed and/or for services rendered pursuant to the initial 50-year contract and additional contracts with the U.S government, which are not presently billable but which will be billed under the terms of the contracts.

Income Taxes — Registrant's income tax calculations require estimates due principally to the regulated nature of the operations of GSWC and BVES, the multiple states in which Registrant operates, and potential future tax rate changes. Registrant uses the asset and liability method of accounting for income taxes under which deferred tax assets and liabilities are recognized for future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective tax bases. Deferred tax assets and liabilities are measured using enacted tax rates expected to apply to taxable income in the years in which these temporary differences are expected to be recovered or settled. Changes in regulatory treatment, or significant changes in tax-related estimates, assumptions or law, could have a material impact on the financial position and results of operations of Registrant.

As regulated utilities, GSWC and BVES treat certain temporary differences as flowed-through adjustments in computing their income tax expense consistent with the income tax approach approved by the CPUC for ratemaking purposes. Flowed-through adjustments increase or decrease tax expense in one period, with an offsetting decrease or increase occurring in another period. Giving effect to these temporary differences as flowed-through adjustments typically results in a greater variance between the effective tax rate and the statutory federal income tax rate in any given period than would otherwise exist if GSWC or BVES were not required to account for their income taxes as regulated enterprises. As of December 31, 2023, Registrant's total amount of unrecognized tax benefits was zero.

Pension Benefits — Registrant's pension benefit obligations and related costs are calculated using actuarial concepts within the framework of accounting guidance for employers' accounting for pensions and post-retirement benefits other than pensions. Two critical assumptions, the discount rate and the expected return on plan assets, are important elements of expense and/or liability measurement. We evaluate these critical assumptions annually. Other assumptions include employee demographic factors such as retirement patterns, mortality, turnover and rate of compensation increase. The discount rate enables Registrant to state expected future cash payments for benefits as a present value on the measurement date. The guideline for setting this rate is a high-quality, long-term corporate bond rate. Registrant's discount rates were determined by considering the average of pension yield curves constructed using a large population of high-quality corporate bonds. The resulting discount rates reflect the matching of plan liability cash flows to the yield curves. A lower discount rate increases the present value of benefit obligations and increases periodic pension expense. Conversely, a higher discount rate decreases the present value of benefit obligations and decreases periodic pension expense. To determine the expected long-term rate of return on the plan assets, Registrant considers the current and expected asset allocation, as well as historical and expected returns on each plan asset class. A lower expected rate of return on plan assets will increase pension expense. The long-term expected return on the pension plan's assets was 5.75% for 2023 and 2022.

For the pension plan obligation, Registrant decreased the discount rate to 5.16% as of December 31, 2023 from 5.41% as of December 31, 2022 to reflect market interest-rate conditions at December 31, 2023. A hypothetical 25-basis point decrease in the assumed discount rate would have decreased total net periodic pension expense for 2023 by approximately $46,000, which includes an increase in service cost that was more than offset by the decrease in interest cost, and would have increased the projected benefit obligation and accumulated benefit obligation at December 31, 2023 by a total of $6.1 million. A 25-basis point decrease in the long-term return on pension-plan-asset assumption would have increased 2023 pension cost by approximately $456,000.

In addition, changes in the fair value of plan assets will impact future pension cost and the Plan's funded status. Changes in market conditions can affect the value of plan assets held to fund future long-term pension benefits. Any reductions in the value of plan assets will result in increased future expense, an increase in the underfunded position, and increase the required future contributions.

The CPUC has authorized GSWC and BVES to each maintain a two-way balancing account to track differences between their forecasted annual pension expenses adopted in rates and the actual annual expense to be recorded in accordance with the accounting guidance for pension costs. As of December 31, 2023, GSWC has a $1.1 million over-collection in its two-way pension balancing account for the general office and water regions. As of December 31, 2023, BVES has a $277,000 over-collection in its two-way pension balancing account.

Funding requirements for qualified defined benefit pension plans are determined by government regulations. In establishing the contribution amount, Registrant has considered the potential impact of funding-rule changes under the Pension Protection Act of 2006. Registrant contributes the minimum required contribution as determined by government regulations or the forecasted annual pension cost authorized by the CPUC and included in customer rates, whichever is higher. In accordance with this funding policy, for 2024, the pension contribution is expected to be approximately $3.3 million. Any differences between the forecasted annual pension costs in rates and the actual pension costs are included in the two-way pension balancing accounts. Additionally, market factors can affect assumptions we use in determining funding requirements with respect to our pension plan. For example, a relatively modest change in our assumptions regarding discount rates can materially affect our calculation of funding requirements. To the extent that market data compels us to reduce the discount rate used in our assumptions, our benefit obligations could materially increase.

Changes in demographics, including increased numbers of retirees or increases in life expectancy assumptions may also increase the funding requirements of our obligations related to the pension plan. Mortality assumptions are a critical component of benefit obligation amounts and a key factor in determining the expected length of time for annuity payments. Assuming no changes in actuarial assumptions or plan amendments, the costs over the long term are expected to decrease due to the closure of Registrant's defined benefit pension plan to new employees as of January 1, 2011. Employees hired or rehired after December 31, 2010 are eligible to participate in a defined contribution plan instead of the pension plan.

Liquidity and Capital Resources

AWR

AWR's regulated business is capital intensive and requires considerable capital resources. A portion of these capital resources is provided by internally generated cash flows from operations. AWR anticipates that interest expense will increase in future periods due to the need for additional external capital to fund construction programs at its regulated utilities and if market interest rates increase. In addition, as the capital investment program continues to increase, AWR and its subsidiaries anticipate they will need to access external financing more often.

AWR funds its operating expenses and pays dividends on its outstanding Common Shares primarily through dividends from its wholly owned subsidiaries. The ability of GSWC and BVES to pay dividends to AWR is restricted by California law. Under these restrictions, approximately $703.8 million was available for GSWC to pay dividends to AWR on December 31, 2023. Approximately $72.3 million was available for BVES to pay dividends to AWR as of December 31, 2023. ASUS's ability to pay dividends to AWR is dependent upon state laws in which each ASUS Subsidiary operates, as well as ASUS's ability to pay dividends under California law.

When necessary, AWR obtains funds from external sources through the capital markets and from bank borrowings. Access to external financing on reasonable terms depends on the credit ratings of AWR and GSWC and current business conditions, including that of the water utility industry in general as well as conditions in the debt or equity capital markets.

On June 28, 2023, AWR and GSWC each executed new credit agreements with terms of five years provided by a syndicate of banks and financial institutions for total combined unsecured revolving credit facilities of $350.0 million. These syndicated credit facilities replaced AWR's previous credit agreement with a sole bank. AWR previously borrowed under a revolving credit facility with a borrowing capacity of $280.0 million and provided funds to both GSWC and ASUS in support of their operations through intercompany borrowing agreements on terms that are similar to that of the credit facility. AWR's new credit agreement was for a $150.0 million unsecured revolving credit facility to support AWR (parent) and its contracted services subsidiary, while GSWC's credit agreement is a $200.0 million unsecured revolving credit facility to support its water operations and capital expenditures. AWR (parent) may also from time to time borrow under its credit facility in order to make equity contributions to GSWC and BVES. Both credit facilities may be expanded up to an additional $75.0 million, subject to the lenders' approval. On November 6, 2023, AWR's credit facility was amended to increase the borrowing capacity from $150.0 million to $165.0 million to provide additional support to AWR (parent) and its contracted services subsidiary. In connection with the increase in borrowing capacity, the amendment also provides for the addition of a new bank to the existing syndicate group participating in AWR's credit facility. AWR's and GSWC's outstanding borrowings under the new credit facilities were $141.5 million and $150.0 million, respectively, as of December 31, 2023.

BVES has a separate revolving credit facility without a parent guaranty, which was amended on June 16, 2023, to increase BVES's borrowing capacity from $35.0 million to $50.0 million. The amendment to BVES's credit agreement also included (i) the extension of the term of the credit facility to July 1, 2026, (ii) conversion of the interest rate on new borrowings to the benchmark rate Secured Overnight Financing Rate ("SOFR"), and (iii) an option to increase the facility by an additional $25.0 million, subject to lender approval. On February 15, 2024, BVES increased the borrowing capacity from $50.0 million to $65.0 million. The CPUC requires BVES to completely pay off all borrowings under its revolving credit facility within a 24-month period. BVES's pay-off period for its credit facility ends in August 2024. Accordingly, the $42.0 million outstanding under BVES's credit facility has been classified as a current liability in AWR's Consolidated Balance Sheet as of December 31, 2023.

Our primary sources of liquidity to fund operations continue to be from the recovery of costs charged to customers at our regulated utilities and the collection of payments from the U.S government. We believe that capital investment costs associated with our capital programs at our regulated utilities will continue to be recovered through water and electric rates charged to customers, as well as funds from credit facilities from our regulated utilities. In addition, AWR's credit facility will continue to be used to support ASUS's operations and AWR (parent). The long-term capital-intensive nature of our regulated utilities have required us to continually seek future financing opportunities beyond the short-term. Future long-term financing at GSWC and BVES will consist of both long-term debt and equity issuances in order to manage to the CPUC-authorized capital structure. Under the current financing applications authorized by the CPUC, GSWC and BVES have $105.0 million and $40.0 million, respectively, remaining available that provides for long-term financing and which are expected to be used over the next 6-18 months to pay down portions of the outstanding borrowings under the respective credit facilities. On January 22, 2024, GSWC filed a new financing application with the CPUC, pending approval, that requests the authorization for the issuance and sale of additional long-term debt and equity securities of up to $750.0 million. On June 13, 2023, BVES filed a new financing application with the CPUC that is also pending approval, and that requests the authorization for the issuance and sale of additional long-term debt and equity securities of up to $120.0 million. The CPUC issued a ruling on January 8, 2024 in BVES's pending financing application stating that a proposed decision is expected to be received no later than 90 days from the date of the ruling. In addition, AWR intends to seek $150.0 million to $200.0 million of additional capital over the next three years through equity offerings, which may include an at-the-market program. AWR could use the net proceeds from equity offerings for, but not limited to, equity contributions to its wholly owned subsidiaries.

Management believes that AWR's and GSWC's sound capital structures and strong credit ratings, combined with its financial discipline, will enable AWR to access the debt and equity markets. However, unpredictable financial market conditions in the future may limit its access or impact the timing of when to access the market, in which case AWR may choose to temporarily reduce its capital spending.

AWR's ability to pay cash dividends on its Common Shares outstanding depends primarily upon cash flows from its subsidiaries. AWR intends to continue paying quarterly cash dividends on or about March 1, June 1, September 1 and December 1, subject to earnings and financial conditions, regulatory requirements and such other factors as the Board of Directors may deem relevant. On February 6, 2024, AWR's Board of Directors approved a first quarter dividend of $0.43 per share on AWR's Common Shares. Dividends on the Common Shares will be paid on March 1, 2024 to shareholders of record at the close of business on February 20, 2024. AWR has paid common dividends every year since 1931, and has increased the dividends received by shareholders each calendar year for 69 consecutive years, which places it in an exclusive group of companies on the New York Stock Exchange that have achieved that result. AWR's quarterly dividend rate has grown at a compound annual growth rate of 9.4% over the last five years. AWR's current policy is to achieve a compound annual growth rate in the dividend of more than 7% over the long-term.

Cash Flows from Operating Activities:

Cash flows from operating activities have generally provided sufficient cash to fund operating requirements, including a portion of construction expenditures at GSWC and BVES, and construction expenses at ASUS, and to pay dividends. AWR's future cash flows from operating activities are expected to be affected by a number of factors, including utility regulation; changes in tax law; maintenance expenses; inflation; compliance with environmental, health and safety standards; production costs; customer growth; per-customer usage of water and electricity; weather and seasonality; conservation efforts; compliance with local governmental requirements, including mandatory restrictions on water use; the lingering effects of the COVID-19 pandemic on its customers' ability to pay utility bills; and required cash contributions to pension and post-retirement plans. Future cash flows from contracted services subsidiaries will depend on new business activities, existing operations, the construction of new and/or replacement infrastructure at military bases, timely economic price and equitable adjustment of prices, and timely collection of payments from the U.S. government and other prime contractors operating at the military bases, and any adjustments arising out of an audit or investigation by federal governmental agencies.

ASUS funds its operating expenses primarily through internal operating sources, which include U.S. government funding under long-term contracts with the U.S. government for operations and maintenance costs and construction activities, as well as investments by, or loans from, AWR. ASUS, in turn, provides funding to its subsidiaries. ASUS's subsidiaries may also from time to time provide funding to ASUS or other subsidiaries of ASUS.

Cash flows from operating activities are primarily generated by net income, adjusted for non-cash expenses such as depreciation and amortization, and deferred income taxes. Cash generated by operations varies during the year. Net cash provided by operating activities of AWR was $67.7 million for 2023 as compared to $117.8 million for the same period in 2022. During 2022, GSWC and BVES received $9.5 million and $473,000, respectively, in COVID-19 relief funds from the state of California to provide assistance to customers for delinquent water and electric customer bills incurred during the pandemic. There were no similar relief funds received during 2023.

The decrease in operating cash flow was also due to a 7.8% decrease in billed water consumption, as well as the delay in receiving the water general rate case final decision as billed water revenues in 2022 and 2023 through July 30, 2023 were based on 2021 adopted rates pending a final CPUC decision, while operating expenses continued to rise primarily due to inflation. A final decision from the CPUC was received on June 29, 2023 on the water general rate case with 2022 and 2023 rates retroactive to January 1, 2022 and 2023, respectively. GSWC filed for the implementation of the CPUC-approved rate increases that went into effect on July 31, 2023. In addition, GSWC filed for the recovery of retroactive rate amounts accumulated through July 30, 2023 related to the CPUC approved rate increases for 2022 and 2023, and surcharges were implemented in October 2023 to recover the cumulative retroactive rate differences over 36-months.

Furthermore, the decrease in operating cash flows was due to differences in the timing of vendor payments and the timing of billing of and cash receipts for construction work at military bases. The billings (and cash receipts) for this construction work generally occur at completion of the work or in accordance with a billing schedule contractually agreed to with the U.S. government and/or other prime contractors. Thus, cash flow from construction-related activities may fluctuate from period to period with such fluctuations representing timing differences of when the work is being performed and when the cash is received for payment of the work.

The timing of cash receipts and disbursements related to other working capital items also affected the change in net cash provided by operating activities.

Cash Flows from Investing Activities:

Net cash used in investing activities was $188.8 million for the year ended December 31, 2023 as compared to $167.1 million for the same period in 2022, which is mostly related to capital expenditures at the regulated utilities. AWR invests capital to provide essential services to its regulated customer base, while working with the CPUC to have the opportunity to earn a fair rate of return on investment. AWR's infrastructure investment plan consists of both infrastructure renewal programs (to replace infrastructure, including those to mitigate wildfire risk) and major capital investment projects (to construct new water treatment, supply and delivery facilities). The regulated utilities may also be required from time to time to relocate existing infrastructure in order to accommodate local infrastructure improvement projects. Projected capital expenditures and other investments are subject to periodic review and revision.

During 2024, the water and electric segments' company-funded capital expenditures are estimated to be approximately $160 – $200 million, barring any delays resulting from changes in capital improvement schedules due to unfavorable weather conditions and supply chain issues.

Cash Flows from Financing Activities:

AWR's financing activities include primarily: (i) the issuance and repayment of long-term debt and notes payable to banks, (ii) the proceeds from unsecured new or existing revolving credit facilities for AWR, GSWC and BVES, and (iii) the payment of dividends on Common Shares. In order to finance new infrastructure, GSWC also receives customer advances (net of refunds) for, and contributions in aid of, construction. Borrowings on AWR's new credit facility is used to support AWR (parent) and its contracted services subsidiary and borrowings on GSWC's and BVES's credit facilities are used to fund GSWC and BVES capital expenditures, respectively, until long-term financing is arranged. AWR (parent) may also from time to time make equity contributions to GSWC and BVES. Overall debt levels are expected to increase to fund a portion of the costs of the capital expenditures that will be made by the regulated utilities.

Net cash provided by financing activities was $129.2 million for the year ended December 31, 2023 as compared to cash provided of $50.3 million for 2022. The increase in cash provided by financing activities in 2023 was due primarily to an increase in total borrowing levels necessary to support operations affected by a decrease in cash flows from operating activities and to support, among other things, the capital expenditures program at the regulated utilities. In January 2023, GSWC issued $130.0 million of unsecured notes in a private placement and used the proceeds to pay down the majority of its outstanding intercompany borrowings from AWR, which in turn used the proceeds to pay down outstanding borrowings under the AWR credit facility at that time.

On June 28, 2023, AWR and GSWC each executed new unsecured syndicated credit facilities to replace AWR's previous credit agreement with a sole bank. During the year ended December 31, 2023, AWR had a net increase in borrowings on its credit facilities of $54.6 million to support operations and capital expenditures. During 2022, AWR had a net increase in borrowings on its credit facilities of $72.0 million.

GSWC

GSWC funds its operating expenses, payments on its debt, dividends to AWR on its outstanding common shares, and a portion of its construction expenditures through internal sources. Internal sources of cash flow are provided primarily by retention of a portion of earnings from operating activities. Internal cash generation is influenced by factors such as weather patterns, conservation efforts, environmental regulation, litigation, changes in tax law and deferred taxes, changes in supply costs and regulatory decisions affecting GSWC's ability to recover these supply costs, timing of rate relief, increases in maintenance expenses and capital expenditures, surcharges authorized by the CPUC to enable GSWC to recover expenses previously incurred from customers, and CPUC requirements to refund amounts previously charged to customers. Internal cash flows have also been impacted by delays in receiving payments from GSWC customers due to the lingering effects of the COVID-19 pandemic.

GSWC may, at times, utilize external sources for long-term financing, as well as obtain funds from equity investments from its parent, AWR, to help fund a portion of its operations and construction expenditures. On June 28, 2023, GSWC executed its own separate credit agreement that provides for a $200.0 million unsecured revolving credit facility to support GSWC's operations and capital expenditures. GSWC's borrowing capacity under this credit agreement may be expanded up to an additional $75.0 million, subject to the lenders' approval. Previously, AWR borrowed under a revolving credit facility and provided funds to GSWC in support of its operations under intercompany borrowing arrangements.

In January 2023, GSWC issued (i) one common share to AWR for $10.0 million, and (ii) $130.0 million in unsecured long-term notes in a private placement. GSWC used the proceeds from both the issuance of equity and long-term debt to pay-off all intercompany borrowings from AWR. On June 28, 2023, GSWC borrowed for the first time under its new syndicated credit facility and used the proceeds to again pay-off its short-term intercompany borrowings due to AWR. The CPUC requires GSWC to pay-off all intercompany borrowings it has from AWR within a 24-month period. GSWC's borrowings under its new credit facility will also be required to be paid-off in full within a 24-month period. GSWC's next pay-off period ends in June 2025. Under the current financing application authorized by the CPUC, GSWC has $105.0 million remaining available that provides for long-term financing and which are expected to be used over the next 6-18 months to pay down portions of the outstanding borrowings under GSWC's credit facility. On January 22, 2024, GSWC filed a new financing application with the CPUC, pending approval, that requests the authorization for the issuance and sale of additional long-term debt and equity securities of up to $750.0 million.

In addition, GSWC receives advances and contributions from customers, home builders and real estate developers to fund construction necessary to extend service to new areas. Advances for construction are generally refundable at a rate of 2.5% in equal annual installments over 40 years. Utility plant funded by advances and contributions is excluded from rate base. GSWC amortizes contributions in aid of construction at the same composite rate of depreciation for the related property.

Cash Flows from Operating Activities:

Net cash provided by operating activities was $54.3 million for the year ended December 31, 2023 as compared to $94.5 million for 2022. During the first quarter of 2022, GSWC received $9.5 million in COVID-19 relief funds from the state of California to provide assistance to customers for delinquent water customer bills incurred during the pandemic. There were no similar relief funds received during 2023. The decrease in operating cash flow was also due to a 7.8% decrease in billed water consumption, as well as the delay in receiving the water general rate case final decision as billed water revenues in 2022 and 2023 through July 30, 2023 were based on 2021 adopted rates pending a final CPUC decision, while operating expenses continued to rise primarily due to inflation. A final decision from the CPUC was received on June 29, 2023 on the water general rate case with 2022 and 2023 rates retroactive to January 1, 2022 and 2023, respectively. GSWC filed for the implementation of new 2023 rate increases that went into effect on July 31, 2023. In addition, GSWC filed for the recovery of retroactive rate amounts accumulated through July 30, 2023 related to the new 2022 and 2023 rates, and surcharges were implemented in October 2023 to recover the cumulative retroactive rate differences over 36-months. The decrease in operating cash flow was also due to the timing of vendor payments. The timing of cash receipts and disbursements related to other working capital items also affected the change in net cash provided by operating activities.

Cash Flows from Investing Activities:

Net cash used in investing activities was $162.2 million for the year ended December 31, 2023 as compared to $147.7 million for 2022, which is mostly related to spending under GSWC's infrastructure investment plans that are consistent with capital budgets authorized in its general rate cases.

Cash Flows from Financing Activities:

Net cash provided by financing activities was $110.6 million for the year ended December 31, 2023 as compared to $53.1 million for 2022. The increase in net cash provided by financing activities in 2023 was due primarily to an increase in total borrowing levels necessary to support water operations affected by a decrease in cash flows from operating activities and to support, among other things, the capital expenditures program at GSWC.

In January 2023, GSWC issued $130.0 million of unsecured notes in a private placement and $10.0 million of equity to AWR. GSWC used the proceeds from both issuances to pay-off all of its outstanding intercompany borrowings from AWR at that time. On June 28, 2023, GSWC entered into an unsecured revolving credit facility. GSWC used the proceeds from the borrowings under the new credit facility to again pay-off all of its intercompany borrowings owed to AWR. The CPUC requires GSWC to fully pay-off all intercompany borrowings from AWR within a 24-month period. GSWC's borrowings under its new credit facility will also be required to be paid-off in full within a 24-month period.

Contractual Obligations and Commitments

Registrant has various contractual obligations, which are recorded as liabilities in the consolidated financial statements. Other items, such as certain purchase commitments, are not recognized as liabilities in the consolidated financial statements but are required to be disclosed. In addition to contractual maturities, Registrant has certain debt instruments that contain annual sinking funds or other principal payments. Registrant believes that it will be able to refinance debt instruments at their maturity through public issuance or private placement of debt or equity. Annual payments to service debt are generally made from cash flows from operations.

The following table reflects Registrant's contractual obligations and commitments to make future payments pursuant to contracts as of December 31, 2023. The table reflects only financial obligations and commitments. Therefore, performance obligations associated with our initial 50-year, firm-fixed-price contract and additional firm-fixed-price contracts with the U.S. government at our contracted services segment are not included in the amounts below. Registrant believes that it will be able to refinance debt instruments at their maturity through public issuance or private placement of debt or equity. Annual payments to service debt are generally made from cash flows from operations.

	Payments/Commitments Due (1)	
($ in thousands)	**Total**	**Less than 1 Year**
Notes/Debentures (2)	$ 187,000	$ —
Private Placement Notes (3)	380,000	—
Tax-Exempt Obligations (4)	9,459	121
Other Debt Instruments (5)	2,588	232
Total AWR Long-Term Debt	$ 579,047	$ 353
Credit Facilities (6)	$ 333,500	$ 42,000
Interest on Long-Term Debt (7)	275,444	28,587
Advances for Construction (8)	71,109	3,678
Renewable Energy Credit Agreement (9)	8,948	131
Purchased Power Contracts (10)	45,801	4,685
Capital Expenditures (11)	105,165	102,865
Water Purchase Agreements (12)	2,732	491
Operating Leases (13)	9,290	2,161
Employer Contributions (14)	3,300	3,300
SUB-TOTAL	855,289	187,898
Other Commitments (15)	11,399	—
TOTAL	$ 1,445,735	$ 188,251

(1) Excludes dividends and facility fees.

(2) The notes and debentures have been issued by GSWC under an Indenture dated September 1, 1993, as amended in December 2008. The notes and debentures do not contain any financial covenants that Registrant believes to be material or any cross-default provisions.

(3) Consists of GSWC senior private placement notes of $345.0 million and BVES unsecured private placement notes of $35.0 million, issued in April 2022, totaling $380.0 million issued to various banks, including $160.0 million of unsecured private placement notes issued in July 2020 by GSWC and $130.0 million of unsecured private placement notes in January 2023 by GSWC. Under the terms of each of the senior notes, GSWC may not incur any additional debt or pay any distributions to its shareholders if, after giving effect thereto, it would have a debt to capitalization ratio in excess of 0.6667-to-1 or a debt to earnings before interest, taxes, depreciation and amortization ratio of more than 8-to-1. GSWC is in compliance with all of its covenant provisions as of December 31, 2023. GSWC does not currently have any outstanding mortgages or other liens on indebtedness on its properties.

(4) Consists of obligations at GSWC related to (i) a loan agreement supporting $7.7 million in outstanding debt issued by the California Pollution Control Financing Authority, and (ii) $1.7 million of obligations with respect to GSWC's 500 acre-foot entitlement to water from the State Water Project ("SWP"). These obligations do not contain any financial covenants believed to be material to Registrant or any cross-default provisions. In regard to its SWP entitlement, GSWC has entered into agreements with various developers for a portion of its 500 acre-foot entitlement to water from the SWP.

(5) Consists of the outstanding debt portion of funds received under the American Recovery and Reinvestment Act for reimbursements of capital costs related to the installation of meters for conversion of non-metered service to metered service in GSWC's Arden-Cordova District.

(6) Credit facilities consists of (i) a $165.0 million revolving credit facility under AWR, of which $141.5 million was outstanding as of December 31, 2023; (ii) a $200.0 million revolving credit facility under GSWC, of which $150.0 million was outstanding as of December 31, 2023; and (iii) a $50.0 million revolving credit facility under BVES, of which $42.0 million was outstanding as of December 31, 2023.

(7) Consists of expected interest expense payments based on the assumption that GSWC's long-term debt remains outstanding until maturity.

(8) Advances for construction represent contract refunds mostly from GSWC to developers for the cost of water systems paid for by the developers. The advances are generally refundable in equal annual installments over 40-year periods.

(9) Consists of an agreement by BVES to purchase renewable energy credits through 2035. These renewable energy credits are used to meet California's renewables portfolio standard.

(10) Consists of BVES fixed-cost purchased power contracts executed (i) in September 2019 with Morgan Stanley Capital Group Inc., and (ii) in July 2023 with Shell Energy North America (US), L.P.

(11) Consists primarily of capital expenditures estimated to be required under signed contracts at GSWC and BVES as of December 31, 2023.

(12) Water purchase agreements consist of (i) a remaining amount of $1.3 million under an agreement expiring in 2028 to use water rights from a third party, and (ii) an aggregate amount of $1.4 million of other water purchase commitments with other third parties, which expire between 2025 through 2038.

(13) Reflects future minimum payments under noncancelable operating leases for both GSWC and ASUS.

(14) Consists of expected contributions to Registrant's defined benefit pension plan for the year 2024. Contributions to the pension plan are expected to be the higher of the minimum required contributions under the Employee Retirement Income Security Act ("ERISA") or the amounts that are recovered in customer rates and approved by the CPUC. These amounts are estimates and are subject to change based on, among other things, the limits established for federal tax deductibility (pension plan) and the significant impact that returns on plan assets and changes in discount rates have on such amounts.

(15) Other commitments consist primarily of (i) $10.5 million in asset retirement obligations of GSWC that reflect the retirement of wells by GSWC, which by law need to be properly capped at the time of removal; (ii) irrevocable letters of credit in the amount of $874,600 for the deductible in Registrant's business automobile insurance policies; and (iii) a $15,000 irrevocable letter of credit issued on behalf of GSWC pursuant to a franchise agreement with the City of Rancho Cordova. All of the letters of credit are issued pursuant to AWR's revolving credit facility.

Information comparing the liquidity and capital resources for fiscal years 2022 and 2021 can be found under Item 7, Management's Discussion and Analysis under the heading "*Liquidity and Capital Resources*" in AWR's Annual Report on Form 10-K for the fiscal year ended December 31, 2022 filed with the SEC.

BVES Power-Supply Arrangements

BVES purchases power pursuant to purchase power contracts approved by the CPUC. Prior to 2023, BVES had entered into purchase power contracts with three- and five-year terms depending on the amount of power and the period during which the power is purchased under the contracts. These remaining contracts will expire in 2024. In July 2023, the CPUC approved a new power purchase agreement between BVES and a third party to procure renewable portfolio standard eligible energy and renewable energy credits as a bundled product. BVES will begin taking power under this long-term contract during the fourth quarter of 2024 to replace the existing expiring contracts. The new contract provides for the purchase of electricity during a delivery period from November 1, 2024 through December 31, 2035. In addition to the purchased power contracts, BVES buys additional energy to meet peak demand as needed and sells surplus power when necessary. BVES is pursuing short- and long-term renewable energy contracts to replace any power purchase agreements that have expired in addition to satisfying its requirements related to its resource portfolio for the next compliance period (2021-2024) and beyond. The average price per MWh, including fixed costs, decreased to $79.80 per MWh in 2023 from $97.89 per MWh in 2022. BVES has an electric-supply-cost balancing account, as approved by the CPUC, to alleviate any impacts to earnings.

Construction Program

GSWC maintains an ongoing water distribution main replacement program throughout its customer service areas based on the age and type of distribution-system materials, priority of leaks detected, remaining productive life of the distribution system and an underlying replacement schedule. In addition, GSWC and BVES upgrade their facilities in accordance with industry standards, local and CPUC requirements and new legislation. California requires investor-owned electric utilities to submit an annual wildfire mitigation plan to the CPUC for approval, and requires all electric utilities to prepare plans on constructing, maintaining, and operating their electrical lines and equipment to minimize the risk of catastrophic wildfires.

As of December 31, 2023, GSWC and BVES have unconditional purchase obligations for capital projects of approximately $105.2 million. During the years ended December 31, 2023, 2022 and 2021, GSWC and BVES had capital expenditures of $182.7 million, $174.3 million and $150.6 million, respectively. A portion of these capital expenditures was funded by developers through contributions in aid of construction, which are not required to be repaid, and refundable advances. During the years ended December 31, 2023, 2022 and 2021, capital expenditures funded by developers were $7.0 million, $6.9 million and $8.0 million, respectively. During 2024, the water and electric segments' company-funded capital expenditures are estimated to be approximately $160 – $200 million, barring any delays resulting from changes in capital improvement schedules due to unfavorable weather conditions and supply chain issues. These amounts include approximately $16.7 million estimated to be spent by BVES on wildfire mitigation projects.

Contracted Services

Under the terms of the contracts with the U.S. government, each contract's price is subject to an economic price adjustment ("EPA") on an annual basis. In the event that ASUS (i) is managing more assets at specific military bases than were included in the U.S. government's request for proposal, (ii) is managing assets that are in substandard condition as compared to what was disclosed in the request for proposal, (iii) prudently incurs costs not contemplated under the terms of the contract, and/or (iv) becomes subject to new regulatory requirements, such as more stringent water-quality standards, ASUS is permitted to file, and has filed, requests for equitable adjustment ("REAs"). The timely filing for and receipt of EPAs and/or REAs continues to be critical in order for ASUS's subsidiaries to recover increasing costs of operating, maintaining, renewing and replacing the water and/or wastewater systems at the military bases it serves.

During sequestration or automatic spending cuts, the subsidiaries of ASUS did not experience any earnings impact to their existing operations and maintenance and renewal and replacement services, as utility privatization contracts are an "excepted service." With the expiration of sequestration, similar issues including further sequestration pursuant to the Balanced Budget and Emergency Deficit Control Act may arise as part of the fiscal uncertainty and/or future debt-ceiling limits imposed by Congress. Any future impact on ASUS and its operations through its subsidiaries will likely be limited to (a) the timing of funding to pay for services rendered, (b) delays in the processing of EPAs and/or REAs, (c) the timing of the issuance of contract modifications for new construction work not already funded by the U.S. Government, and/or (d) delays in solicitation for and/or awarding of new contracts under the Department of Defense contracting programs.

At times, the DCAA and/or the DCMA may, at the request of a contracting officer, perform audits/reviews of contractors for compliance with certain government guidance and regulations, such as the Federal Acquisition Regulations and Defense Federal Acquisition Regulation Supplements. Certain audit/review findings, such as system deficiencies for government-contract-business-system requirements, may result in delays in the resolution of filings submitted to and/or the ability to file new proposals with the U.S. government.

Below is a summary of current and projected EPA filings for price adjustments to operations and maintenance fees and renewal and replacement fees for ASUS's subsidiaries in fiscal 2024.

Military Base	EPA period	Filing Date
Fort Bliss (FBWS)	October 2023 - September 2024	Third Quarter 2023
Fort Gregg-Adams (ODUS)	February 2024 - January 2025	Fourth Quarter 2023
Joint Base Langley Eustis and Joint Expeditionary Base Little Creek Fort Story (ODUS)	April 2024 - March 2025	First Quarter of 2024
Joint Base Andrews (TUS)	February 2024 - January 2025	Fourth Quarter 2023
Fort Jackson (PSUS)	February 2024 - January 2025	Fourth Quarter 2023
Fort Liberty (ONUS)	March 2024 - February 2025	First Quarter 2024
Eglin Air Force Base (ECUS)	June 2024 - May 2025	Second Quarter 2024
Fort Riley (FRUS)	July 2024 - June 2025	Second Quarter 2024

Regulatory Matters

A discussion on various regulatory matters is included in the section titled *"Overview"* in this Form 10-K*'s "Management's Discussion and Analysis of Financial Condition and Results of Operations."* The discussion below focuses on other regulatory matters and developments.

Certificates of Public Convenience and Necessity

GSWC and BVES hold Certificates of Public Convenience and Necessity ("CPCN") granted by the CPUC in each of the ratemaking areas they serve. ASUS subsidiaries are regulated, if applicable, by the state in which it primarily conducts water and/or wastewater operations. FBWS holds a CPCN from the Public Utilities Commission of Texas. The Virginia State Corporation Commission exercises jurisdiction over ODUS as a public service company. The Maryland Public Service Commission approved the right of TUS to operate as a water and wastewater utility at Joint Base Andrews, Maryland, based on certain conditions and is expected to approve the right of PRUS to operate as a water and wastewater utility at Naval Air Station Patuxent River, Maryland when operations begin. The South Carolina Public Service Commission exercises jurisdiction over PSUS as a public service company. ONUS is regulated by the North Carolina Public Service Commission. ECUS, FRUS and BSUS are not subject to regulation by their respective states' utility commissions.

GSWC and BVES are subject to regulation by the CPUC which has broad authority over service and facilities, rates, classification of accounts, valuation of properties, the purchase, disposition and mortgaging of properties necessary or useful in rendering public utility service, the issuance of securities, the granting of certificates of public convenience and necessity as to the extension of services and facilities and various other matters.

Rates that GSWC and BVES are authorized to charge are determined by the CPUC in general rate cases and are derived using rate base, cost of service and cost of capital, as projected for a future test year. Rates charged to customers vary according to customer class and rate jurisdiction and are generally set at levels allowing for recovery of prudently incurred costs, including a fair return on rate base. Rate base generally consists of the original cost of utility plant in service, plus certain other assets, such as working capital and inventory, less accumulated depreciation on utility plant in service, deferred income tax liabilities and certain other deductions.

GSWC is required to file a water general rate case application every three years according to a schedule established by the CPUC. General rate cases typically include an increase in the test year with inflation-rate adjustments for expenses in the second and third years of the rate case cycle. For capital projects, there are two test years. Rates are based on a forecast of expenses and capital costs for each test year. GSWC's cost of capital is determined in a separate proceeding. Investor-owned water utilities serving California are required to file their cost of capital applications on a triennial basis. BVES's general rate cases are typically filed every four years, which also includes a determination of BVES's cost of capital. Rates may also be increased by offsets for certain expense increases, including, but not limited to, supply-cost offset and balancing-account amortization, advice letter filings related to certain plant additions and other operating cost increases.

Neither the operations of AWR nor the operations and rates of ASUS are directly regulated by the CPUC. The CPUC does, however, regulate certain transactions between GSWC, BVES and ASUS and between GSWC and BVES and AWR.

General Rate Cases and Other Regulatory Matters

Water Segment

Recent Changes in Rates:

Rates that GSWC is authorized to charge are determined by the CPUC in general rate cases. Water revenues billed to customers for the year ended December 31, 2022 and from January 1, 2023 through July 30, 2023 were based on 2021 adopted rates. On June 29, 2023, GSWC received a final decision on its water general rate case application that determined new rates for 2022 and 2023 and are effective and retroactive to January 1, 2022 and January 1, 2023, respectively. The impact of retroactive rates for the full year of 2022 and the second-year 2023 rate increases have been reflected in the results for 2023. GSWC filed for the implementation of new 2023 rate increases effective on July 31, 2023. In October 2023, GSWC also filed for the recovery of all retroactive amounts for 2022 and 2023 accumulated up to the effective date of the new 2023 rates, July 30, 2023. Surcharges were implemented in October 2023 to recover these cumulative retroactive rate differences over 36 months, which through December 31, 2023 totaled $52.8 million and were included in CPUC-authorized general rate case memorandum accounts recognized as regulatory assets.

Water General Rate Case for the years 2025–2027:

On August 14, 2023, GSWC filed a general rate case application for all its water regions and the general office. This general rate case will determine new water rates for the years 2025 – 2027. Among other things, GSWC requested capital budgets of approximately $611.4 million for the three-year capital cycle. GSWC also requested the continuation of mechanisms to accommodate fully decoupled revenues and sales and track differences between recorded and CPUC-authorized supply-related expenses. GSWC has requested the CPUC to permit it to continue using a revenue decoupling mechanism. As of the filing date of this Form 10-K, a proposed decision in the water general rate case is scheduled for the fourth quarter of 2024, with new rates to become effective January 1, 2025.

Cost of Capital Proceeding for the years 2022–2024:

On June 29, 2023, a final decision was adopted by the CPUC in the cost of capital proceeding that, among other things, (i) adopts GSWC's requested capital structure; (ii) adopts a cost of debt of 5.1% for GSWC as compared to 6.6% previously authorized; (iii) adopts a return on equity of 8.85% for GSWC as compared to 8.9% previously authorized; (iv) allows for the continuation of the WCCM through December 31, 2024; and (v) adopts the new cost of capital for the three-year period commencing January 1, 2022 through December 31, 2024. Based on the final decision issued in June, all adjustments to rates were prospective and not retroactive. GSWC filed an advice letter that implemented the new cost of capital effective July 31, 2023.

On June 30, 2023, GSWC filed an advice letter to establish the WCCM for 2023, which increased the 8.85% adopted return on equity in the decision to 9.36% effective July 31, 2023. Additionally, on October 12, 2023, GSWC filed an advice letter to establish the WCCM for 2024, which has been approved by the CPUC, and increased GSWC's 9.36% adopted return on equity to 10.06% effective January 1, 2024.

2024 COC Application:

Investor-owned water utilities serving California are required to file their cost of capital applications on a triennial basis. GSWC's next cost of capital application was scheduled to be filed on May 1, 2024 effective for the years 2025 - 2027. However, GSWC, along with three other Class A investor-owned water utilities in California, filed a joint request with the CPUC to defer the filing deadline of the next cost of capital applications by one year, which was approved on February 2, 2024. The joint request asked that the utilities keep the cost of capital currently authorized for 2024 in effect through 2025, and file new cost of capital applications by May 1, 2025 to set the cost of debt, return on equity and capital structure starting January 1, 2026. GSWC's current authorized rate of return on rate base is 7.93% effective January 1, 2024, which will continue in effect through December 31, 2025. Additionally, GSWC's WCCM will remain active through the one year deferral period.

San Juan Oaks Mutual Acquisition:

In August 2023, GSWC entered into an agreement to purchase the water and wastewater system assets from San Juan Oaks Mutual Water Company ("SJO Mutual") in San Benito County, California. The new master-planned community, known as San Juan Oaks, will serve up to an estimated 1,300 customers once the community is built as planned. The transaction is subject to CPUC approval. In December 2023, GSWC filed an application to establish the new service area and to set water and sewer rates for the San Juan Oaks service area in San Benito County, California.

Electric Segment

Recent Changes in Rates:

On August 30, 2022, BVES filed a new general rate case application with the CPUC to determine new rates for the years 2023–2026. Electric revenues billed to customers for 2023 were based on 2022 adopted rates and will remain in effect until finalization of the pending general rate case application. On December 15, 2022, the CPUC approved a decision for BVES to establish a general rate case memorandum account that makes the new 2023 rates effective and retroactive to January 1, 2023. Because new rates are expected to be retroactive to January 1, 2023, when a decision is issued in the electric general rate case, cumulative adjustments will be recorded at that time.

Vegetation Management, Wildfire Mitigation Plans and Legislation:

The CPUC adopted regulations intended to enhance the fire safety of overhead electric power lines. Those regulations included increased minimum clearances around electric power lines. BVES was authorized to track incremental costs incurred to implement the regulations in a fire hazard prevention memorandum account for the purpose of obtaining cost recovery in a future general rate case. The August 2019 final decision also authorized BVES to record incremental costs related to vegetation management, such as costs for increased minimum clearances around electric power lines, in the CPUC-approved memorandum account for future recovery. As of December 31, 2023, BVES had approximately $11.8 million in incremental vegetation management costs recorded as a regulatory asset. As part of its general rate case application filing with the CPUC in August 2022, BVES requested recovery of the costs accumulated in this memorandum account as of March 31, 2022.

California legislation enacted in September 2018 requires all investor-owned electric utilities to have a wildfire mitigation plan ("WMP") approved by the OEIS and ratified by the CPUC. The WMP must include a utility's plans on constructing, maintaining, and operating its electrical lines and equipment to minimize the risk of catastrophic wildfire. In May 2023, BVES submitted its WMP covering the three-year period 2023-2025 to OEIS for approval prior to going to the CPUC for ratification. In the fourth quarter of 2023, OEIS issued a final decision of approval and the CPUC ratified BVES's 2023-2025 WMP. As of December 31, 2023, BVES has approximately $5.9 million related to expenses accumulated in its WMP memorandum accounts that have been recognized as regulatory assets for future recovery. All capital expenditures and other costs incurred through December 31, 2023 as a result of BVES's WMPs are not currently in rates and have been filed for future recovery in BVES's general rate case application in August 2022.

Additionally, the governor of California approved AB 1054 in July 2019 that, among other things, changed the burden of proof applicable in CPUC proceedings in which an electric utility with a valid safety certification seeks to recover wildfire costs. Previously, an electric utility seeking to recover costs had the burden to prove that it acted reasonably. Under AB 1054, if an electric utility has a valid safety certification, it will be presumed to have acted reasonably unless a party to the relevant proceeding creates a "serious doubt" as to the reasonableness of the utility's conduct. In December 2023, OEIS issued a renewal of the safety certification for BVES for 12 months.

For more information regarding significant regulatory matters, see Note 3 of "*Notes to Financial Statements*" included in Part II, Item 8, in Financial Statements and Supplementary Data.

Environmental Matters

AWR's subsidiaries are subject to stringent environmental regulations. GSWC is required to comply with the safe drinking water standards established by the United States Environmental Protection Agency ("USEPA") and the Division of Drinking Water ("DDW"), under the SWRCB. The USEPA regulates contaminants that may have adverse health effects that are known or likely to occur at levels of public health concern, and the regulation of which will provide a meaningful opportunity for health risk reduction. The DDW, acting on behalf of the USEPA, administers the USEPA's program in California. Similar state agencies administer these rules in the other states in which Registrant operates.

GSWC currently tests its water supplies and water systems according to, among other things, requirements listed in the Federal Safe Drinking Water Act ("SDWA"). GSWC works proactively with third parties and governmental agencies to address issues relating to known contamination threatening GSWC water sources. GSWC also incurs operating costs for testing to determine the levels, if any, of the constituents in its sources of supply, and additional expense to treat contaminants in order to meet the federal and state maximum contaminant level standards and consumer demands. GSWC expects to incur additional capital costs as well as increased operating costs to maintain or improve the quality of water delivered to its customers in light of anticipated stress on water resources associated with watershed and aquifer pollution, drought impacts, as well as to meet future water quality standards and consumer expectations. The CPUC ratemaking process provides GSWC with the opportunity to recover prudently incurred capital and operating costs in future filings associated with achieving water quality standards. Management believes that such incurred and expected future costs should be authorized for recovery by the CPUC.

Drinking Water Notification Levels

In July 2018, DDW issued drinking water notification levels for certain fluorinated organic chemicals used to make certain fabrics and other materials, and used in various industrial processes. These chemicals were also present in certain fire suppression agents. These chemicals are referred to as PFAS. Notification levels are health-based advisory levels established for contaminants in drinking water for which maximum contaminant levels have not been established. The USEPA has also established health advisory levels for these compounds. Notification to consumers and stakeholders is required when the advisory levels or notification levels are exceeded. Assembly Bill 756, signed into law in July 2019 and effective in January 2020, requires, among other things, additional notifications by water systems when they detect levels of PFAS above response levels.

GSWC is in the process of collecting and analyzing samples for PFAS. GSWC has removed some wells from service, and expects to incur additional costs to treat impacted wells. GSWC has provided customers with information regarding PFAS detection and provides updated information via its website. In February 2020, DDW established new response levels for two of the PFAS compounds: 10 parts per trillion ("ppt") for perfluorooctanoic acid ("PFOA") and 40 ppt for perfluorooctanesulfonic acid ("PFOS"). In March 2021, DDW issued drinking-water notification and response levels of 0.5 parts per billion ("ppb") and 5 ppb, respectively, for perfluorobutane sulfonic acid ("PFBS"). In June 2022, the USEPA issued interim updated drinking-water health advisories for PFOA and PFOS, and also issued final health advisories for PFBS and other compounds known as GenX chemicals. In October 2022, DDW issued drinking-water notification and response levels of 3 ppt and 20 ppt, respectively, for perfluorohexane sulfonic acid ("PFHxS"). Lower MCL levels are expected to be promulgated in 2024 and depending on how low the levels are set, these new requirements will likely increase GSWC's water treatment and other operating costs.

Drinking Water Proposed Maximum Contaminant Levels

In March 2023, the USEPA proposed maximum contaminant levels ("MCLs") for six PFAS compounds in drinking water. When finalized, the proposed regulation will require public water systems to monitor and treat water for these chemicals. It will also require water systems to notify its customers and reduce the levels if it exceeds the regulatory standards. The USEPA anticipates finalizing and adopting this rule in early 2024. Once the rule is finalized, water systems will be required to comply with the MCLs after a specified implementation period, which is currently anticipated to be three years from the rule-adoption date. These proposed MCLs, once finalized, are expected to increase GSWC's water treatment and other operating costs. The CPUC has authorized GSWC to track incremental costs, including laboratory testing and monitoring costs, customer and public notification costs, and chemical and operating treatment costs, incurred as a result of PFAS contamination in a memorandum account to be filed with the CPUC for future recovery.

Matters Relating to Environmental Cleanup

GSWC has been involved in environmental remediation and cleanup at one of its plant sites that contained an underground storage tank which was used to store gasoline for its vehicles. This tank was removed from the ground in July 1990 along with the dispenser and ancillary piping. Since then, GSWC has been involved in various remediation activities at this site.

As of December 31, 2023, the total amount spent to clean up and remediate GSWC's plant facility was approximately $6.3 million, of which $1.5 million has been paid by the State of California Underground Storage Tank Fund. Amounts paid by GSWC have been included in rate base and approved by the CPUC for recovery. As of December 31, 2023, GSWC has a regulatory asset and an accrued liability for the estimated remaining cost of $1.3 million to complete the cleanup at the site. The estimate includes costs for continued activities of groundwater cleanup and monitoring, future soil treatment, and site closure related activities. The ultimate cost may vary as there are many unknowns in remediation of underground gasoline spills and this is an estimate based on currently available information. Management also believes it is probable that the estimated additional costs will continue to be approved in rate base by the CPUC.

Lead and Copper Rule Revisions

On December 16, 2021, the USEPA announced the Lead and Copper Rule Revisions under an executive order with a compliance date of October 16, 2024. Additionally, the USEPA announced its intention to develop a new proposed rule, the Lead and Copper Rule Improvements ("LCRI") that will further strengthen the regulatory framework prior to the October 2024 compliance date. There are still many unknowns regarding the implementation of the rule. The details of the requirements will be better understood over the next year once the LCRI is published and a final rule is approved.

Matters Relating to Military Base Contracts

Each of the ASUS's subsidiaries is responsible for testing the water and wastewater systems on the military bases on which it operates in accordance with applicable law.

Each of the ASUS's subsidiaries has the right to seek an equitable adjustment to its contract in the event that there are changes in environmental laws, a change in the quality of water used in providing water service or wastewater discharged by the U.S. government, or contamination of the air or soil not caused by the fault or negligence of ASUS's Subsidiary. These changes can impact operations and maintenance and renewal and replacement costs under the contracts. The U.S. government is responsible for environmental contamination due to its fault or negligence and for environmental contamination that occurred prior to the execution of a contract.

Security Issues

We have physical and information security policies throughout our operations. Training on these matters begins during employee orientation and is ongoing through a series of training courses in addition to periodic, unannounced training exercises. We collaborate with various agencies, associations and third parties regarding information on possible threats and security measures for our operations. Risk assessments are conducted periodically to evaluate the effectiveness of existing security controls. These assessments provide areas for additional security focus, new controls, and policy changes.

Both GSWC and BVES have security systems and infrastructure in place intended to prevent unlawful intrusion, service disruption and cyber-attacks. GSWC and BVES utilize a variety of physical security measures to protect their facilities. These measures consider advances in security and emergency preparedness technology and relevant industry developments in developing their respective capital-improvement plans, and both intend to seek approval of the CPUC to recover any additional costs that either may incur in enhancing the security, reliability and resiliency of their utility systems.

On October 23, 2018, America's Water Infrastructure Act ("AWIA") became law. GSWC must now conduct additional risk and resilience assessments and develop emergency response plans for each of its water systems. These assessments and plans include natural hazards as well as malevolent acts. The first such assessments were completed in 2020. They will be reviewed and must be resubmitted every five years.

ASUS's subsidiaries operate facilities within the boundaries of military bases, which provide limited access to the general public. To further enhance security, in prior years, certain upgrades were completed at various military bases through contract modifications funded by the U.S. government.

Registrant has evaluated its cyber-security systems and continues to address identified areas of improvement with respect to U.S. government regulations regarding cyber-security of government contractors. These improvements include the physical security at all of the office and employee facilities it operates.

Despite its efforts, Registrant cannot guarantee that intrusions, cybersecurity incident or other attacks will not cause water, wastewater or electric system problems, disrupt service to customers, compromise important data or systems or result in unintended release of customer or employee information.

Water Supply

GSWC

During 2023, GSWC delivered approximately 54.3 million hundred cubic feet ("ccf") of water to its customers, which is an average of about 342 acre-feet per day or 111 million gallons per day (an acre-foot is approximately 435.6 ccf or 326,000 gallons). Approximately 53% of GSWC's supply came from groundwater produced from wells situated throughout GSWC's service areas. GSWC supplemented its groundwater production with wholesale purchases from MWD member agencies and regional water suppliers (roughly 43% of total demand) and with authorized diversions from rivers (roughly 4%) under agreements with the United States Bureau of Reclamation and the Sacramento Municipal Utility District. GSWC also utilizes recycled water supplies to serve recycled water customers in several service areas. GSWC continually assesses its water rights and groundwater storage assets to maximize use of lower cost groundwater sources where available.

Groundwater

GSWC has a diverse water supply portfolio which includes adjudicated groundwater rights, surface water rights, and a number of unadjudicated water rights to help meet supply requirements. The productivity of GSWC's groundwater resources varies from year to year depending upon a variety of factors, including natural replenishment from snow-melt or rainfall, the availability of imported replenishment water, the amount of water previously stored in groundwater basins, natural or man-made contamination, legal production limitations, and the amount and seasonality of water use by GSWC's customers and others. GSWC actively participates in efforts to protect groundwater basins from over-use and from contamination. In some periods, these efforts may require reductions in groundwater pumping and increased reliance on alternative water resources. GSWC also participates in the implementation of California's Sustainable Groundwater Management Act.

From time to time, GSWC may purchase or temporarily use water rights from others for delivery to customers. GSWC has contracts to purchase water or water rights for an aggregate amount of $2.7 million as of December 31, 2023. Included in the $2.7 million is a remaining commitment of $1.3 million under an agreement with the City of Claremont to lease water rights that were ascribed to the City as part of the Six Basins adjudication. The initial term of the agreement expires in 2028. GSWC may exercise an option to renew this agreement for ten additional years. The remaining $1.4 million is for commitments for purchased water with other third parties, which expire through 2038.

Imported Water

GSWC also manages a portfolio of water supply arrangements with water wholesalers who may import water from outside the immediate service area. For example, GSWC has contracts with various governmental entities and other parties to purchase water through a total of 59 connections for distribution to customers, in addition to numerous emergency connections. MWD is a public agency organized and managed to provide a supplemental, imported supply to its member public agencies. There are 26 such member agencies, consisting of 14 cities, 11 municipal water districts and one county water authority. GSWC has 45 connections to MWD's water distribution facilities and those of member agencies. GSWC purchases MWD water through six separate member agencies aggregating 43,810 acre-feet annually. MWD sources its supplies from Northern California via the State Water Project and the Colorado River through the Colorado River Aqueduct, which it owns and operates, and from local programs and transfer arrangements.

MWD currently has supply levels of 1.14 million acre-feet ("MAF") with annual demands of approximately 1.54 MAF resulting in a supply gap of 399 thousand acre feet. MWD has available access to store more than 1.65 MAF of water in Lake Mead as part of an intentionally created surplus program developed under a 2007 Interim Shortage agreement and is available for use during dry years. In addition, MWD, along with the seven other Basin states which use water from the Colorado River, developed and agreed to the Drought Contingency Plan in 2019 where each lower Basin state which diverts water from the Colorado River below Lees Ferry agrees to store defined amounts of water in Lake Mead to prevent both Lake Mead and Lake Powell from reaching critically low levels. California is a lower Basin state. On December 1, 2023, the Department of Water Resources set the initial allocation for the water year to 10% due to the possibility that 2024 may be a dry year.

Drought Impact

In May 2018, the California Legislature passed two bills that provide a framework for long-term water-use efficiency standards and drought planning and resiliency. The initial steps in implementation of this legislation have been laid out in a summary document by the California Department of Water Resources ("DWR") and SWRCB. A notable milestone is the establishment of an indoor water use standard of 55 gallons per capita per day ("gpcd") until 2025. Legislation signed by the Governor into law in September 2022 has set more stringent indoor standard targets than initially set forth in the 2018 legislation. The indoor standard will now be set at 47 gpcd in 2025 and then reduced to 42 gpcd in 2030 (previously had been set at 52.5 gpcd and 50 gpcd, respectively). The SWRCB released a draft of the Conservation Regulation in mid-year 2023.

The SWRCB is expected to consider the adoption of the regulation by October 2024. Water suppliers including GSWC have provided extensive comments to date on the draft regulation and will work with state agencies on the final regulation and its implementation.

California's recent period of multi-year drought has resulted in reduced recharge to the state's groundwater basins. GSWC utilizes groundwater from numerous groundwater basins throughout the state. Several of these basins, especially smaller basins, experienced lower groundwater levels because of the drought. Several of GSWC's service areas rely on groundwater as their only source of supply. Given the critical nature of the groundwater levels in California's Central Coast area, GSWC implemented mandatory water restrictions in certain service areas in accordance with CPUC procedures. In the event of water supply shortages from the locally available supply, GSWC would need to transport additional water from other areas, increasing the cost of water supply.

After a very wet 2023, California could still potentially be entering into a dry 2024 even with the recent storm events in California in January and February 2024. Since the start of the water year, both the Sierra snowpack and precipitation has been below normal. The southern Sierra snowpack was at 52% of normal and the 5-station precipitation index was at 71% of normal on February 12, 2024. However, a series of atmospheric storm events in late January and early February are providing a promising outlook to the State's supply conditions. As of February 13, 2024, the U.S. Drought Monitor reported that none of California was in drought with only 7% identified as "abnormally dry" as compared to a year ago when 85% was in "moderate drought."

Prolonged drought conditions also exist on the Colorado River System, which is experiencing historically low reservoir levels in Lake Mead and Lake Powell. Urgent action to reduce water demand on the lower river by 2 to 4 million acre feet annually has been requested by the US Bureau of Reclamation (the "Bureau"). In December 2023, several California water agencies signed agreements with the Bureau to conserve up to 643,000 Acre-feet of water in Lake Mead through 2025. This includes contracts with the Coachella Valley Water District, the Quechan Indian Tribe and the Imperial Irrigation District. Additional contracts are expected to be signed by Palo Verde Irrigation District in cooperation with MWD in 2024. GSWC will continue to monitor developments related to the Colorado River System and assess its impact on GSWC.

Military Base Operations

The U.S. government is responsible for providing the source of supply for all water on each of the bases served by ASUS's subsidiaries at no cost to ASUS's subsidiaries. Once received from the U.S. government, ASUS's subsidiaries are responsible for ensuring the continued compliance of the provided source of supply with all federal, state and local regulations. Furthermore, ASUS's subsidiaries are responsible for ensuring compliance with the reduction and/or removal of all constituents required under its wastewater treatment plant operating permits. ASUS works closely with state regulators and industry associations to stay current with emergent issues and proactively addresses any change in wastewater treatment regulation to ensure permit compliance.

New Accounting Pronouncements

Registrant is subject to newly issued accounting requirements as well as changes in existing requirements issued by the Financial Accounting Standards Board. See *Note 1* of *Notes to Consolidated Financial Statements.*

Item 7A. Quantitative and Qualitative Disclosures About Market Risk

Registrant is exposed to certain market risks, including fluctuations in interest rates, and commodity price risk primarily relating to changes in the market price of electricity. Market risk is the potential loss arising from adverse changes in prevailing market rates and prices.

Interest Rate Risk

A significant portion of Registrant's capital structure is comprised of fixed-rate debt consisting of notes and debentures. Market risk related to our fixed-rate debt is deemed to be the potential increase in fair value resulting from a decrease in interest rates. At December 31, 2023, the fair value of Registrant's long-term debt was $556.2 million. A hypothetical ten percent change in market interest rates would result in an increase or decrease of approximately $21.8 million in the fair value of Registrant's long-term debt.

Registrant is also exposed to risk resulting from changes in interest rates as a result of its issuances of short-term debt through unsecured revolving credit facilities. At December 31, 2023, Registrant had outstanding consolidated borrowings under its credit facilities of $333.5 million that are exposed to variable short-term interest rate risk. The impact of a 100-basis point change in interest rates on pretax income is approximately $3.3 million as of December 31, 2023.

Commodity/Derivative Risk

BVES is exposed to commodity price risk primarily relating to changes in the market price of electricity. To manage its exposure to energy price risk, BVES from time to time executes purchased power contracts that qualify or have elements of the contract that qualify as derivative instruments, requiring mark-to-market derivative accounting under the accounting guidance for derivatives.

BVES has entered into long-term fixed price contracts to purchase power over three and five-year terms. These long-term contracts will expire during the fourth quarter of 2024 and are subject to the accounting guidance for derivatives and require mark-to-market derivative accounting. In July 2023, the CPUC approved a new power purchase agreement between BVES and a third party to procure renewable portfolio standard eligible energy and RECs as a bundled product. BVES will begin taking power under this long-term contract during the fourth quarter of 2024 to replace the existing expiring contracts. The new contract provides for the purchase of electricity during a delivery period from November 1, 2024 through December 31, 2035. Under this contract, there is an embedded derivative that also requires mark-to-market accounting.

The CPUC authorized the use of a regulatory asset and liability memorandum account to offset the mark-to-market entries required by the accounting guidance. Accordingly, all unrealized gains and losses generated from derivative instruments in purchase power contracts are deferred on a monthly basis into a non-interest-bearing regulatory memorandum account that tracks the changes in fair value of the derivative throughout the terms of the contracts. As a result, these unrealized gains and losses do not impact Registrant's earnings. As of December 31, 2023, there was a $2.4 million derivative liability at fair value for the derivatives in the purchase power contracts, with a corresponding regulatory asset recorded in the derivative instrument memorandum account as a result of overall fixed prices under BVES's purchase power contracts being higher than future energy prices.

Except as discussed above, Registrant has had no other derivative financial instruments, financial instruments with significant off-balance sheet risks or financial instruments with concentrations of credit risk.

Item 8. Financial Statements and Supplementary Data

Report of Independent Registered Public Accounting Firm

To the Board of Directors and Shareholders of American States Water Company

Opinions on the Financial Statements and Internal Control over Financial Reporting

We have audited the accompanying consolidated balance sheets and statements of capitalization of American States Water Company and its subsidiaries (the "Company") as of December 31, 2023 and 2022, and the related consolidated statements of income, of changes in common shareholders' equity and of cash flows for each of the three years in the period ended December 31, 2023, including the related notes and financial statement schedule listed in the index appearing under Item 15(a)(2) (collectively referred to as the "consolidated financial statements"). We also have audited the Company's internal control over financial reporting as of December 31, 2023, based on criteria established in Internal Control - Integrated Framework (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO).

In our opinion, the consolidated financial statements referred to above present fairly, in all material respects, the financial position of the Company as of December 31, 2023 and 2022, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2023 in conformity with accounting principles generally accepted in the United States of America. Also in our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2023, based on criteria established in Internal Control - Integrated Framework (2013) issued by the COSO.

Basis for Opinions

The Company's management is responsible for these consolidated financial statements, for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in Management's Report on Internal Control over Financial Reporting appearing under Item 9A. Our responsibility is to express opinions on the Company's consolidated financial statements and on the Company's internal control over financial reporting based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud, and whether effective internal control over financial reporting was maintained in all material respects.

Our audits of the consolidated financial statements included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audits also included performing such other procedures as we considered necessary in the circumstances. We believe that our audits provide a reasonable basis for our opinions.

Definition and Limitations of Internal Control over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (i) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (ii) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (iii) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Critical Audit Matter

The critical audit matter communicated below is a matter arising from the current period audit of the consolidated financial statements that was communicated or required to be communicated to the audit committee and that (i) relates to accounts or disclosures that are material to the consolidated financial statements and (ii) involved our especially challenging, subjective, or complex judgments. The communication of critical audit matters does not alter in any way our opinion on the consolidated financial statements, taken as a whole, and we are not, by communicating the critical audit matter below, providing a separate opinion on the critical audit matter or on the accounts or disclosures to which it relates.

Accounting for the Effects of Rate Regulation

As described in Notes 1 and 3 to the consolidated financial statements, the Company records regulatory assets, which represent probable future recovery of costs from customers through the ratemaking process, and regulatory liabilities, which represent probable future refunds that are to be credited to customers through the ratemaking process. Accounting for such costs and credits as regulatory assets and liabilities is in accordance with the guidance for accounting for the effects of certain types of regulation. In determining the probability of costs being recognized in other periods, management considers regulatory rules and decisions, past practices and other facts or circumstances that would indicate if recovery is probable. As of December 31, 2023, there were $151 million of regulatory assets and $82 million of regulatory liabilities.

The principal considerations for our determination that performing procedures relating to accounting for the effects of rate regulation is a critical audit matter are the significant judgment by management in the accounting for regulatory assets and liabilities related to assessing the probability that costs will be recovered or that amounts will be refunded, the timing of recognition of regulatory assets and liabilities as a result of established practice, new or changes in regulatory and legislative proceedings, or other relevant facts and circumstances. This in turn led to significant auditor judgment, subjectivity and effort in performing audit procedures and evaluating audit evidence obtained relating to management's accounting for regulatory assets and liabilities.

Addressing the matter involved performing procedures and evaluating audit evidence in connection with forming our overall opinion on the consolidated financial statements. These procedures included testing the effectiveness of controls relating to management's assessment and consideration of regulatory and legislative proceedings and other evidence informing the probability that costs will be recovered, and amounts will be refunded, and the timing of the inclusion of these deferrals in rates as well as the disclosure impacts. These procedures also included, among others, evaluating the reasonableness of management's judgments regarding the probability and timing of recovery of regulatory assets and refund of regulatory liabilities based on the Company's correspondence with regulators, status of regulatory proceedings, past practices, and other relevant information; evaluating the related accounting and disclosure implications; and calculating regulatory assets and liabilities balances based on provisions and formulas outlined in rate orders and other correspondence with the Company's regulator.

/s/ PricewaterhouseCoopers LLP

Los Angeles, California
February 21, 2024

We have served as the Company's auditor since 2002.

Report of Independent Registered Public Accounting Firm

To the Board of Directors and Shareholder of Golden State Water Company

Opinion on the Financial Statements

We have audited the accompanying balance sheets and statements of capitalization of Golden State Water Company (the "Company") as of December 31, 2023 and 2022, and the related statements of income, of changes in common shareholder's equity and of cash flows for each of the three years in the period ended December 31, 2023, including the related notes (collectively referred to as the "financial statements"). In our opinion, the financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2023 and 2022, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2023 in conformity with accounting principles generally accepted in the United States of America.

Basis for Opinion

These financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's financial statements based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits of these financial statements in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether due to error or fraud. The Company is not required to have, nor were we engaged to perform, an audit of its internal control over financial reporting. As part of our audits we are required to obtain an understanding of internal control over financial reporting but not for the purpose of expressing an opinion on the effectiveness of the Company's internal control over financial reporting. Accordingly, we express no such opinion.

Our audits included performing procedures to assess the risks of material misstatement of the financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the financial statements. We believe that our audits provide a reasonable basis for our opinion.

Critical Audit Matter

The critical audit matter communicated below is a matter arising from the current period audit of the financial statements that was communicated or required to be communicated to the audit committee and that (i) relates to accounts or disclosures that are material to the financial statements and (ii) involved our especially challenging, subjective, or complex judgments. The communication of critical audit matters does not alter in any way our opinion on the financial statements, taken as a whole, and we are not, by communicating the critical audit matter below, providing a separate opinion on the critical audit matter or on the accounts or disclosures to which it relates.

Accounting for the Effects of Rate Regulation

As described in Notes 1 and 3 to the financial statements, the Company records regulatory assets, which represent probable future recovery of costs from customers through the ratemaking process, and regulatory liabilities, which represent probable future refunds that are to be credited to customers through the ratemaking process. Accounting for such costs and credits as regulatory assets and liabilities is in accordance with the guidance for accounting for the effects of certain types of regulation. In determining the probability of costs being recognized in other periods, management considers regulatory rules and decisions, past practices and other facts or circumstances that would indicate if recovery is probable. As of December 31, 2023, there were $121 million of regulatory assets and $75 million of regulatory liabilities.

The principal considerations for our determination that performing procedures relating to accounting for the effects of rate regulation is a critical audit matter are the significant judgment by management in the accounting for regulatory assets and liabilities related to assessing the probability that costs will be recovered or that amounts will be refunded, the timing of recognition of regulatory assets and liabilities as a result of established practice, new or changes in regulatory and legislative proceedings, or other relevant facts and circumstances. This in turn led to significant auditor judgment, subjectivity and effort in performing audit procedures and evaluating audit evidence obtained relating to management's accounting for regulatory assets and liabilities.

Addressing the matter involved performing procedures and evaluating audit evidence in connection with forming our overall opinion on the financial statements. These procedures included testing the effectiveness of controls relating to management's assessment and consideration of regulatory and legislative proceedings and other evidence informing the probability that costs will be recovered, and amounts will be refunded, and the timing of the inclusion of these deferrals in rates as well as the disclosure impacts. These procedures also included, among others, evaluating the reasonableness of management's judgments regarding the probability and timing of recovery of regulatory assets and refund of regulatory liabilities based on the Company's correspondence with regulators, status of regulatory proceedings, past practices, and other relevant information; evaluating the related accounting and disclosure implications; and calculating regulatory assets and liabilities balances based on provisions and formulas outlined in rate orders and other correspondence with the Company's regulator.

/s/ PricewaterhouseCoopers LLP

Los Angeles, California
February 21, 2024

We have served as the Company's auditor since 2002.

AMERICAN STATES WATER COMPANY
CONSOLIDATED BALANCE SHEETS

(in thousands)	December 31, 2023	December 31, 2022
Assets		
Utility Plant		
Regulated utility plant, at cost:		
Water	$ 2,082,927	$ 2,006,468
Electric	156,471	133,815
Total	2,239,398	2,140,283
Non-regulated utility property, at cost	40,223	38,066
Total utility plant, at cost	2,279,621	2,178,349
Less — accumulated depreciation	(624,472)	(606,231)
	1,655,149	1,572,118
Construction work in progress	237,131	181,648
Net utility plant	1,892,280	1,753,766
Other Property and Investments		
Goodwill	1,116	1,116
Other property and investments	42,932	36,907
Total other property and investments	44,048	38,023
Current Assets		
Cash and cash equivalents	14,073	5,997
Accounts receivable — customers, less allowance for doubtful accounts	34,250	26,206
Unbilled receivable (Note 2)	23,516	20,663
Receivable from U.S. government, less allowance for doubtful accounts (Note 2)	49,306	34,974
Other accounts receivable, less allowance for doubtful accounts	6,340	4,215
Income taxes receivable	52	3,901
Materials and supplies	17,574	14,623
Regulatory assets — current	45,144	14,028
Prepayments and other current assets	5,767	5,450
Contract assets (Note 2)	9,956	9,390
Purchase power contract derivative at fair value (Note 5)	—	11,847
Total current assets	205,978	151,294
Other Assets		
Unbilled revenue — receivable from U.S. government (Note 2)	4,886	6,456
Receivable from U.S. government (Note 2)	42,183	50,482
Contract assets (Note 2)	4,422	5,592
Operating lease right-of-use assets	7,982	9,535
Regulatory assets	25,585	5,694
Other	18,758	13,532
Total other assets	103,816	91,291
Total Assets	$ 2,246,122	$ 2,034,374

The accompanying notes are an integral part of these consolidated financial statements.

AMERICAN STATES WATER COMPANY
CONSOLIDATED BALANCE SHEETS

(in thousands)	December 31, 2023	December 31, 2022
Capitalization and Liabilities		
Capitalization		
Common shareholders' equity	$ 776,109	$ 709,549
Long-term debt	575,555	446,547
Total capitalization	1,351,664	1,156,096
Current Liabilities		
Notes payable to banks	42,000	255,500
Long-term debt — current	353	399
Accounts payable	68,705	84,849
Income taxes payable	492	1,848
Accrued other taxes	14,654	16,257
Accrued employee expenses	14,738	13,996
Accrued interest	8,607	5,308
Regulatory liabilities	—	4,574
Contract liabilities (Note 2)	1,352	903
Operating lease liabilities	1,856	1,892
Purchase power contract derivative at fair value (Note 5)	2,360	—
Other	11,506	10,996
Total current liabilities	166,623	396,522
Other Credits		
Notes payable to banks	291,500	22,000
Advances for construction	67,431	64,351
Contributions in aid of construction — net	151,414	147,918
Deferred income taxes	161,577	149,677
Regulatory liabilities	1,222	40,602
Unamortized investment tax credits	1,011	1,082
Accrued pension and other post-retirement benefits	32,652	33,636
Operating lease liabilities	6,619	8,090
Other	14,409	14,400
Total other credits	727,835	481,756
Commitments and Contingencies (Notes 14 and 15)		
Total Capitalization and Liabilities	$ 2,246,122	$ 2,034,374

The accompanying notes are an integral part of these consolidated financial statements.

AMERICAN STATES WATER COMPANY
CONSOLIDATED STATEMENTS OF CAPITALIZATION

	December 31,	
(in thousands, except number of shares)	2023	2022
Common Shareholders' Equity:		
Common Shares, no par value:		
Authorized: 60,000,000 shares		
Outstanding: 36,980,612 shares in 2023 and 36,962,241 shares in 2022	$ 263,179	$ 260,158
Retained earnings	512,930	449,391
	776,109	709,549
Long-Term Debt		
Notes/Debentures:		
6.81% notes due 2028	15,000	15,000
6.59% notes due 2029	40,000	40,000
7.875% notes due 2030	20,000	20,000
7.23% notes due 2031	50,000	50,000
6.00% notes due 2041	62,000	62,000
Private Placement Notes:		
3.45% notes due 2029	15,000	15,000
5.87% notes due 2028	40,000	40,000
2.17% notes due 2030	85,000	85,000
2.90% notes due 2040	75,000	75,000
4.548% notes due 2032	17,500	17,500
4.949% notes due 2037	17,500	17,500
5.12% notes due 2033	100,000	—
5.22% notes due 2038	30,000	—
Tax-Exempt Obligations:		
5.50% notes due 2026	7,730	7,730
State Water Project due 2035	1,729	2,834
Other Debt Instruments:		
American Recovery and Reinvestment Act Obligation due 2033	2,588	2,809
	579,047	450,373
Less: Current maturities	(353)	(399)
Debt issuance costs	(3,139)	(3,427)
	575,555	446,547
Total Capitalization	$ 1,351,664	$ 1,156,096

The accompanying notes are an integral part of these consolidated financial statements.

AMERICAN STATES WATER COMPANY
CONSOLIDATED STATEMENTS OF INCOME

(in thousands, except per share amounts)	For the years ended December 31, 2023	2022	2021
Operating Revenues			
Water	$ 433,473	$ 340,602	$ 347,112
Electric	41,832	39,986	38,345
Contracted services	120,394	110,940	113,396
Total operating revenues	595,699	491,528	498,853
Operating Expenses			
Water purchased	72,864	75,939	77,914
Power purchased for pumping	12,829	11,861	11,103
Groundwater production assessment	20,850	19,071	19,412
Power purchased for resale	13,275	15,039	11,240
Supply cost balancing accounts	12,118	(12,000)	(11,421)
Other operation	40,271	38,095	34,738
Administrative and general	88,273	86,190	83,547
Depreciation and amortization	42,403	41,315	39,596
Maintenance	14,218	13,392	12,781
Property and other taxes	24,046	22,894	22,522
ASUS construction	57,912	53,171	56,909
Gain on sale of assets	(100)	(75)	(465)
Total operating expenses	398,959	364,892	357,876
Operating Income	196,740	126,636	140,977
Other Income and Expenses			
Interest expense	(42,762)	(27,027)	(22,834)
Interest income	7,416	2,326	1,493
Other, net	5,126	125	5,134
Total other income and expenses	(30,220)	(24,576)	(16,207)
Income before income tax expense	166,520	102,060	124,770
Income tax expense	41,599	23,664	30,423
Net Income	$ 124,921	$ 78,396	$ 94,347
Weighted Average Number of Shares Outstanding	36,976	36,955	36,921
Basic Earnings Per Common Share	$ 3.37	$ 2.12	$ 2.55
Weighted Average Number of Diluted Shares	37,077	37,039	37,010
Fully Diluted Earnings Per Share	$ 3.36	$ 2.11	$ 2.55
Dividends Paid Per Common Share	$ 1.655	$ 1.525	$ 1.400

The accompanying notes are an integral part of these consolidated financial statements.

AMERICAN STATES WATER COMPANY
CONSOLIDATED STATEMENTS OF CHANGES
IN COMMON SHAREHOLDERS' EQUITY

(in thousands)	Common Shares Number of Shares	Common Shares Amount	Retained Earnings	Total
Balances at December 31, 2020	36,889	$ 256,666	$ 385,007	$ 641,673
Add:				
Net income			94,347	94,347
Issuances of Common Shares under stock-based compensation plans	47	—		—
Stock-based compensation, net of taxes paid from shares withheld from employees related to net share settlements		1,616		1,616
Dividend equivalent rights on stock-based awards not paid in cash		160		160
Deduct:				
Dividends on Common Shares			51,689	51,689
Dividend equivalent rights on stock-based awards not paid in cash			160	160
Balances at December 31, 2021	36,936	258,442	427,505	685,947
Add:				
Net income			78,396	78,396
Issuances of Common Shares under stock-based compensation plans	26	—		—
Stock-based compensation, net of taxes paid from shares withheld from employees related to net share settlements		1,562		1,562
Dividend equivalent rights on stock-based awards not paid in cash		154		154
Deduct:				
Dividends on Common Shares			56,356	56,356
Dividend equivalent rights on stock-based awards not paid in cash			154	154
Balances at December 31, 2022	36,962	260,158	449,391	709,549
Add:				
Net income			124,921	124,921
Issuances of Common Shares under stock-based compensation plans	19	—		—
Stock-based compensation, net of taxes paid from shares withheld from employees related to net share settlements		2,834		2,834
Dividend equivalent rights on stock-based awards not paid in cash		187		187
Deduct:				
Dividends on Common Shares			61,195	61,195
Dividend equivalent rights on stock-based awards not paid in cash			187	187
Balances at December 31, 2023	36,981	$ 263,179	$ 512,930	$ 776,109

The accompanying notes are an integral part of these consolidated financial statements.

AMERICAN STATES WATER COMPANY
CONSOLIDATED STATEMENTS OF CASH FLOWS

(in thousands)	For the years ended December 31, 2023	2022	2021
Cash Flows From Operating Activities:			
Net income	$ 124,921	$ 78,396	$ 94,347
Adjustments to reconcile net income to net cash provided by operating activities:			
Depreciation and amortization	43,254	41,697	39,974
Provision for doubtful accounts	932	1,043	1,119
Deferred income taxes and investment tax credits	4,783	2,803	3,561
Stock-based compensation expense	3,298	2,571	2,566
(Gain) loss on investments held in a trust	(5,008)	5,177	(4,287)
Other — net	289	38	(381)
Changes in assets and liabilities:			
Accounts receivable — customers	(6,632)	5,424	(4,688)
Unbilled receivable	(1,283)	9,699	(1,037)
Other accounts receivable	(2,241)	2,115	(1,422)
Receivables from the U.S. government	(6,033)	(5,638)	(4,713)
Materials and supplies	(2,951)	(2,460)	(3,544)
Prepayments and other assets	1,581	3,146	1,323
Contract assets	604	(5,395)	235
Regulatory assets/liabilities	(81,373)	(18,915)	(5,842)
Accounts payable	(10,862)	11,767	(2,881)
Income taxes receivable/payable	2,493	(6,479)	(2,254)
Contract liabilities	449	646	(1,543)
Accrued pension and other post-retirement benefits	1,046	(3,087)	3,051
Other liabilities	416	(4,749)	2,000
Net cash provided (used)	67,683	117,799	115,584
Cash Flows From Investing Activities:			
Capital expenditures	(188,540)	(166,240)	(144,515)
Other investing activities	(224)	(862)	(577)
Net cash provided (used)	(188,764)	(167,102)	(145,092)
Cash Flows From Financing Activities:			
Receipt of advances for and contributions in aid of construction	11,889	6,901	12,432
Refunds on advances for construction	(4,540)	(5,321)	(4,666)
Repayments of long-term debt	(334)	(377)	(28,356)
Proceeds from the issuance of long-term debt, net of issuance costs	129,665	34,789	—
Net changes in notes payable to banks	54,590	72,000	71,300
Dividends paid	(61,195)	(56,356)	(51,689)
Other	(918)	(1,299)	(1,287)
Net cash provided (used)	129,157	50,337	(2,266)
Net change in cash and cash equivalents	8,076	1,034	(31,774)
Cash and cash equivalents, beginning of year	5,997	4,963	36,737
Cash and cash equivalents, end of year	$ 14,073	$ 5,997	$ 4,963

The accompanying notes are an integral part of these consolidated financial statements.

GOLDEN STATE WATER COMPANY
BALANCE SHEETS

(in thousands)	December 31, 2023	December 31, 2022
Assets		
Utility Plant, at cost	$ 2,082,927	$ 2,006,468
Less — accumulated depreciation	(543,135)	(530,925)
	1,539,792	1,475,543
Construction work in progress	195,742	141,175
Net utility plant	1,735,534	1,616,718
Other Property and Investments	40,480	34,655
	40,480	34,655
Current Assets		
Cash and cash equivalents	3,195	370
Accounts receivable — customers, less allowance for doubtful accounts	31,018	23,107
Unbilled receivable	17,185	15,006
Other accounts receivable, less allowance for doubtful accounts	4,301	2,721
Intercompany receivable	380	621
Income taxes receivable from Parent	222	1,692
Materials and supplies	7,380	6,120
Regulatory assets — current	44,007	14,028
Prepayments and other current assets	4,544	4,464
Total current assets	112,232	68,129
Other Assets		
Operating lease right-of-use assets	7,796	9,208
Regulatory assets	2,944	—
Other	17,169	12,598
Total other assets	27,909	21,806
Total Assets	$ 1,916,155	$ 1,741,308

The accompanying notes are an integral part of these financial statements.

GOLDEN STATE WATER COMPANY
BALANCE SHEETS

(in thousands)	December 31, 2023	December 31, 2022
Capitalization and Liabilities		
Capitalization		
Common shareholder's equity	$ 703,828	$ 643,906
Long-term debt	540,738	411,748
Total capitalization	1,244,566	1,055,654
Current Liabilities		
Long-term debt — current	353	399
Accounts payable	55,488	65,944
Accrued other taxes	12,658	14,501
Accrued employee expenses	11,502	11,233
Accrued interest	7,508	4,364
Operating lease liabilities	1,725	1,788
Other	10,715	10,152
Total current liabilities	99,949	108,381
Other Credits		
Intercompany note payable	—	129,000
Notes payable to banks	150,000	—
Advances for construction	67,411	64,331
Contributions in aid of construction — net	151,414	147,918
Deferred income taxes	147,458	138,788
Regulatory liabilities	1,222	40,602
Unamortized investment tax credits	1,011	1,082
Accrued pension and other post-retirement benefits	32,309	33,421
Operating lease liabilities	6,568	7,878
Other	14,247	14,253
Total other credits	571,640	577,273
Commitments and Contingencies (Notes 14 and 15)		
Total Capitalization and Liabilities	$ 1,916,155	$ 1,741,308

The accompanying notes are an integral part of these financial statements.

GOLDEN STATE WATER COMPANY
STATEMENTS OF CAPITALIZATION

(in thousands, except number of shares)	December 31, 2023	December 31, 2022
Common Shareholder's Equity:		
Common Shares, no par value: Authorized: 1,000 shares Outstanding: 171 shares in 2023 and 170 shares in 2022	$ 370,909	$ 358,123
Retained earnings	332,919	285,783
	703,828	643,906
Long-Term Debt		
Notes/Debentures:		
6.81% notes due 2028	15,000	15,000
6.59% notes due 2029	40,000	40,000
7.875% notes due 2030	20,000	20,000
7.23% notes due 2031	50,000	50,000
6.00% notes due 2041	62,000	62,000
Private Placement Notes:		
3.45% notes due 2029	15,000	15,000
5.87% notes due 2028	40,000	40,000
2.17% notes due 2030	85,000	85,000
2.90% notes due 2040	75,000	75,000
5.12% notes due 2033	100,000	—
5.22% notes due 2038	30,000	—
Tax-Exempt Obligations:		
5.50% notes due 2026	7,730	7,730
State Water Project due 2035	1,729	2,834
Other Debt Instruments:		
American Recovery and Reinvestment Act Obligation due 2033	2,588	2,809
	544,047	415,373
Less: Current maturities	(353)	(399)
Debt issuance costs	(2,956)	(3,226)
	540,738	411,748
Total Capitalization	$ 1,244,566	$ 1,055,654

The accompanying notes are an integral part of these financial statements.

GOLDEN STATE WATER COMPANY
STATEMENTS OF INCOME

(in thousands)	For the years ended December 31, 2023	2022	2021
Operating Revenues			
Water	$ 433,473	$ 340,602	$ 347,112
Total operating revenues	433,473	340,602	347,112
Operating Expenses			
Water purchased	72,864	75,939	77,914
Power purchased for pumping	12,829	11,861	11,103
Groundwater production assessment	20,850	19,071	19,412
Supply cost balancing accounts	13,839	(8,643)	(11,295)
Other operation	29,064	28,117	25,781
Administrative and general	59,313	58,358	55,552
Depreciation and amortization	35,886	34,805	33,384
Maintenance	9,906	9,559	9,056
Property and other taxes	19,845	19,080	19,041
Gain on sale of assets	(100)	—	(409)
Total operating expenses	274,296	248,147	239,539
Operating Income	159,177	92,455	107,573
Other Income and Expenses			
Interest expense	(31,283)	(22,742)	(21,474)
Interest income	5,557	1,083	428
Other, net	4,946	(680)	4,783
Total other income and expenses	(20,780)	(22,339)	(16,263)
Income from operations before income tax expense	138,397	70,116	91,310
Income tax expense	35,689	16,346	22,095
Net Income	$ 102,708	$ 53,770	$ 69,215

The accompanying notes are an integral part of these financial statements.

GOLDEN STATE WATER COMPANY
STATEMENTS OF CHANGES IN
COMMON SHAREHOLDER'S EQUITY

	Common Shares			
(in thousands, except number of shares)	**Number of Shares**	**Amount**	**Retained Earnings**	**Total**
Balances at December 31, 2020	170	$ 354,906	$ 228,392	$ 583,298
Add:				
Net income			69,215	69,215
Stock-based compensation, net of taxes paid from shares withheld from employees related to net share settlements		1,473		1,473
Dividend equivalent rights on stock-based awards not paid in cash		151		151
Deduct:				
Dividends on Common Shares			38,300	38,300
Dividend equivalent rights on stock-based awards not paid in cash			151	151
Balances at December 31, 2021	170	356,530	259,156	615,686
Add:				
Net income			53,770	53,770
Stock-based compensation, net of taxes paid from shares withheld from employees related to net share settlements		1,450		1,450
Dividend equivalent rights on stock-based awards not paid in cash		143		143
Deduct:				
Dividends on Common Shares			27,000	27,000
Dividend equivalent rights on stock-based awards not paid in cash			143	143
Balances at December 31, 2022	170	358,123	285,783	643,906
Add:				
Net income			102,708	102,708
Issuance of Common Share to Parent	1	10,000		10,000
Stock-based compensation, net of taxes paid from shares withheld from employees related to net share settlements		2,614		2,614
Dividend equivalent rights on stock-based awards not paid in cash		172		172
Deduct:				
Dividends on Common Shares			55,400	55,400
Dividend equivalent rights on stock-based awards not paid in cash			172	172
Balances at December 31, 2023	171	$ 370,909	$ 332,919	$ 703,828

The accompanying notes are an integral part of these financial statements.

GOLDEN STATE WATER COMPANY
STATEMENTS OF CASH FLOWS

(in thousands)	For the years ended December 31, 2023	2022	2021
Cash Flows From Operating Activities:			
Net income	$ 102,708	$ 53,770	$ 69,215
Adjustments to reconcile net income to net cash provided by operating activities:			
Depreciation and amortization	36,623	35,072	33,643
Provision for doubtful accounts	754	1,018	1,018
Deferred income taxes and investment tax credits	2,949	855	2,308
Stock-based compensation expense	2,994	2,269	2,313
(Gain) loss on investments held in a trust	(5,008)	5,177	(4,287)
Other — net	106	9	(209)
Changes in assets and liabilities:			
Accounts receivable — customers	(6,321)	6,263	(4,287)
Unbilled receivable	(2,179)	5,519	(1,195)
Other accounts receivable	(1,484)	931	592
Materials and supplies	(1,260)	(736)	(1,725)
Prepayments and other assets	1,838	2,125	1,860
Regulatory assets/liabilities	(74,378)	(12,704)	(2,854)
Accounts payable	(5,420)	7,671	(10)
Intercompany receivable/payable	248	(805)	1,479
Income taxes receivable/payable from/to Parent	1,470	(4,664)	(1,640)
Accrued pension and other post-retirement benefits	979	(3,228)	2,908
Other liabilities	(278)	(4,034)	1,165
Net cash provided (used)	54,341	94,508	100,294
Cash Flows From Investing Activities:			
Capital expenditures	(160,939)	(146,730)	(123,526)
Note receivable from AWR (parent)	—	—	(26,000)
Receipt of payment of note receivable from AWR (parent)	—	—	26,000
Other investing activities	(1,215)	(1,001)	(733)
Net cash provided (used)	(162,154)	(147,731)	(124,259)
Cash Flows From Financing Activities:			
Proceeds from issuance of Common Shares to AWR (parent)	10,000	—	—
Receipt of advances for and contributions in aid of construction	11,889	6,901	12,397
Refunds on advances for construction	(4,540)	(5,321)	(4,666)
Repayments of long-term debt	(334)	(377)	(28,356)
Proceeds from the issuance of long-term debt, net of issuance costs	129,665	—	—
Net change in intercompany borrowings	(129,000)	80,000	49,000
Net borrowings on notes payable to banks	149,198	—	—
Dividends paid	(55,400)	(27,000)	(38,300)
Other	(840)	(1,135)	(1,163)
Net cash provided (used)	110,638	53,068	(11,088)
Net change in cash and cash equivalents	2,825	(155)	(35,053)
Cash and cash equivalents, beginning of year	370	525	35,578
Cash and cash equivalents, end of year	$ 3,195	$ 370	$ 525

The accompanying notes are an integral part of these financial statements.

Note 1 — Summary of Significant Accounting Policies

Nature of Operations: American States Water Company ("AWR") is the parent company of Golden State Water Company ("GSWC"), Bear Valley Electric Service Inc. ("BVES"), and American States Utility Services, Inc. ("ASUS") (and its subsidiaries, Fort Bliss Water Services Company ("FBWS"), Old Dominion Utility Services, Inc. ("ODUS"), Terrapin Utility Services, Inc. ("TUS"), Palmetto State Utility Services, Inc. ("PSUS"), Old North Utility Services, Inc. ("ONUS"), Emerald Coast Utility Services, Inc. ("ECUS"), Fort Riley Utility Services, Inc. ("FRUS"), Bay State Utility Services LLC ("BSUS"), and Patuxent River Utility Services LLC ("PRUS")). AWR and its subsidiaries may be collectively referred to as "Registrant" or "the Company." AWR, through its wholly owned subsidiaries, serves over one million people in ten states.

GSWC and BVES are both California public utilities. GSWC engages in the purchase, production, distribution and sale of water throughout California serving approximately 264,100 customers connections. BVES distributes electricity in several San Bernardino County mountain communities in California serving approximately 24,800 customers connections. The California Public Utilities Commission ("CPUC") regulates GSWC's and BVES's businesses in matters including properties, rates, services, facilities, and transactions between GSWC, BVES, and their affiliates.

ASUS, through its subsidiaries, operates, maintains and performs construction activities (including renewal and replacement capital work) on water and/or wastewater systems at various U.S. military bases primarily pursuant to initial 50-year, firm-fixed-price contracts with the U.S. government. These contracts are subject to annual economic price adjustments and modifications for changes in circumstances, changes in laws and regulations and additions to the contract value for new construction of facilities at the military bases. ASUS also from time to time performs construction services on military bases as a subcontractor or pursuant to a task order agreement.

On August 15, 2023, ASUS was awarded a new 50-year contract by the U.S. government to operate, maintain, and provide construction management services for the water distribution and wastewater collection and treatment facilities at Naval Air Station Patuxent River, a United States Navy air station located in Maryland. The initial firm-fixed-price value of the contract is estimated at $349 million over a 50-year period and is subject to annual economic price adjustments. This initial value is also subject to adjustment based on the results of a joint inventory of assets to be performed during the transition period and will be finalized during the first year of operations.

On September 29, 2023, ASUS was awarded a new 15-year contract by the U.S. government, that is different than ASUS's other existing 50-year contracts, to operate, maintain, and provide construction management services for the water distribution and wastewater collection and treatment facilities at Joint Base Cape Cod ("JBCC") located in Massachusetts. Under this contract, ASUS will have the opportunity to perform work at JBCC through the periodic issuance of task orders by the U.S. government for up to a maximum initial firm-fixed-price value of $45.0 million over a 15-year period, subject to adjustments as task orders are issued. In September 2023, the first task order was issued with a value of $2.3 million to perform an evaluation, construction and transition services that are scheduled for completion in 2024.

There is no direct regulatory oversight by the CPUC over AWR or the operations, rates or services provided by ASUS or its subsidiaries.

Basis of Presentation: The consolidated financial statements and notes thereto are presented in a combined report filed by two separate Registrants: AWR and GSWC. References in this report to "Registrant" are to AWR and GSWC, collectively, unless otherwise specified. AWR owns all of the outstanding common shares of GSWC, BVES and ASUS. ASUS owns all of the outstanding common shares of its subsidiaries. The consolidated financial statements of AWR include the accounts of AWR and its subsidiaries. These financial statements are prepared in conformity with accounting principles generally accepted in the United States of America. Intercompany transactions and balances have been eliminated in the AWR consolidated financial statements.

Related-Party and Intercompany Transactions: As discussed in Note 9, prior to AWR and GSWC entering into new separate credit agreements on June 28, 2023 that replaced AWR's previous credit agreement, AWR borrowed under its credit facility and provided funds to both GSWC and ASUS in support of their operations. Under AWR's new credit facility, AWR borrows and continues to provide funds to ASUS in support of its operations, through an intercompany borrowing agreement, and AWR (parent). The interest rate charged to ASUS is sufficient to cover AWR's interest expense under the credit facility. GSWC's new credit facility provides support for its water operations. BVES has a separate credit facility and has also issued long-term debt to support its operations.

Furthermore, GSWC, BVES and ASUS provide and/or receive various support services to and from their parent, AWR, and among themselves. GSWC allocates certain corporate office administrative and general costs to its affiliates, BVES and ASUS, using allocation factors approved by the CPUC. During the years ended December 31, 2023, 2022 and 2021, GSWC allocated to ASUS approximately $5.0 million, $5.2 million and $5.3 million, respectively, of corporate office administrative and general costs. During the years ended December 31, 2023, 2022 and 2021, GSWC allocated corporate office administrative and general costs to BVES of approximately $3.5 million, $2.7 million and $2.8 million, respectively.

In January 2023, the Board of Directors approved the issuance of one GSWC common share to AWR for $10.0 million. Also in January 2023, GSWC issued $130.0 million in unsecured private placement long-term notes. GSWC used the proceeds from both the issuance of equity and long-term debt issued to pay-off all intercompany borrowings due to AWR at that time. On June 28, 2023, GSWC borrowed for the first time under its new syndicated credit facility and used the proceeds to again pay-off its short-term intercompany borrowings due to AWR. The CPUC requires GSWC to pay-off all intercompany borrowings it has from AWR within a 24-month period. GSWC's borrowings under its new credit facility will also be required to be paid-off in full within a 24-month period.

COVID-19: During 2021, as a response to orders issued by the CPUC and the governor of California related to the COVID-19 pandemic, GSWC and BVES suspended customer service disconnections for nonpayment at the time. However, pursuant to the CPUC's decision in the Second Phase of the Low-Income Affordability Rulemaking, the moratorium on water-service disconnections due to non-payment of past-due amounts billed to residential customers expired on February 1, 2022, with service disconnections due to nonpayment for delinquent residential customers resuming in June 2022. Payment plan options have been offered to customers; however, GSWC has continued to experience non-payments of past-due bills from customers as a result of the lingering effects of the pandemic during 2023. The CPUC authorized GSWC and BVES to track incremental costs, including bad debt expense, in excess of what is included in their respective revenue requirements incurred as a result of the pandemic in COVID-19 emergency-related memorandum accounts.

In July 2021, the governor of California approved SB-129 Budget Act of 2021, in which nearly $1 billion in relief funding for overdue water customer bills, and nearly $1 billion in relief funding for overdue electric customer bills were included. The water customer relief funding was managed by the State Water Resources Control Board ("SWRCB") through the California Water and Wastewater Arrearage Payment Program ("Arrearage Program") to provide assistance to customers for their water debt accrued during the COVID-19 pandemic by remitting federal funds that the state received from the American Rescue Plan Act of 2021 to the utility on behalf of eligible customers. In addition, on July 10, 2023, the governor of California signed a budget trailer bill expanding the Arrearage Program. This new Extended Water and Wastewater Arrearage Program ("Extended Arrearage Program") extended the COVID relief period to December 31, 2022, with the state legislature allocating an additional $600 million in federal funding.

In January 2022, GSWC received $9.5 million in COVID relief funds through the Arrearage Program to provide assistance to customers for their water debt accrued during the COVID-19 pandemic by remitting federal funds that the state received from the American Rescue Plan Act of 2021 to the utility on behalf of eligible customers. In December 2023, GSWC filed an application with the SWRCB through the Extended Arrearage Program to obtain additional COVID relief funds to provide further assistance to its customers for their water debt accrued during the COVID-19 pandemic. GSWC has received confirmation from SWRCB that it is currently processing GSWC's application and expects to disburse approximately $3.5 million in additional COVID relief funds through this Program. All funds to be received will be applied to customer eligible delinquent balances. In February and December 2022, BVES received $321,000 and $152,000, respectively, from the state of California for similar customer relief funding for unpaid electric customer bills incurred during the pandemic. The CPUC requires that amounts tracked in GSWC's and BVES's COVID-19 memorandum accounts for unpaid customer bills be first offset by any (i) federal and state relief for water or electric utility bill debt, and (ii) customer payments through payment plan arrangements, prior to receiving recovery from customers at large. As of December 31, 2023, GSWC fully offset its bad debt-related CEMA balance as a result of additional COVID relief funds approved. In addition, BVES has filed to recover the remaining balance in its COVID-19 memorandum account through its general rate case application filed in August 2022.

On April 10, 2023, the Biden Administration terminated the COVID-19 national emergency. The COVID-19 emergency-related memorandum accounts for GSWC and BVES expired when the COVID-19 national emergency ended.

Utility Accounting: Registrant's accounting policies conform to accounting principles generally accepted in the United States of America ("GAAP"), including the accounting principles for rate-regulated enterprises, which reflect the ratemaking policies of the CPUC and, to the extent applicable, the Federal Energy Regulatory Commission. GSWC and BVES have incurred various costs and received various credits reflected as regulatory assets and liabilities. Accounting for such costs and credits as regulatory assets and liabilities is in accordance with the guidance for accounting for the effects of certain types of regulation. This guidance sets forth the application of GAAP for those companies whose rates are established by or are subject to approval by an independent third-party regulator.

Under such accounting guidance, rate-regulated entities defer costs and credits on the balance sheet as regulatory assets and liabilities when it is probable that those costs and credits will be recognized in the ratemaking process in a period different from the period in which they would have been reflected in income by an unregulated company. These regulatory assets and liabilities are then recognized in the income statement in the period in which the same amounts are reflected in the rates charged for service. The amounts included as regulatory assets and liabilities that will be collected or refunded over a period exceeding one year are classified as long-term assets and liabilities as of December 31, 2023 and 2022.

Regulatory assets are reviewed for recoverability each reporting period. If a regulatory asset is no longer deemed probable of recovery, the deferred cost is charged to earnings.

Property and Depreciation: Registrant's property consists primarily of regulated utility plant at GSWC and BVES. GSWC and BVES capitalize, as utility plant, the cost of construction and the cost of additions, betterments and replacements of retired units of property. Such costs include labor, material and certain indirect costs. Indirect costs are allocated to each project based on total costs.

Water systems acquired are recorded at estimated original cost of utility plant when first devoted to utility service and the applicable depreciation is recorded to accumulated depreciation. Any difference between the estimated original cost, less accumulated depreciation, and the purchase price, if recognized by the CPUC, is recorded as an acquisition adjustment within utility plant.

Depreciation for the regulated utilities is computed on the straight-line, remaining-life basis, group method, in accordance with the applicable ratemaking process. The provision for depreciation expressed as a percentage of the aggregate depreciable asset balances for regulated utilities was 2.2% for each of the years 2023, 2022 and 2021. Depreciation expense for regulated utilities, excluding amortization expense and depreciation on transportation equipment, totaled $38.3 million, $37.3 million and $35.5 million for the years ended December 31, 2023, 2022 and 2021, respectively. Depreciation computed on regulated utilities' transportation equipment is recorded in other operating expenses and totaled $851,000, $382,000 and $379,000 for the years 2023, 2022 and 2021, respectively. For the year ended December 31, 2023, approximately $212,000 of additional depreciation expense on GSWC's transportation equipment was recorded that relates to the cumulative retroactive impact for the full year of 2022 approved in the CPUC final decision in GSWC's general rate case that resulted from an increase to the transportation equipment composite depreciation rates that are retroactive to January 1, 2022. Expenditures for maintenance and repairs are expensed as incurred. Retired property costs, including costs of removal, are charged to the accumulated provision for depreciation.

Estimated useful lives of regulated utilities' utility plant, as authorized by the CPUC, are as follows:

Source of water supply	20 years to 60 years
Pumping	26 years to 41 years
Water treatment	26 years to 32 years
Transmission and distribution	15 years to 80 years
Generation	40 years
Other plant	5 years to 62 years

Non-regulated property consists primarily of equipment utilized by ASUS and its subsidiaries for its operations. This property is stated at cost, net of accumulated depreciation, which is calculated using the straight-line method over the useful lives of the assets.

Asset Retirement Obligations: GSWC has a legal obligation for the retirement of its wells, which by law need to be properly capped at the time of removal. As such, GSWC incurs asset retirement obligations. GSWC records the fair value of a liability for these asset retirement obligations in the period in which they are incurred. When the liability is initially recorded, GSWC capitalizes the cost by increasing the carrying amount of the related long-lived asset. Over time, the liability is accreted to its present value each period, and the capitalized cost is depreciated over the useful life of the related asset. Upon settlement of the liability, GSWC either settles the obligation for its recorded amount or incurs a gain or loss upon settlement. Retirement costs have historically been recovered through rates subsequent to the retirement costs being incurred. Accordingly, recoverability of GSWC's asset retirement obligations are reflected as a regulatory asset (Note 3). GSWC also reflects the loss or gain at settlement as a regulatory asset or liability on the balance sheet.

With regards to removal costs associated with certain other long-lived assets, such as water mains, distribution and transmission assets, asset retirement obligations have not been recognized as GSWC believes there is no legal obligation to do so. There are no CPUC rules or regulations that require GSWC to remove any of its other long-lived assets. In addition, GSWC's water pipelines are not subject to regulation by any federal regulatory agency. GSWC has franchise agreements with various municipalities in order to use the public right of way for utility purposes (i.e., operate water distribution and transmission assets), and if certain events occur in the future, GSWC could be required to remove or relocate certain of its pipelines. However, it is not possible to estimate an asset retirement amount since the timing and the amount of assets that may be required to be removed, if any, is not known.

Amounts recorded for asset retirement obligations are subject to various assumptions and determinations, such as determining whether a legal obligation exists to remove assets, estimating the fair value of the costs of removal, when final removal will occur and the credit-adjusted risk-free interest rates to be utilized on discounting future liabilities. Changes that may arise over time with regard to these assumptions will change amounts recorded in the future. Revisions in estimates for timing or estimated cash flows are recognized as changes in the carrying amount of the liability and the related capitalized asset. The estimated fair value of the costs of removal is based on third-party costs.

Impairment of Long-Lived Assets: Long-lived assets are reviewed for impairment when events or changes in circumstances indicate that the carrying amount of an asset may not be fully recoverable in accordance with accounting guidance for impairment or disposal of long-lived assets. Registrant would recognize an impairment loss on its regulated assets only if the carrying value amount of a long-lived asset is not recoverable from customer rates authorized by the CPUC. Impairment loss is measured as the excess of the carrying value over the amounts recovered in customer rates. For the years ended December 31, 2023, 2022 and 2021, no impairment loss was incurred.

Goodwill: At December 31, 2023 and 2022, AWR had approximately $1.1 million of goodwill. The $1.1 million goodwill arose from ASUS's acquisition of a subcontractor's business at some of its subsidiaries. In accordance with the accounting guidance for testing goodwill, AWR annually assesses qualitative factors to determine whether the existence of events or circumstances leads to a determination that it is more likely than not that the fair value of a reporting unit is less than its carrying amount. For 2023 and 2022, AWR's assessment of qualitative factors did not indicate that an impairment had occurred for goodwill at ASUS.

Cash and Cash Equivalents: Cash and cash equivalents include short-term cash investments with an original maturity of three months or less. At times, cash and cash equivalent balances may be in excess of federally insured limits. Cash and cash equivalents are held with financial institutions with high credit standings.

Accounts Receivable: Accounts receivable is reported on the balance sheet net of any allowance for doubtful accounts. The allowance for doubtful accounts is Registrant's best estimate of the amount of probable credit losses in Registrant's existing accounts receivable from its water and electric customers, and is determined based on expected losses rather than incurred losses. Registrant reviews the allowance for doubtful accounts quarterly. Account balances are written off against the allowance when it is probable the receivable will not be recovered. When utility customers request extended payment terms, credit is extended based on regulatory guidelines, and collateral is not required.

Receivables from the U.S. government include amounts due under contracts with the U.S. government to operate and maintain, and/or provide construction services for the water and/or wastewater systems at military bases. Other accounts receivable consist primarily of amounts due from third parties (non-utility customers) for various reasons, including amounts due from contractors, amounts due under settlement agreements and amounts due from other third-party prime government contractors pursuant to agreements for construction of water and/or wastewater facilities for such third-party prime contractors. The allowance for these other accounts receivable is based on Registrant's evaluation of the receivable portfolio under current conditions and a review of specific problems and such other factors that, in Registrant's judgment, should be considered in estimating losses. Allowances for doubtful accounts are disclosed in Note 18.

Materials and Supplies: Materials and supplies are stated at the lower of cost or net realizable value. Cost is computed using weighted average cost. Major classes of materials include pipe, meters, hydrants and valves.

Interest: Interest incurred during the construction of capital assets has generally not been capitalized for financial reporting purposes as such policy is not followed in the ratemaking process. Interest expense is generally recovered through the regulatory process. At times, the CPUC has authorized certain capital projects to be filed for revenue recovery with advice letters when those projects are completed. During the time that such projects are under development and construction, GSWC or BVES may record an allowance for funds used during construction ("AFUDC") as a component of construction work in progress to offset the cost of financing project construction. After construction is completed, GSWC and BVES is permitted to recover these costs through the inclusion in rate base. For the year ended December 31, 2023, 2022 and 2021, BVES recorded $14,000, $106,000 and $216,000, respectively in AFUDC.

Debt Issuance Costs and Redemption Premiums: Original debt issuance costs are deducted from the carrying value of the associated debt liability and amortized over the lives of the respective issuances of long-term debt. Premiums paid on the early redemption of debt are deferred as regulatory assets and amortized over the period that GSWC and BVES recovers such costs in rates, which is generally over the term of the new debt issued to finance early debt redemption. At December 31, 2023 and 2022, Registrant's long-term debt have been issued by GSWC and BVES.

Advances for Construction and Contributions in Aid of Construction: Advances for construction represent amounts advanced by developers for the cost to construct water system facilities in order to extend water service to their properties. Advances are refundable in equal annual installments, generally over 40 years. In certain instances, GSWC makes refunds on these advances over a specific period of time based on operating revenues related to the main or as new customers are connected to receive service from the main. Contributions in aid of construction are similar to advances but require no refunding. Generally, GSWC and BVES depreciate contributed property and amortize contributions in aid of construction at the composite rate of the related property. Utility plant funded by advances and contributions are excluded from rate base.

Fair Value of Financial Instruments: For cash and cash equivalents, accounts receivable, accounts payable and short-term debt, the carrying amount is assumed to approximate fair value due to the short-term nature of the amounts. The table below estimates the fair value of long-term debt held by AWR and GSWC, respectively. Rates available to AWR and GSWC at December 31, 2023 and 2022 for debt with similar terms and remaining maturities were used to estimate fair value for long-term debt. Changes in the assumptions will produce differing results.

	2023		2022	
(dollars in thousands)	**Carrying Amount**	**Fair Value**	**Carrying Amount**	**Fair Value**
Long-term debt—AWR **(1)(2)**	$ 579,047	$ 556,214	$ 450,373	$ 424,151

	2023		2022	
(dollars in thousands)	**Carrying Amount**	**Fair Value**	**Carrying Amount**	**Fair Value**
Long-term debt—GSWC **(1)**	$ 544,047	$ 522,883	$ 415,373	$ 391,198

(1) Excludes debt issuance costs and redemption premiums.

(2) Includes debt held by BVES of $35.0 million as of December 31, 2023 and 2022, respectively.

The accounting guidance for fair value measurements applies to all financial assets and financial liabilities that are being measured and reported on a fair value basis. Under the accounting guidance, Registrant has made fair value measurements that are classified and disclosed in one of the following three categories:

Level 1: Unadjusted quoted prices in active markets that are accessible at the measurement date for identical, unrestricted assets or liabilities;

Level 2: Quoted prices in markets that are not active or inputs which are observable, either directly or indirectly, for substantially the full term of the asset or liability; or

Level 3: Prices or valuation techniques that require inputs that are both significant to the fair value measurement and unobservable (i.e., supported by little or no market activity).

Registrant makes fair value measurements on its publicly issued notes, private placement notes and other long-term debt using current U.S. corporate debt yields for similar debt instruments. Under the fair value guidance, these are classified as Level 2, which consists of quoted prices in markets that are not active, or inputs which are observable, either directly or indirectly, for substantially the full term of the asset or liability.

The following table sets forth by level, within the fair value hierarchy, Registrant's long-term debt measured at fair value as of December 31, 2023:

(dollars in thousands)	**Level 1**	**Level 2**	**Level 3**	**Total**
Long-term debt—AWR	—	$ 556,214	—	$ 556,214
(dollars in thousands)	**Level 1**	**Level 2**	**Level 3**	**Total**
Long-term debt—GSWC	—	$ 522,883	—	$ 522,883

Stock-Based Awards: AWR has issued stock-based awards to its employees under stock incentive plans. AWR has also issued stock-based awards to its Board of Directors under non-employee directors stock plans. Registrant applies the provisions in the accounting guidance for share-based payments in accounting for all of its stock-based awards. See Note 13 for further discussion.

Note 2 — Revenues

Most of Registrant's revenues are accounted for under the revenue recognition accounting standard, *"Revenue from Contracts with Customers - (Topic 606)."*

GSWC and BVES provide utility services to customers as specified by the CPUC. The transaction prices for water and electric revenues are based on tariff rates authorized by the CPUC, which include both quantity-based and flat-rate charges. Tariff revenues represent the adopted revenue requirement authorized by the CPUC intended to provide GSWC and BVES with an opportunity to recover its costs and earn a reasonable return on its net capital investment. The annual revenue requirements are comprised of supply costs, operation and maintenance costs, administrative and general costs, depreciation and taxes in amounts authorized by the CPUC, and a return on rate base consistent with the capital structure authorized by the CPUC.

Water and electric revenues are recognized over time as customers simultaneously receive and use the utility services provided. Water and electric revenues include amounts billed to customers on a cyclical basis, nearly all of which are based on meter readings for services provided. Customer bills also include surcharges for cost-recovery activities, which represent CPUC-authorized balancing and memorandum accounts that allow for the recovery of previously incurred operating costs. Revenues from these surcharges have no impact to earnings as they are offset by corresponding increases in operating expenses to reflect the recovery of the associated costs. Customer payment terms are approximately 20 business days from the billing date. Unbilled revenues are amounts estimated to be billed for usage since the last meter-reading date to the end of the accounting period. The most recent customer billed usage forms the basis for estimating unbilled revenue.

GSWC and BVES bill certain sales and use taxes levied by state or local governments to its customers. Included in these sales and use taxes are franchise fees, which are paid to various municipalities and counties (based on their ordinances) in order to use public rights of way for utility purposes. GSWC and BVES bill these franchise fees to its customers based on a CPUC-authorized rate for each ratemaking area as applicable. These franchise fees, which are required to be paid regardless of GSWC's or BVES's ability to collect them from its customers, are accounted for on a gross basis. Franchise fees billed to customers and recorded as operating revenue were approximately $4.9 million, $4.0 million and $4.2 million for the years ended December 31, 2023, 2022 and 2021, respectively. When GSWC or BVES acts as an agent, where the tax is not required to be remitted if it is not collected from customers, the tax is accounted for on a net basis.

As currently authorized by the CPUC, GSWC and BVES record in revenues the difference between the adopted level of volumetric revenues as authorized by the CPUC for metered accounts (volumetric revenues) and the actual volumetric revenues recovered in customer rates. For GSWC, the difference is tracked under the Water Revenue Adjustment Mechanism ("WRAM") regulatory accounts, and for BVES the difference is tracked in the Base Revenue Requirement Adjustment Mechanism ("BRRAM") regulatory account. If this difference results in an under-collection of revenues, additional revenue is recorded only to the extent that the difference is expected to be collected within 24 months following the end of the year in which they are recorded in accordance with Accounting Standards Codification ("ASC") Topic 980, *Regulated Operations*.

ASUS's initial 50-year, firm-fixed-price contract and additional firm-fixed-price contracts, together referred to as ("50-year contract") with the U.S. government are considered service concession arrangements under ASC 853 *Service Concession Arrangements*. ASUS's military base contracts consist primarily of 50-year contracts and one 15-year contract with the U.S. government. The services under these contracts are accounted for under Topic 606 *Revenue from Contracts with Customers* and the water and/or wastewater systems are not recorded as Property, Plant and Equipment on Registrant's balance sheet. For ASUS, performance obligations consist of (i) performing ongoing operation and maintenance of the water and/or wastewater systems and treatment plants for each military base served, and (ii) performing construction activities (including renewal and replacement capital work) on each military base served. The transaction price for each performance obligation is either delineated in, or initially derived from, the applicable 50-year contract and/or any subsequent contract modifications. Depending on the state in which operations are conducted, ASUS's subsidiaries are also subject to certain state non-income tax assessments, which are accounted for on a gross basis and have been immaterial to date.

The ongoing performance of operation and maintenance of the water and/or wastewater systems and treatment plants is viewed as a single performance obligation for each of the contract with the U.S. government. Registrant recognizes revenue for operations and maintenance fees monthly using the "right to invoice" practical expedient under ASC Topic 606. ASUS has a right to the consideration from the U.S. government in an amount that corresponds directly to the value for services provided to the U.S. government based on its subsidiaries' performance completed to-date. The contractual operations and maintenance fees are firm-fixed, and the level of effort or resources expended in the performance of the operations-and-maintenance-fees performance obligation is largely consistent over the contract term. Therefore, Registrant has determined that the monthly amounts invoiced for operations and maintenance performance are a fair reflection of the value transferred to the U.S.

government. Invoices to the U.S. government for operations and maintenance service, as well as construction activities, are due upon receipt.

ASUS's construction activities consist of various projects to be performed. Each of these capital upgrade projects' transaction prices are delineated either in the 50-year contract or through a specific contract modification for each construction project, which includes the transaction price for that project, or through a task order under a task order agreement. For renewal and replacement projects, the initial transaction price is based on the individual scope of work in accordance with contractual unit prices within the 50-year contract. Each construction project is viewed as a separate, single performance obligation. Therefore, it is generally unnecessary to allocate a construction transaction price to more than one construction performance obligation. Revenues for construction activities are recognized over time, with progress toward completion measured based on the input method using costs incurred relative to the total estimated costs (cost-to-cost method). Due to the nature of these construction projects, Registrant has determined the cost-to-cost input measurement to be the best method to measure progress towards satisfying its construction contract performance obligations, as compared to using an output measurement such as units produced. Changes in job performance, job site conditions, change orders and/or estimated profitability may result in revisions to costs and income for ASUS, and are recognized in the period in which any such revisions are determined. Pre-contract costs for ASUS, which consist of design and engineering labor costs, are deferred if recovery is probable, and are expensed as incurred if recovery is not probable. Deferred pre-contract costs have been immaterial to date.

Contracted services revenues recognized during the years ended December 31, 2023, 2022 and 2021 from performance obligations satisfied in previous periods were not material.

Although GSWC and BVES have a diversified base of residential, commercial, industrial and other customers, revenues derived from residential and commercial customers account for nearly 90% of total water revenues, and 90% of total electric revenues. The vast majority of ASUS's revenues are from the U.S. government. For the years ended December 31, 2023, 2022, and 2021, disaggregated revenues from contracts with customers by segment are as follows:

(dollar in thousands)	**For The Year Ended December 31, 2023**	**For The Year Ended December 31, 2022**	**For The Year Ended December 31, 2021**
Water:			
Tariff-based revenues	$ 394,623	$ 324,838	$ 345,562
CPUC-approved surcharges (cost-recovery activities)	2,955	2,461	3,280
Other	2,753	2,351	2,227
Water revenues from contracts with customers	400,331	329,650	351,069
WRAM under/(over)-collection (alternative revenue program)	33,142	10,952	(3,957)
Total water revenues **(1)**	433,473	340,602	347,112
Electric:			
Tariff-based revenues	40,130	39,750	37,124
CPUC-approved surcharges (cost-recovery activities)	567	144	310
Electric revenues from contracts with customers	40,697	39,894	37,434
BRRAM under/(over)-collection (alternative revenue program)	1,135	92	911
Total electric revenues	41,832	39,986	38,345
Contracted services:			
Water	75,785	68,626	71,210
Wastewater	44,609	42,314	42,186
Contracted services revenues from contracts with customers	120,394	110,940	113,396
Total AWR revenues	$ 595,699	$ 491,528	$ 498,853

(1) Water revenues for the year ended December 31, 2023 includes approximately $30 million from the impact of retroactive new rates for the full year of 2022 as a result of the CPUC's approval of GSWC's general rate case (Note 3). Furthermore, the CPUC also issued a final decision in June 2023 on GSWC's cost of capital proceeding. As a result of the final cost of capital decision (Note 3), for the year ended December 31, 2023, water revenues include an increase of $6.4 million from the reversal of revenues subject to refund due to a change in estimates from what had been recorded during 2022.

The opening and closing balances of the receivable from the U.S. government, contract assets and contract liabilities from contracts with customers, which related entirely to ASUS, are as follows:

(dollar in thousands)	December 31, 2023	December 31, 2022
Unbilled receivables	$ 9,693	$ 10,125
Receivable from the U.S. government	$ 91,489	$ 85,456
Contract assets	$ 14,378	$ 14,982
Contract liabilities	$ 1,352	$ 903

Unbilled receivables and receivable from the U.S. government represent receivables where the right to payment is conditional only by the passage of time.

Contract Assets - Contract assets are assets of ASUS and its subsidiaries and consist of unbilled revenues recognized from work-in-progress construction projects, where the right to payment is conditional on something other than the passage of time. The classification of this asset as current or noncurrent is based on the timing of when ASUS expects to bill these amounts.

Contract Liabilities - Contract liabilities are liabilities of ASUS and its subsidiaries and consist of billings in excess of revenue recognized. The classification of this liability as current or noncurrent is based on the timing of when ASUS expects to recognize revenue. Revenues for the year ended December 31, 2023 included in contract liabilities at the beginning of the period were not material.

As of December 31, 2023, AWR's aggregate remaining performance obligations, which are entirely from the contracted services segment, were $4.0 billion. ASUS expects to recognize revenue on these remaining performance obligations over the remaining term of each of the contracts, with original contract terms that range from 15 to 50 years. Each of the contracts with the U.S. government is subject to termination, in whole or in part, prior to the end of its contract term for the convenience of the U.S. government.

Note 3 — Regulatory Matters

In accordance with accounting principles for rate-regulated enterprises, GSWC and BVES record regulatory assets, which represent probable future recovery of costs from customers through the ratemaking process, and regulatory liabilities, which represent probable future refunds that are to be credited to customers through the ratemaking process. At December 31, 2023, GSWC and BVES had approximately $68.4 million of regulatory liabilities, net of regulatory assets, not accruing carrying costs. Of this amount, (i) $74.0 million of regulatory liabilities are excess deferred income taxes arising from the lower federal income tax rate under the Tax Cuts and Jobs Act enacted in December 2017 that are being refunded to customers (Note 11), (ii) $4.3 million of net regulatory assets relates to flowed-through deferred income taxes including the gross-up portion on the deferred tax resulting from the excess deferred income tax regulatory liability (Note 11), (iii) $3.8 million of regulatory liabilities relates to the underfunded position in Registrant's pension and other post-retirement obligations (excluding the two-way pension balancing accounts), and (iv) $2.4 million of net regulatory asset relates to a memorandum account authorized by the CPUC to track unrealized gains and losses on BVES's purchase power contracts over the terms of the contracts. The remainder relates to other items that do not provide for or incur carrying costs.

Regulatory assets represent costs incurred by GSWC and/or BVES for which they have received or expect to receive rate recovery in the future. In determining the probability of costs being recognized in other periods, GSWC and BVES consider regulatory rules and decisions, past practices, and other facts or circumstances that would indicate if recovery is probable. If the CPUC determines that a portion of either GSWC's or BVES's assets are not recoverable in customer rates, the applicable utility must determine if it has suffered an asset impairment that requires it to write down the asset's value. Regulatory assets are offset against regulatory liabilities within each ratemaking area. Amounts expected to be collected or refunded in the next twelve months have been classified as current assets and current liabilities by ratemaking area. Regulatory assets, less regulatory liabilities, included in the consolidated balance sheets are as follows:

	December 31,	
(dollars in thousands)	**2023**	**2022**
GSWC		
2022/2023 general rate case memorandum accounts (unbilled revenue)	$ 52,795	$ —
Water revenue adjustment mechanism, net of the modified cost balancing account	41,545	31,803
Asset retirement obligations (Note 1)	7,099	6,411
COVID-19 memorandum accounts	1,199	3,478
Flowed-through deferred income taxes, net (Note 11)	3,190	(1,134)
Low income rate assistance balancing accounts	5,763	2,526
Pensions and other post-retirement obligations (Note 12)	(4,867)	738
Other regulatory assets	9,462	10,289
Excess deferred income taxes (Note 11)	(70,189)	(71,870)
Other regulatory liabilities	(268)	(8,815)
Total GSWC	$ 45,729	$ (26,574)
BVES		
Derivative instrument memorandum account (Note 5)	2,360	(11,847)
Wildfire mitigation and other fire prevention related costs memorandum accounts	17,716	13,007
Electric supply cost adjustment mechanism	2,583	3,627
Other regulatory assets	7,697	4,338
Other regulatory liabilities	(6,578)	(8,005)
Total AWR	$ 69,507	$ (25,454)

Water General Rate Case and the 2022/2023 General Rate Case Memorandum Accounts:

On June 29, 2023, the CPUC adopted a final decision in GSWC's general rate case application for all its water regions and its general office that determines new water rates for the years 2022–2024. Among other things, the final decision (i) adopted the full settlement agreement between GSWC and the Public Advocates Office at the CPUC ("Public Advocates") that resolved all issues related to the 2022 annual revenue requirement in the general rate case application and made the 2022 rates retroactive to January 1, 2022, and (ii) allowed for additional increases in adopted revenues for 2023 and 2024 subject to an earnings test and inflationary index values at the time of filing for implementation of the new rates. As a result, the impact of retroactive rates for the full year of 2022 have been reflected in the results of operations for the year ended December 31, 2023. Upon receiving the final decision, GSWC filed for the implementation of new 2023 rate increases that went into effect on July 31, 2023. The new rates for 2023 were retroactive to January 1, 2023.

Due to the delay in finalizing the water general rate case, water revenues billed to customers for the year ended December 31, 2022 and for the period from January 1, 2023 to July 30, 2023 were based on 2021 adopted rates. GSWC was authorized to create general rate case memorandum accounts to track the revenue differences between the 2021 adopted rates and the new 2022 and 2023 rates authorized by the CPUC. As of December 31, 2023, there is a net aggregate $52.8 million under-collection in the general rate case memorandum accounts that GSWC has recorded as regulatory assets for retroactive water revenues related to difference between the 2021 adopted rates billed to customers and the rates authorized in the final decision for the full year of 2022 and the 2023 second-year rate increases recorded from January 1 to July 30, 2023. In October 2023, surcharges were implemented by GSWC to recover the cumulative retroactive rate differences over 36 months.

Cost of Capital Proceeding:

On June 29, 2023, a final decision was adopted by the CPUC in the cost of capital proceeding that, among other things, (i) adopts GSWC's requested capital structure of 57% equity and 43% debt; (ii) adopts a cost of debt of 5.1% for GSWC as compared to 6.6% previously authorized; (iii) adopts a return on equity of 8.85% for GSWC as compared to 8.9% previously authorized; (iv) allows for the continuation of the Water Cost of Capital Mechanism ("WCCM") through December 31, 2024; and (v) adopts the new cost of capital for the three-year period commencing January 1, 2022 through December 31, 2024. Based on the Company's assessment of the final decision issued in June, all adjustments to rates are to be prospective. GSWC filed an advice letter that implemented the new cost of capital effective July 31, 2023.

Following the receipt of the final decision adopted on June 29, 2023 in the cost of capital proceeding, management updated its analysis and reassessed the accounting estimates recorded to date related to GSWC's lower cost of debt. Accordingly, GSWC recorded a change in its estimate that resulted in an increase to water revenues for the year ended December 31, 2023 in the amount of $6.4 million as a result of reversing its regulatory liability for revenues subject to refund that it had recorded during 2022.

The WCCM adjusts the return on equity and rate of return on rate base between the three-year cost of capital proceedings only if there is a positive or negative change of more than 100 basis points based on the average of Moody's Aa utility bond rate as measured over the period from October 1 through September 30. If there is a positive or negative change of more than 100 basis points, the return on equity is adjusted by one half of the difference. For the period from October 1, 2021 through September 30, 2022, Moody's Aa utility bond rate increased by 102.80 basis points from the benchmark, which triggered the WCCM adjustment. GSWC recognized revenues for the period from January 1 through July 30, 2023 and all of 2022 based on the previously authorized return of equity of 8.9% that had also been billed to water customers through the same period. On June 30, 2023, GSWC filed an advice letter to establish the WCCM for 2023, which increased GSWC's 8.85% adopted return on equity in the decision to 9.36% effective July 31, 2023. Additionally, for the period from October 1, 2022 through September 30, 2023, the Moody's Aa utility bond rate increased by 139.70 basis points from the benchmark, which triggered another WCCM adjustment. On October 12, 2023, GSWC filed an advice letter to establish the WCCM for 2024, which has been approved by the CPUC. As a result of this approval, GSWC's 9.36% adopted return on equity increased to 10.06% effective January 1, 2024.

Alternative-Revenue Programs:

GSWC records the difference between what it bills its water customers and that which is authorized by the CPUC using the Water Revenue Adjustment Mechanism ("WRAM") and the Modified Cost Balancing Account ("MCBA") approved by the CPUC. The over- or under-collection of the WRAM is aggregated with the MCBA over- or under-collection for the corresponding ratemaking area and bears interest at the current 90-day commercial paper rate.

As of December 31, 2023, GSWC had an aggregated regulatory asset of $41.5 million, which is comprised of a $43.9 million under-collection in the WRAM accounts and a $2.4 million over-collection in the MCBA accounts. During 2023, GSWC recorded additional net under-collections in the WRAM/MCBA accounts of approximately $30.1 million related to the 2023 year that resulted largely from lower-than-adopted water usage as authorized in the general rate case decision. GSWC recorded a net reduction of $9.8 million of under-collections during the first quarter of 2023 to reflect the cumulative full-year impact of 2022 based on authorized 2022 amounts approved in the general rate case decision for both the WRAM and MCBA accounts. On July 27, 2023, the CPUC approved the recovery of all pre-2023 WRAM/MCBA balances. Accordingly, GSWC has implemented surcharges and surcredits to recover/refund all of its WRAM/MCBA balances accumulated as of December 31, 2022.

As required by the accounting guidance for alternative revenue programs, GSWC is required to collect its WRAM balances within 24 months following the end of the year in which an under-collection is recorded. As of December 31, 2023, there were no material WRAM under-collections that were estimated to be collected over more than 24 months.

***Pensions and Other Post-retirement Obligations*:**

A net regulatory liability and asset have been recorded at December 31, 2023 and 2022, respectively, for costs that would otherwise be charged to "other comprehensive income" within shareholders' equity for the funded status of Registrant's pension and other post-retirement benefit plans because the cost of these plans has historically been recovered through rates. As discussed in Note 12, as of December 31, 2023, Registrant's overfunded position for these plans that have been recorded as regulatory liabilities totaled $3.8 million.

In addition, the CPUC has authorized GSWC and BVES to each use two-way balancing accounts to track differences between the forecasted annual pension expenses adopted in their respective customer rates and the actual annual expense to be recorded in accordance with the accounting guidance for pension costs. The two-way balancing accounts bear interest at the current 90-day commercial paper rate. As of December 31, 2023, GSWC has a $1.1 million over-collection related to the general office and water regions, and BVES has a $277,000 over-collection in its two-way balancing account.

***COVID-19 Emergency Memorandum Accounts*:**

The CPUC has authorized GSWC and BVES to track incremental costs, including bad debt expense in excess of what is included in their respective revenue requirements, the purchase of personal protective equipment, and other incremental COVID-19 related costs incurred as a result of the pandemic in COVID-19 emergency-related memorandum accounts, which GSWC and BVES both intend to file with the CPUC for future recovery of these costs.

In December 2023, GSWC filed an application with the SWRCB through the Extended Arrearage Program to obtain additional COVID relief funds to provide further assistance to its customers for their water debt accrued during the COVID-19 pandemic. GSWC has received confirmation from SWRCB that it is currently processing GSWC's application and expects to disburse approximately $3.5 million in additional COVID relief funds through this program. All funds to be received will be applied to customer eligible delinquent balances. As of December 31, 2023, GSWC has recorded a reduction to its bad debt-related amounts included in its COVID-19 memorandum account, with a corresponding reduction to its estimated customer bad debt reserves. As of December 31, 2023, GSWC and BVES had approximately $1.2 million and $500,000, respectively, in regulatory asset accounts related to the purchase of personal protective equipment, bad debt expense in excess of their revenue requirements, additional incurred printing costs, and other incremental COVID-19-related costs. Emergency-related memorandum accounts are well-established cost recovery mechanisms authorized as a result of a state/federal declared emergency, and are recognized as regulatory assets for future recovery. As a result, the amounts recorded in the COVID-19 emergency-related memorandum accounts have not impacted GSWC's or BVES's earnings.

The CPUC requires that amounts tracked in GSWC's and BVES's COVID-19 memorandum accounts for unpaid customer bills be first offset by any (i) federal and state relief for water or electric utility bill debt, and (ii) customer payments through payment plan arrangements, prior to receiving recovery from customers at large. As of December 31, 2023, GSWC fully offset its bad debt-related CEMA balance as a result of additional COVID relief funds approved. In addition, BVES has filed to recover the remaining balance in its COVID-19 memorandum account through its general rate case application filed in August 2022.

Low Income Balancing Accounts:

This regulatory asset reflects the net balance of the incremental administration costs, not already reflected in authorized rates, the customers' discounts issued and the revenues generated by the low-income surcharges for the Customer Assistance Program in GSWC's water regions and the California Alternate Rates for Energy program for BVES. These low-income programs, which are mandated by the CPUC, currently provide a flat discount based on 20% of a typical customer bill for qualified low-income water customers and a 20% discount for qualified low-income electric customers. The low-income balancing accounts accrue interest at the prevailing 90-day commercial paper rate. As of December 31, 2023, there is an aggregate $5.7 million under-collection in the low-income balancing accounts. Surcharges have been implemented to recover the costs included in these balancing accounts.

Other BVES Regulatory Assets:

Wildfire Mitigation and Other Fire Prevention Related Costs Memorandum Accounts

The CPUC adopted regulations intended to enhance the fire safety of overhead electric power lines. Those regulations included increased minimum clearances around electric power lines. BVES was authorized to track incremental costs incurred to implement the regulations in a fire hazard prevention memorandum account for the purpose of obtaining cost recovery in a future general rate case. In August 2019, the CPUC issued a final decision on the electric general rate case, which set new rates through the year 2022. Among other things, the decision authorized BVES to record incremental costs related to vegetation management, such as costs for increased minimum clearances around electric power lines, in a CPUC-approved memorandum account for potential future recovery. As of December 31, 2023, BVES has approximately $11.8 million in incremental vegetation management costs recorded as a regulatory asset. BVES has requested recovery of these costs in its general rate case application filed with the CPUC in August 2022 for future recovery. The incremental costs related to vegetation management included in the memorandum account will be subject to review during the general rate case proceeding.

California legislation enacted in September 2018 requires all investor-owned electric utilities to have a wildfire mitigation plan (“WMP”) approved by the Office of Energy Infrastructure Safety (“OEIS”) and ratified by the CPUC. The WMP must include a utility’s plans on constructing, maintaining, and operating its electrical lines and equipment to minimize the risk of catastrophic wildfire. In May 2023, BVES submitted its WMP covering the period from 2023 to 2025 to OEIS for approval prior to going to the CPUC for ratification. In the fourth quarter of 2023, OEIS issued a final decision of approval and the CPUC ratified BVES’s 2023-2025 WMP. As of December 31, 2023, BVES has approximately $5.9 million related to expenses accumulated in its WMP memorandum accounts that have been recognized as regulatory assets for future recovery.

All capital expenditures and other costs incurred through December 31, 2023 as a result of BVES’s WMPs are not currently in rates and have been filed for future recovery in BVES’s general rate case application. These costs will be subject to review during the general rate case proceeding.

2023 Winter Storm Other Regulatory Asset

BVES activated a CEMA to track the incremental costs incurred in response to a severe winter storm that occurred during certain weeks of the first and second quarters of 2023. The governor of California declared a state of emergency for the storm. Incremental costs of approximately $1.3 million were incurred and included in the CEMA account, which has been recorded as a regulatory asset as of December 31, 2023 for future recovery. The incremental costs included in the CEMA account will be subject to review and approval by the CPUC. CEMA accounts are well-established cost recovery mechanisms authorized as a result of a state/federal declared emergency, and are therefore recognized as regulatory assets for future recovery. As a result, the amounts recorded in this CEMA account has not impacted BVES’s earnings.

Electric Supply Cost Adjustment Mechanism

Under the current electric supply cost adjustment mechanism approved by the CPUC, BVES tracks the difference between its adopted supply costs included in rates and actual supply costs, which consist largely of purchased power for resale under the existing long-term fixed price purchase power agreements. The under-collections included in the electric supply cost balancing account are being recovered through surcharges. Annually, BVES files an advice letter with the CPUC to revise the surcharge that incorporates the under-collected balances through the previous calendar year's end if the balance meets the minimum balance filing threshold. During 2023, BVES recorded an additional under-collection of $1.9 million in the electric supply cost balancing account. In January 2024, BVES filed an advice letter to implement a revised surcharge to recover the cumulative balances as of December 31, 2023. The new surcharge was effective February 1, 2024.

Other Regulatory Assets:

Other regulatory assets represent costs incurred by GSWC or BVES for which they have received or expect to receive rate recovery in the future. Registrant believes that these regulatory assets are supported by regulatory rules and decisions, past practices, and other facts or circumstances that indicate recovery is probable. If the CPUC determines that a portion of either GSWC’s or BVES’s assets are not recoverable in customer rates, the applicable entity must determine if it has suffered an asset impairment that requires it to write down the regulatory asset to the amount that is probable of recovery.

Note 4 — Utility Plant and Intangible Assets

The following table shows Registrant's utility plant (regulated utility plant and non-regulated utility property) by major asset class:

(dollars in thousands)	AWR December 31, 2023	AWR December 31, 2022	GSWC December 31, 2023	GSWC December 31, 2022
Water				
Land	$ 18,290	$ 18,427	$ 18,290	$ 18,427
Intangible assets	30,917	30,511	30,917	30,511
Source of water supply	111,112	109,918	111,112	109,918
Pumping	234,264	227,668	234,264	227,668
Water treatment	98,533	90,411	98,533	90,411
Transmission and distribution	1,489,974	1,431,437	1,489,974	1,431,437
Other	140,060	136,162	99,837	98,096
	2,123,150	2,044,534	2,082,927	2,006,468
Electric				
Transmission and distribution	126,143	105,499	—	—
Generation	12,583	12,583	—	—
Other (1)	17,745	15,733	—	—
	156,471	133,815	—	—
Less — accumulated depreciation	(624,472)	(606,231)	(543,135)	(530,925)
Construction work in progress	237,131	181,648	195,742	141,175
Net utility plant	$ 1,892,280	$ 1,753,766	$ 1,735,534	$ 1,616,718

(1) Includes intangible assets of $1.2 million for the years ended December 31, 2023 and 2022 for studies performed.

As of December 31, 2023 and 2022, intangible assets consist of the following:

(dollars in thousands)	Weighted Average Amortization Period	AWR December 31, 2023	AWR December 31, 2022	GSWC December 31, 2023	GSWC December 31, 2022
Intangible assets:					
Conservation programs	3 years	$ 9,486	$ 9,486	$ 9,486	$ 9,486
Water and service rights (2)	30 years	8,695	8,695	8,124	8,124
Water planning studies	14 years	14,164	13,757	12,926	12,519
Total intangible assets		32,345	31,938	30,536	30,129
Less — accumulated amortization		(27,275)	(26,811)	(26,294)	(25,374)
Intangible assets, net of amortization		$ 5,070	$ 5,127	$ 4,242	$ 4,755
Intangible assets not subject to amortization (3)		$ 383	$ 383	$ 382	$ 382

(2) Includes intangible assets of $571,000 for contracted services included in "Other Property and Investments" on the consolidated balance sheets as of December 31, 2023 and 2022.

(3) The intangible assets not subject to amortization primarily consist of organization and consent fees.

For the years ended December 31, 2023, 2022 and 2021, amortization of intangible assets was $1.1 million, $641,000 and $700,000, respectively, for both AWR and GSWC.

Estimated future consolidated amortization expense related to intangible assets are as follows (in thousands):

		Amortization Expense
2024	$	911
2025		911
2026		911
2027		911
2028		911
Total	$	4,555

Asset Retirement Obligations:

The following is a reconciliation of the beginning and ending aggregate carrying amount of asset retirement obligations, which are included in "Other Credits" on the balance sheets as of December 31, 2023 and 2022:

(dollars in thousands)		GSWC
Obligation at December 31, 2021	$	9,717
Accretion		386
Obligation at December 31, 2022	$	10,103
Accretion		406
Obligation at December 31, 2023	$	10,509

Note 5 — Derivative Instruments

BVES has entered into long-term fixed price contracts to purchase power over three- and five-year terms. These long-term contracts will expire during the fourth quarter of 2024 and are subject to the accounting guidance for derivatives and require mark-to-market derivative accounting. In July 2023, the CPUC approved a new power purchase agreement between BVES and a third party to procure renewable portfolio standard eligible energy and renewable energy credits as a bundled product. BVES will begin taking power under this long-term contract during the fourth quarter of 2024 to replace the existing expiring contracts. The new contract provides for the purchase of electricity during a delivery period from November 1, 2024 through December 31, 2035. Under this contract, there is an embedded derivative that also requires mark-to-market accounting.

The CPUC authorized the use of a regulatory asset and liability memorandum account to offset the mark-to-market entries required by the accounting guidance. Accordingly, all unrealized gains and losses generated from derivative instruments in purchase power contracts are deferred on a monthly basis into a non-interest-bearing regulatory memorandum account that tracks the changes in fair value of the derivative throughout the terms of the contracts. As a result, these unrealized gains and losses do not impact Registrant's earnings. As of December 31, 2023, there was a $2.4 million derivative liability at fair value for the derivatives in the purchase power contracts, with a corresponding regulatory asset recorded in the derivative instrument memorandum account as a result of overall fixed prices under BVES's purchase power contracts being higher than future energy prices. The notional volume of derivatives remaining under these long-term contracts as of December 31, 2023 was approximately 685,256 megawatt hours.

Registrant's valuation model utilizes various inputs that include quoted market prices for energy over the duration of the contracts. The market prices used to determine the fair value for these derivative instruments were estimated based on independent sources such as broker quotes and publications that are not observable in or corroborated by the market. When such inputs have a significant impact on the measurement of fair value, the instrument is categorized as Level 3 as described in Note 1. Accordingly, the valuation of the derivatives on Registrant's purchase power contracts have been classified as Level 3 for all periods presented.

The change in fair value was due to the change in market energy prices for the years 2023 and 2022. The following table presents changes in the fair value of the Level 3 derivatives for the years 2023 and 2022:

(dollars in thousands)		2023		2022
Fair value at beginning of the period	$	11,847	$	4,441
Unrealized (losses) gains on purchase power contracts		(14,207)		7,406
Fair value at end of the period	$	(2,360)	$	11,847

Note 6 — Military Base Operations

ASUS's subsidiaries have entered into service contracts with the U.S. government to operate and maintain, as well as perform construction activities to renew and replace, the water and/or wastewater systems at a military base or bases. The amounts charged for these services are primarily based upon the terms of the initial 50-year contract between ASUS's subsidiaries and the U.S. government. Under the terms of each of these agreements, ASUS's subsidiaries agree to operate and maintain the water and/or wastewater systems for: (i) a monthly net fixed-price for operation and maintenance, and (ii) an amount to cover renewal and replacement capital work. In addition, these contracts may also include firm-fixed-priced initial capital upgrade projects to upgrade the existing infrastructure. Contract modifications are also issued for other necessary capital upgrades to the existing infrastructure approved by the U.S. government. ASUS through its subsidiaries may also from time to time perform construction services on military bases as a subcontractor or pursuant to task orders or fixed-price task order agreements. The contract serving Joint Base Cape Cod is currently the only task order agreement with the U.S. government. This task order agreement has a term of 15 years.

Under the terms of each of these contracts, prices are subject to an economic price adjustment ("EPA") provision, on an annual basis. Prices may also be equitably adjusted for changes in law and other circumstances. ASUS's subsidiaries are permitted to file, and has filed, requests for equitable adjustment. Each of the contracts may be subject to termination, in whole or in part, prior to the end of the 50-year term for convenience of the U.S. government or as a result of default or nonperformance by an ASUS subsidiary.

ASUS has experienced delays in receiving EPAs as provided for under its 50-year contracts. Because of the delays, EPAs, when finally approved, are retroactive. During 2023, with the exception of the newly awarded contracts, the U.S. government approved EPAs at all of the bases served. In some cases, these EPAs included retroactive operation and maintenance management fees for prior periods. For the years ended December 31, 2023, 2022 and 2021, retroactive operation and maintenance management fees related to prior periods were immaterial.

Note 7 — Earnings Per Share and Capital Stock

In accordance with the accounting guidance for participating securities and earnings per share ("EPS"), Registrant uses the "two-class" method of computing EPS. The "two-class" method is an earnings allocation formula that determines EPS for each class of common stock and participating security. AWR has participating securities related to restricted stock units that earn dividend equivalents on an equal basis with AWR's Common Shares that have been issued under AWR's stock incentive plans for employees and the non-employee directors stock plans. In applying the "two-class" method, undistributed earnings are allocated to both Common Shares and participating securities.

The following is a reconciliation of Registrant's net income and weighted average Common Shares outstanding used to calculate basic EPS:

Basic:	**For The Years Ended December 31,**		
(in thousands, except per share amounts)	**2023**	**2022**	**2021**
Net income	$ 124,921	$ 78,396	$ 94,347
Less: impact from participating securities	372	197	244
Total income available to common shareholders	$ 124,549	$ 78,199	$ 94,103
Weighted average Common Shares outstanding, basic	36,976	36,955	36,921
Basic earnings per Common Share	$ 3.37	$ 2.12	$ 2.55

Diluted EPS is based upon the weighted average number of Common Shares, including both outstanding shares and shares potentially issuable in connection with restricted stock units granted under AWR's stock incentive plans for employees and directors, and net income.

The following is a reconciliation of Registrant's net income and weighted average Common Shares outstanding used to calculate diluted EPS:

Diluted: **(in thousands, except per share amounts)**	**For The Years Ended December 31,** **2023**	**2022**	**2021**
Common shareholders earnings, basic	$ 124,549	$ 78,199	$ 94,103
Undistributed earnings for dilutive stock options and restricted stock units	189	55	110
Total common shareholders earnings, diluted	$ 124,738	$ 78,254	$ 94,213
Weighted average Common Shares outstanding, basic	36,976	36,955	36,921
Stock-based compensation (1)	101	84	89
Weighted average Common Shares outstanding, diluted	37,077	37,039	37,010
Diluted earnings per Common Share	$ 3.36	$ 2.11	$ 2.55

(1) In applying the treasury stock method of reflecting the dilutive effect of outstanding stock-based compensation in the calculation of diluted EPS, 115,684, 96,988 and 100,020 restricted stock units, including performance awards to officers of AWR, at December 31, 2023, 2022 and 2021, respectively, were deemed to be outstanding in accordance with accounting guidance on earnings per share.

During the years ended December 31, 2023, 2022 and 2021, AWR issued Common Shares totaling 18,371, 25,956 and 47,182, respectively, under AWR's employee stock incentive plans and the non-employee directors' plans. During 2023, 2022 and 2021, there were no cash proceeds received by AWR as a result of the exercise of stock options. AWR has not issued any Common Shares during 2023, 2022 and 2021 under AWR's Common Share Purchase and Dividend Reinvestment Plan ("DRP") and the 401(k) Plan. Shares reserved for the 401(k) Plan are in relation to AWR's matching contributions and investment by participants. As of December 31, 2023, there were 1,055,948 and 387,300 Common Shares authorized for issuance directly by AWR but unissued under the DRP and the 401(k) Plan, respectively.

During 2023, GSWC issued one common shares to AWR for $10.0 million. Proceeds from the stock issuances were used to pay down a portion of intercompany borrowings owed to AWR as described in Note 1. No shares were issued by GSWC during 2022 and 2021.

During the years ended December 31, 2023, 2022 and 2021, AWR and GSWC made payments to taxing authorities on employees' behalf for shares withheld related to net share settlements. These payments are included in the stock-based compensation caption of the statements of equity. GSWC's outstanding common shares are owned entirely by its parent, AWR. To the extent GSWC does not reimburse AWR for stock-based compensation awarded under various stock compensation plans, such amounts increase the value of GSWC's common shareholder's equity.

Note 8 — Dividend Limitations

GSWC is prohibited from paying dividends if, after giving effect to the dividend, its total indebtedness to capitalization ratio (as defined) would be more than 0.6667-to-1. Dividends in the amount of $55.4 million, $27.0 million and $38.3 million were paid to AWR by GSWC during the years 2023, 2022 and 2021, respectively.

The ability of AWR, GSWC, BVES and ASUS to pay dividends is also restricted by California law. Under California law, AWR, GSWC, BVES and ASUS are each permitted to distribute dividends to its shareholders so long as the Board of Directors determines, in good faith, that either: (i) the value of the corporation's assets equals or exceeds the sum of its total liabilities immediately after the dividend, or (ii) its retained earnings equals or exceeds the amount of the distribution. Under the least restrictive of the California tests, approximately $776.1 million was available to pay dividends to AWR's shareholders at December 31, 2023. Approximately $703.8 million was available for GSWC to pay dividends to AWR at December 31, 2023.

Note 9 — Bank Debts

Registrant's bank debts consist of outstanding borrowings made under three separate credit facilities at AWR (parent), GSWC and BVES.

AWR (parent) and GSWC Credit Facilities:

On June 28, 2023, AWR and GSWC, each entered into new credit agreements with a term of five years provided by a syndicate of banks and financial institutions. Both credit agreements will mature on June 28, 2028. In connection with the new credit agreements, AWR and GSWC incurred, legal and other fees totaling $632,000 and $802,000, respectively. The syndicated credit facilities replaced AWR's previous credit agreement with a sole bank where AWR had a borrowing capacity of $280.0 million that supported GSWC and ASUS operations. Funds from the new facilities were used to pay-off in full all outstanding borrowings under AWR's prior credit facility and GSWC's outstanding intercompany borrowings from AWR.

AWR's credit agreement provided for a $150.0 million unsecured revolving credit facility to support AWR (parent) and ASUS. Under AWR's credit agreement, the borrowing capacity may be expanded up to an additional amount of $75 million, subject to the lenders' approval. On November 6, 2023, AWR's credit facility was amended to increase the borrowing capacity from $150.0 million to $165.0 million to provide additional support to ASUS and AWR (parent). In connection with the increase in borrowing capacity, the amendment also provides for the addition of a new bank to the existing syndicate group participating in AWR's credit facility. Furthermore, the aggregate amount that may be outstanding under letters of credit for AWR is $10.0 million. Loans may be obtained under the credit facilities at the option of AWR and bear interest at rates based on either a base rate plus an applicable margin or an adjusted term secured overnight financing rate ("SOFR") determined by the SOFR administrator, currently the Federal Reserve Bank of New York, plus an applicable margin. The applicable margin depends upon AWR's credit ratings. As of December 31, 2023, AWR's outstanding borrowings under its credit facility of $141.5 million have been classified as non-current liabilities on AWR's Consolidated Balance Sheet.

AWR's credit agreement contains affirmative and negative covenants and events of default customary for credit facilities of this type, including, among other things, affirmative covenants relating to compliance with law and material contracts, and negative covenants relating to additional indebtedness, liens, investments, restricted payments and asset sales by AWR and its subsidiaries, other than BVES. AWR is not permitted to have a consolidated total capitalization ratio (as defined in the credit agreement), excluding BVES, greater than 0.65 to 1.00 at the end of any quarter. Default under any indebtedness of any subsidiary of AWR, other than BVES, will result in a default under AWR's credit agreement. As of December 31, 2023, AWR was in compliance with these requirements. As of December 31, 2023, AWR had a capitalization ratio of 0.54 to 1.00.

GSWC's credit agreement provides for a $200.0 million unsecured revolving credit facility to support its operations and capital expenditures. Under GSWC's credit agreement, the borrowing capacity may be expanded up to an additional amount of $75.0 million, also as subject to the lenders' approval. The aggregate amount that may be outstanding under letters of credit is $20.0 million. Loans may be obtained under this credit facility at the option of GSWC and bear interest at rates based on either a base rate plus an applicable margin or an adjusted term SOFR determined by the SOFR administrator plus an applicable margin. The applicable margin depends upon GSWC's credit rating.

GSWC's credit facility is considered a short-term debt arrangement by the CPUC. GSWC has been authorized by the CPUC to borrow under the credit facility for a term of up to 24 months. Borrowings under this credit facility are, therefore, required to be fully paid off within a 24-month period. GSWC's next pay-off period ends in June 2025. Accordingly, as of December 31, 2023, GSWC's outstanding borrowings under its credit facility of $150.0 million has been classified as non-current liabilities on GSWC's Balance Sheet. Similar to AWR's credit agreement, GSWC's credit agreement also contains affirmative and negative covenants and events of default customary for credit facilities of its type. GSWC is also not permitted to have a total capitalization ratio greater than 0.65 to 1.00 at the end of any quarter. Default under any indebtedness of any subsidiary of AWR will not result in a default under GSWC's credit agreement. As of December 31, 2023, GSWC was in compliance with these requirements, with total funded debt ratio of 0.50 to 1.00.

BVES Credit Facility:

BVES has a separate revolving credit facility without a parent guaranty that supports its electric operations and capital expenditures. On June 16, 2023, BVES's credit agreement was amended to increase the borrowing capacity from $35.0 million to $50.0 million. In addition, the amendment to the credit agreement also (i) extended the credit facility to July 1, 2026, (ii) converted the interest rate on new borrowings to the benchmark rate of SOFR, plus a margin, and (iii) provides an option to increase the facility by an additional $25.0 million, subject to lender approval. On February 15, 2024, BVES, through its fourth amendment, increased the borrowing capacity from $50.0 million to $65.0 million. BVES's revolving credit facility is considered a short-term debt arrangement by the CPUC. BVES has been authorized by the CPUC to borrow under this credit facility for a term of up to 24 months. Borrowings under this credit facility are, therefore, required to be fully paid off within a 24-month period. BVES's next pay-off period for its credit facility ends in August 2024. Accordingly, the $42.0 million outstanding under BVES's credit facility has been classified as a current liability in AWR's Consolidated Balance Sheet as of December 31, 2023.

Pursuant to BVES's amended credit facility agreement, effective December 20, 2023 and throughout 2024, BVES must maintain a minimum interest coverage ratio of 3.0 times interest expense, and 4.5 times interest expense thereafter. BVES is also required to maintain a maximum consolidated total debt to consolidated total capitalization ratio of 0.65 to 1.00. As of December 31, 2023, BVES was in compliance with these requirements, with an actual interest coverage ratio of 4.51 times interest expense and a total funded debt ratio of 0.52 to 1.00 as of December 31, 2023. In addition, BVES is required to have a current safety certification issued by the CPUC, which it currently has.

Registrant's borrowing activities (excluding letters of credit) for the years ended December 31, 2023 and 2022 were as follows:

	December 31,	
(in thousands, except percent)	**2023**	**2022**
Balance Outstanding at December 31,	$ 333,500	$ 277,500
Interest Rate at December 31,	6.33% ~ 6.96%	5.07% ~ 5.89%
Average Amount Outstanding	$ 243,355	$ 226,556
Weighted Average Annual Interest Rate	6.11 %	2.55 %
Maximum Amount Outstanding	$ 333,500	$ 277,500

Note 10 — Long-Term Debt

Registrant's long-term debt consists of notes and debentures of GSWC and BVES. Registrant summarizes its long-term debt in the Statements of Capitalization. GSWC and BVES do not currently have any secured debt.

On January 13, 2023, GSWC issued $130.0 million unsecured private-placement notes consisting of: $100.0 million aggregate principal amount of Series A Senior Notes at a coupon rate of 5.12% due January 31, 2033 and $30.0 million aggregate principal amount of Series B Senior Notes at a coupon rate of 5.22% due January 31, 2038. GSWC used the proceeds to pay down intercompany borrowings with AWR and to fund operations and capital expenditures for GSWC. Interest is payable semiannually on January 31 and July 31 of each year. The Series A and Series B notes are unsecured and rank equally with GSWC's unsecured and unsubordinated debt. GSWC may, at its option, redeem all or portions of the notes at any time upon written notice, subject to payment of a make-whole premium based on 50 basis points above the applicable treasury yield. The make-whole premiums and covenant requirements under these new notes are similar to the terms of the other private placement notes issued by GSWC. Pursuant to the terms of each of these notes, GSWC must maintain a total indebtedness to capitalization ratio (as defined) of less than 0.6667-to-1 and a total indebtedness to earnings before income taxes, depreciation and amortization ("EBITDA") of less than 8-to-1. As of December 31, 2023, GSWC had a total indebtedness to capitalization ratio of 0.4956-to-1 and a total indebtedness to EBITDA of 3.4-to-1.

On April 28, 2022, BVES completed the issuance of $35.0 million in unsecured private-placement notes consisting of $17.5 million at a coupon rate of 4.548% due April 28, 2032 and $17.5 million at a coupon rate of 4.949% due April 28, 2037. BVES used the proceeds from the notes to pay down all amounts under its revolving credit facility outstanding at the time of issuing the notes. Interest on these notes is payable semiannually, and the covenant requirements under these notes are similar to the terms of BVES's revolving credit facility (Note 9).

Registrant's annual maturities of all long-term debt at December 31, 2023 are as follows (in thousands):

2024	$ 353
2025	370
2026	8,116
2027	403
2028	55,421
Thereafter	514,384
Total	$ 579,047

Note 11 — Taxes on Income

Registrant records deferred income taxes for temporary differences pursuant to the accounting guidance that addresses items recognized for income tax purposes in different periods than when they are reported in the financial statements. These items include differences in net asset basis (primarily related to differences in depreciation lives and methods, and differences in capitalization methods) and the treatment of certain regulatory balancing accounts, and construction contributions and advances. The accounting guidance for income taxes requires that rate-regulated enterprises record deferred income taxes and offsetting regulatory liabilities and assets for temporary differences where the rate regulator has prescribed flow-through treatment for rate-making purposes (Note 3). Deferred investment tax credits (“ITC”) are amortized ratably to deferred tax expense over the remaining lives of the property that gave rise to the credits.

GSWC is included in both AWR’s consolidated federal income tax and its combined California state franchise tax returns. The impact of California’s unitary apportionment on the amount of AWR’s California income tax liability is a function of both the profitability of AWR’s non-California activities and the proportion of AWR’s California sales to its total sales. GSWC’s income tax expense is computed as if GSWC were autonomous and separately files its income tax returns, which is consistent with the method adopted by the CPUC in setting GSWC’s customer rates.

On August 16, 2022, the Inflation Reduction Act of 2022 (“IRA”) was signed into federal law. IRA, among other things, imposes a nondeductible 1% excise tax after December 31, 2022 on the fair market value of certain stock that is “repurchased” by a publicly traded U.S. corporation or acquired by certain of its subsidiaries. The taxable amount is reduced by the fair market value of certain issuances of stock throughout the year. Registrant did not have a stock repurchase program in effect for 2023 and does not have current plans to institute such a program; consequently, this excise tax was not incurred in 2023 and is not expected to have a material impact on its consolidated financial position in the future. If average annual adjusted financial statement income exceeds $1 billion over a 3-taxable-year period, IRA also imposes a 15% corporate alternative minimum tax on adjusted financial statement income for taxable years beginning after December 31, 2022. Registrant does not expect to incur this tax in the foreseeable future.

The significant components of the deferred tax assets and liabilities as reflected in the balance sheets at December 31, 2023 and 2022 are:

	AWR		GSWC	
	December 31,		December 31,	
(dollars in thousands)	**2023**	**2022**	**2023**	**2022**
Deferred tax assets:				
Regulatory-liability-related (1)	$ 32,042	$ 31,330	$ 30,407	$ 29,623
Contributions and advances	6,660	6,544	6,981	6,896
Other	5,924	7,424	6,041	7,874
Total deferred tax assets	$ 44,626	$ 45,298	$ 43,429	$ 44,393
Deferred tax liabilities:				
Fixed assets	$ (161,820)	$ (155,955)	$ (155,131)	$ (150,133)
Regulatory-asset-related: depreciation and other	(36,337)	(30,226)	(33,242)	(28,489)
Balancing and memorandum accounts (non-flowed-through)	(8,046)	(8,794)	(2,514)	(4,559)
Total deferred tax liabilities	(206,203)	(194,975)	(190,887)	(183,181)
Accumulated deferred income taxes, net	$ (161,577)	$ (149,677)	$ (147,458)	$ (138,788)

(1) Primarily represents the gross-up portion of the deferred income tax (on the excess-deferred-tax regulatory liability) brought about by the Tax Cuts and Jobs Act's reduction of the federal income tax rate.

The current and deferred components of income tax expense are as follows:

(dollars in thousands)	AWR Year Ended December 31, 2023	2022	2021
Current			
Federal	$ 26,327	$ 14,845	$ 19,592
State	10,489	6,016	7,270
Total current tax expense	$ 36,816	$ 20,861	$ 26,862
Deferred			
Federal	$ 4,157	$ 2,991	$ 2,802
State	626	(188)	759
Total deferred tax (benefit) expense	4,783	2,803	3,561
Total income tax expense	$ 41,599	$ 23,664	$ 30,423

(dollars in thousands)	GSWC Year Ended December 31, 2023	2022	2021
Current			
Federal	$ 22,564	$ 10,582	$ 13,698
State	10,176	4,909	6,089
Total current tax expense	$ 32,740	$ 15,491	$ 19,787
Deferred			
Federal	$ 2,867	$ 1,507	$ 2,251
State	82	(652)	57
Total deferred tax (benefit) expense	2,949	855	2,308
Total income tax expense	$ 35,689	$ 16,346	$ 22,095

The reconciliations of the effective tax rates ("ETR") to the federal statutory rate are as follows:

(dollars in thousands)	AWR Year Ended December 31, 2023	2022	2021
Federal taxes on pretax income at statutory rate	$ 34,969	$ 21,433	$ 26,202
Increase (decrease) in taxes resulting from:			
State income tax, net of federal benefit	9,785	4,335	6,425
Excess deferred tax amortization	(1,648)	(1,311)	(1,356)
Flow-through on fixed assets	1,067	1,076	1,069
Flow-through on removal costs	(2,255)	(1,802)	(1,962)
Investment tax credit	(71)	(71)	(71)
Other – net	(248)	4	116
Total income tax expense from operations	$ 41,599	$ 23,664	$ 30,423
Pretax income from operations	$ 166,520	$ 102,060	$ 124,770
Effective income tax rate	25.0 %	23.2 %	24.4 %

(dollars in thousands)	GSWC Year Ended December 31, 2023	2022	2021
Federal taxes on pretax income at statutory rate	$ 29,063	$ 14,724	$ 19,175
Increase (decrease) in taxes resulting from:			
State income tax, net of federal benefit	9,169	3,119	4,923
Excess deferred tax amortization	(1,681)	(1,130)	(1,184)
Flow-through on fixed assets	1,041	1,010	1,008
Flow-through on removal costs	(2,225)	(1,715)	(1,954)
Investment tax credit	(71)	(71)	(71)
Other – net	393	409	198
Total income tax expense from operations	$ 35,689	$ 16,346	$ 22,095
Pretax income from operations	$ 138,397	$ 70,116	$ 91,310
Effective income tax rate	25.8 %	23.3 %	24.2 %

The AWR and GSWC ETRs differ from the federal corporate statutory tax rate of 21% primarily due to (i) state taxes; (ii) permanent differences, including certain tax effects from stock compensation; (iii) the ongoing amortization of the excess deferred income tax liability; and (iv) differences between book and taxable income that are treated as flowed-through adjustments in accordance with regulatory requirements (principally from plant, rate-case, and compensation-related items). As regulated utilities, GSWC and BVES treat certain temporary differences as being flowed through to customers in computing their income tax expense consistent with the income tax method used in their CPUC-jurisdiction rate making. Flowed-through items either increase or decrease tax expense and thus impact the ETR.

AWR and GSWC had no unrecognized tax benefits at December 31, 2023, 2022 and 2021.

Registrant's policy is to classify interest on income tax over/underpayments in interest income/expense and penalties in "other" expenses. Registrant did not have any material interest receivables/payables from/to taxing authorities as of December 31, 2023 and 2022, nor did it recognize any material interest income/expense or accrue any material tax-related penalties during the years ended December 31, 2023, 2022 and 2021.

Registrant files federal, California and various other state income tax returns. AWR's 2020–2022 tax years remain subject to examination/assessment by the Internal Revenue Service. AWR filed refund claims with the California Franchise Tax Board ("FTB") for the 2005 through 2020 tax years in connection with prior federal refund claims, other state issues, or both, and the FTB continues to review the claims. While the statute of limitations to assess tax has closed through the tax year 2018, the 2019–2022 tax years remain subject to examination/assessment by the FTB.

Note 12 — Employee Benefit Plans

Pension and Post-Retirement Medical Plans:

Registrant maintains a defined benefit pension plan (the "Pension Plan") that provides eligible employees (those aged 21 and older, hired before January 1, 2011) monthly benefits upon retirement based on average salaries and length of service. The eligibility requirement to begin receiving these benefits is 5 years of vested service. The normal retirement benefit is equal to 2% of the 5 highest consecutive years' average earnings multiplied by the number of years of credited service, up to a maximum of 40, reduced by a percentage of primary Social Security benefits. There is also an early retirement option. Annual contributions are made to the Pension Plan, which comply with the funding requirements of the Employee Retirement Income Security Act ("ERISA"). At December 31, 2023, Registrant had 903 participants in the Pension Plan.

Employees hired or rehired after December 31, 2010 are eligible to participate in a defined contribution plan. Registrant's existing 401(k) Investment Incentive Program was amended to include this defined contribution plan. Under this plan, Registrant provides a contribution ranging from 3% to 5.25% of eligible pay each pay period into investment vehicles offered by the plan's trustee. Full vesting under this plan occurs upon 3 years of service. Employees hired before January 1, 2011 continue to participate in and accrue benefits under the terms of the Pension Plan.

Registrant also provides post-retirement medical benefits for all active employees hired before February of 1995 through a medical insurance plan. Eligible employees, who retire prior to age 65, and/or their spouses, are able to retain the benefits under the plan for active employees until reaching age 65. Eligible employees upon reaching age 65, and those eligible employees retiring at or after age 65, and/or their spouses, receive coverage through a Medicare supplement insurance policy paid for by Registrant subject to an annual cap limit. Registrant's post-retirement medical plan does not provide prescription drug benefits to Medicare-eligible employees and is not affected by the Medicare Prescription Drug Improvement and Modernization Act of 2003.

In accordance with the accounting guidance for the effects of certain types of regulation, Registrant has established a regulatory asset or liability for its underfunded or overfunded position, respectively, in its pension and post-retirement medical plans that is expected to be recovered through rates in future periods. The changes in actuarial gains and losses, prior service costs and transition assets or obligations are tracked and recognized as an adjustment to the regulatory account as these amounts are recognized as components of net periodic pension cost each year and in the rate-making process.

The following table sets forth the Pension Plan's and post-retirement medical plan's funded status and amounts recognized in Registrant's balance sheets and the components of net pension cost and accrued liability at December 31, 2023 and 2022:

	Pension Benefits		Post-Retirement Medical Benefits	
(dollars in thousands)	**2023**	**2022**	**2023**	**2022**
Change in Projected Benefit Obligation:				
Projected benefit obligation at beginning of year	$ 190,678	$ 259,751	$ 2,014	$ 2,686
Service cost	3,196	5,644	130	129
Interest cost	10,142	7,401	106	60
Actuarial (gain) loss	8,525	(72,710)	49	(570)
Benefits/expenses paid	(9,578)	(9,408)	(334)	(291)
Projected benefit obligation at end of year	$ 202,963	$ 190,678	$ 1,965	$ 2,014
Changes in Plan Assets:				
Fair value of plan assets at beginning of year	$ 186,906	$ 233,524	$ 11,240	$ 13,773
Actual return on plan assets	25,031	(40,299)	1,921	(2,242)
Employer contributions	2,946	3,089	265	263
Benefits/expenses paid	(9,578)	(9,408)	(599)	(554)
Fair value of plan assets at end of year	$ 205,305	$ 186,906	$ 12,827	$ 11,240
Funded Status:				
Overfunded/(underfunded) amount recognized	$ 2,342	$ (3,772)	$ 10,862	$ 9,226

The change in the underfunded status of the pension was due to an increase in plan asset performance, partially offset by a decrease in the discount rate, which decreased from 5.41% as of December 31, 2022 to 5.16% as of December 31, 2023.

(dollars in thousands)	Pension Benefits 2023	Pension Benefits 2022	Post-Retirement Medical Benefits 2023	Post-Retirement Medical Benefits 2022
Amounts recognized on the balance sheets:				
Non-current assets	$ 2,342	$ —	$ 10,862	$ 9,226
Current liabilities	—	—	—	—
Non-current liabilities	—	(3,772)	—	—
Net amount recognized	$ 2,342	$ (3,772)	$ 10,862	$ 9,226
Amounts recognized in regulatory assets (liabilities) consist of:				
Prior service cost (credit)	$ 1,454	$ 1,889	$ —	$ —
Net loss (gain)	(1,899)	4,123	(6,272)	(5,846)
Regulatory assets (liabilities)	(445)	6,012	(6,272)	(5,846)
Prefunded plan costs	(1,897)	(2,240)	(4,590)	(3,380)
Net liability (asset) recognized	$ (2,342)	$ 3,772	$ (10,862)	$ (9,226)
Changes in plan assets and benefit obligations recognized in regulatory assets (liabilities):				
Regulatory asset (liability) at beginning of year	$ 6,012	$ 25,691	$ (5,846)	$ (9,839)
Net (loss) gain	(6,023)	(19,245)	(1,395)	2,259
New prior service cost	—	—	—	—
Amortization of prior service (cost) credit	(434)	(434)	—	—
Amortization of net gain (loss)	—	—	969	1,734
Total change in regulatory asset (liability)	(6,457)	(19,679)	(426)	3,993
Regulatory asset (liability) at end of year	$ (445)	$ 6,012	$ (6,272)	$ (5,846)
Net periodic pension costs	$ 3,289	$ 313	$ (1,210)	$ (2,132)
Change in regulatory asset (liability)	(6,457)	(19,679)	(426)	3,993
Total recognized in net periodic pension cost and regulatory asset (liability)	$ (3,168)	$ (19,366)	$ (1,636)	$ 1,861
Additional year-end information for plans with an accumulated benefit obligation in excess of plan assets:				
Projected benefit obligation	$ 202,963	$ 190,678	$ 1,965	$ 2,014
Accumulated benefit obligation	$ 192,986	$ 181,376	N/A	N/A
Fair value of plan assets	$ 205,305	$ 186,906	$ 12,827	$ 11,240
Weighted-average assumptions used to determine benefit obligations at December 31:				
Discount rate	5.16 %	5.41 %	5.04 %	5.34 %
Rate of compensation increase	*	*	N/A	N/A

- Age-graded ranging from 2.5% to 7.0%.

The components of net periodic pension and post-retirement benefits cost, before allocation to the overhead pool, for 2023, 2022 and 2021 are as follows:

	Pension Benefits			Post-Retirement Medical Benefits		
(dollars in thousands, except percent)	**2023**	**2022**	**2021**	**2023**	**2022**	**2021**
Components of Net Periodic Benefits Cost:						
Service cost	$3,196	$5,644	$6,316	$130	$129	$149
Interest cost	10,142	7,401	6,833	106	60	110
Expected return on plan assets	(10,483)	(13,166)	(12,541)	(477)	(587)	(537)
Amortization of prior service cost (credit)	434	434	434	—	—	—
Amortization of actuarial (gain) loss	—	—	3,817	(969)	(1,734)	(1,417)
Net periodic pension cost under accounting standards	$3,289	$313	$4,859	$(1,210)	$(2,132)	$(1,695)
Regulatory adjustment	(281)	—	(1,277)	—	—	—
Total expense recognized, before surcharges and allocation to overhead pool	$3,008	$313	$3,582	$(1,210)	$(2,132)	$(1,695)
Weighted-average assumptions used to determine net periodic cost:						
Discount rate	5.41 %	2.89 %	2.55 %	5.34 %	2.46 %	2.20 %
Expected long-term return on plan assets	5.75 %	5.75 %	6.00 %	*	*	*
Rate of compensation increase	**	**	**	N/A	N/A	N/A

*5.50% for union plan and 3.9% for non-union (net of income taxes) in 2023 and 2022 and 5.75% for union plan and 4.0% for non-union (net of income taxes) in 2021.

** Age-graded ranging from 2.5% to 7.0%.

Regulatory Adjustment:

The CPUC authorized GSWC and BVES to track differences between the forecasted annual pension expenses adopted in rates and the actual annual expenses to be recorded in accordance with the accounting guidance for pension costs in a two-way pension balancing account. During the years ended December 31, 2023 and 2021, GSWC's actual pension expense was higher than the amounts included in water customer rates by $281,000 and $1.3 million, respectively. During the year ended December 31, 2022, GSWC's actual expense was lower than the amounts included in water customer rates by $1.5 million and recorded as a reduction to water revenues. The cumulative amount recorded in GSWC's two-way pension balancing account is included within the pensions and other post-retirement obligations regulatory asset discussed in Note 3. During the years ended December 31, 2023, 2022 and 2021, BVES's actual expense was lower than the amounts included in electric rates by $270,000, $490,000 and $246,000, respectively. These over-collections were recorded as a reduction to electric revenues.

Plan Funded Status:

The Pension Plan was overfunded and underfunded at December 31, 2023 and 2022, respectively. Registrant's market related value of plan assets is equal to the fair value of plan assets. Past volatile market conditions have affected and continue to affect the value of GSWC's trust established to fund its future long-term pension benefits. These benefit plan assets and related obligations are measured annually using a December 31 measurement date. Changes in the Pension Plan's funded status will affect the assets and liabilities recorded on the balance sheet in accordance with accounting guidance on employers' accounting for defined benefit pension and other post-retirement plans. Due to Registrant's regulatory recovery treatment, the recognition of the under or overfunded status for the Pension Plan has been offset by a regulatory asset or liability, respectively, pursuant to guidance on the accounting for the effects of certain types of regulation.

Plan Assets:

The assets of the pension and post-retirement medical plans are managed by a third party trustee. The investment policy allocation of the assets in the trust was approved by Registrant's Administrative Committee (the "Committee") for the pension and post-retirement medical funds, which has oversight responsibility for all retirement plans. The primary objectives underlying the investment of the pension and post-retirement plan assets are: (i) attempt to maintain a fully funded status with a cushion for unexpected developments, possible future increases in expense levels and/or a reduction in the expected return on investments; (ii) seek to earn long-term returns that compare favorably to appropriate market indexes, peer group universes and the policy asset allocation index; (iii) seek to provide sufficient liquidity to pay current benefits and expenses; (iv) attempt to limit risk exposure through prudent diversification; and (v) seek to limit costs of administering and managing the plans.

The Committee recognizes that risk and volatility are present to some degree with all types of investments. High levels of risk may be avoided through diversification by asset class, style of each investment manager and sector and industry limits. Investment managers are retained to manage a pool of assets and allocate funds in order to achieve an appropriate, diversified and balanced asset mix. The Committee's strategy balances the requirement to maximize returns using potentially higher-return generating assets, such as equity securities, with the need to control the risk of its benefit obligations with less volatile assets, such as fixed-income securities.

The Committee approves the target asset allocations. Registrant's pension and post-retirement plan weighted-average asset allocations at December 31, 2023 and 2022, by asset category are as follows:

	Pension Benefits		Post-Retirement Medical Benefits	
Asset Category	**2023**	**2022**	**2023**	**2022**
Actual Asset Allocations:				
Equity securities	56 %	56 %	60 %	59 %
Debt securities	39 %	39 %	39 %	39 %
Real Estate Funds	5 %	5 %	— %	— %
Cash equivalents	— %	— %	1 %	2 %
Total	100 %	100 %	100 %	100 %

Equity securities did not include AWR's Common Shares as of December 31, 2023 and 2022.

Target Asset Allocations:	Pension Benefits	Post-retirement Medical Benefits
Equity securities	60 %	60 %
Debt securities	40 %	40 %
Total	100 %	100 %

The Pension Plan assets are in collective trust funds managed by a management firm appointed by the Committee. The fair value of these collective trust funds is measured using net asset value per share. In accordance with ASU 2015-07 *Disclosures for Investments in Certain Entities that Calculate Net Asset Value per Share (or Its Equivalents)*, the fair value of the collective trust funds is not categorized in the fair value hierarchy as of December 31, 2023 and 2022.

The following tables set forth the fair value, measured by net asset value, of the pension investment assets as of December 31, 2023 and 2022:

	Net Asset Value as of December 31, 2023			
(dollars in thousands)	Fair Value	Unfunded Commitments	Redemption Frequency	Redemption Notice Period
Cash equivalents	$ 814	—	N/A	N/A
Fixed income fund	80,737	—	Daily	Daily
Equity securities:				
U.S. small/mid cap funds	19,162	—	Daily	Daily
U.S. large cap funds	49,770	—	Daily	Daily
International funds	45,377	—	Daily	Daily
Total equity funds	114,309	—		
Real estate funds	9,445	—	Daily	Daily
Total	$ 205,305	—		

(dollars in thousands)	Net Asset Value as of December 31, 2022 Fair Value	Unfunded Commitments	Redemption Frequency	Redemption Notice Period
Cash equivalents	$ 801	—	N/A	N/A
Fixed income fund	73,863	—	Daily	Daily
Equity securities:				
U.S. small/mid cap funds	17,136	—	Daily	Daily
U.S. large cap funds	44,572	—	Daily	Daily
International funds	42,239	—	Daily	Daily
Total equity funds	103,947			
Real estate funds	8,295	—	Daily	Daily
Total	$ 186,906	—		

The collective trust funds may be invested or redeemed daily, and generally do not have any significant restrictions to redeem the investments.

As previously discussed in Note 1, the accounting guidance for fair value measurements establishes a framework for measuring fair value and requires fair value measurements to be classified and disclosed in one of three levels. As required by the accounting guidance, assets and liabilities are classified in their entirety based on the lowest level of input that is significant to the fair value measurement. All equity investments in the post-retirement medical plan are Level 1 investments in mutual funds. The fixed income category includes corporate bonds and notes. The majority of fixed income investments range in maturities from less than 1 to 20 years. The fair values of these investments are based on quoted market prices in active markets.

The following tables set forth by level, within the fair value hierarchy, the post-retirement plan's investment assets measured at fair value as of December 31, 2023 and 2022:

(dollars in thousands)	Fair Value as of December 31, 2023 Level 1	Level 2	Level 3	Total
Fair Value of Post-Retirement Plan Assets:				
Cash equivalents	$ 189	—	—	$ 189
Fixed income	5,001	—	—	5,001
U.S. equity securities	7,637	—	—	7,637
Total investments measured at fair value	$ 12,827	—	—	$ 12,827

(dollars in thousands)	Fair Value as of December 31, 2022 Level 1	Level 2	Level 3	Total
Fair Value of Post-Retirement Plan Assets:				
Cash equivalents	$ 215	—	—	$ 215
Fixed income	4,380	—	—	4,380
U.S. equity securities	6,645	—	—	6,645
Total investments measured at fair value	$ 11,240	—	—	$ 11,240

Plan Contributions:

During 2023, Registrant contributed $2.9 million to its pension plan and did not make a contribution to the post-retirement medical plan. Registrant expects to contribute approximately $3.3 million to its pension plan in 2024. Registrant's policy is to fund the plans annually at a level which is deductible for income tax purposes and is consistent with amounts recovered in customer rates while also complying with ERISA's funding requirements.

Benefit Payments:

Estimated future benefit payments at December 31, 2023 are as follows (in thousands):

	Pension Benefits	Post-Retirement Medical Benefits
2024	$ 10,604	$ 295
2025	11,089	279
2026	11,539	276
2027	12,075	252
2028	12,568	226
Thereafter	70,006	713
Total	$ 127,881	$ 2,041

Assumptions:

Certain actuarial assumptions, such as the discount rate, long-term rate of return on plan assets, mortality, and the healthcare cost trend rate have a significant effect on the amounts reported for net periodic benefit cost as well as the related benefit obligation amounts.

Discount Rate — The assumed discount rate for pension and post-retirement medical plans reflects the market rates for high-quality corporate bonds currently available. Registrant's discount rates were determined by considering the average of pension yield curves constructed of a large population of high quality corporate bonds. The resulting discount rate reflects the matching of plan liability cash flows to the yield curves.

Expected Long-Term Rate of Return on Assets — The long-term rate of return on plan assets represents an estimate of long-term returns on an investment portfolio consisting of a mixture of equities, fixed income and other investments. To develop the expected long-term rate of return on assets assumption for the pension plan, Registrant considered the historical returns and the future expectations for returns for each asset class, as well as the target asset allocation of the pension portfolio. Registrant's policy is to fund the medical benefit trusts based on actuarially determined amounts as allowed in rates approved by the CPUC. Registrant has invested the funds in the post-retirement trusts that are intended to achieve a desired return and minimize amounts necessary to recover through rates. The mix is expected to provide for a return on assets similar to the Pension Plan and to achieve Registrant's targeted allocation. This resulted in the selection of the 5.50% long-term rate of return on assets assumption for the union plan and 3.9% (net of income taxes) for the non-union plan portion of the post-retirement plan.

Mortality — Mortality assumptions are a critical component of benefit obligation amounts and a key factor in determining the expected length of time for annuity payments. Registrant uses the latest mortality tables published by the Society of Actuaries. Accordingly, the benefit obligation amounts as of December 31, 2023 and 2022 have incorporated recent updates to the mortality tables.

Healthcare Cost Trend Rate **—** The assumed health care cost trend rate for 2024 starts at 5.9% grading down to 4.0% in 2047 for those under age 65, and at 6.3% grading down to 4.0% in 2047 for those 65 and over. Assumed health care cost trend rates have a significant effect on the amounts reported for the health care plans.

***Supplemental Executive Retirement Plan*:**

Registrant has a supplemental executive retirement plan ("SERP") that is intended to restore retirement benefits to certain key employees and officers of Registrant that are limited by Sections 415 and 401(a)(17) of the Internal Revenue Code of 1986, as amended. The Board of Directors approved the establishment of a Rabbi Trust created for the SERP. Assets in a Rabbi Trust can be subject to the claims of creditors; therefore, they are not considered as an asset for purposes of computing the SERP's funded status. As of December 31, 2023, the balance in the Rabbi Trust totaled $34.1 million and is included in Registrant's other property and investments.

All equity investments in the Rabbi Trust are Level 1 (as defined in Note 1) investments in mutual funds. The fixed income category includes corporate bonds and notes. The fair values of these investments are based on quoted market prices in active markets.

The following tables set forth by level, within the fair value hierarchy, the Rabbi Trust investment assets measured at fair value as of December 31, 2023 and 2022:

	Fair Value as of December 31, 2023			
(dollars in thousands)	**Level 1**	**Level 2**	**Level 3**	**Total**
Fair Value of Assets held in Rabbi Trust:				
Cash equivalents	$ 6	—	—	$ 6
Fixed income securities	13,676	—	—	13,676
Equity securities	20,461	—	—	20,461
Total investments measured at fair value	$ 34,143	—	—	$ 34,143

	Fair Value as of December 31, 2022			
(dollars in thousands)	**Level 1**	**Level 2**	**Level 3**	**Total**
Fair Value of Assets held in Rabbi Trust:				
Cash equivalents	$ 9	—	—	$ 9
Fixed income securities	10,962	—	—	10,962
Equity securities	16,560	—	—	16,560
Total investments measured at fair value	$ 27,531	—	—	$ 27,531

The following provides a reconciliation of benefit obligations, funded status of the SERP, as well as a summary of significant estimates at December 31, 2023 and 2022:

(dollars in thousands)	**2023**	**2022**
Change in Benefit Obligation:		
Benefit obligation at beginning of year	$ 30,807	$ 36,089
Service cost	1,248	1,191
Interest cost	1,644	1,022
Actuarial loss (gain)	840	(6,522)
Benefits paid	(945)	(973)
Benefit obligation at end of year	$ 33,594	$ 30,807
Changes in Plan Assets:		
Fair value of plan assets at beginning and end of year	—	—
Funded Status:		
Net amount recognized as accrued cost	$ (33,594)	$ (30,807)

(in thousands)	2023	2022
Amounts recognized on the balance sheets:		
Current liabilities	$ (942)	$ (942)
Non-current liabilities	(32,652)	(29,865)
Net amount recognized	$ (33,594)	$ (30,807)
Amounts recognized in regulatory assets consist of:		
Prior service cost	$ —	$ —
Net loss	2,869	1,995
Regulatory assets	2,869	1,995
Unfunded accrued cost	30,725	28,812
Net liability recognized	$ 33,594	$ 30,807
Changes in plan assets and benefit obligations recognized in regulatory assets consist of:		
Regulatory asset at beginning of year	$ 1,995	$ 9,097
Net gain (loss)	840	(6,522)
Amortization of prior service credit	—	—
Amortization of net gain (loss)	34	(580)
Total change in regulatory asset	874	(7,102)
Regulatory asset at end of year	$ 2,869	$ 1,995
Net periodic pension cost	$ 2,858	$ 2,793
Change in regulatory asset	874	(7,102)
Total recognized in net periodic pension and regulatory asset	$ 3,732	$ (4,309)
Additional year-end information for plans with an accumulated benefit obligation in excess of plan assets:		
Projected benefit obligation	$ 33,594	$ 30,807
Accumulated benefit obligation	30,794	28,157
Fair value of plan assets	—	—
Weighted-average assumptions used to determine benefit obligations:		
Discount rate	5.15 %	5.42 %
Rate of compensation increase	*	*

* Age graded from 4.0% to 5.5% per year.

The components of SERP expense, before allocation to the overhead pool, for 2023, 2022 and 2021 are as follows:

(dollars in thousands, except percent)	2023	2022	2021
Components of Net Periodic Benefits Cost:			
Service cost	$ 1,248	$ 1,191	$ 1,392
Interest cost	1,644	1,022	915
Amortization of net (gain) loss	(34)	580	1,678
Net periodic pension cost	$ 2,858	$ 2,793	$ 3,985
Weighted-average assumptions used to determine net periodic cost:			
Discount rate	5.42 %	2.87 %	2.52 %
Rate of compensation increase	*	*	*

* Age graded from 4.0% to 5.5% per year.

Benefit Payments: Estimated future benefit payments for the SERP at December 31, 2023 are as follows (in thousands):

2024	$	942
2025		2,344
2026		2,519
2027		2,630
2028		2,604
Thereafter		13,551
Total	$	24,590

401(k) Investment Incentive Program:

Registrant has a 401(k) Investment Incentive Program under which employees may invest a percentage of their pay, up to a maximum investment prescribed by law, in an investment program managed by an outside investment manager. Registrant's cash contributions to the 401(k) are based upon a percentage of individual employee contributions and for the years ended December 31, 2023, 2022 and 2021 were $2.9 million, $2.7 million and $2.7 million, respectively. The Investment Incentive Program also incorporates the defined contribution plan for employees hired on or after January 1, 2011. The cash contributions to the defined contribution plan for the years ended December 31, 2023, 2022 and 2021 were $2.2 million, $2.0 million and $1.9 million, respectively.

Note 13 — Stock-Based Compensation Plans

Summary Description of Stock Incentive Plans

As of December 31, 2023, AWR had three stock incentive plans: the 2016 stock incentive plan for its employees, and the 2003 and 2023 non-employee directors plans for its Board of Directors, each more fully described below.

2016 Employee Plans — AWR adopted this employee plan, following shareholder approval, to provide stock-based incentive awards in the form of restricted stock units, stock options and restricted stock to employees as a means of promoting the success of Registrant by attracting, retaining and more fully aligning the interests of employees with those of customers and shareholders. The 2016 employee plan also provides for the grant of performance awards. There are no stock options or restricted stock grants currently outstanding. For restricted stock unit awards, the Compensation Committee determines the specific terms, conditions and provisions relating to each restricted stock unit. Each employee who has been granted a time-vested restricted stock unit is entitled to dividend equivalent rights in the form of additional restricted stock units until vesting of the time-vested restricted stock units. In general, time-vested restricted stock units vest over a period of three years. Restricted stock units may also vest upon retirement if the grantee is at least 55 and the sum of the grantee's age and years of service are equal to or greater than 75, or upon death or total disability. In addition, restricted stock units may vest following a change in control if the applicable subsidiary of AWR terminates the grantee other than for cause or the employee terminates employment for good reason. Each restricted stock unit is non-voting and entitles the holder of the restricted stock unit to receive one Common Share.

The Compensation Committee also has the authority to determine the number, amount or value of performance awards, the duration of the performance period or performance periods applicable to the award and the performance criteria applicable to each performance award for each performance period. Each outstanding performance award granted by the Compensation Committee has been in the form of restricted stock units that generally vest over a period of three years as provided in the performance award agreement. The amount of the performance award paid to an employee depends upon satisfaction of performance criteria following the end of a three-year performance period. Performance awards may also vest and be payable upon retirement if the grantee is at least 55 and the sum of the grantee's age and years of service are equal to or greater than 75, or upon death or total disability. In addition, performance awards may vest following a change in control if the applicable subsidiary of AWR terminates the grantee other than for cause or the employee terminates employment for good reason. The amount of the payment for performance awards granted will be at target in the event of death or a termination of employment (other than for cause) by the applicable subsidiary of AWR or termination by the employee for good reason within 24 months after a change in control. In all other circumstances, adjustments will be made to the amount of the payment to take into account the shortened performance period.

2003 and 2023 Directors Plans — The Board of Directors and shareholders of AWR have approved the 2003 and 2023 directors plans in order to provide the non-employee directors with supplemental stock-based compensation to encourage them to increase their stock ownership in AWR. New grants may not be made under the 2003 directors plan. Under the 2023 non-employee directors plan, non-employee directors are entitled to receive restricted stock units in an amount determined by the Board of Directors prior to the meeting; provided that, in no event may that amount be equal to more than two times the then current annual retainer for services as a director divided by the fair market value of AWR's Common Shares on the date preceding the annual meeting. Such units are convertible into AWR's Common Shares 90 days after the grant date.

All non-employee directors of AWR who were directors of AWR at the 2003 annual meeting have also received restricted stock units, which will be distributed upon termination of the director's service as a director.

All restricted stock units and performance awards have been granted with dividend equivalent rights payable in the form of additional restricted stock units.

Recognition of Compensation Expense

Registrant recognizes compensation expense related to the fair value of stock-based compensation awards. Share-based compensation cost is measured at the grant date, based on the calculated fair value of the award, and is recognized as an expense over the employee's requisite service period (generally the vesting period of the equity grant). Immediate vesting occurs if the employee is at least 55 years old and the sum of the employee's age and years of employment is equal to or greater than 75. Registrant assumes that pre-vesting forfeitures will be minimal, and recognizes pre-vesting forfeitures as they occur, which results in a reduction in compensation expense.

The following table presents share-based compensation expenses for the years ended December 31, 2023, 2022 and 2021. These expenses resulting from restricted stock units, including performance awards, are included in administrative and general expenses in AWR's and GSWC's statements of income:

	AWR			GSWC		
	For The Years Ended December 31,			For The Years Ended December 31,		
(in thousands)	2023	2022	2021	2023	2022	2021
Stock-based compensation related to:						
Restricted stock units	$ 3,298	$ 2,571	$ 2,566	$ 2,994	$ 2,269	$ 2,313
Total stock-based compensation expense	$ 3,298	$ 2,571	$ 2,566	$ 2,994	$ 2,269	$ 2,313

Equity-based compensation cost capitalized as part of utility plant for the years ended December 31, 2023, 2022 and 2021 was approximately $450,000, $290,000 and $336,000, respectively, for both AWR and GSWC. For the years ended December 31, 2023, 2022 and 2021, approximately $750,000, $900,000 and $1.4 million, respectively, of tax benefits from stock-based awards were recorded for both AWR and GSWC.

Registrant amortizes stock-based compensation over the requisite (vesting) period for the entire award. Time-vesting restricted stock units vest and become non-forfeitable in installments of 33% the first two years and 34% in the third year, starting one year from the date of the grant. Outstanding performance awards vest and become non-forfeitable in installments of 33% the first two years and 34% in the third year and are distributed at the end of the performance period to the extent that the Compensation Committee determines that the performance criteria set forth in the award agreement have been satisfied.

Restricted Stock Units (Time-Vested) — A restricted stock unit ("RSU") represents the right to receive a share of AWR's Common Shares and are valued based on the fair market value of AWR's Common Shares on the date of grant. The fair value of RSUs were determined based on the closing trading price of Common Shares on the grant date. A summary of the status of Registrant's outstanding RSUs, excluding performance awards, to employees and directors as of December 31, 2023, and changes during the year ended December 31, 2023, is presented below:

	Number of Restricted Share Units	Weighted Average Grant-Date Value
Restricted share units at January 1, 2023	47,552	$ 49.01
Granted	19,837	94.71
Vested	(16,574)	87.28
Forfeited	(488)	92.84
Restricted share units at December 31, 2023	50,327	$ 54.00

As of December 31, 2023, there was approximately $622,000 of total unrecognized compensation cost related to time-vested restricted stock units granted under AWR's employee stock plans. That cost is expected to be recognized over a weighted average period of 1.53 years.

Restricted Stock Units (Performance Awards) – During the years ended December 31, 2023, 2022 and 2021, the Compensation Committee granted performance awards in the form of restricted stock units to officers of Registrant. A performance award represents the right to receive a share of AWR's Common Shares if the Compensation Committee determines that specified performance goals have been met over the performance period specified in the grant (generally three years). Each grantee of any outstanding performance award may earn between 0% and up to 200% or 250% of the target amount, which varies depending on the target and Registrant's performance against performance goals, which are determined by the Compensation Committee on the date of grant. As determined by the Compensation Committee, the performance awards granted during the years ended December 31, 2023, 2022 and 2021 included various performance-based conditions and one market-based condition related to total shareholder return ("TSR") that will be earned based on Registrant's TSR compared to the TSR for a specific peer group of investor-owned water companies.

A summary of the status of Registrant's outstanding performance awards to officers as of December 31, 2023, and changes during the year ended December 31, 2023, is presented below:

	Number of Performance awards	Weighted Average Grant-Date Value
Performance awards at January 1, 2023	49,435	$ 83.70
Granted	19,696	96.04
Performance criteria adjustment	8,321	91.73
Vested	(12,095)	89.59
Performance awards at December 31, 2023	65,357	$ 87.35

A portion of the fair value of performance awards was estimated at the grant date based on the probability of satisfying the market-based condition using a Monte-Carlo simulation model, which assesses the probabilities of various outcomes of the market condition. The portion of the fair value of the performance awards associated with performance-based conditions was based on the fair market value of AWR's Common Shares at the grant date. The fair value of each outstanding performance award grant is amortized into compensation expense in installments of 33% the first two years and 34% in the third year of their respective vesting periods, which is generally over 3 years unless earlier vested pursuant to the terms of the agreement. The accrual of compensation costs is based on the estimate of the final expected value of the award and is adjusted as required for the portion based on the performance-based condition. Unlike the awards with performance-based conditions, for the portion based on the market-based condition, compensation cost is recognized, and not reversed, even if the market condition is not achieved, as required by the accounting guidance for share-based awards. As of December 31, 2023, $272,000 of unrecognized compensation costs related to performance awards is expected to be recognized over a weighted average period of 1.50 years.

Note 14 - Commitments

GSWC's Water Supply:

GSWC has contracts to purchase water or water rights for an aggregate amount of $2.7 million as of December 31, 2023. Included in the $2.7 million is a commitment of $1.3 million to use water rights from a third party under an agreement, which expires in 2028. The remaining $1.4 million is for commitments for purchased water with other third parties, which expire from 2025 through 2038.

GSWC's estimated future minimum payments under these purchased water supply commitments at December 31, 2023 are as follows (in thousands):

2024	$ 491
2025	441
2026	391
2027	391
2028	213
Thereafter	805
Total	$ 2,732

***BVES Commitments*:**

Purchase Power Contracts:

BVES had entered into long-term, fixed-price contracts to purchase power over three- and five-year terms. These long-term contracts will expire during the fourth quarter of 2024. In July 2023, the CPUC approved a new power purchase agreement between BVES and a third party to procure renewable portfolio standard ("RPS") eligible energy and renewable energy credits as a bundled product. BVES will begin taking power under this long-term contract during the fourth quarter of 2024 to replace the existing expiring contracts. The new contract provides for the purchase of electricity during a delivery period from November 1, 2024 through December 31, 2035. As of December 31, 2023, BVES has power purchase commitments under these contracts that totals $45.8 million.

Renewables Portfolio Standard:

BVES is subject to the renewables portfolio standard law, which requires BVES to meet certain targets for purchases of energy from qualified renewable energy resources. BVES had an agreement with a third party to purchase RECs whereby BVES agreed to purchase approximately 578,000 RECs over a ten-year period through 2023, which has been used towards BVES meeting California's RPS requirements. On January 18, 2023, BVES filed a compliance report with the CPUC that covered pre-2023 compliance period, which did not reflect any RPS procurement deficiencies.

BVES executed a contract in July 2023 with a third party to procure RPS eligible energy and RECs as a bundled product. The RECs under this agreement will be delivered following the year in which energy is purchased. BVES has agreed to purchase approximately 587,000 RECs over the eleven-year term of the contract. In addition, BVES has executed additional REC purchase agreements that delivered in 2023 a total of 30,000 RECs with an additional 15,000 RECs delivered in January 2024. As of December 31, 2023, BVES believes that it has purchased sufficient RECs to be in compliance through 2024 and management does not believe any provision for loss or potential penalties is required as of December 31, 2023. The cost of RECS are recorded to the electric supply cost balancing account when retired. BVES has commitments for RECs under contracts totaling $9.0 million as of December 31, 2023.

See Note 16 for Registrant's future minimum payments under long-term non-cancelable operating leases.

Note 15 - Contingencies

***Environmental Clean-Up and Remediation at GSWC*:**

GSWC has been involved in environmental remediation and cleanup at one of its plant sites that contained an underground storage tank, which was used to store gasoline for its vehicles. This tank was removed from the ground in July 1990 along with the dispenser and ancillary piping. Since then, GSWC has been involved in various remediation activities at this site.

As of December 31, 2023, the total spent to clean-up and remediate the plant site was approximately $6.3 million, of which $1.5 million has been paid by the State of California Underground Storage Tank Fund. Amounts paid by GSWC have been included in rate base and approved by the CPUC for recovery. As of December 31, 2023, GSWC has a regulatory asset and an accrued liability for the estimated remaining cost of $1.3 million to complete the cleanup at the site. The estimate includes costs for continued activities of groundwater cleanup and monitoring, future soil treatment and site-closure-related activities. The ultimate cost may vary as there are many unknowns in remediation of underground gasoline spills and this is an estimate based on currently available information. Management believes it is probable that the estimated additional costs will continue to be approved in rate base by the CPUC.

Contracted Services:

Most of ASUS's contract services are provided to the U.S. government pursuant to the terms of the initial 50-year, firm-fixed-price contracts and additional firm-fixed-price contracts subject to annual economic price adjustments. ASUS's subsidiaries also, from time to time, performs construction services on military bases as a subcontractor or pursuant to a task order agreement. Entering into contracts with the U.S. government subjects ASUS and its subsidiaries to potential government audits or investigations of its business practices and compliance with government procurement statutes and regulations. ASUS had been under a civil government investigation over bidding and estimating practices used in certain capital upgrade projects. In July 2023, ASUS and the U.S. government entered into an agreement that settled civil and monetary claims by the U.S. government. This settlement did not have a material impact on Registrant's financial statements.

***Other Litigation*:**

Registrant is also subject to other ordinary routine litigation incidental to its business, some of which may include claims for compensatory and punitive damages. Management believes that rate recovery, proper insurance coverage and reserves are in place to insure against, among other things, property, general liability, employment, and workers' compensation claims incurred in the ordinary course of business. Insurance coverage may not cover certain claims involving punitive damages. Registrant does not believe the outcome from any pending suits or administrative proceedings will have a material effect on Registrant's consolidated results of operations, financial position, or cash flows.

Note 16 — Leases

Right-of-use ("ROU") assets represent the right to use an underlying asset for the lease term, and lease liabilities represent the obligation to make lease payments arising from the lease. ROU assets and liabilities are recognized at the lease commencement date based on the estimated present value of lease payments over the lease term. As of December 31, 2023, Registrant has right-of-use assets of $8.0 million, short-term operating lease liabilities of $1.9 million and long-term operating lease liabilities of $6.6 million. Currently, Registrant does not have any financing leases.

Significant assumptions and judgments made as part of the lease standard include determining (i) whether a contract contains a lease, (ii) whether a contract involves an identified asset, and (iii) which party to the contract directs the use of the asset. The discount rates used to calculate the present value of lease payments were determined based on hypothetical borrowing rates available to Registrant over terms similar to the lease terms.

Registrant's leases consist of real estate and equipment leases, which are mostly GSWC's. Most of Registrant's leases require fixed lease payments. Some real estate leases have escalation payments which depend on an index. Variable lease costs were not material. Lease terms used to measure the lease liability include options to extend the lease if the option is reasonably certain to be exercised. Lease and non-lease components were combined to measure lease liabilities.

Registrant's supplemental lease information for the year ended December 31, 2023 is as follows (in thousands, except for weighted average data):

	For The Year Ended December 31, 2023	For The Year Ended December 31, 2022
Operating lease costs	$2,486	$2,609
Short-term lease costs	$147	$198
Weighted average remaining lease term (in years)	4.55	5.27
Weighted-average discount rate	4.0%	3.9%
Non-cash transactions		
Lease liabilities arising from obtaining right-of-use assets	$565	$1,569

For the years 2023, 2022 and 2021, Registrant's consolidated rent expense was approximately $2.3 million, $2.6 million and $2.5 million, respectively. Registrant's future minimum payments under long-term non-cancelable operating leases as of December 31, 2023 are as follows (in thousands):

2024	$	2,161
2025		2,066
2026		1,816
2027		1,556
2028		1,305
Thereafter		386
Total lease payments		9,290
Less: imputed interest		815
Total lease obligations		8,475
Less: current obligations		1,856
Long-term lease obligations	$	6,619

The consolidated operations of AWR and the operations of GSWC in regard to future minimum payments under long-term non-cancelable operating leases are not materially different.

Note 17 - Business Segments

AWR has three reportable segments, water, electric and contracted services. GSWC has one segment, water. On a stand-alone basis, AWR has no material assets other than its equity investments in its subsidiaries, note payables to banks, deferred income taxes and intercompany note receivables.

All GSWC and BVES business activities are conducted in California. Activities of ASUS and its subsidiaries are conducted in California, Florida, Kansas, Maryland, Massachusetts, New Mexico, North Carolina, South Carolina, Texas and Virginia. Some of ASUS's wholly owned subsidiaries are regulated by the state in which the subsidiary primarily conducts water and/or wastewater operations. Fees charged for operations and maintenance and renewal and replacement services are based upon the terms of the contracts with the U.S. government, which have been filed, as appropriate, with the commissions in the states in which ASUS's subsidiaries are incorporated.

The tables below set forth information relating to AWR's operating segments and AWR (parent). The utility plant balances are net of respective accumulated provisions for depreciation. Capital additions reflect capital expenditures paid in cash and exclude U.S. government-funded and third-party prime funded capital expenditures for ASUS's subsidiaries and property installed by developers and conveyed to GSWC and BVES.

	As Of And For The Year Ended December 31, 2023				
(dollars in thousands)	**Water**	**Electric**	**Contracted Services**	**AWR Parent**	**Consolidated AWR**
Operating revenues	$ 433,473	$ 41,832	$ 120,394	$ —	$ 595,699
Operating income (loss)	159,177	11,196	26,151	216	196,740
Interest expense (income), net	25,726	2,238	1,321	6,061	35,346
Net property, plant and equipment	1,735,534	140,279	16,467	—	1,892,280
Depreciation and amortization expense **(1)**	35,886	3,256	3,261	—	42,403
Income tax expense (benefit)	35,689	1,515	6,109	(1,714)	41,599
Capital additions	160,939	25,372	2,229	—	188,540

	As Of And For The Year Ended December 31, 2022				
(dollars in thousands)	**Water**	**Electric**	**Contracted Services**	**AWR Parent**	**Consolidated AWR**
Operating revenues	$ 340,602	$ 39,986	$ 110,940	$ —	$ 491,528
Operating income (loss)	92,455	11,740	22,449	(8)	126,636
Interest expense (income), net	21,659	831	(132)	2,343	24,701
Net property, plant and equipment	1,616,718	119,560	17,488	—	1,753,766
Depreciation and amortization expense **(1)**	34,805	2,792	3,718	—	41,315
Income tax expense (benefit)	16,346	2,439	5,476	(597)	23,664
Capital additions	146,730	18,069	1,441	—	166,240

	As Of And For The Year Ended December 31, 2021				
(dollars in thousands)	**Water**	**Electric**	**Contracted Services**	**AWR Parent**	**Consolidated AWR**
Operating revenues	$ 347,112	$ 38,345	$ 113,396	$ —	$ 498,853
Operating income (loss)	107,573	10,738	22,675	(9)	140,977
Interest expense (income), net	21,046	141	(637)	791	21,341
Net property, plant and equipment	1,499,745	106,508	19,751	—	1,626,004
Depreciation and amortization expense **(1)**	33,384	2,572	3,640	—	39,596
Income tax expense (benefit)	22,095	2,975	5,434	(81)	30,423
Capital additions	123,526	19,859	1,130	—	144,515

(1) Depreciation computed on regulated utilities' transportation equipment is recorded in other operating expenses and totaled $851,000, $382,000 and $379,000 for the years ended December 31, 2023, 2022 and 2021, respectively. For the year ended December 31, 2023, approximately $212,000 of additional depreciation expense on GSWC's transportation equipment was recorded that relates to the cumulative retroactive impact for the full year of 2022 approved in the CPUC final decision in GSWC's general rate case that resulted from an increase to the transportation equipment composite depreciation rates that are retroactive to January 1, 2022.

The following table reconciles total net property, plant and equipment (a key figure for ratemaking) to total consolidated assets (in thousands):

	December 31,	
	2023	2022
Total net property, plant and equipment	$ 1,892,280	$ 1,753,766
Other assets	353,842	280,608
Total consolidated assets	$ 2,246,122	$ 2,034,374

Note 18 — Allowance for Doubtful Accounts

Registrant's allowance for doubtful accounts as of December 31, 2023 was developed based on expected credit losses and other considerations that may impact the customers' ability to pay their bills. The estimate considers customer payment history and trends but also any COVID relief funds that Registrant receives.

GSWC received confirmation from SWRCB that it is currently processing GSWC's application and expects to disburse approximately $3.5 million of COVID relief funds through the Extended Arrearage Program that will provide further assistance to customers for water debt accrued during the COVID-19 pandemic (Note 1). The CPUC has authorized GSWC and BVES to track incremental costs, including bad debt expense in excess of what is included in their respective revenue requirements, incurred as a result of the pandemic in COVID-19 related memorandum accounts to be filed with the CPUC for future recovery. In January 2022, GSWC received $9.5 million in COVID relief funds from the state of California through the initial California Water and Wastewater Arrearage Payment Program, which were applied to delinquent customers' eligible balances incurred during the COVID-19 pandemic. During 2022, BVES received a total of $473,000 from the state of California for similar relief funding for unpaid electric bills incurred during the pandemic. Pursuant to CPUC requirements, as of December 31, 2023, 2022 and 2021, GSWC and BVES have reflected these relief funds as a reduction to its COVID-19 memorandum accounts, as well as a reduction to its estimated allowance for doubtful accounts.

Other accounts receivable consist primarily of amounts due from third parties (non-utility customers) for various reasons, including amounts due from contractors, amounts due under settlement agreements, and amounts due from other third-party prime government contractors pursuant to agreements for construction of water and/or wastewater facilities for such third-party prime contractors.

The table below presents Registrant's provision for doubtful accounts charged to expense and accounts written off, net of recoveries. Provisions included in 2023, 2022 and 2021 for AWR and GSWC are as follows:

	AWR		
	December 31,		
(dollars in thousands)	2023	2022	2021
Balance at beginning of year	$ 4,440	$ 3,569	$ 5,316
Provision charged **(1)**	932	2,842	8,150
Accounts written off, net of recoveries **(2)**	(1,782)	(1,971)	(9,897)
Balance at end of year	$ 3,590	$ 4,440	$ 3,569
Allowance for doubtful accounts related to accounts receivable-customer	$ 3,537	$ 4,387	$ 3,516
Allowance for doubtful accounts related to other accounts receivable	53	53	53
Total allowance for doubtful accounts	$ 3,590	$ 4,440	$ 3,569

(1) In 2022 and 2021, includes amounts in excess of GSWC's and BVES's respective revenue requirements incurred during the COVID-19 pandemic. These incremental amounts are recorded as regulatory assets in the COVID-19 memorandum accounts.

(2) Reflects consideration of government relief funds expected to be received in 2024 and received in 2022 from the state of California for unpaid water and electric utility bills incurred during the pandemic. A total of $3.5 million is expected to be received for unpaid water utility bills in 2024, and $9.5 million and $473,000 was received in 2022 for unpaid water and electric utility bills, respectively.

(dollars in thousands)	GSWC December 31, 2023	2022	2021
Balance at beginning of year	$ 4,196	$ 3,221	$ 4,960
Provision charged **(3)**	754	2,501	7,732
Accounts written off, net of recoveries **(4)**	(1,503)	(1,526)	(9,471)
Balance at end of year	$ 3,447	$ 4,196	$ 3,221
Allowance for doubtful accounts related to accounts receivable-customer	$ 3,394	$ 4,143	$ 3,168
Allowance for doubtful accounts related to other accounts receivable	53	53	53
Total allowance for doubtful accounts	$ 3,447	$ 4,196	$ 3,221

(3) In 2022 and 2021, includes amounts in excess of GSWC's revenue requirement incurred during the COVID-19 pandemic. This incremental amount was recorded as a regulatory asset in the COVID-19 memorandum account.

(4) Reflects consideration of government relief funds expected to be received in 2024 and received in 2022 from the state of California for unpaid water utility bills incurred during the pandemic. A total of $3.5 million is expected to be received in 2024 and $9.5 million was received in 2022 for unpaid water utility bills.

Note 19 — Supplemental Cash Flow Information

The following table sets forth non-cash financing and investing activities and other cash flow information (in thousands).

	AWR December 31,			GSWC December 31,		
	2023	2022	2021	2023	2022	2021
Taxes and Interest Paid:						
Income taxes paid, net	$ 34,682	$ 27,370	$ 29,153	$ 31,625	$ 20,155	$ 21,428
Interest paid, net of capitalized interest	39,367	26,005	22,540	28,099	22,294	21,156
Non-Cash Transactions:						
Accrued payables for investment in utility plant	34,906	40,034	32,855	33,465	38,302	30,656
Property installed by developers and conveyed	4,690	1,549	7,222	4,690	1,549	7,222

Item 9. Changes in and Disagreements with Accountants on Accounting and Financial Disclosure

None.

Item 9A. Controls and Procedures

(a) Conclusion Regarding the Effectiveness of Disclosure Controls and Procedures

Under the supervision and with the participation of our management, including our principal executive officer and principal financial officer, we conducted an evaluation of our disclosure controls and procedures, as such term is defined under Rule 13a-15(e) or 15d-15(e) promulgated under the Securities Exchange Act of 1934, as amended (the "Exchange Act"). Based on this evaluation, our principal executive officer and our principal financial officer concluded that the disclosure controls and procedures of AWR and GSWC were effective as of the end of the period covered by this annual report.

(b) Management's Report on Internal Control over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting, as such term is defined in Exchange Act Rule 13a-15(f). Under the supervision and with the participation of our management, including our principal executive officer and principal financial officer, we conducted an evaluation of the effectiveness of our internal control over financial reporting based on the framework in *Internal Control - Integrated Framework* (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission. Based on our evaluation under the framework in *Internal Control - Integrated Framework*, our management concluded that the internal control over financial reporting of AWR and GSWC was effective as of December 31, 2023.

(c) Attestation Report of the Independent Registered Public Accounting Firm

The effectiveness of our internal control over financial reporting of AWR as of December 31, 2023 has been audited by PricewaterhouseCoopers LLP, an independent registered public accounting firm, as stated in their report which is included herein.

(d) Changes in Internal Control over Financial Reporting

There have been no changes in our internal control over financial reporting (as such term is defined in Rules 13a-15(f) or 15d(f) under the Exchange Act) of AWR and GSWC that occurred during the fourth quarter of 2023 that have materially affected, or are reasonably likely to materially affect, our internal control over financial reporting.

Item 9B. Other Information

During the quarter ended December 31, 2023, no officer or director adopted, terminated, or modified any Rule 10b5-1 plans or non-Rule 10b5-1 plans.

Item 9C. Disclosure Regarding Foreign Jurisdictions that Prevent Inspections.

Not applicable.

PART III

Item 10. Directors, Executive Officers and Corporate Governance

Information responsive to Part III, Item 10 is included in the Proxy Statement, to be filed by AWR with the SEC pursuant to Regulation 14A, under the captions therein entitled: (i) “Proposal 1: Election of Directors”; (ii) “Executive Officers”; (iii) “Governance of the Company”; (iv) “Stock Ownership”; (v) “Nominating and Governance Committee”; (vi) “Audit and Finance Committee;” and (vii) “Obtaining Additional Information From Us” and is incorporated herein by reference pursuant to General Instruction G(3).

Item 11. Executive Compensation

Information responsive to Part III, Item 11 is included in the Proxy Statement, to be filed by AWR with the SEC pursuant to Regulation 14A, under the captions therein entitled: (i) “Proposal 1: Election of Directors”; (ii) “Executive Officers;” (iii) “Governance of the Company” and (iv) “Compensation Committee” and is incorporated herein by reference pursuant to General Instruction G(3).

Item 12. Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters

Information responsive to Part III, Item 12 is included in the Proxy Statement, to be filed by AWR with the SEC pursuant to Regulation 14A, under the captions entitled “Stock Ownership” are incorporated herein by reference pursuant to General Instruction G(3).

Securities Authorized for Issuance under Equity Compensation Plans:

AWR has made stock awards to its executive officers and managers under the 2016 employee plan. It has also made stock awards to its non-employee directors under the 2003 and 2023 director plans. Information regarding the securities, which have been issued and which are available for issuance under these plans is set forth in the table below as of December 31, 2023. This table does not include any AWR Common Shares that may be issued under our 401(k) plan.

Plan Category	Number of securities to be issued upon exercise of outstanding options, warrants and rights(1)	Weighted-average exercise price of outstanding options, warrants and rights(2)	Number of securities remaining available for future issuance under equity compensation plans (excluding securities Reflected in the first column)(3)
Equity compensation plans approved by shareholders	146,314	N/A	1,145,567
Equity compensation plans not approved by shareholders	–	–	–
Total	146,314	N/A	1,145,567

(1) Amount shown in this column consists of 27,836 time-vested restricted stock units outstanding under the 2016 employee plan (including dividend equivalents thereon with respect to declared dividends), 95,987 performance awards at the maximum level (including dividend equivalents thereon with respect to declared dividends) outstanding under the 2016 employee plan, and 22,491 restricted stock units (including dividend equivalents thereon with respect to declared dividends) outstanding under the 2003 directors plan.

(2) Amount shown in this column is for options granted only. As of December 31, 2023, there were no options outstanding.

(3) Amount shown in this column consists of 192,206 shares available under the 2003 directors plan, 246,396 shares available under the 2023 directors plan, and 706,965 shares available under the 2016 employee plan. The only increase in restricted stock units in the 2003 directors plan will come from restricted stock units that may be issued under the 2003 directors plan pursuant to dividend equivalent rights on dividends not yet declared with respect to restricted stock units previously granted under the 2003 directors plan. No additional stock awards may be granted under the 2003 directors plan.

Item 13. Certain Relationships and Related Transactions, and Director Independence

Information responsive to Part III, Item 13 is included in the Proxy Statement, to be filed by AWR with the SEC pursuant to Regulation 14A, under the caption therein entitled "Governance of the Company" and is incorporated herein by reference pursuant to General Instruction G(3).

Item 14. Principal Accounting Fees and Services

Information responsive to Part III, Item 14 is included in the Proxy Statement, to be filed by AWR with the SEC pursuant to Regulation 14A, under the caption therein entitled "Proposal 3: Ratification of Auditors" and is incorporated herein by reference pursuant to General Instruction G(3).

PART IV

Item 15. Exhibits, Financial Statement Schedules

(a) The following documents are filed as a part of this Annual Report on Form 10-K:

1. Reference is made to the Financial Statements incorporated herein by reference to Part II, Item 8 hereof.

2. Schedule I — Condensed Financial Information of American States Water Company Parent at December 31, 2023 and 2022 and for the years ended December 31, 2023, 2022 and 2021. Schedules II, III, IV, and V are omitted as they are not applicable.

See page 127.

3. Reference is made to Item 15(b) of this Annual Report on Form 10-K.

(b) Exhibits:

3.1	Amended and Restated By-Laws of American States Water Company incorporated by reference to Exhibit 3.1 of Registrant's Form 10-Q filed for September 30, 2023
3.2	By-laws of Golden State Water Company incorporated by reference to Exhibit 3.2 of Registrant's Form 8-K filed May 13, 2011 (File No. 1-14431)
3.3	Amended and Restated Articles of Incorporation of American States Water Company, as amended, incorporated by reference to Exhibit 3.1 of Registrant's Form 8-K filed June 19, 2013
3.4	Restated Articles of Incorporation of Golden State Water Company, as amended, incorporated herein by reference to Exhibit 3.1 of Registrant's Form 10-Q for the quarter ended September 30, 2005 (File No. 1-14431)
4.1	Indenture, dated September 1, 1993 between Golden State Water Company and The Bank of New York Mellon Trust Company, N.A., as successor trustee, as supplemented, incorporated herein by reference to Exhibit 4.01 of Golden State Water Company Form S-3 filed December 12, 2008 (File No. 333-156112)
4.2	Note Purchase Agreement dated as of October 11, 2005 between Golden State Water Company and Co-Bank, ACB incorporated by reference to Exhibit 4.1 of Registrant's Form 8-K filed October 13, 2005 (File No. 1-14431)
4.3	Description of Common Shares (1)
4.4	Description of Debt Securities incorporated by reference to Exhibit 4.4 to Registrant's Form 10-K for the year ended December 31,2021
10.1	Second Sublease dated October 5, 1984 between Golden State Water Company and Three Valleys Municipal Water District incorporated herein by reference to Registrant's Registration Statement on Form S-2, Registration No. 33-5151
10.2	Loan Agreement between California Pollution Control Financing Authority and Golden State Water Company, dated as of December 1, 1996 incorporated by reference to Exhibit 10.7 of Registrant's Form 10-K for the year ended December 31, 1998 (File No. 1-14431)
10.3	Water Supply Agreement dated as of June 1, 1994 between Golden State Water Company and Central Coast Water Authority incorporated herein by reference to Exhibit 10.15 of Registrant's Form 10-K with respect to the year ended December 31, 1994 (File No. 1-14431)
10.4	2003 Non-Employee Directors Stock Purchase Plan, as amended, incorporated herein by reference to Exhibit 10.4 to Registrant's Form 8-K filed on May 20, 2015 (File No. 1-14431) (2)
10.5	Dividend Reinvestment and Common Share Purchase Plan incorporated herein by reference to American States Water Company Registrant's Form S-3D filed November 12, 2008 (File No. 1-14431)
10.6	Change in Control Agreement between American States Water Company or a subsidiary and certain executives incorporated herein by reference to Exhibit 10.6 to Registrant's Form 10-K for the year ended December 31, 2022 (2)
10.7	Golden State Water Company Supplemental Executive Retirement Plan, amended and restated, incorporated herein by reference to Exhibit 10.7 to Registrant's Form 10-Q filed on May 2, 2022 (2)
10.8	Credit Agreement of American States Water Company dated June 28, 2023, as amended , incorporated by reference to Exhibit 10.8 to Registrant's Form 10-Q filed for September 30, 2023
10.9	Officer Relocation Policy incorporated herein by reference to Exhibit 10.5 to Registrant's Form 8-K filed on July 31, 2009 (2)

10.10	Credit Agreement of Golden State Water Company dated June 28, 2023 incorporated by reference to Registrant's Form 8-K filed on July 5, 2023
10.11	2016 Stock Incentive Plan incorporated by reference to Exhibit 10.1 to Registrant’s Form 8-K filed on May 19, 2016 (2)
10.12	2023 Non-Employee Directors Plan incorporated by reference herein to Exhibit 10.1 to Registrant's Form 8-K filed on May 26, 2023 (2)
10.13	Form of Restricted Stock Award Agreement for officers with respect to time-vested restricted stock awards under the 2016 Stock Incentive Plan after December 31, 2017 incorporated by reference to Exhibit 10.1 of Form 8-K filed on November 3, 2017 (2)
10.14	Note Purchase Agreement dated July 8, 2020 incorporated by reference to Exhibit 10.1 to Registrant’s Form 8-K filed July 14, 2020
10.15	Form of 2021 Performance Award Agreement incorporated by reference to Exhibit 10.1 of Registrant's Form 8-K filed February 5, 2021 (2)
10.16	Separation Agreement and General Release of Claims dated August 10, 2021 incorporated by reference to Exhibit 10.1 to Registrant’s Form 8-K filed on August 13, 2021 (2)
10.17	Retirement Agreement and General Release of Claims effective January 14, 2022, incorporated by reference to Exhibit 10.1 to Registrant's Form 8-K filed on January 21, 2022 (2)
10.18	Contract for Professional Services effective January 15, 2022, incorporated by reference to Exhibit 10.2 to Registrant's Form 8-K filed on January 21, 2022 (2)
10.19	Form of 2022 Performance Award Agreement incorporated by reference to Exhibit 10.1 of Registrant's Form 8-K filed February 4, 2022 (2)
10.20	Form of 2023 Performance Award Agreement incorporated by reference to Exhibit 10.1 of Registrant's Form 8-K filed February 10, 2023 (2)
10.21	Form of Indemnification Agreement for directors and officers incorporated by reference to Exhibit 10.24 to Registrant's Form 10-K for the year ended December 31, 2022 (2)
10.22	Short-Term Incentive Program incorporated by reference to Exhibit 10.1 of Registrant’s Form 8-K filed on March 31, 2023 (2)
10.23	Form of 2023 Short-Term Incentive Program Award Agreement incorporated by reference to Exhibit 10.2 of Registrant’s Form 8-K filed on March 31, 2023 (2)
19.1	Insider Trading Policy (1)
21	Subsidiaries of Registrant (1)
23.1	Consent of Independent Registered Public Accounting Firm for AWR (1)
31.1	Certification of Chief Executive Officer pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 for AWR (1)
31.1.1	Certification of Chief Executive Officer pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 for GSWC (1)
31.2	Certification of Chief Financial Officer pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 for AWR (1)
31.2.1	Certification of Chief Financial Officer pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 for GSWC (1)
32.1	Certification of Chief Executive Officer pursuant to Section 906 of the Sarbanes-Oxley Act of 2002 (3)
32.2	Certification of Chief Financial Officer pursuant to Section 906 of the Sarbanes-Oxley Act of 2002 (3)
97.1	Policy Regarding the Recoupment of Certain Performance-Based Compensation Payments revised October 31, 2023 incorporated by reference to Exhibit 10.9 to Registrant's Form 10-Q filed for September 30, 2023
101.INS	Inline XBRL Instance Document - the instance document does not appear in the Interactive Data File because its XBRL tags are embedded within the Inline XBRL document.
101.SCH	Inline XBRL Taxonomy Extension Schema (3)
101.CAL	Inline XBRL Taxonomy Extension Calculation Linkbase (3)
101.DEF	Inline XBRL Taxonomy Extension Definition Linkbase (3)

101.LAB	Inline XBRL Taxonomy Extension Label Linkbase (3)
101.PRE	Inline XBRL Taxonomy Extension Presentation Linkbase (3)
104	Cover Page Interactive Data File - (formatted as Inline XBRL and contained in Exhibit 101)

(c) See Item 15(a)(2)

(1) Filed concurrently herewith
(2) Management contract or compensatory arrangement
(3) Furnished concurrently herewith

Item 16. Form 10-K Summary

None.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, Registrants have duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

	AMERICAN STATES WATER COMPANY ("AWR"):
By:	/s/ EVA G. TANG
	Eva G. Tang Senior Vice President-Finance, Chief Financial Officer, Treasurer and Corporate Secretary
	GOLDEN STATE WATER COMPANY ("GSWC"):
By:	/s/ EVA G. TANG
	Eva G. Tang Senior Vice President-Finance, Chief Financial Officer and Secretary
Date:	February 21, 2024

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of Registrants and in the capacities and on the dates indicated.

	Date:
/s/ ANNE M. HOLLOWAY Anne M. Holloway Chairman of the Board and Director of AWR and GSWC	February 21, 2024
/s/ ROBERT J. SPROWLS Robert J. Sprowls Principal Executive Officer, President and Chief Executive Officer of AWR and GSWC and Director of AWR and GSWC	February 21, 2024
/s/ EVA G. TANG Eva G. Tang Principal Financial and Accounting Officer, Senior Vice President-Finance, Chief Financial Officer, Treasurer and Corporate Secretary of AWR; and Principal Financial and Accounting Officer, Senior Vice President-Finance, Chief Financial Officer and Secretary of GSWC	February 21, 2024
/s/ DIANA M. BONTÁ Diana M. Bontá Director of AWR and GSWC	February 21, 2024
/s/ STEVEN D. DAVIS Steven D. Davis Director of AWR and GSWC	February 21, 2024
/s/ THOMAS A. EICHELBERGER Thomas A. Eichelberger Director of AWR and GSWC	February 21, 2024
/s/ JOHN R. FIELDER John R. Fielder Director of AWR and GSWC	February 21, 2024
/s/ MARY ANN HOPKINS Mary Ann Hopkins Director of AWR and GSWC	February 21, 2024
/s/ C. JAMES LEVIN C. James Levin Director of AWR and GSWC	February 21, 2024
/s/ ROGER M. ERVIN Roger M. Ervin Director of AWR and GSWC	February 21, 2024

CONDENSED BALANCE SHEETS

(in thousands)	December 31, 2023	December 31, 2022
Assets		
Cash and equivalents	$ 3,547	$ 93
Prepayments and other current assets	116	—
Income taxes receivable	39	20
Intercompany note receivables	39,044	159,582
Total current assets	42,746	159,695
Investments in subsidiaries	870,020	799,802
Deferred taxes and other assets	10,135	9,891
Total assets	$ 922,901	$ 969,388
Liabilities and Capitalization		
Notes payable to bank	$ —	$ 255,500
Income taxes payable	2,422	2,158
Other liabilities	577	454
Total current liabilities	2,999	258,112
Notes payable to bank	141,500	—
Deferred taxes and other liabilities	2,293	1,727
Total other liabilities	143,793	1,727
Common shareholders' equity	776,109	709,549
Total capitalization	776,109	709,549
Total liabilities and capitalization	$ 922,901	$ 969,388

The accompanying condensed notes are an integral part of these condensed financial statements.

AMERICAN STATES WATER COMPANY
SCHEDULE I - CONDENSED FINANCIAL INFORMATION OF PARENT

CONDENSED STATEMENTS OF INCOME

(In thousands, except per share amounts)	For the Years Ended December 31, 2023	2022	2021
Operating revenues and other income	$ —	$ —	$ —
Operating expenses and other expenses	5,576	2,093	542
Loss before equity in earnings of subsidiaries and income taxes	(5,576)	(2,093)	(542)
Equity in earnings of subsidiaries	128,783	79,892	94,808
Income before income taxes	123,207	77,799	94,266
Income tax benefit	(1,714)	(597)	(81)
Net income	$ 124,921	$ 78,396	$ 94,347
Weighted Average Number of Common Shares Outstanding	36,976	36,955	36,921
Basic Earnings Per Common Share	$ 3.37	$ 2.12	$ 2.55
Weighted Average Number of Diluted Common Shares Outstanding	37,077	37,039	37,010
Fully Diluted Earnings per Common Share	$ 3.36	$ 2.11	$ 2.55
Dividends Paid Per Common Share	$ 1.655	$ 1.525	$ 1.400

The accompanying condensed notes are an integral part of these condensed financial statements.

CONDENSED STATEMENTS OF CASH FLOWS

(in thousands)	For the Years Ended December 31, 2023	2022	2021
Cash Flows From Operating Activities	$ 67,041	$ 56,398	$ 36,799
Cash Flows From Investing Activities:			
Loans (made to)/repaid from, wholly-owned subsidiaries	121,000	(81,000)	(46,000)
Increase in investment of subsidiary	(10,000)	—	—
Net cash provided (used) by investing activities	111,000	(81,000)	(46,000)
Cash Flows From Financing Activities:			
Net borrowings on notes payable to banks	(113,392)	81,000	60,500
Proceeds from note payable to GSWC	—	—	(26,000)
Repayment of note payable to GSWC	—	—	26,000
Dividends paid	(61,195)	(56,356)	(51,689)
Net cash provided (used) by financing activities	(174,587)	24,644	8,811
Net change in cash and cash equivalents	3,454	42	(390)
Cash and equivalents at beginning of period	93	51	441
Cash and equivalents at the end of period	$ 3,547	$ 93	$ 51

The accompanying condensed notes are an integral part of these condensed financial statements.

Note 1 — Basis of Presentation

The accompanying condensed financial statements of AWR (parent) should be read in conjunction with the consolidated financial statements and notes thereto of American States Water Company and subsidiaries ("Registrant") included in Part II, Item 8 of this Form 10-K. AWR's (parent) significant accounting policies are consistent with those of Registrant and its wholly owned subsidiaries, Golden State Water Company ("GSWC"), Bear Valley Electric Service, Inc. ("BVES") and American States Utility Services, Inc. ("ASUS"), except that all subsidiaries are accounted for as equity method investments.

Related-Party Transactions:

As further discussed in *Note 2 — Notes Payable to Banks*, AWR (parent) currently has access to a $165.0 million syndicated credit facility. AWR (parent) borrows under this facility and provides funds to ASUS in support of their operations and itself. Prior to the new credit agreement in June 2023, described below, AWR (parent) had a credit facility with access of up to $280.0 million and had provided funds to both GSWC and ASUS in support of their operations. Any amounts owed to AWR (parent) for borrowings under this facility are reflected as intercompany receivables on the Condensed Balance Sheets. The interest rate charged to its subsidiaries is sufficient to cover AWR (parent)'s interest cost under the credit facility. AWR may, from time to time, also make equity investments in its subsidiaries.

In October 2020, AWR (parent) issued an interest-bearing promissory note to GSWC, which expired in May 2023. Under the terms of the note, AWR (parent) was permitted to borrow from GSWC amounts up to $30.0 million for working capital purposes. AWR (parent) agreed to pay any unpaid principal amounts outstanding under this note, plus accrued interest. During 2021, AWR (parent) borrowed and repaid a total of $26.0 million from GSWC under the terms of the note. There were no borrowings or repayments made during 2022 and 2023. As of December 31, 2023 and 2022, there were no amounts outstanding under this note.

In January 2023, the Board of Directors approved the issuance of one GSWC Common Share to AWR (parent) for $10.0 million. In January 2023, GSWC issued $130.0 million in unsecured long-term notes in a private placement. GSWC used the proceeds from both the issuance of equity and long-term debt to pay-off all intercompany borrowings from AWR (parent).

AWR (parent) guarantees performance of ASUS's contracts with the U.S. government and agrees to provide necessary resources, including financing, which are necessary to assure the complete and satisfactory performance of such contracts.

Note 2 — Note Payable to Banks

On June 28, 2023, AWR (parent) entered into a new credit agreement with a term of five years provided by a syndicate of banks and financial institutions. The credit agreement will mature on June 28, 2028. In connection with the new credit agreement, AWR (parent) incurred legal and other fees totaling $632,000. The syndicated credit facility replaced AWR (parents)'s previous credit agreement with a sole bank where it had a borrowing capacity of $280.00 million. Funds from the new facilities were used to pay-off in full all outstanding borrowings under AWR (parent)'s prior credit facility.

The new credit agreement provides for a $150.0 million unsecured revolving credit facility. Under the credit agreement, the borrowing capacity may be expanded up to an additional amount of $75 million, subject to the lenders' approval. The aggregate amount that may be outstanding under letters of credit is $10.0 million. Loans may be obtained under the credit facilities at the option of AWR (parent) and bear interest at rates based on either a base rate plus an applicable margin or an adjusted term SOFR determined by the SOFR administrator, currently the Federal Reserve Bank of New York, plus an applicable margin. The applicable margin depends upon AWR's credit ratings.

On November 6, 2023, the credit facility was amended to increase the borrowing capacity from $150.0 million to $165.0 million. In connection with the increase in borrowing capacity, the amendment also provides for the addition of a new bank to the existing syndicate group participating in AWR's credit facility. As of December 31, 2023, outstanding borrowings under its credit facility of $141.5 million have been classified as non-current liabilities on its Condensed Balance Sheet.

The credit agreement contains affirmative and negative covenants and events of default customary for credit facilities of this type, including, among other things, affirmative covenants relating to compliance with law and material contracts, and negative covenants relating to additional in indebtedness, liens, investments, restricted payments and asset sales by AWR (parent) and its subsidiaries, other than BVES. AWR (parent) is not permitted to have a consolidated total capitalization ratio (as defined in the credit agreement), excluding BVES, greater than 0.65 to 1.00 at the end of any quarter. Default under any indebtedness of any subsidiary of AWR (parent), other than BVES, will result in a default under its credit agreement. As of December 31, 2023, AWR (parent) had a debt ratio of 0.54 to 1.00.

AWR (parent)'s borrowing activities (excluding letters of credit) for the years ended December 31, 2023 and 2022 were as follows:

	December 31,	
(in thousands, except percent)	2023	2022
Balance Outstanding at December 31,	$ 141,500	$ 255,500
Interest Rate at December 31,	6.45 %	5.07 %
Average Amount Outstanding	$ 156,533	$ 213,758
Weighted Average Annual Interest Rate	5.92 %	2.56 %
Maximum Amount Outstanding	$ 257,500	$ 255,500

Note 3 — Income Taxes

AWR (parent) receives a tax benefit for expenses incurred at the parent-company level. AWR (parent) also recognizes the effect of AWR's consolidated California unitary apportionment, which is beneficial or detrimental depending on a combination of the profitability of AWR's consolidated non-California activities as well as the proportion of its consolidated California sales to total sales.

Note 4 — Dividend from Subsidiaries

Cash dividends in the amount of $71.4 million, $56.4 million and $38.3 million were paid to AWR (parent) by its wholly owned subsidiaries during the years ended December 31, 2023, 2022 and 2021, respectively.

DESCRIPTION OF COMMON SHARES

American States Water Company ("AWR") is currently authorized to issue 60,000,000 common shares. AWR has no other class of equity securities outstanding.

Information on the number of common shares outstanding may be found in AWR's most recent Form 10-K or Form 10-Q filing. A general summary of the rights and obligations of AWR's common shares is set forth below. More detailed information regarding these rights and obligations may be found in AWR's Articles of Incorporation and Bylaws listed as Exhibit 3.3 and 3.1, respectively, in AWR's most recent Form 10-K or Form 10-Q filed with the Securities and Exchange Commission and in Division I of the California Corporations Code.

Dividends

Common shareholders are entitled to receive such dividends as may be declared by the board of directors of AWR (the "Board") out of funds legally available therefor. AWR's Articles of Incorporation do not restrict its ability to pay dividends. However, certain of AWR's agreements governing its indebtedness contain restrictions on AWR's ability to declare and pay dividends under certain limited circumstances.

AWR currently obtain funds to pay dividends on its common shares principally from dividends paid by its subsidiaries. American States Utility Services, Inc. and its subsidiaries are not subject to any contractual restrictions on their ability to pay dividends. Golden State Water Company ("GSWC") and Bear Valley Electric Service, Inc. have credit agreements that contain restrictions on their ability to declare and pay dividends under certain limited circumstances. AWR's ability to pay dividends to common shareholders and the ability of its subsidiaries to pay dividends are also generally subject to restrictions imposed by the laws of the state in which the subsidiary is incorporated. Additional information on these restrictions can be found in AWR's most recent Form 10-K or 10-Q filing with the Securities and Exchange Commission.

AWR has paid cash dividends on its common shares quarterly since its formation as a holding company in 1998. Prior to this, GSWC had paid dividends on its common shares since 1931. AWR intends to continue its practice of paying quarterly cash dividends. However, the payment, amount and timing of dividends are dependent upon future earnings, the financial requirements of AWR and its subsidiaries and other factors considered relevant by the Board.

Board of Directors

The Board is classified. Under the terms of the Bylaws of AWR, the authorized number of directors must be at least six but no more than 11. Under the terms of the Articles of Incorporation of AWR, if the authorized number of directors is less than nine and AWR's common shares are listed on the New York Stock Exchange (the "NYSE"), the Board will be divided into two classes. If the authorized number of directors is nine or more and AWR's common shares are listed on the NYSE, the Board will be classified into three classes. If AWR's common shares cease to be listed on the NYSE, the Board will no longer be classified. The Board is currently divided into three classes. One class of directors is elected annually.

Each class of the Board must be approximately equal in size to the other class. However, in the event that there is a change in the authorized number of directors, each continuing director will continue as a director of the class to which he or she is a member until the expiration of his or her term or his or her prior death, resignation or removal. All vacancies, except those resulting from a removal of a director, may be filled by the affirmative vote of a majority of directors then in office, even if less than a quorum.

Advance Notice Bylaws

In order for a shareholder to bring business before a shareholders' meeting or nominate a director, the shareholder must give timely notice in proper written form to AWR's secretary, be a record owner of AWR's common shares at the time of giving such notice and otherwise comply with the procedures set forth in AWR's Bylaws and the Securities Exchange Act of 1934. In order for a notice to be timely, it must be given not less than 90 days nor more than 110 days prior to the first anniversary of the preceding year's annual meeting if the notice is for an annual meeting. If the annual meeting date is changed by more than 30 days from the anniversary date of the annual meeting, a notice will be timely if received within ten days following the earlier of the date on which notice of the meeting was mailed to shareholders or public disclosure of the date of the annual meeting is made.

In addition, any shareholder bringing business before a shareholders' meeting or nominating a director must be present or represented by a qualified representative at such meeting. A "qualified representative" is any duly authorized officer, manager or partner of a shareholder or any person authorized by a writing executed by such shareholder and delivered to us at least 48 hours prior to the shareholders' meeting stating that such person is authorized to act on the shareholder's behalf.

Voting Rights

Each common shareholder is entitled to one vote per share. Under California law and AWR’s bylaws, common shareholders have cumulative voting rights with respect to the election of directors, if certain conditions are met. No shareholder will be entitled to cumulate votes for any candidate or candidates unless such candidate or candidates’ names have been placed in nomination prior to the voting and a shareholder has given notice at the meeting prior to the voting of the shareholder’s intention to cumulate the shareholder’s votes. If any shareholder has given such notice, all shareholders may cumulate their votes for candidates in nomination. The existence of a classified board along with cumulative voting may make it more difficult for a shareholder owning a significant amount of AWR’s common shares to effect a change in the majority of the Board than would be the case if cumulative voting did not exist.

AWR may not take any of the following actions without the approval of a majority of the Continuing Directors or a vote of 66 2/3% of the outstanding shares of AWR:

(a) Subject to clause (c) below, sell, convey, lease or otherwise dispose of all or substantially all of its assets, property, assets or business;

(b) Approve the sale, conveyance, lease or other disposition by any subsidiary of AWR of all or substantially all of the assets, property or business of the subsidiary;

(c) Sell, transfer, convey or otherwise dispose of more than a majority of the outstanding capital stock of a subsidiary if such subsidiary holds 50% or more of the consolidated assets of AWR, other than to an entity the majority of the voting power of the capital stock or equity interest of which is owned and controlled by AWR;

(d) Consolidate or merge with or into any other corporation or other business entity, except, if immediately after such consolidation or merger, the shareholders of AWR immediately prior to such consolidation or merger will own more than 60% of the voting power of the outstanding capital stock or other equity interests of the surviving entity; or

(e) Approve the consolidation or merger of any subsidiary of AWR with or into any other corporation or business entity if such subsidiary holds assets accounting for 50% or more of AWR’s consolidated assets.

A "Continuing Director" means any member of the Board who is not an Acquiring Person or an affiliate or associate of an Acquiring Person or a representative of either of them and either was a member of the Board prior to the time any person became an Acquiring Person or, if the person became a member of the Board subsequent to the time any person became an Acquiring Person, such member's nomination or renomination was recommended or approved by a majority of the Continuing Directors. An "Acquiring Person" is a person or entity who, either alone, or together with all associates and affiliates of such person or entity, is an owner of 20% or more of AWR's common shares, unless such person or entity is an Exempt Person or such person or entity acquires 20% or more of AWR's voting stock in connection with a transaction or series of transactions approved prior to such transaction or transactions by the Board. An "Exempt Person" is AWR, any majority owned subsidiary of AWR or any employee benefit or stock plan of AWR or any trust established or holding shares for such a plan.

Amendments to Articles of Incorporation and Bylaws

Under California law, except as otherwise provided in AWR's Articles of Incorporation, an amendment may be approved to AWR's Articles of Incorporation by a majority of the outstanding common shares of AWR entitled to vote and by the Board, and an amendment may generally only be approved to AWR's Bylaws by either a majority of the outstanding common shares of AWR entitled to vote or by the Board. Under AWR's Articles of Incorporation, amendments to the provisions of AWR's Articles of Incorporation relating to the classification of directors, supermajority voting and acquisitions and dispositions of the type described above in the second paragraph under "Voting Rights" may only be approved by the Board and an affirmative vote of 66 2/3% of the outstanding shares of AWR. Except as expressly provided in the California Corporations Code, an amendment to AWR's Bylaws relating to calling special meetings, proper business for shareholder meetings and number of directors may only be approved by a majority of the Board or 66 2/3% of AWR's outstanding common shares.

Other Matters

Special meetings of AWR's shareholders may be called only by the Board, the chair of the Board, AWR's chief executive officer or, if there is no chief executive officer, our president, or by the holders of shares entitled to cast at least ten percent of the votes at the meeting.

Subject to the preferential rights of any preferred shareholders, upon the liquidation, dissolution or winding up of AWR, AWR will ratably distribute its assets legally available for distribution to holders of its common shares. Common shareholders have no preemptive or other subscription or conversion rights and no liability for further calls upon their shares. The common shares are not subject to assessment.

None of AWR's common shares are subject to any sinking fund provisions.

AWR has the right to issue preferred shares under its Articles of Incorporation. No preferred shares are currently outstanding. If preferred shares are issued by AWR, the rights of the common shareholders would be subject to the rights, preferences and privileges of the preferred shares.

The common shares are listed on the New York Stock Exchange under the symbol "AWR." The transfer agent and registrar for AWR's common shares is Computershare Investor Services. Common shareholders may participate in AWR's common share purchase and dividend reinvestment plan.

American States Water Company
Insider Trading Policy
October 31, 2023

Contents

Page

AMERICAN STATES WATER COMPANY
INSIDER TRADING POLICY
Dated October 31, 2023

Federal and state laws prohibit trading in the securities of a company while in possession of material nonpublic information that would result in breaching a duty of trust or confidence. These laws also prohibit anyone who is aware of material nonpublic information from providing this information to others who may trade. Violating such laws can undermine investor trust, harm the reputation and integrity of American States Water Company (together with its subsidiaries, the "Company"), and result in your dismissal from the Company or even serious criminal and civil charges against you and the Company. The Company reserves the right to take whatever disciplinary or other measure(s) it determines in its sole discretion to be appropriate in any particular situation, including disclosure of wrongdoing to governmental authorities.

This Insider Trading Compliance Policy (this "Policy") outlines your responsibilities to avoid insider trading and implements certain procedures to help you avoid even the appearance of insider trading. This Policy supersedes the Company's Insider Trading Policy previously approved by the Board.

I. Summary

Preventing insider trading is necessary to comply with securities laws and to preserve the reputation and integrity of the Company. "Insider trading" occurs when any person purchases or sells a security while in possession of material nonpublic information relating to the security. Insider trading is a crime. The criminal penalties for violating insider trading laws include imprisonment and fines of up to $5 million for individuals and $25 million for corporations. Insider trading may also result in civil penalties, including disgorgement of profits and civil fines. Insider trading is also prohibited by this Policy, and violation of this Policy may result in Company-imposed sanctions, including removal or dismissal for cause.

This Policy applies to all officers, directors, and employees of the Company. For purposes of this Policy, "officers" refer to those individuals who meet the definition of "officer" under Section 16 of the Securities Exchange Act of 1934 (as amended, the "Exchange Act"). As someone subject to this Policy, you are responsible for ensuring that Immediate Family Members also comply with this Policy. "Immediate Family Members" for purposes of this Policy are family members, including a spouse, who reside with you, anyone else who resides in your household (other than domestic servants) and any family members who do not live in your household but whose transactions in Company securities are directed by you or are subject to your influence or control (such as parents or children who consult with you before they trade in Company securities). This Policy also applies to any entities you control, including any corporations, limited liability companies, partnerships, or trusts, and transactions by these entities should be treated for the purposes of this Policy and applicable securities laws as if they were for your own account. The Company may determine that this Policy applies to additional persons with access to material nonpublic information concerning the Company and/or third parties conducting business with the Company, such as temporary employees, contractors or consultants. This Policy extends to all activities within and outside your Company duties. Every officer, director, and employee must review this Policy. Questions regarding the Policy should be directed to the Company's Compliance Officer (as defined below). Officers, directors and employees, together with any other person designated as being subject to this Policy by the Compliance Officer, are referred to collectively as "Covered Persons."

The Chief Financial Officer of the Company or his or her designee (the "Compliance Officer") shall be responsible for the administration of this Policy.

In the absence of the Compliance Officer, responsibility for administering this Policy will rest with such other employee as may be designated by the Compliance Officer.

In all cases, as someone subject to this Policy, you bear full responsibility for ensuring your compliance with this Policy, and also for ensuring that Immediate Family Members and entities under your influence or control are in compliance with this Policy.

Actions taken by the Company, the Compliance Officer, or any other Company personnel do not constitute legal advice, nor do they insulate you from the consequences of noncompliance with this Policy.

II. Statement of Policies Prohibiting Insider Trading

No Covered Person shall purchase or sell any type of security while in possession of material nonpublic information relating to the security or the issuer of such security, that would result in breaching a duty of trust or confidence, whether the issuer of such security is the Company or any other company. In addition, if a Covered Person is in possession of material nonpublic information about other publicly-traded companies, such as suppliers, customers, competitors or potential acquisition targets, the Covered Person may not trade in such other companies' securities until the information becomes public or is no longer material. Further, no Covered Person shall purchase or sell any security of any other company, including another company in the Company's industry, while in possession of material nonpublic information if such information is obtained in the course of the Covered Person's employment or service with the Company.

Additionally, no officer, director or employee shall purchase or sell any security of the Company during the period beginning on the 14th calendar day before the end of any fiscal quarter of the Company and ending upon completion of the second full trading day after the public release of earnings data for such fiscal quarter or during any other trading suspension period declared by the Company.

These prohibitions do not apply to:

- purchases of the Company's securities from the Company or sales of the Company's securities to the Company;
- exercises of stock options or other equity awards or the surrender of shares to the Company in payment of the exercise price or in satisfaction of any tax withholding obligations in a manner permitted by the applicable equity award agreement, or vesting of equity-based awards that, in each case, do not involve a market sale of

the Company's securities (the "cashless exercise" of a Company stock option through a broker *does* involve a market sale of the Company's securities, and therefore would not qualify under this exception).

- *bona fide* gifts of the Company's securities;
- elective transactions with respect to Company securities under the Company's 401(k) plan and dividend reinvestment and share purchase plan, other than changes in elections under either plan; or
- purchases or sales of the Company's securities made pursuant to any binding contract, specific instruction or written plan entered into while the purchaser or seller, as applicable, was unaware of any material nonpublic information and which contract, instruction, or plan meets all requirements of the affirmative defense provided by Rule 10b5-1 ("Rule 10b5-1") promulgated under the Securities Exchange Act of 1934, as amended (the "1934 Act"), that (i) was precleared in advance pursuant to this Policy and (ii) has not been amended or modified in any respect after such initial preclearance without such amendment or modification being precleared in advance pursuant to this Policy. For more information about Rule 10b5-1 trading plans, see Section VI below.

From time to time, events will occur that are material to the Company and cause certain officers, directors, or employees to be in possession of material nonpublic information. When that happens, the Company will recommend that those in possession of the material nonpublic information suspend all trading in the Company's securities until the information is no longer material or has been publicly disclosed.

When such event-specific blackout periods occur, those subject to it will be notified by the Company. The event-specific blackout period will not be announced to those not subject to it, and those subject to it or otherwise aware of it should not disclose it to others.

Even if the Company has not notified you that you are subject to an event-specific blackout period, if you are aware of material nonpublic information about the Company, you should not trade in Company securities. Any failure by the Company to designate you as subject to an event-specific blackout period, or to notify you of such designation, does not relieve you of your obligation not to trade in the Company's securities while possessing material nonpublic information.

In addition, Covered Persons shall not directly or indirectly communicate material nonpublic information to anyone outside the Company (except in accordance with the Company's policies regarding confidential information) or to anyone within the Company other than on a "need-to-know" basis.

III. Explanation of Insider Trading

"Insider trading" refers to the purchase or sale of a security while in possession of material nonpublic information relating to the security.

"Securities" includes stocks, equity, bonds, notes, debentures, options, warrants, and other convertible securities, as well as derivative instruments. For the avoidance of doubt, the term "Company securities" includes the securities of subsidiaries of the Company.

"Purchase" and "sale" are defined broadly under the federal securities law. "Purchase" includes not only the actual purchase of a security, but also any contract to purchase or otherwise acquire a security. "Sale" includes not only the actual sale of a security, but also any contract to sell or otherwise dispose of a security. These definitions extend to a broad range of transactions, including conventional cash-for-stock transactions, conversions, the exercise of stock options, transfers, gifts, and acquisitions and exercises of warrants or puts, calls, pledging and margin loans, and swaps or other derivative securities and elections under the Company's 401(k) plan and dividend reinvestment and share purchase plan with respect to the Company's securities.

A. What Information is Material?

Information is considered "material" if there is a substantial likelihood that a reasonable investor would consider it important in making a decision to buy, sell, or hold a security, or if the information is likely to have a significant effect on the market price of the security. Material information can be positive or negative and can relate to virtually any aspect of a company's business or to any type of security, debt, or equity. Also, information that something is likely to happen in the future—or even just that it may happen—could be deemed material.

Examples of material information include (but are not limited to) information about:

- corporate earnings or earnings forecasts;
- possible mergers, acquisitions, tender offers, or dispositions;
- important business developments, such as developments regarding strategic collaborations;
- changes in the frequency or amount of dividends;
- changes in debt ratings or analyst upgrades or downgrades of the issuer or one of its securities;
- significant changes in accounting treatment, write-offs or restatements;
- management or control changes;
- significant borrowing or financing developments, including pending public sales or offerings of debt or equity securities;
- stock splits and repurchases;
- defaults on borrowings;
- bankruptcies;
- cybersecurity or data security incidents; and
- significant litigation or regulatory actions.

Moreover, material information does not have to be related to a company's business. For example, the contents of a forthcoming newspaper column that is expected to affect the market price of a security can be material.

Questions regarding material information should be directed to the Company's Compliance Officer. A good rule of thumb: When in doubt, do not trade.

B. What Is Nonpublic?

Information is "nonpublic" if it is not available to the general public. In order for information to be considered "public," it must be widely disseminated in a manner making it generally available to investors in a Regulation FD-compliant method, such as through a press release, a filing with the U.S. Securities and Exchange Commission (the "SEC") or a Regulation FD-compliant conference call. The Compliance Officer shall have sole discretion to decide whether information is public for purposes of this Policy.

The circulation of rumors, even if accurate and reported in the media, does not constitute public dissemination. In addition, even after a public announcement, a reasonable period of time may need to lapse in order for the market to react to the information. Generally, the passage of two full trading days following release of the information to the public is a reasonable waiting period before such information is deemed to be public.

C. Who Is an Insider?

"Insiders" include officers, directors, and any employees of a company, or anyone else who has material nonpublic information about a company. Insiders have independent fiduciary duties to their company and its shareholders not to trade on material nonpublic information relating to the company's securities. Insiders may not trade in the Company's securities while in possession of material nonpublic information relating to the Company, nor may they tip such information to anyone outside the Company (except in accordance with the Company's policies regarding the protection or authorized external disclosure of Company information) or to anyone within the Company other than on a "need-to-know" basis.

D. Trading by Persons Other Than Insiders

Insiders may be liable for communicating or tipping material nonpublic information to a third party ("tippee"), and insider trading violations are not limited to trading or tipping by insiders. Persons other than insiders can also be liable for insider trading, including tippees who trade on material nonpublic information tipped to them or individuals who trade on material nonpublic information that has been misappropriated. Insiders may be held liable for tipping even if they receive no personal benefit from tipping and even if no close personal relationship exists between them and the tippee.

Tippees inherit an insider's duties and are liable for trading on material nonpublic information illegally tipped to them by an insider. Similarly, just as insiders are liable for the insider trading of their tippees, so are tippees who pass the information along to others who trade. In other words, a tippee's liability for insider trading is no different from that of an insider. Tippees can obtain material nonpublic information by receiving overt tips from others or through, among other things, conversations at social, business, or other gatherings.

E. Penalties for Engaging in Insider Trading

Penalties for trading on or tipping material nonpublic information can extend significantly beyond any profits made or losses avoided, both for individuals engaging in such unlawful conduct and their employers. The SEC and Department of Justice have made the civil and criminal prosecution of insider trading violations a top priority. Enforcement remedies available to the government or private plaintiffs under the federal securities laws include:

- SEC administrative sanctions;
- securities industry self-regulatory organization sanctions;
- civil injunctions;
- damage awards to private plaintiffs;
- disgorgement of all profits;
- civil fines for the violator of up to three times the amount of profit gained or loss avoided;
- civil fines for the employer or other controlling person of a violator (i.e., where the violator is an employee or other controlled person) of up to the greater of $1.425 million or three times the amount of profit gained or loss avoided by the violator;
- criminal fines for individual violators of up to $5 million ($25 million for an entity); and
- jail sentences of up to 20 years.

In addition, insider trading could result in serious sanctions by the Company, including dismissal. Insider trading violations are not limited to violations of the federal securities laws. Other federal and state civil or criminal laws, such as the laws prohibiting mail and wire fraud and the Racketeer Influenced and Corrupt Organizations Act (RICO), may also be violated in connection with insider trading.

F. Size of Transaction and Reason for Transaction Do Not Matter

The size of the transaction or the amount of profit received does not have to be significant to result in prosecution. The SEC has the ability to monitor even the smallest trades, and the SEC performs routine market surveillance. Brokers or dealers are required by law to inform the SEC of any possible violations by people who may have material nonpublic information. The SEC aggressively investigates even small insider trading violations.

G. Examples of Insider Trading

Examples of insider trading cases include actions brought against officers, directors, and employees who traded in a company's securities after learning of significant confidential corporate developments; friends, business associates, family members, and other tippees of such officers, directors, and employees who traded in the securities after receiving such information; government employees who learned of such information in the course of their employment; and other persons who misappropriated, and took advantage of, confidential information from their employers.

The following are illustrations of insider trading violations. These illustrations are hypothetical and, consequently, not intended to reflect on the actual activities or business of the Company or any other entity.

Trading by Insider

An officer of X Corporation learns that earnings to be reported by X Corporation will increase dramatically. Prior to the public announcement of such earnings, the officer purchases X Corporation's stock. The officer, an insider, is liable for all profits as well as penalties of up to three times the amount of all profits. The officer is also subject to, among other things, criminal prosecution, including up to $5 million in additional fines and 20 years in jail. Depending upon the circumstances, X Corporation and the individual to whom the officer reports could also be liable as controlling persons.

Trading by Tippee

An officer of X Corporation tells a friend that X Corporation is about to publicly announce that it has concluded an agreement for a major acquisition. This tip causes the friend to purchase X Corporation's stock in advance of the announcement. The officer is jointly liable with his friend for all the friend's profits, and each is liable for all civil penalties of up to three times the amount of the friend's profits. The officer and his friend are also subject to criminal prosecution and other remedies and sanctions, as described above.

IV. Statement of Procedures to Prevent Insider Trading

The following procedures have been established, and will be maintained and enforced, by the Company to prevent insider trading.

A. Blackout Periods

The period during which the Company prepares quarterly financials is a sensitive time for insider trading purposes, as Company personnel may be more likely to possess, or be presumed to possess, material nonpublic information. To avoid the appearance of impropriety and assist Company personnel in planning transactions in the Company's securities for appropriate times, no officer, director, or employee shall purchase or sell any security of the Company during the period beginning on the 14th calendar day before the end of any fiscal quarter of the Company and ending upon completion of the second full trading day after the public release of earnings data for such fiscal quarter or during any other trading suspension period declared by the Company, such period, a "blackout period." A "trading day" is a day on which U.S. national stock exchanges are open for trading. If, for example, the Company were to make an announcement on Monday prior to 9:30 a.m. Eastern Time, then the blackout period would terminate after the close of trading on Tuesday. If an announcement were made on Monday after 9:30 a.m. Eastern Time, then the blackout period would terminate after the close of trading on Wednesday. If you have any question as to whether information is publicly available, please direct an inquiry to the Compliance Officer.

See Section II for certain exceptions that would apply even during blackout periods. Other exceptions to the blackout period policy may be approved only by the Compliance Officer.

From time to time, the Company, through the Board of Directors or the Company's Chief Financial Officer, may recommend that officers, directors, employees, or others suspend trading in the Company's securities because of developments that have not yet been disclosed to the public. Subject to the exceptions noted above, all those affected should not trade in the Company's securities while the suspension is in effect and should not disclose to others that the Company has suspended trading.

B. Preclearance of All Trades by All Officers, Directors and Key Employees

To provide assistance in preventing inadvertent violations of applicable securities laws and to avoid the appearance of impropriety in connection with the purchase and sale of the Company's securities, all transactions in the Company's securities (including, without limitation, acquisitions and dispositions of Company shares, the exercise of stock options, elective transactions under the Company's 401(k)/deferred compensation plans and the Company's dividend reinvestment and share purchase plan, and the sale of Company securities issued under equity incentive plans) by officers, directors, and key employees (each, a "Preclearance Person") must be precleared by the Compliance Officer. Transactions under a previously established Rule 10b5-1 Trading Plan that has been preapproved in accordance with this Policy are not subject to further preclearance. Preclearance does not relieve you of your responsibility under SEC rules and should not be understood to represent legal advice by the Company that a proposed transaction complies with the law.

A request for preclearance must be in writing (e.g. by e-mail), should be made at least two business days in advance of the proposed transaction, and should include the identity of the Preclearance Person, a description of the proposed transaction (for example, an open market purchase, or sale, an option exercise, etc.), the proposed date of the transaction, and the number of shares or other securities to be involved. In addition, the Preclearance Person must certify that he or she is not aware of material nonpublic information about the Company. The Compliance Officer, or the Chief Executive Officer for transactions by the Compliance Officer, shall have sole discretion to decide whether to clear any contemplated transaction. All trades that are precleared must be effected within five business days of receipt of the preclearance. A precleared trade (or any portion of a precleared trade) that has not been effected during the five business day period must be re-submitted for pre-clearance determination prior to execution. Notwithstanding receipt of preclearance, if the Preclearance Person becomes aware of material nonpublic information or becomes subject to a blackout period before the transaction is effected, the transaction may not be completed.

None of the Company, the Compliance Officer or Chief Executive Officer, or the Company's other employees will have any liability for any delay in reviewing, or refusal of, a request for preclearance submitted pursuant to this Section IV.B. Notwithstanding any preclearance of a transaction pursuant to this Section IV.B, none of the Company, its officers, outside counsel, or the Company's other employees assumes any liability for the legality or consequences of such transaction to the person engaging in such transaction.

C. Post-Termination Transactions

If you are in possession of material nonpublic information when your service terminates, you may not trade in the Company's securities until that information has become public or is no longer material. Persons subject to Section 16 under the 1934 Act may have additional requirements.

D. Information Relating to the Company

Access to material nonpublic information about the Company, including the Company's business, earnings, or prospects, should be limited to officers, directors, and employees of the Company on a "need-to-know" basis. In addition, such information should not be communicated to anyone outside the Company under any circumstances (except in accordance with the Company's policies regarding the protection or authorized external disclosure of Company information) or to anyone within the Company on an other than "need-to-know" basis.

V. <u>Prohibited Transactions</u>

The Company has determined that there is a heightened legal risk and the appearance of improper or inappropriate conduct if persons subject to this Policy engage in certain types of transactions. Therefore, Covered Persons shall comply with the following policies with respect to certain transactions in the Company's securities:

A. Short Sales

Short sales of the Company's securities are prohibited by this Policy. Short sales of the Company's securities, or sales of shares that the insider does not own at the time of sale, or sales of shares against which the insider does not deliver the shares within 20 days after the sale, evidence an expectation on the part of the seller that the securities will decline in value, and, therefore, signal to the market that the seller has no confidence in the Company or its short-term prospects. In addition, Section 16(c) of the Exchange Act absolutely prohibits Section 16 reporting persons (i.e., directors, officers, and the Company's 10% shareholders) from making short sales of the Company's equity securities.

B. Options

Transactions in puts, calls, or other derivative securities involving the Company's equity securities, on an exchange, on an over-the-counter market, or in any other organized market, are prohibited by this Policy. A transaction in options is, in effect, a bet on the short-term movement of the Company's stock and, therefore, creates the appearance that a Covered Person is trading based on material nonpublic information. Transactions in options, whether traded on an exchange, on an over-the-counter market, or any other organized market, also may focus a Covered Person's attention on short-term performance at the expense of the Company's long-term objectives.

C. Hedging Transactions

Hedging transactions involving the Company's securities, such as prepaid variable forward sale contracts, equity swaps, collars and exchange funds, or other transactions that hedge or offset, or are designed to hedge or offset, any decrease in the market value of the Company's equity securities, are prohibited by this Policy. Such transactions allow the Covered Person to continue to own the covered securities, but without the full risks and rewards of ownership. When that occurs, the Covered Person may no longer have the same objectives as the Company's other shareholders.

D. Margin Accounts and Pledging

Individuals are prohibited from pledging Company securities as collateral for a loan, purchasing Company securities on margin (i.e., borrowing money to purchase the securities), or placing Company securities in a margin account. This prohibition does not apply to permitted cashless exercises of stock options under the Company's equity plans, nor to situations approved in advance by the Compliance Officer.

E. Director and Executive Officer Cashless Exercises

The Company will not arrange with brokers to administer cashless exercises on behalf of directors and executive officers of the Company. Directors and executive officers of the Company may use the cashless exercise feature of their equity awards only if (i) the director or officer retains a broker independently of the Company, (ii) the Company's involvement is limited to confirming that it will deliver the shares promptly upon payment of the exercise price, and (iii) the director or officer uses a cashless exercise arrangement, in which the Company agrees to deliver shares against the payment of the purchase price on the same day the sale of Company shares underlying the equity award settles. Under a cashless exercise, a broker, the issuer, and the issuer's transfer agent work together to make all transactions settle simultaneously. This approach is to avoid any inference that the Company has "extended credit" in the form of a personal loan to the director or executive officer. Questions about cashless exercises should be directed to the Compliance Officer.

F. Partnership Distributions

Nothing in this Policy is intended to limit the ability of an investment fund, a venture capital partnership or other similar entity with which a director is affiliated to distribute Company securities to its partners, members, or other similar persons. It is the responsibility of each affected director and the affiliated entity, in consultation with their own counsel (as appropriate), to determine the timing of any distributions, based on all relevant facts and circumstances and applicable securities laws.

VI. Rule 10b5-1 Trading Plans and Section 16.

A. Rule 10b5-1 Trading Plans

The trading restrictions set forth in this Policy, other than those transactions described under "Prohibited Transactions," do not apply to transactions under a previously established contract, plan, or instruction to trade in the Company's securities entered into in accordance with Rule 10b5-1 adopted in accordance with the requirements set forth in Attachment B. Rule 10b5-1 provides a defense from insider trading liability. In order to be eligible to rely on this defense, a person must enter into a Rule 10b5-1 trading plan that meets the conditions specified in Rule 10b5-1. Rule 10b5-1 presents an opportunity for insiders to establish plans during an open trading window to sell or purchase Company securities without the restrictions imposed by trading windows – even when in possession of material nonpublic information concerning the Company. Rule 10b5-1 only provides an "affirmative defense" if there is an insider trading lawsuit. It does not prevent anyone from bringing a lawsuit, nor does it prevent the media from reporting on any transactions executed pursuant to a plan. Compliance of a trading plan with the terms of Rule 10b5-1 and the execution of transactions pursuant to the trading plan are the sole responsibility of the person initiating the trading plan, and none of the Company, its counsel, the Compliance Officer, or the Company's other employees assume any liability for any delay in reviewing and/or refusing to approve a trading plan submitted for approval nor the legality or consequences relating to a person entering into, informing the Company of, or trading under a trading plan.

Trading plans do not exempt you from complying with Section 16 short-swing profit rules or liability, if applicable.

B. Section 16: Insider Reporting Requirements, Short-Swing Profits, and Short Sales (Applicable to Officers, Directors, and 10% Shareholders)

1. Reporting Obligations Under Section 16(a): SEC Forms 3, 4, and 5

Section 16(a) of the 1934 Act generally requires all officers, directors, and 10% stockholders ("Section 16 Insiders"), within 10 days after becoming a Section 16 Insider, to file with the SEC an "Initial Statement of Beneficial Ownership of Securities" on SEC Form 3, listing the amount of the Company's shares, options, and warrants that the Section 16 Insider beneficially owns. Following the initial filing on SEC Form 3, changes in beneficial ownership of the Company's shares, options, and warrants must be reported on SEC Form 4, generally within two days after the date on which such change occurs, or in certain cases on Form 5, within 45 days after fiscal year-end. The two-day Form 4 deadline begins to run from the trade date rather than the settlement date. A Form 4 must be filed even if, as a result of balancing transactions, there has been no net change in holdings. In certain situations, purchases or sales of Company shares made within six months *prior* to the filing of a Form 3 must be reported on Form 4. Similarly, certain purchases or sales of Company shares made within six months *after* an officer or director ceases to be a Section 16 Insider must be reported on Form 4.

2. Recovery of Profits Under Section 16(b)

For the purpose of preventing the unfair use of information that may have been obtained by a Section 16 Insider, any profits realized by a Section 16 Insider from any "purchase" and "sale" of Company shares during a six-month period, so called "short-swing profits," may be recovered by the Company. When such a purchase and sale occurs, good faith is no defense. The insider is liable, even if compelled to sell for personal reasons, and even if the sale takes place after full disclosure and without the use of any material nonpublic information.

The Section 16 Insider's liability under Section 16(b) of the 1934 Act is only to the Company itself. The Company, however, cannot waive its right to short swing profits, and any Company shareholder can bring suit in the name of the Company. Reports of ownership filed with the SEC on Form 3, Form 4, or Form 5 pursuant to Section 16(a) (discussed above) are readily available to the public, and certain attorneys carefully monitor these reports for potential Section

16(b) violations. In addition, liabilities under Section 16(b) may require separate disclosure in the Company's annual report to the SEC on Form 10-K or its proxy statement for its annual meeting of shareholders. No suit may be brought more than two years after the date the profit was realized. However, if the Section 16 Insider fails to file a report of the transaction under Section 16(a), as required, the two-year limitation period does not begin to run until after the transactions giving rise to the profit have been disclosed. Failure to report transactions and late filing of reports require separate disclosure in the Company's proxy statement.

Officers and directors should consult the attached "Short-Swing Profit Rule Section 16(b) Checklist" attached hereto as "Attachment A" in addition to consulting the Compliance Officer prior to engaging in any transactions involving the Company's securities, including, without limitation, the Company's shares, options, or warrants.

3. Short Sales Prohibited Under Section 16(c)

Section 16(c) of the 1934 Act absolutely prohibits Section 16 Insiders from making short sales of the Company's equity securities. Short sales include sales of shares that the Section 16 Insider does not own at the time of sale, or sales of shares against which the Section 16 Insider does not deliver the shares within 20 days after the sale. Under certain circumstances, the purchase or sale of put or call options, or the writing of such options, can result in a violation of Section 16(c). Section 16 Insiders violating Section 16(c) face criminal liability.

You should consult the Compliance Officer if you have any questions regarding reporting obligations, short-swing profits or short sales under Section 16.

VII. Interpretation, Amendment and Implementation of this Policy

The Compliance Officer shall have the authority to interpret and update this Policy and all related policies and procedures. In particular, such interpretations and updates of this Policy, as authorized by the Compliance Officer, may include amendments to or departures from the terms of this Policy, to the extent consistent with the general purpose of this Policy and applicable securities laws. Any material amendment to this Policy must be approved by the Board of Directors of the Company.

Actions taken by the Company, the Compliance Officer, or any other Company personnel do not constitute legal advice, nor do they insulate you from the consequences of noncompliance with this Policy or with securities laws.

VIII. Certification of Compliance

After reading this Policy, all officers, directors, and employees should complete the Acknowledgment in the Company's Training and Compliance system.

Attachment A

Short-Swing Profit Rule Section 16(b) Checklist

Note: ANY combination of PURCHASE AND SALE or SALE AND PURCHASE within six months of each other by an officer, director, or 10% shareholder (or any family member living in the same household or certain affiliated entities) results in a violation of Section 16(b), and the "profit" must be recovered by American States Water Company (the "Company"). It makes no difference how long the shares being sold have been held or, for officers and directors, that you were an insider for only one of the two matching transactions. The highest priced sale will be matched with the lowest priced purchase within the six-month period.

Sales

If a sale is to be made by an officer, director, or 10% shareholder (or any Immediate Family Member or certain affiliated entities of such persons): Have there been any purchases by the insider (or Immediate Family Members or certain affiliated entities) within the past six months?

1. Have there been any option grants or exercises not exempt under Rule 16b-3 within the past six months?

2. Are any purchases (or nonexempt option exercises) anticipated or required within the next six months?

3. Has a Form 4 been prepared?

Note: If a sale is to be made by an affiliate of the Company, has a Form 144 been prepared and has the broker been reminded to sell pursuant to Rule 144?

Purchases And Option Exercises

If a purchase or option exercise for Company shares is to be made:

1. Have there been any sales by the insider (or Immediate Family Members or certain affiliated entities) within the past six months?

2. Are any sales anticipated or required within the next six months (such as tax-related or year-end transactions)?

3. Has a Form 4 been prepared?

Before proceeding with a purchase or sale, consider whether you are aware of material nonpublic information that could affect the price of the Company shares. *All transactions in the Company's securities by officers and directors must be precleared by contacting the Company's Compliance Officer.*

Attachment B

REQUIREMENTS FOR ESTABLISHING AND TRADING UNDER A 10B5-1 TRADING PLAN

1.1 Minimum Plan Requirements. Your 10b5-1 trading plan must be entered into in good faith and during an open trading window at a time when you do not possess material nonpublic information concerning the Company. Your 10b5-1 trading plan may not be entered into as part of a plan or scheme to otherwise trade on the basis of material nonpublic information concerning the Company.

To comply with these requirements, your trading plan must:

a. Be in writing and preapproved by the Compliance Officer before you may enter into it.

b. Include appropriate trading instructions. You may either specify the price, number of shares and date of trades ahead of time or provide a formula or other instructions by which your broker can determine the price, amount and date of trades. Alternatively, you may simply authorize your broker to make purchase and sale decisions on your behalf without any control or influence by you.

c. For Section 16 officers only, include closed trading windows for the five trading days before and one trading day after the release of quarterly earnings. Because transactions by Section 16 officers are reported publicly, this proscription is intended to avoid the disclosure of trades in the immediate run up to and aftermath of the Company's announcement of quarterly earnings.

d. Prohibit you from exercising any influence over the amount of securities to be traded, the price at which they are to be traded, or the date of the trade. You may delegate discretionary authority to your broker, but in no event may you consult with your broker regarding executing transactions, or otherwise disclose information to your broker concerning the Company that might influence the execution of transactions, under your 10b5-1 trading plan after it commences.

e. Include a minimum cooling off period. Specifically, if you are a Section 16 officer or director, trading under your 10b5-1 trading plan may not begin until after the expiration of a cooling off period ending on the later of (1) 90 days after your adoption of your 10b5-1 trading plan or (2) two business days following the disclosure of the Company's financial results on Form 10-Q or Form 10-K, as applicable, for the fiscal quarter in which your 10b5-1 trading plan was adopted or modified, up to a maximum of 120 days. For all persons other than issuers, directors or officers, the applicable cooling-off period is 30 days after the adoption or modification of the trading plan. A cooling off period is required by SEC rules and designed to minimize the risk that a claim will be made that you were aware of material nonpublic information concerning the Company when you entered into the 10b5-1 trading plan and that the plan was not entered into or carried out in good faith.

f. Note that any amendment to an existing Rule 10b5-1 plan is considered a termination of the old plan and the adoption of a new plan, therefore triggering a cooling period of the same duration. An amendment includes a modification to the amount, price or timing of the purchase or sale of the securities or a modification to a written formula/algorithm that affects the amount, price or timing of the purchase or sale of the securities.

g. Include an expiration date that is at least six months but not more than 18 months from the effective date of your trading plan. We will not approve plans with terms of less than 6 months or in excess of 18 months. Shorter-term plans may be viewed as an attempt to make advantageous short-term trades, and longer-term plans are likely to have to be amended or terminated, which defeats the ultimate purpose of 10b5-1 trading plans.

h. Include representations at entry. Your 10b5-1 trading plan must include representations that, at the time of adoption or modification, that you (1) are not aware of material nonpublic information about the Company or its securities and (2) you are adopting or modifying the contract, instruction or plan in good faith and not as part of plan or scheme to evade the prohibitions of SEC Rule 10b5-1. All persons entering into a Rule 10b5-1 plan must be acting in good faith throughout the duration of the plan, not just when entering into the plan.

1.2 Trading Outside Your 10b5-1 Trading Plan. You may only purchase or sell Company securities outside of your 10b5-1 trading plan in accordance with our Insider Trading Policy. Changing elections with respect to Company stock under the Company's 401K Plan, the dividend reinvestment and stock purchase plan and the defined contribution plan would constitute transactions outside of the 10b5-1 trading plan and thus not subject to its protections. Such changes to elections may only be made outside of the "blackout periods". See Section IV.A. In addition, you may not buy or sell Company securities in an effort to use a hedging strategy to offset your plan trades while a plan is in effect. Any trading outside of your 10b5-1 trading plan will be subject to heightened scrutiny for potential hedging and, depending on the circumstances, it may be advisable not to engage in any trading outside the plan.

1.3 Cashless Exercises of Options. The cashless exercise of options under trading plans is permitted only through "same-day sales," in which the option holder does not pay for the stock up front, but rather receives cash equal to the difference between the stock value and option exercise price. Transactions prohibited under Section V of this Policy, including short sales and hedging transactions, may not be carried out through a Trading Plan.

1.4 Limit on Overlapping Plans. You may not have more than one 10b5-1 trading plan outstanding at the same time, except in limited circumstanced pursuant to Rule 10b5-1 and subject in all cases to preapproval by the Compliance Officer. Your trading plan cannot overlap with other trading plans. Anyone other than the Company is generally prohibited from having more than one Rule 10b5-1 trading plan for open market purchases or sales of an issuer's securities. However, this restriction does not apply if someone transacts directly with the Company, such as participating in the Company's dividend reinvestment plan (DRIP), in which transactions are not executed on the open market. This restriction also does not apply to plans authorizing an agent to sell only enough securities as are necessary to satisfy tax withholding obligations arising exclusively from the vesting of a compensatory award, such as on the vesting and settlement of restricted stock units (defined as "sell to cover" Rule 10b5-1 plans), provided that the award holder is not permitted to exercise control over the timing of such sales. A series of separate contracts with different broker-dealers to execute trades pursuant to a single Rule 10b5-1 plan will be treated as a single plan. Someone, other than the Company, may maintain two separate Rule 10b5-1 plans for open market purchases or sales of securities if trading under the later-commencing plan is not authorized to begin until after all trades under the earlier-commencing plan are completed or expire without execution. If the first plan is terminated early, the first trade under the later-commencing plan, however, must not be scheduled to occur until after the effective cooling-off period following the termination of the earlier plan.

1.5 Limit on "Single Trade" Plans. Subject to and in accordance with the terms of Rule 10b5-1, you may not have more than one "single trade" 10b5-1 trading plan during any 12-month period. A plan will not be treated as a single-trade plan if, for example, it gives the person's agent discretion over whether to execute the plan as a single transaction, or provides that the agent's future acts will depend on events or data not known at the time the plan is entered into and it is reasonably foreseeable at the time the plan is entered into that the plan might result in multiple trades. Also, sell-to-cover Rule 10b5-1 plans are exempt from this limitation.

1.6 Good Faith Requirements. The requirement that all Rule 10b5-1 plans are entered into in good faith means that the person entering into the plan has acted in good faith with respect to the plan, meaning that good faith must extend throughout the duration of the plan, not just when entering into the plan. For example, influencing the timing of the Company's disclosure so that trades under a plan are more profitable would run afoul of this ongoing good faith requirement.

1.7 Amendment, Suspension or Termination of the Trading Plan. Amendments, suspensions, and terminations will be viewed in hindsight and could call into question whether the 10b5-1 trading plan was entered into in good faith. As a result, amendments, suspensions, and terminations of 105-1 trading plans require pre-approval of the Compliance Officer, who will inquire into the change in circumstances that has occurred since the inception of the plan that is giving rise to the requested amendment, suspension, or termination. Scheduled sales or purchases of Company securities pursuant to your 10b5-1 trading plan will not be halted during the pendency of your amendment, suspension, or termination request. The Company has the right at any time to require additional and/or different requirements in connection with the amendment, suspension, or termination of a trading plan in order to protect you and the Company from potential liability. Further, your 10b5-1 trading plan may be terminated or suspended by the Company at any time and for any reason. In addition, you may voluntarily amend, suspend or terminate your 10b5-1 Trading Plan, subject to the following conditions:

a. You may only amend, suspend or terminate your 10b5-1 trading plan during a trading window and following preclearance by the Compliance Officer.

b. You may not amend, suspend or terminate your 10b5-1 trading plan if at the time of the amendment, suspension or termination you possess material nonpublic information concerning the Company.

c. You must sign a certificate in favor of the Company and your broker affirmatively stating that you do not possess material nonpublic information concerning the Company at the time of the amendment, suspension or termination.

d. Your amendment, suspension or termination must include any applicable cooling-off period pursuant to Rule 10b5-1.

e. No suspension of a 10b5-1 trading plan may exceed 60 calendar days.

f. A minimum of one year must elapse between your termination of an existing 10b5-1 Trading Plan and your entry into a new 10b5-1 trading plan.

g. You will be limited to one amendment or suspension of your 10b5-1 trading plan during its term.

1.8 Additional Plan Provisions. 10b5-1 trading plans must be operated in good faith and otherwise comply with Rule 10b5-1. None of the requirements or plan terms currently contemplated by these guidelines are exhaustive or limiting on the Company. The Company has the right to require the inclusion of additional provisions in your plan designed to protect you and/or the Company, whether before or after the plan has been approved by the Compliance Officer, or to delete or amend existing provisions.

1.9 Disclosures. The Company will be required to make certain quarterly disclosures, in accordance with Rule 10b5-1, regarding any adoption, modification or termination of a 10b5-1 trading plan by a director or Section 16 officer. Upon the occurrence of any such adoption, modification or termination, such persons are required to promptly furnish the Compliance Officer (via email) information regarding the date of adoption, termination or modification of the 10b5-1 trading plan, the 10b5-1 trading plan's duration, the aggregate number of securities to be sold or purchased under the 10b5-1 trading plan and any other information reasonably requested by the Compliance Officer.

Subsidiaries of
American States Water Company

Golden State Water Company

American States Utility Services, Inc.

Fort Bliss Water Services Company

Old Dominion Utility Services, Inc.

Terrapin Utility Services, Inc.

Palmetto State Utility Services, Inc.

Old North Utility Services, Inc.

Emerald Coast Utility Services, Inc.

Fort Riley Utility Services, Inc.

Bay State Utility Services LLC

Patuxent River Utility Services LLC

California Cities Water Company, Inc.

Bear Valley Electric Service, Inc.

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference in the Registration Statements on Forms S-3D (No. 333-155310) and S-8 (Nos. 333-108095, 333-213049 and 333-273526) of American States Water Company of our report dated February 21, 2024 relating to the financial statements, financial statement schedule and the effectiveness of internal control over financial reporting, which appears in this Form 10-K.

/s/ PricewaterhouseCoopers LLP

Los Angeles, California
February 21, 2024

Certification pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 for AWR

I, Robert J. Sprowls, certify that:

1) I have reviewed this annual report on Form 10-K of American States Water Company (referred to as "the Registrant") for the year ended December 31, 2023;

2) Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3) Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the Registrant as of, and for, the periods presented in this report;

4) The Registrant's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the Registrant and have:

    a) designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the Registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

    b) designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

    c) evaluated the effectiveness of the Registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

    d) disclosed in this report any change in the Registrant's internal control over financial reporting that occurred during the Registrant's most recent fiscal quarter (the Registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the Registrant's internal control over financial reporting.

5) The Registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the Registrant's auditors and the audit committee of Registrant's board of directors (or persons performing the equivalent function):

    a) all significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the Registrant's ability to record, process, summarize and report financial information; and

    b) any fraud, whether or not material, that involves management or other employees who have a significant role in the Registrant's internal controls over financial reporting.

Dated: February 21, 2024	By:	/s/ ROBERT J. SPROWLS
		Robert J. Sprowls President and Chief Executive Officer

Certification pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 for GSWC

I, Robert J. Sprowls, certify that:

1) I have reviewed this annual report on Form 10-K of Golden State Water Company (referred to as "GSWC") for the year ended December 31, 2023;
2) Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3) Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the GSWC as of, and for, the periods presented in this report;
4) GSWC's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for GSWC and have:
    a) designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to GSWC, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
    b) designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
    c) evaluated the effectiveness of GSWC's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
    d) disclosed in this report any change in GSWC's internal control over financial reporting that occurred during GSWC's most recent fiscal quarter (GSWC's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, GSWC's internal control over financial reporting.
5) GSWC's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the GSWC's auditors and the audit committee of GSWC's board of directors (or persons performing the equivalent function):
    a) all significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the GSWC's ability to record, process, summarize and report financial information; and
    b) any fraud, whether or not material, that involves management or other employees who have a significant role in GSWC's internal controls over financial reporting.

Dated: February 21, 2024

By: /s/ ROBERT J. SPROWLS
Robert J. Sprowls
President and Chief Executive Officer

Certification pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 for AWR

I, Eva G. Tang, certify that:

1) I have reviewed this annual report on Form 10-K of American States Water Company (referred to as "the Registrant") for the year ended December 31, 2023;

2) Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3) Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the Registrant as of, and for, the periods presented in this report;

4) The Registrant's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the Registrant and have:

   a) designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the Registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

   b) designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

   c) evaluated the effectiveness of the Registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

   d) disclosed in this report any change in the Registrant's internal control over financial reporting that occurred during the Registrant's most recent fiscal quarter (the Registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the Registrant's internal control over financial reporting.

5) The Registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the Registrant's auditors and the audit committee of Registrant's board of directors (or persons performing the equivalent function):

   a) all significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the Registrant's ability to record, process, summarize and report financial information; and

   b) any fraud, whether or not material, that involves management or other employees who have a significant role in the Registrant's internal controls over financial reporting.

Dated: February 21, 2024	By:	/s/ EVA G. TANG
		Eva G. Tang Senior Vice President-Finance, Chief Financial Officer, Treasurer and Corporate Secretary

Certification pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 for GSWC

I, Eva G. Tang, certify that:

1) I have reviewed this annual report on Form 10-K of Golden State Water Company (referred to as "GSWC") for the year ended December 31, 2023;
2) Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3) Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of GSWC as of, and for, the periods presented in this report;
4) GSWC's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for GSWC and have:
    a) designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to GSWC, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
    b) designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
    c) evaluated the effectiveness of GSWC's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
    d) disclosed in this report any change in GSWC's internal control over financial reporting that occurred during GSWC's most recent fiscal quarter (GSWC's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, GSWC's internal control over financial reporting.
5) GSWC's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to GSWC's auditors and the audit committee of GSWC's board of directors (or persons performing the equivalent function):
    a) all significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect GSWC's ability to record, process, summarize and report financial information; and
    b) any fraud, whether or not material, that involves management or other employees who have a significant role in GSWC's internal controls over financial reporting.

Dated: February 21, 2024	By:	/s/ EVA G. TANG
		Eva G. Tang Senior Vice President-Finance, Chief Financial Officer and Secretary

Certification pursuant to Section 906 of the Sarbanes-Oxley Act of 2002

In connection with the Annual Report of American States Water Company and Golden State Water Company (the “Registrant”) on Form 10-K for the year ended December 31, 2023, as filed with the Securities and Exchange Commission on the date hereof (the “Report”), I, Robert J. Sprowls, certify, pursuant to 18 U.S.C. § 1350, as adopted pursuant to § 906 of the Sarbanes-Oxley Act of 2002, that, to the best of my knowledge:

(1) The Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) The information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Registrant.

/s/ ROBERT J. SPROWLS

Robert J. Sprowls
President and Chief Executive Officer

Dated: February 21, 2024

Certification pursuant to Section 906 of the Sarbanes-Oxley Act of 2002
(18 U.S.C. Section 1350)

In connection with the Annual Report of American States Water Company and Golden State Water Company (the "Registrant") on Form 10-K for the year ended December 31, 2023, as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I, Eva G. Tang, certify, pursuant to 18 U.S.C. § 1350, as adopted pursuant to § 906 of the Sarbanes-Oxley Act of 2002, that, to the best of my knowledge:

(1) The Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) The information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Registrant.

/s/ EVA G. TANG

Eva G. Tang
Senior Vice President-Finance, Chief Financial Officer,
Treasurer and Corporate Secretary

Dated: February 21, 2024

Attachment 25: EPA Procedures for Rounding

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WSG 20
Date Signed: April 6, 1981

MEMORANDUM

SUBJECT: Procedures for Rounding-Off Analytical Data to Determine Compliance with Maximum Contaminant Levels Present in NIPDWR

FROM: Joseph A. Cotruvo, Ph.D., Director
Criteria and Standards Division, ODW (WH-550)

TO: Water Supply Representatives, Regions I-X, and holders of the Water Supply Guidance Series

All Maximum Contaminant Levels (MCL) contained in the National Interim Primary Drinking Water Regulations are expressed in the number of significant digits permitted by the precision and accuracy of the specified analytical procedure(s). Data reported to the State or EPA should be in a form containing the same number of significant digits as the MCL. In calculating data for compliance purposes, it is necessary to round-off by dropping the digits that are not significant. The last significant digit should be increased by one unit if the digit dropped is 5, 6, 7, 8 or 9. If the digit is 0, 1, 2, 3, or 4, do not alter the preceding number.

For example, if the monthly mean for coliform bacteria is 1.4999, the reported result should be 1 (one). A result of 3.50 should be rounded to 4 (four).

Chemical and radiological data may be treated in like manner. Analytical results for mercury of 0.0016 would round off to 0.002 while 5.4 pCi/l of combined radium-226 and radium-228 would round down to 5 pCi/l.

Attachment 26: Proposed PFAS National Primary Drinking Water Regulation (FAQ)

FAQ

Proposed PFAS National Primary Drinking Water Regulation FAQs for Drinking Water Primacy Agencies

Overview: What action is EPA taking to address PFAS in drinking water?

The U.S. Environmental Protection Agency (EPA) is taking a key step to protect public health by proposing to establish legally enforceable levels for six per- and polyfluoroalkyl substances (PFAS) known to occur in drinking water, fulfilling a foundational commitment in the Agency's PFAS Strategic Roadmap. Through this proposed rule, EPA is leveraging the most recent science and building on existing state efforts to limit PFAS and provide a nationwide, health-protective standard for these specific PFAS in drinking water.

Some states have established drinking water regulations or guidance values for some PFAS, leading the way in monitoring for and limiting PFAS. The National Primary Drinking Water Regulation (NPDWR) proposed by EPA, if finalized, will provide a nationwide, health-protective level for six PFAS in drinking water: PFOA, PFOS, PFHxS, GenX Chemicals, PFNA, and PFBS. EPA's proposed rule is informed by regulatory development requirements under the Safe Drinking Water Act (SDWA), including EPA's analysis of the best available and most recent peer-reviewed science. The proposal also takes into account the feasibility of analysis and treatment, as well as consideration of costs and benefits.

At this time, communities and water systems should follow applicable state requirements, recognizing that EPA's proposed rule does not currently require water systems to take any action. When the final NPDWR goes into effect, states will be required to have a standard that is no less strict than the NPDWR – as SDWA requires.

Question 1: What is the difference between this proposed drinking water regulation for PFOA, PFOS, PFHxS, GenX Chemicals, PFNA, and PFBS and the 2022 EPA Health Advisories for PFOA, PFOS, PFBS, and GenX Chemicals?

This is a proposed rule for public comment. It does not require any actions for drinking water systems until the rule is finalized. Once the rule is finalized, water systems would have three years to be in compliance with the MCLs.

The proposed regulation includes Maximum Contaminant Levels (MCLs) which, if finalized, are legally enforceable regulatory drinking water standards. EPA establishes MCLs as close as feasible to the health based, non-enforceable, Maximum Contaminant Level Goal (MCLG), taking into consideration the ability to measure and treat to remove a contaminant, as well as the costs and benefits.

Drinking water health advisories are different from MCLs and MCLGs. Each serves a different purpose. Health advisories are not regulatory and are not legally enforceable. Health advisories reflect EPA's assessment of health risks of a contaminant based on the best available science and provide advice and information on actions that water systems may take to address contamination for these and other PFAS. After EPA has considered public comments and issues a final NPDWR, EPA will decide whether to update or remove the interim health advisories for PFOA and PFOS and the final health advisories for PFBS and GenX Chemicals. For more information on the health advisories, please visit https://www.epa.gov/sdwa/drinking-water-health-advisories-pfoa-and-pfos.

Question 2: Why did EPA propose a Hazard Index for PFHxS, GenX Chemicals, PFNA, and PFBS?

EPA is following recent peer-reviewed science that indicates that mixtures of PFAS can pose a health risk greater than each chemical on its own. A Hazard Index helps to account for the increased risk from mixtures of PFAS that may be found in contaminated drinking water. The Hazard Index is a long-established tool that EPA regularly uses, for example, to inform risks of chemical mixtures. It is, for example used at contaminated Superfund sites (under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)). A Hazard Index considers how toxic each of the four PFAS are and allows a site-specific determination based on the specific drinking water concentrations.

Question 3: How is the Hazard Index for PFHxS, GenX Chemicals, PFNA, and PFBS calculated?

To determine the Hazard Index for these four PFAS, water systems would monitor and use those sampling results as inputs into a formula with their Health-Based Water Concentration (HBWC) (i.e., the level at which no health effects are expected for that PFAS). The proposed HBWCs for each of the four PFAS are below.

Compound	Health-Based Water Concentration (ppt)
PFHxS	**9.0**
GenX Chemicals	**10**
PFNA	**10**
PFBS	**2000**

Water systems would use a calculator tool provided by EPA to easily determine their Hazard Index result. The tool performs the calculation explained below.

For each of the four PFAS, the calculation first divides the results of the drinking water sample by the HBWC and then adds all the values for each PFAS. If the total value is greater than 1.0, it would be an exceedance of the proposed Hazard Index MCL as follows:

$$\text{Hazard Index} = \left(\frac{[\text{GenX}_{\text{water}}]}{[10\text{ ppt}]}\right) + \left(\frac{[\text{PFBS}_{\text{water}}]}{[2000\text{ ppt}]}\right) + \left(\frac{[\text{PFNA}_{\text{water}}]}{[10\text{ ppt}]}\right) + \left(\frac{[\text{PFHxS}_{\text{water}}]}{[9.0\text{ ppt}]}\right)$$

Where $\text{GenX}_{\text{water}}$ = monitored concentration of GenX
$\text{PFBS}_{\text{water}}$ = monitored concentration of PFBS
$\text{PFNA}_{\text{water}}$= monitored concentration of PFNA
$\text{PFHxS}_{\text{water}}$ = monitored concentration of PFHxS

For example, if the mixture contains the following levels of these four PFAS, the Hazard Index for that mixture would exceed the proposed MCL.

$$2.1 = \left(\frac{[5\text{ ppt}]}{[10\text{ ppt}]}\right) + \left(\frac{[200\text{ ppt}]}{[2000\text{ ppt}]}\right) + \left(\frac{[5\text{ ppt}]}{[10\text{ ppt}]}\right) + \left(\frac{[9\text{ ppt}]}{[9.0\text{ ppt}]}\right)$$

Question 4: Under the proposed rule, do all four PFAS under the Hazard Index need to be present for a water system to exceed the proposed PFAS NPDWR?

No. The Hazard Index works at the local level and applies to any combination of the four PFAS. In some cases, a water system could exceed the proposed Hazard Index MCL when only one, two, or three PFAS are present.

Moreover, a high concentration of one Hazard Index PFAS could drive an MCL exceedance.

Question 5: Why didn't EPA include PFOA and PFOS in the proposed Hazard Index MCL?

EPA determined that PFOA and PFOS are likely carcinogens (i.e., cancer causing) and that there is no level of these contaminants that is without a risk of adverse health effects. Therefore, EPA is proposing to set the MCL for these two contaminants at 4 parts per trillion, the lowest feasible level based on the ability to reliably measure and remove these contaminants from drinking water.

Question 6: What is the Practical Quantitation Level (PQL)?

The PQL is defined as the lowest concentration of a contaminant that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. This level provides the precision and accuracy that EPA estimates can be achieved across laboratories nationwide. EPA has used the PQLs for the six PFAS proposed for regulation in determining the proposed MCLs. EPA has identified the following PQLs for the six PFAS proposed for regulation.

Compound	Practical Quantitation Level (ppt)
PFOS	**4.0**
PFOA	**4.0**
PFHxS	**3.0**
GenX Chemicals	**5.0**
PFNA	**4.0**
PFBS	**3.0**

Question 7: What are the proposed rule's monitoring requirements?

The proposed rule would require that all community water systems and non-transient, non-community water systems conduct initial monitoring within three years after the rule's promulgation. The monitoring must be conducted at the entry point to the distribution system. Based on their size and source water, systems must conduct initial monitoring either twice or quarterly during a 12-month period as follows:

- **Groundwater systems serving greater than 10,000 customers.** Initially, these systems would be required to monitor quarterly within a 12-month period.
- **Groundwater systems serving under 10,000 customers.** EPA is proposing that these systems would initially be required to only monitor twice within a 12-month period, with each sample 90 days apart.
- **Surface water systems.** All surface water systems would initially be required to monitor quarterly within a 12-month period.

In order to reduce costs for systems, systems would be allowed to use previously collected monitoring data to satisfy the initial monitoring requirements, if the sampling was conducted using EPA Methods 533 or 537.1 as part of UCMR 5 or other state-level or other appropriate monitoring campaigns. EPA is aware of many state and federal monitoring programs whose data would potentially satisfy the initial monitoring requirements.
If finalized, after rule promulgation, community water systems and non-transient, non-community water systems would conduct quarterly compliance monitoring. Based on initial monitoring or later compliance results, primacy agencies would have the authority to reduce compliance monitoring frequency for a system to once (for systems serving fewer than 3,300 persons) or twice (for systems serving 3,300 or more persons) every

three years if monitoring results are below the trigger level. The trigger level is set at one-third of the MCLs for PFOA and PFOS (1.3 ppt) and one-third of the Hazard Index MCL (0.33) for mixtures of PFHxS, GenX Chemicals, PFNA, and PFBS. Any system that monitors less frequently and finds sample results at or above the rule trigger level would need to revert to quarterly monitoring.

Reduced monitoring would reduce burden on water systems that demonstrate through sampling that they are at lower risk of PFAS contamination.

Question 8: Why is EPA setting a reduced-monitoring trigger level below the PQL for certain PFAS?

The proposed reduced-monitoring trigger level is set at a level that is useful in determining whether the contaminant is present in a sample rather than to determine its specific concentration. While measurements below the PQLs may be less definitive, they are appropriate for determining if PFAS are present and establishing monitoring frequency.

Question 9: Can systems utilize composite samples?

EPA is proposing not to allow composite samples. Composite sampling is an approach in which equal volumes of water from multiple entry points are combined into a single container and analyzed as a mixture. The reported concentration from the analysis of the composite samples therefore reflects the average of the concentrations from the entry points. This can potentially reduce analytical costs because the required analysis is reduced by combining samples into one. However, because PFAS are in the environment at low concentrations and precision is critical, incidental contamination could result in false positives.

Question 10: Will EPA consider granting monitoring waivers?

Based on consultation with state regulators and small public water systems, EPA believes that the ubiquity and environmental persistence of PFAS would make granting waivers challenging and is therefore not proposing to grant them. EPA is taking comment on whether water systems should be allowed to apply for a monitoring waiver of up to 9 years (one full compliance cycle) for proposed PFAS if after one year of quarterly sampling the results are below the trigger level of 1/3 of the MCL (1.3 ppt).

Question 11: How can a system comply with an MCL when it is set at the Practical Quantitation Level? Would any monitoring result above the PQL result in non-compliance?

Not necessarily. Compliance will be determined based on analytical results at each sampling point. For systems monitoring quarterly, compliance will be determined by running annual averages at the sampling point. If a system takes more than one compliance sample during each quarter at a particular location, the system must average all samples taken at that location during that quarter. A system would not be considered in violation of an MCL unless or until it has completed one year of quarterly sampling (except where a sample would be high enough to cause the annual average to exceed an MCL).

For example, if the results of sampling for PFOA at a compliance location for the most recent four quarters are 2.0, 1.5, 5.0, and 1.5 ppt, the values used to calculate the running annual average would be 0.0, 0.0, 5.0, and 0.0. In this case the PFOA running annual average would be 1.3 ppt and in compliance.

Question 12: Does EPA have PFAS treatment disposal guidance, especially regarding higher volumes of PFAS laden materials such as used carbon and anion exchange media?

A facility that has spent carbon or other media from treating PFAS and/or other contaminants must determine whether the material is a regulated waste. If the material was only used to treat PFAS, it is likely not considered hazardous waste (under federal statutes). EPA published "*Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances*" that describes the options of landfilling, injection and thermal treatment for disposing PFAS laden materials. The guidance notes that thermal treatment techniques, including carbon reactivation, may allow PFAS to migrate to the environment. EPA and partners are undertaking research to further address the subject. EPA is also working to update this guidance in 2023. Materials used to treat PFAS may become hazardous if there are additional contaminants that are hazardous removed along with PFAS.

Question 13: What are Consumer Confidence Reports (CCR) requirements of the proposed rule?

A community water system (CWS) must prepare and deliver to its customers a CCR, also known as an Annual Water Quality Report, which provides information about their local drinking water quality as well as information regarding the water system compliance with drinking water regulations. If this rule is finalized as proposed, CWSs would be required to report measured levels of PFOA, PFOS, PFHxS, GenX Chemicals, PFNA, and PFBS, and the Hazard Index for the mixtures of PFHxS, GenX Chemicals, PFNA, and PFBS.

Question 14: What are the public notification requirements for PFAS under this proposed rule?

The proposed rule would require water systems to provide notification of an MCL violation as soon as practicable but no later than 30 days after the system learns of the violation. The notices would alert consumers of the violation and if there is a risk to public health.

Question 15: What is the timeline and process for state primacy?

Primacy agencies must have regulations for contaminants regulated under National Primary Drinking Water Regulations (NPDWRs) that are no less stringent than the regulations promulgated by EPA. States will have up to two years to develop regulations after the rule is final. EPA will provide guidance to support states, territories, and Tribes in obtaining primacy for the PFAS NPDWR. More information on primacy responsibilities under the Safe Drinking Water Act can be found at: https://www.epa.gov/dwreginfo/primacy-enforcement-responsibility-public-water-systems

Attachment 27: PFAS (Water Boards)

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- In May 2016, the United States Environmental Protection Agency (US EPA) issued a lifetime health advisory for PFOS and PFOA for drinking water, advising municipalities that they should notify their customers of the presence of levels over 70 parts per trillion (ppt) in community water supplies. US EPA recommended that customer notifications include information on the increased risk to health, especially for susceptible populations.
- In July 2018, DDW established an interim notification level of 14 ppt for PFOA and 13 ppt for PFOS and a single response level of 70 ppt for the combined concentrations of PFOA and PFOS.
- In August 2019, DDW revised the notification levels to 6.5 ppt for PFOS and 5.1 ppt for PFOA. The single health advisory level (for the combined values of PFOS and PFOA) remained at 70 ppt.
- On February 6, 2020, DDW issued updated drinking water response levels of 10 ppt for PFOA and 40 ppt for PFOS based on a running four-quarter average.
- On March 5, 2021, DDW issued a drinking water notification level and response level of 0.5 parts per billion (ppb) and 5 ppb, respectively for perfluorobutane sulfonic acid (PFBS).
- On October 31, 2022, DDW issued a drinking water notification level and response level of 3 parts per trillion (ppt) and 20 ppt, respectively for perfluorohexane sulfonic acid (PFHxS).

Additional information about PFOA and PFOS can be found at can be found at the Division of Drinking Water: PFAS Webpage.

Find the name of a PWS provider nearest you or for a particular location - map your location or enter an address.

Find contact information for a PWS provider on the DDW's Drinking Water Watch website - enter the 'Water System Name'.

A map with your local DDW district engineer contact information.

Announcements and background on the issuance of PFAS NLs and other Drinking Water NLs.

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Drinking Water Web Pages

- Division of Drinking Water: PFAS Webpage
- Division of Drinking Water Home Page
- Drinking Water Systems - Information

Questions? Comments?

If you have questions about our program, please email us at:

- PFAS@waterboards.ca.gov

For additional information about PFAS

- Division of Drinking Water District Engineers
- GeoTracker Help Desk
- ITRC PFAS Fact Sheets (English and Spanish)

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(Page last updated 3/17/23)

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