



October 20, 2021

TO: LOCSD Utilities Advisory Committee

FROM: Ron Munds, General Manager

SUBJECT: Agenda Item 3 - 10/20/2021 Utilities Advisory Committee Meeting
Basin Management Committee (BMC) Update – Sustainable Yield/Spring Monitoring Results

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STAFF RECOMMENDATION

Receive information update regarding the September 29, 2021 BMC meeting

DISCUSSION

At the September UAC meeting, there was a discussion regarding the BMC's work effort to update the Sustainable Yield estimate as defined in the Basin Plan. There was a review of the assumptions built into the groundwater model used to determine calculate the Sustainable Yield number which include:

- Precipitation
- Stream Inflow
- Recycled Water Deliveries to Broderson and Bayridge
- Purveyor Pumping
- Non-purveyor Pumping
- Sea Level

At the September 29th BMC meeting, the Directors received a report (attached) which provided recommended changes to the methodology to calculate the Sustainable Yield and procedures and timeline by which the Sustainable Yield would be calculated and adopted each year consistent with the Stipulated Judgement. A key change, which the BMC Directors agreed with, was to change the constraint in the model to not allow seawater to intrude further than has been observed to-date. The other minor change in assumptions in lowering the average annual precipitation from 17.5 inches to 17.3 inches. A detailed explanation of the change is included in the report.

The next BMC meeting has been postponed to October 27th in order for staff to develop the model runs requested by the BMC based on the new direction. The results will be presented in the staff report which is due out on October 22nd.

Spring Monitoring Report

Attached to this report is the Spring Monitoring results. The data was delayed while waiting for confirmation of the data that the BMC receives from the County and State. The results show a slight improvement in the Chloride and Water Levels. There is concern regarding the Chloride levels reported in LA31 since it is quite a bit lower than the historical average. This is still to be resolved. The Fall monitoring program is underway and the results should be available by the end of the year.

Attachment

BMC staff report
Spring Monitoring Report

TO: Los Osos Basin Management Committee

FROM: Dan Heibel, Executive Director

DATE: September 29, 2021

SUBJECT: Item 8b – Sustainable Yield_x Methodology Review and Recommendations

Recommendations

Receive information from BMC Staff's review of the Sustainable Yield_x methodology and provide direction on Staff's recommendations regarding: 1) revisions to the methodology; and 2) the procedure / timeline by which the Sustainable Yield will be calculated each year.

Discussion

Background

In the Stipulated Judgement (SJ) and the Basin Plan, the BMC Parties agreed on a framework and methodology for estimating and updating the Sustainable Yield for the Los Osos Basin (Basin), referred to as Sustainable Yield_x, where "X" represents the Sustainable Yield estimate for that year. The SJ and Basin Plan require the BMC to annually evaluate, confirm and set the Sustainable Yield_x based on the best available data and evidence. At the July 21, 2021 BMC Meeting the BMC directed staff to review the Sustainable Yield estimate and to bring back recommendations for calculating the Sustainable Yield_x.

The Sustainable Yield_x calculation is a critical component of the basin monitoring and management framework established for the Basin. As specified in the Basin Plan, the Sustainable Yield_x is defined as the maximum amount of groundwater that may be extracted from the Basin, with the existing infrastructure, in Year "X" (1) without causing seawater to advance further inland or (2) while maintaining a stable seawater intrusion front and with no active well producing water with chloride concentrations above 250 mg/L. The amount of water that can be extracted under this criteria is determined using the numeric groundwater model (Model) created for the Basin. Additional information regarding the Model and its development and calibration is available in Basin Plan Section 5.6.5.

The Sustainable Yield_x is used to guide the BMC in making decisions regarding the current sustainability and management of pumping by the purveyors within the Basin and is included in calculation of the following metrics and management mechanisms:

Basin Yield Metric

The Basin Yield Metric (BYM) is one of the metrics that the BMC utilizes to track progress in the fight against seawater intrusion. The BYM compares the actual amount of groundwater extractions in a given year with the Sustainable Yield_x for that year. The equation for calculating the Basin Yield is shown below.

$$\text{Basin Yield Metric} = \frac{\text{Year}_{xx} \text{ Groundwater Production}}{\text{Sustainable Yield}_x} * 100$$

Figure 1. Basin Yield Metric Equation

The target BYM identified in the Basin Plan is 80 or lower. This target, which includes a 20% buffer or safety factor was incorporated into the BYM to target Basin conditions that would push the freshwater-seawater interface or seawater intrusion front seaward and to protect against uncertainty. The types of potential uncertainty identified in the Basin Plan include: physical and pumping assumptions in the Model; Model limitations (i.e. Steady State); changes in agricultural pumping; effectiveness in the Urban Water Use Efficiency Program; changes in population; climate variability (including climate change); and natural hazards. Figure 2, which is Figure 38 from the Basin Plan, illustrates the anticipated location of the seawater intrusion front under the Sustainable Yield (BYM 100) pumping scenario and the location under the BYM 80 (20% safety factor) pumping scenario. As shown, with the reduced pumping associated with a BYM of 80 the Model predicts that the seawater intrusion front will be pushed seaward.

The BMC evaluates the BYM on an annual basis and compares the BYM for that year against the target of 80 for estimating whether or not the pumping occurring in a given year is sustainable given the available infrastructure (i.e. wells). A BYM value below 80 is an indicator that Basin pumping is below the maximum sustainable level and a BYM value above 80 indicates that pumping need to be reduced or additional infrastructure is needed to achieve sustainable conditions.



Figure 2. Figure 38 from Basin Plan illustrating seawater intrusion front at BYM 100 and BYM 80

Basin Development Metric

The Basin Development Metric is a comparison of the Sustainable Yield_x and the potential Sustainable Yield that could be achieved through completion of all the potential projects identified in the Basin Plan for implementation. This metric provides the BMC with an indication of how much progress has been made toward implementing the programs identified in the Basin Plan for increasing the Sustainable Yield.

Purveyor Pool

The Sustainable Yield_x is also used for the purposes of determining the Purveyor Pool. The SJ establishes four Pools: the Purveyor Pool; Agricultural Pool; Community Pool; and Private Domestic Pool for the purposes of dividing the Sustainable Yield_x amongst the different groundwater user types within the Basin. The allocation percentages for a Sustainable Yield_x estimate of 2,400 AFY for each of the Pools is shown in Figure 3 below. The SJ currently only allows for adjustments to the Purveyor Pool based on changes to the Sustainable Yield_x (because no private pumpers are parties). Additional information on the Purveyor Pool and its relationship to the Sustainable Yield_x can be found in Section 4 of the SJ.

User	Pool Share (%)	Pool Allowance (AFY)
Purveyor Pool	59.58	1,430
Agricultural Pool	31.25	750.0
Community Pool	2.92	70.0
Private Domestic Pool	6.25	150.0
Subtotal	100.00	2,400

Figure 3. Pool Allocation Based on Sustainable Yield_x of 2,400 AFY

Sustainable Yield_x Methodology and Key Assumptions Review

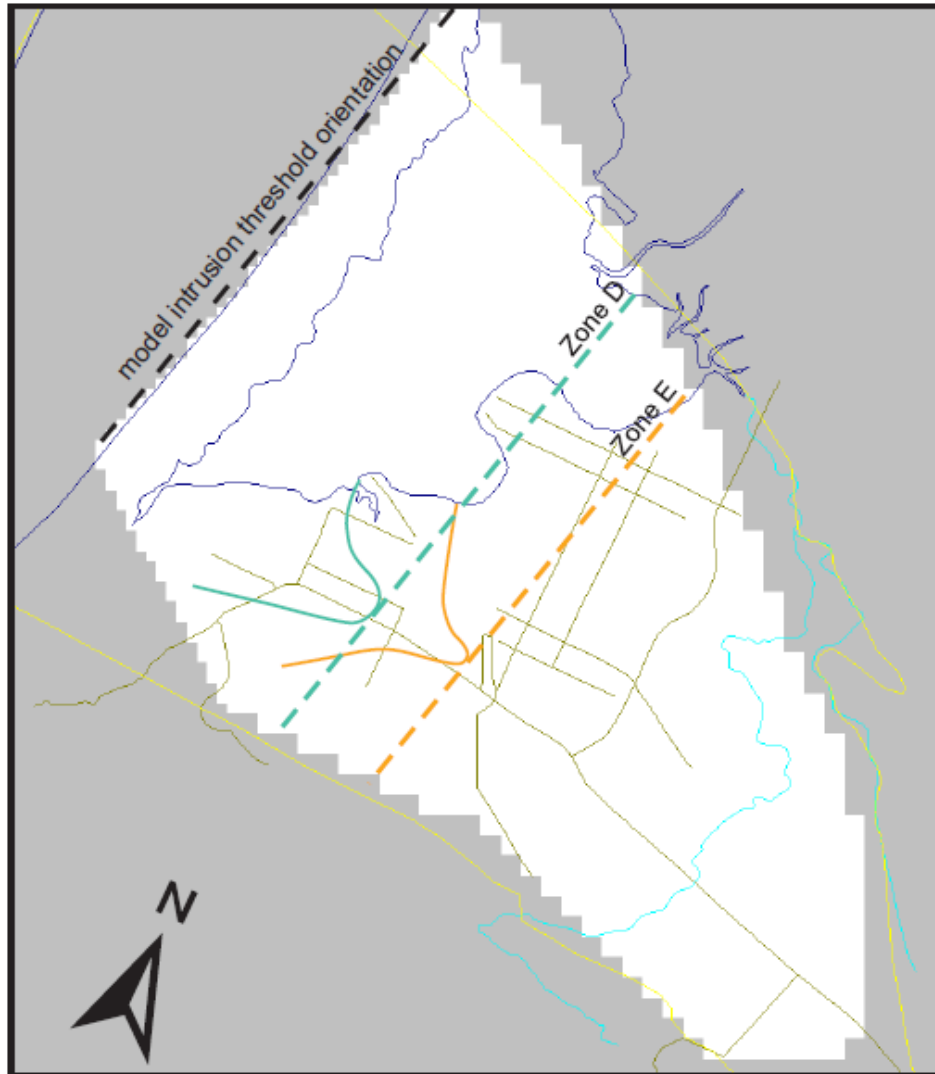
As directed by the BMC, BMC Staff and BMC Party Staff, which includes staff representatives from each of the BMC Parties, reviewed the current methodology and key assumptions for the Sustainable Yield calculation. Based on the review, BMC Staff prepared the following recommendations for the BMC's consideration when approaching the Sustainable Yield_x calculation.

Sustainable Yield Threshold

As described previously, the Sustainable Yield_x is defined as the maximum amount of groundwater that may be extracted from the Basin in Year "X" (1) without causing seawater to advance further inland or (2) while maintaining a stable seawater intrusion front and with no active well producing water with chloride concentrations above 250 mg/L. Based on policy direction that was provided during the development of the Stipulated Judgement, the Basin Plan and the previously developed Sustainable Yield estimates, this was interpreted to allow for the development of Sustainable Yield pumping scenarios and calculation of the Sustainable Yield_x that included seawater intruding further into the

basin than has previously occurred to date (i.e. losing additional ground to seawater intrusion) before stabilizing and meeting the criteria described above.

BMC Staff propose evaluating an alternative approach, which would not allow seawater to intrude further than has been observed to-date (i.e. holding ground against further seawater intrusion). This approach would include establishing thresholds or limits for future seawater intrusion in the basin based on the current extent of seawater intrusion for Zones D and E. These new thresholds or limits would then be the limiting constraints for calculating the Sustainable Yield_x or the amount of pumping that the Model predicts could be achieved without inducing further seawater intrusion into the Basin. Figure 4 illustrates the current estimated extents of seawater intrusion in Zones D and E of the Basin and the associated “intrusion front” threshold lines that could be used as the limiting constraint for the proposed alternative approach to calculating the Sustainable Yield.



Scale 1" = 4000 feet

- Zone D 250 mg/L isochlor (2020 Annual report)
- Zone E 250 mg/L isochlor (2020 Annual report)
- - - Zone D intrusion front Minimum Threshold
- - - Zone E intrusion front Minimum Threshold

Figure 1

Seawater Intrusion
Minimum Thresholds
Sustainable Yield Review

Cleath-Harris Geologists

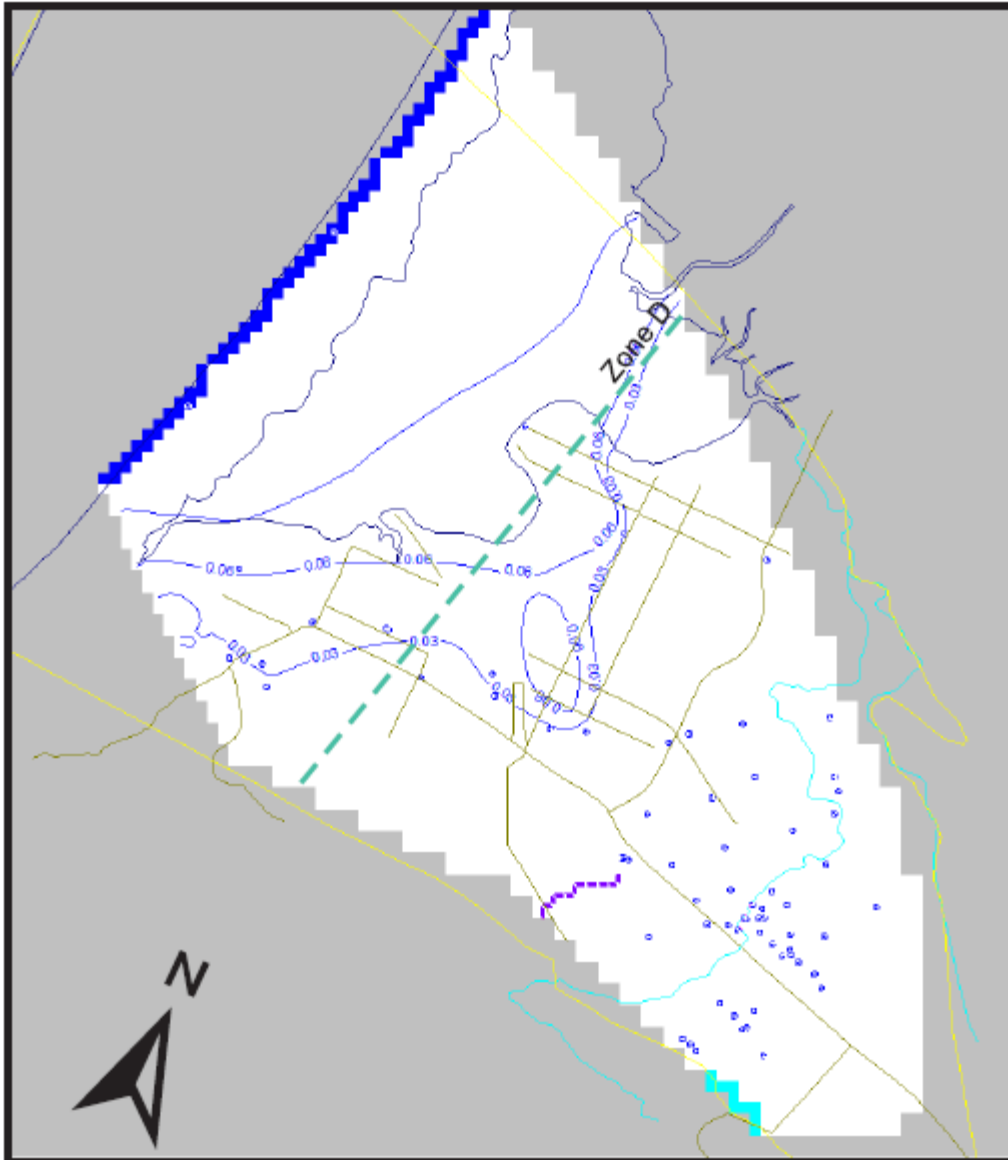
Figure 4. Current estimates of seawater intrusion extent within the basin

For comparison purposes, the estimated extent of seawater intrusion included in the “Basin Yield Metric response to reduced long-term precipitation in the Los Osos Groundwater Basin” 2017 Technical Memorandum Sustainable Yield calculation, is shown in Figure 5 and Figure 6. As shown in these figures, the model estimates that pumping occurring at the 2,760 AFY Sustainable Yield would allow seawater to

intrude further inland than the current extent of seawater intrusion, illustrated by the proposed “intrusion front” threshold developed based on the current extent of seawater intrusion in the Basin.

Based on the desire to avoid further degradation of the Basin from seawater intrusion, BMC Staff recommends that the threshold for calculating Sustainable Yield be modified to represent the current extents of seawater intrusion. Under the proposed alternative approach, the Sustainable Yield_x would be calculated as the amount of water that could be extracted from the basin, with existing infrastructure, without causing seawater to intrude further than the current extent and with no active well producing water with a chloride concentration above 250 mg/L.

Establishing this new threshold is consistent with how basins with similar seawater intrusion threats approach the development of Sustainable Management Criteria (SMC) under the Sustainable Groundwater Management Act (SGMA). SGMA calls for the development of SMC that includes Minimum Thresholds and Measurable Objectives. Minimum Thresholds are established as the minimum threshold or worst-case condition that cannot be exceeded without having undesirable results or detrimental impacts on the basin. Measurable Objectives are set as the desired objective that indicate maintenance or improvement of specific groundwater conditions that is desired to achieve. Under the proposed alternative approach, the “intrusion front” thresholds, established based on the current extent of seawater intrusion, could be the equivalent of the Minimum Threshold under SGMA and the BYM target of 80 could be the equivalent of the Measurable Objective.



Scale 1" = 4000 feet

TDS isoconcentrations in lb/ft3

- 0.03 lb/ft3 = 500 mg/l TDS \approx 250 mg/l Chloride
- 0.06 lb/ft3 = 1,000 mg/l TDS \approx 500 mg/l Chloride
- 0.31 lb/ft3 = 5,000 mg/l TDS \approx 2,500 mg/l Chloride

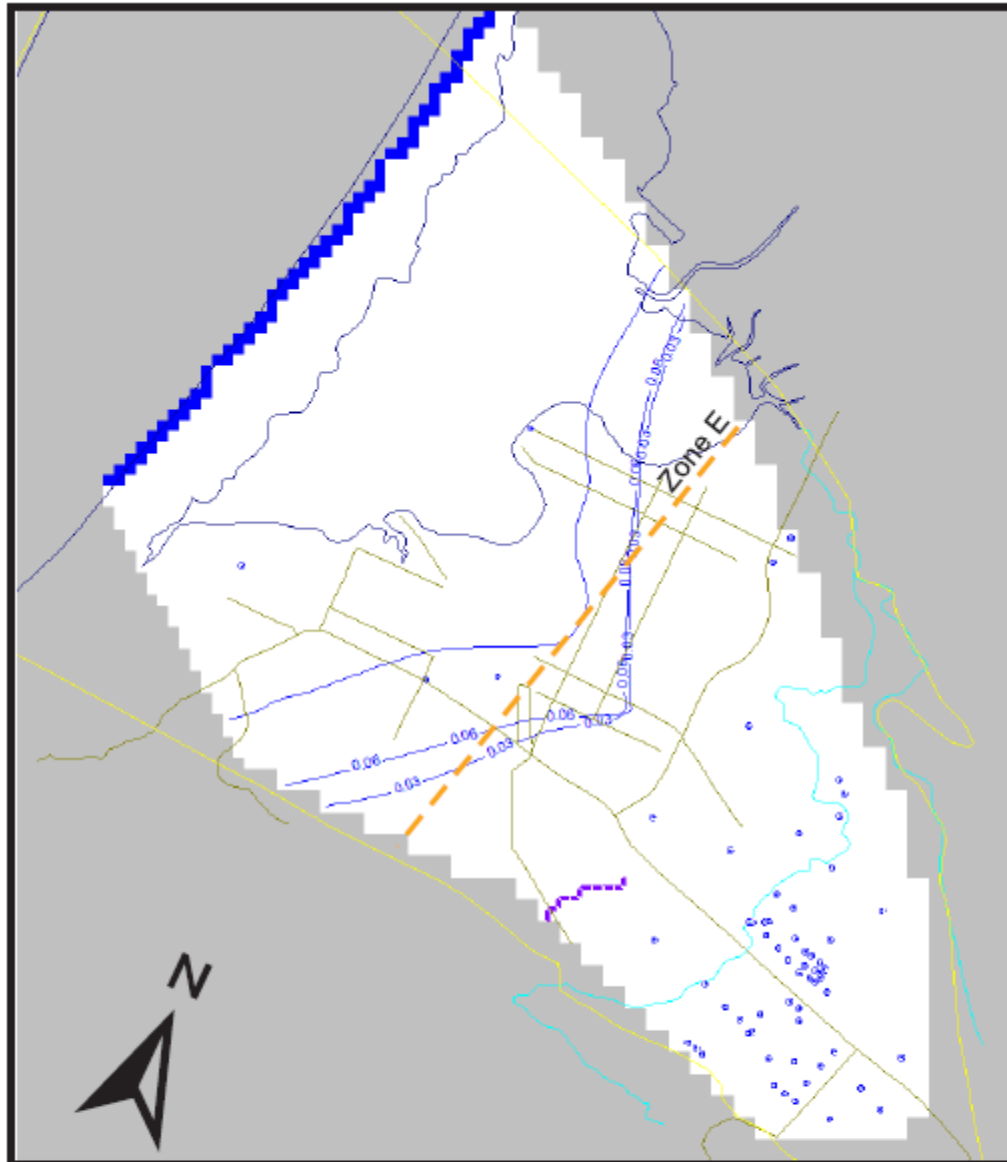
----- Zone D intrusion front
Minimum Threshold

Figure 2

TDS Isoconcentrations
2016 BYM 100 - Zone D
Steady State at 2,760 AFY

Cleath-Harris Geologists

Figure 5. Estimated extent of Zone D seawater intrusion in 2,760 AFY Sustainable Yield estimate



Scale 1" = 4000 feet

TDS isoconcentrations in lb/ft3

0.03 lb/ft3 = 500 mg/l TDS \approx 250 mg/l Chloride
 0.06 lb/ft3 = 1,000 mg/l TDS \approx 500 mg/l Chloride
 0.31 lb/ft3 = 5,000 mg/l TDS \approx 2,500 mg/l Chloride

----- Zone E intrusion front
 Minimum Threshold

Figure 4

TDS Isoconcentrations
 2016 BYM 100 - Zone E
 Steady State at 2,760 AFY

Cleath-Harris Geologists

Figure 6. Estimated extent of Zone E seawater intrusion in 2,760 AFY Sustainable Yield estimate

Precipitation

Precipitation in the Model is currently assumed to be 17.5 inches per year. This average was based on correlating annual rainfall at Morro Bay Fire Department (which has the longest period of record) with rainfall at the South Bay Fire Department (Los Osos). The original correlation (Yates and Williams 2003) resulted in a multiplier of 1.05 (Morro Bay rainfall x 1.05 = Los Osos rainfall). Using the long-term average annual rainfall at Morro Bay of 16.72 inches (through 2003) the corresponding long-term average for Los Osos was 17.5 inches. BMC Staff reviewed the rainfall assumption and performed an evaluation that incorporated the most recent data available from the PRISM Climate Group and the Los Osos Landfill and Morro Bay Fire Department rain gauges. The results of the PRISM data set evaluation, which included data from 1981 - 2010 and is the latest available 30-year normal isohyetal data provided a weighted rainfall average estimate for Los Osos of 17.1 inches/year. The analysis and updated correlation of rainfall data from the Morro Bay Fire Station and the South Bay Fire Department/Los Osos Landfill incorporating data from 1960 – 2020 produced an average rainfall estimate for Los Osos of 17.5 inches/year. Based on the results of this evaluation, BMC Staff is recommending reducing the rainfall/precipitation assumption in the model from 17.5 inches/year to 17.3 inches/year, which represents an average of the results from the two updated evaluations. Additional information on the rainfall analysis is included in Appendix A.

Other Sustainable Yield_x Assumptions

There are number of other assumptions that are utilized within the Model when performing the calculation of Sustainable Yield_x, which are described below. BMC Staff reviewed these assumptions and determined them to be suitably conservative for the Sustainable Yield_x calculation and additional changes are not recommended.

Stream Inflow – Stream Inflow in the Model is limited at 800 AFY and is constrained by stream bed seepage capacity to be approximately 20% of the estimated average watershed runoff.

Recycled Water – Recycled water delivery assumptions included in the Model include 448 AFY to Broderson and 33 AFY to Bayridge Estates.

Non-Purveyor Pumping – Non-Purveyor pumping assumptions in the model are listed below:

Non-Purveyor Pumping Type	Assumed Pumping Rate (AFY)	Notes
Agriculture	750	
Private Domestic	220	
Sea Pines Golf Course*	50	Assumed 30 AFY recycled water from Monarch WWTP (prior to recycled water deliveries from LOWRF)
Memorial Park	50	
Community Park	0	Assumed 5 AFY recycled water

*Pumping rate for Sea Pines to be adjusted based on projected demand and LOWRF recycled water deliveries.

Purveyor Pumping – The amount of purveyor pumping included in the Sustainable Yield_x calculation is iteratively determined by increasing purveyor well pumping until the identified threshold is reached. Pumping rates for individual purveyor wells are optimized, based on available infrastructure, to shift purveyor pumping from the lower aquifer to eastern portions of the Basin and/or to the upper aquifer.

Sea Level – Sea level in the Model is assumed to be 0 ft elevation in National Geodetic Vertical Datum of 1929 (NGVD 29) which is roughly equivalent to Mean Sea Level for the Port San Luis buoy of 2.72 ft in North America Vertical Datum of 1988 (NAVD 88).

Proposed Sustainable Yield Update Process

To meet the requirements of the SJ to determine the Sustainable Yield_x on an annual basis the following process is proposed.

1. Beginning in July of a given year, BMC Staff will evaluate the Sustainable Yield_x for the upcoming year based on changes in Basin Plan infrastructure, groundwater inflow or outflow parameters, the understanding of hydrogeologic or geologic features in the basin or other factors.
2. BMC Staff will then provide a recommendation to the BMC on Sustainable Yield_x for the upcoming year and the reasoning for that recommendation.
 - a. If the recommendation is to modify the Sustainable Yield_x, then recommendations for which parameters to modify from the previous Sustainable Yield_x will be provided.
 - i. If the BMC approves the recommended modifications to the Sustainable Yield_x, BMC Staff will perform the updated Sustainable Yield_x calculations and bring the results back to the BMC for consideration and approval.
 - ii. If the updated Sustainable Yield_x results are unanimously approved by the BMC then the updated Sustainable Yield_x will be documented in the Annual Report for that Year and used for calculation of the Basin Yield Metric, Basin Development Metric and Purveyor Pool for the upcoming year.
 - b. If the recommendation is to not modify the Sustainable Yield_x and the BMC agrees, then the Sustainable Yield_x will remain the same as the previously approved Sustainable Yield_x by the BMC.
 - c. If the BMC cannot come to unanimous agreement of whether or not to modify the Sustainable Yield_x then the Sustainable Yield_x will remain the same as the previously approved Sustainable Yield_x and the BMC will provide direction to Staff on how to proceed.

An example timeline for the envisioned process of updating the Sustainable Yield_x and incorporating it into the BMC monitoring, management and Annual Monitoring Report processes is outlined below:

1. July 2021 BMC Staff begins evaluation of Sustainable Yield₂₀₂₂
2. BMC Staff presents recommendations for Sustainable Yield₂₀₂₂
3. Before January 2022 BMC approves Sustainable Yield₂₀₂₂
4. Sustainable Yield₂₀₂₂ used to establish Purveyor Pool for 2022

5. Sustainable Yield₂₀₂₂ incorporated into Basin Yield and Basin Development Metric calculations for 2022 Annual Monitoring Report (AMR)
6. Sustainable Yield₂₀₂₂ described in 2021 AMR

Financial Considerations

Minimal costs associated with developing a Sustainable Yield_x were included in the BMC CY 2021 Budget as part of Task 6 (2020 Annual Report). However, Cleath-Harris Geologists (CHG) has been tasked to provide additional analysis and attend multiple meetings in support of the Sustainable Yield_x evaluation and calculation and it is recommended that the BMC authorize the Executive Director to utilize \$12,000 of contingency funds, as needed, to compensate CHG for their additional effort and support in preparing the Sustainable Yield₂₀₂₂ calculations. There are currently contingency and Technical Support/Adaptive Management Services funds in the CY 2021 Budget that could be put toward this additional effort associated with the evaluating and updating the Sustainable Yield_x.

Appendix A

Los Osos Long-Term Annual Rainfall

Method 1: Isohyetal map (PRISM 1981-2010 data set)

The Basin area between each isohyetal contour was measured. These areas were multiplied by the intermediate isohyetal value, and added together to determine average annual rainfall, which was 17.1 inches. See attached Figure 1.

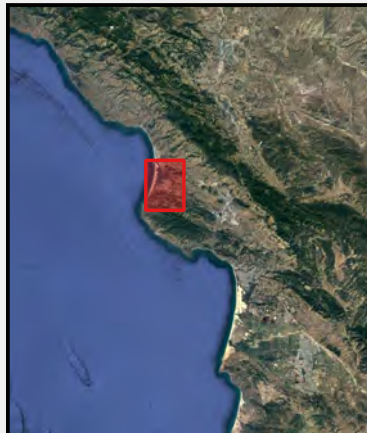
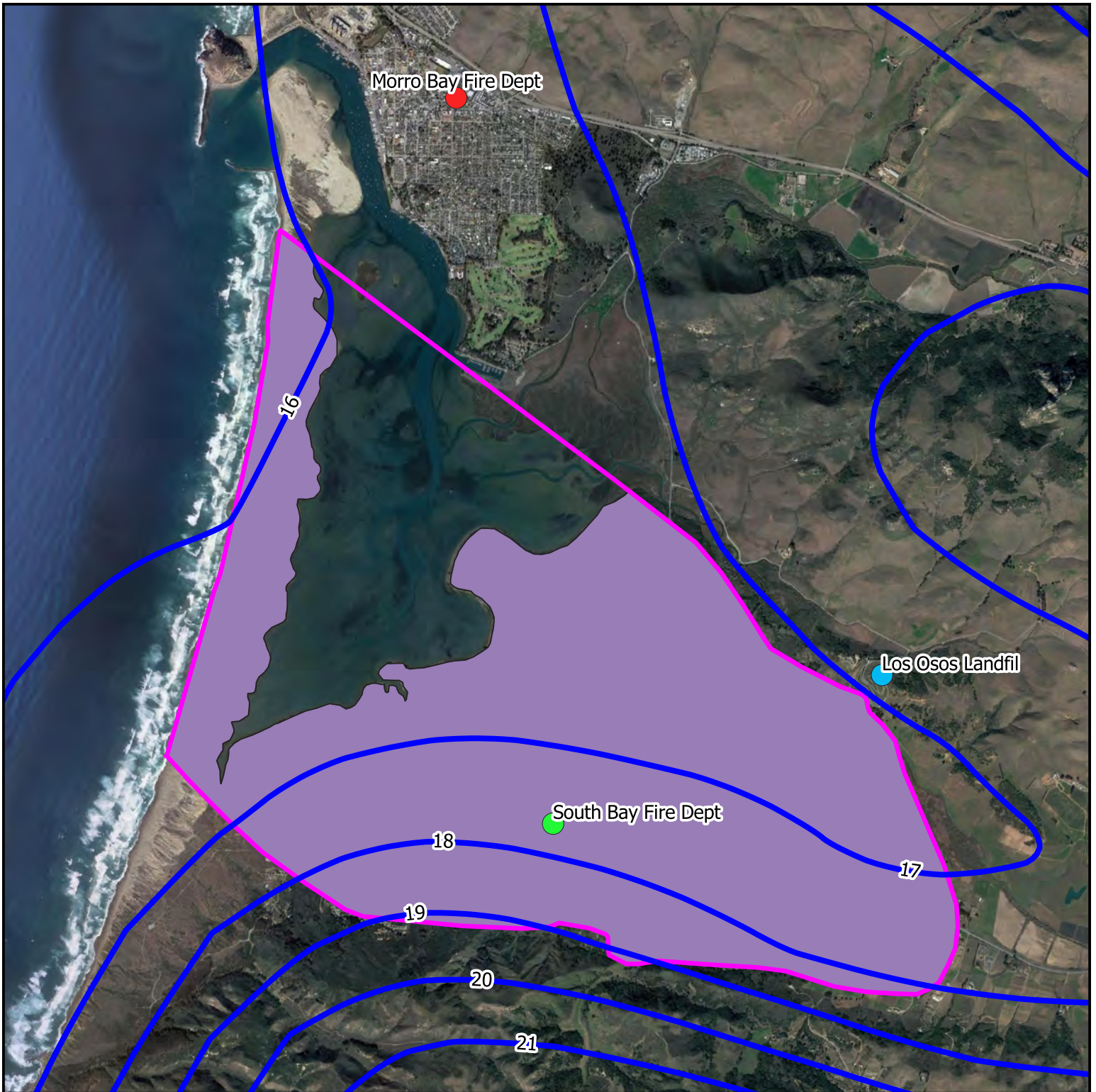
Rainfall (in)	Area (acres)	Ratio	weighted rainfall (in)
16	178	0.037	0.59
16.5	2496	0.518	8.55
17.5	1493	0.31	5.43
18.5	617	0.128	2.37
19	32	0.007	0.13
Total	4816	1	17.1

Method 2: Correlation with long-term rainfall data at the Morro Bay Fire Department.

Rainfall data at the South Bay Fire Department (1975-2001) and the Los Osos Landfill (2006-2020) were combined into a single dataset and correlated with rainfall at the Morro Bay Fire Department. The best fit linear trend line indicates Los Osos averaged 8.7 percent wetter than Morro Bay. The corresponding long-term annual rainfall for Los Osos is 17.5 inches, based on multiplying the long-term annual rainfall value of 16.1 in/year at Morro Bay Fire Department (1960-2020) by 1.0874. See attached Figure 2.

Long-Term Annual Rainfall

Results from the two methods (17.1 inches and 17.5 inches) were averaged to establish the updated long-term annual rainfall of **17.3 inches** for Los Osos.



Explanation

- Isohyetal Contours Inches/ Year
- Measured Area for Isohyetal Calculation
- Los Osos Groundwater Basin Boundary
- Morro Bay Fire Dept
- South Bay Fire Dept
- Los Osos Landfill



[Coord. Sys: State Plane Zone 5, US ft] [Horiz. Datum: NAD83] [Vert. Datum: NAVD88]

**Figure 1
Isohyetal Map of
Los Osos, CA**

Los Osos BMC

Cleath-Harris Geologists

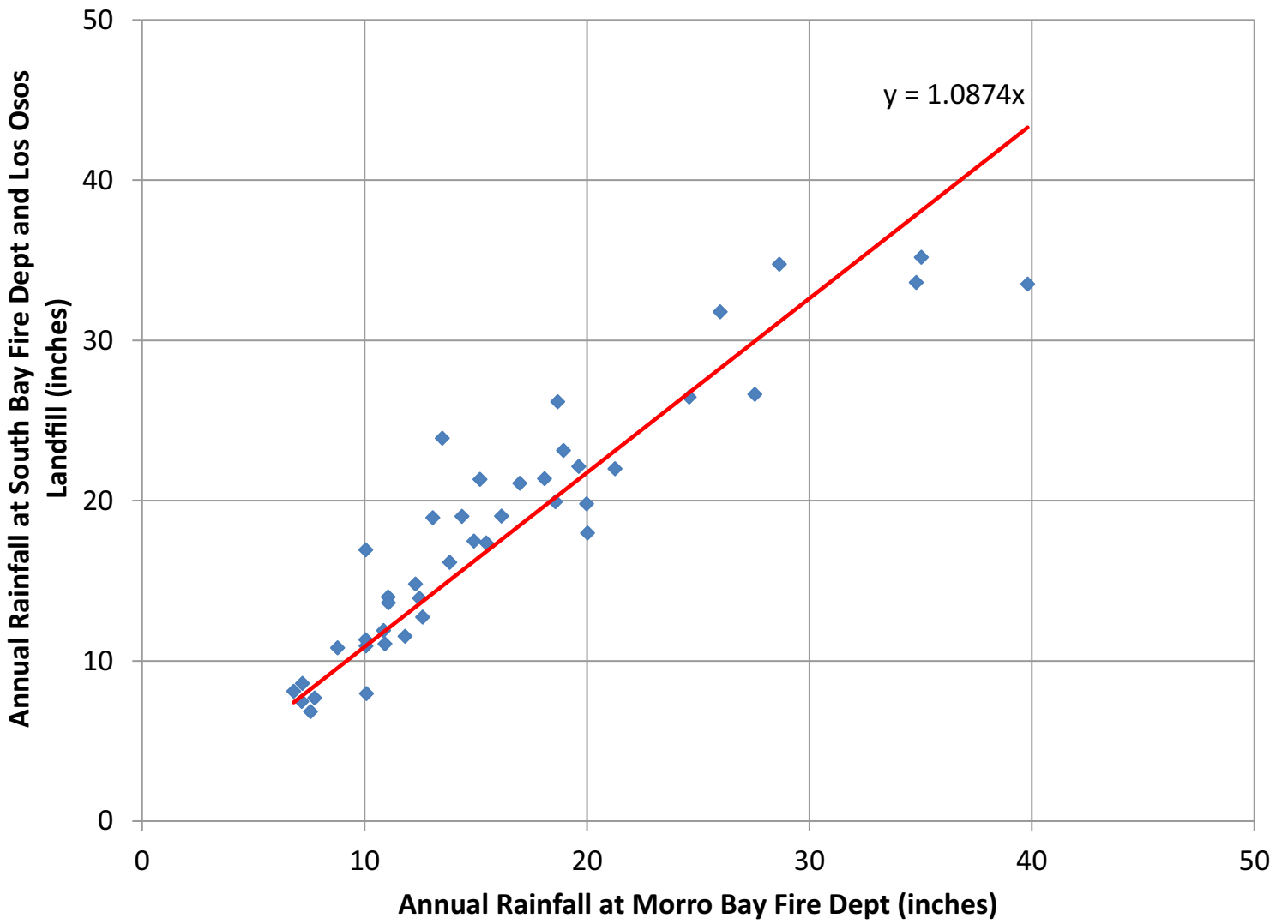


Figure 2

Los Osos - Morro Bay Rainfall Correlation
Los Osos BMC

Cleath-Harris Geologists

TO: Los Osos Basin Management Committee

FROM: Daniel Heimel, Executive Director

DATE: September 29, 2021

SUBJECT: Item 8a – Draft 2021 Spring Lower Aquifer Groundwater Basin Monitoring Results

Recommendations

Receive an update on early findings for the Spring 2021 Lower Aquifer Groundwater Monitoring results.

Discussion

As described in Section 5.14 of the Stipulated Judgment and Chapter 7 of the Basin Plan, the Basin Management Committee (BMC) established a groundwater monitoring program to provide the BMC, parties to the adjudication, private Basin water users and public agencies with continuously updated information on groundwater resources in the Basin. The BMC retained Cleath Harris Geologists (CHG) to perform the groundwater monitoring program for 2021. The following attachments include the draft results from the Spring 2021 lower aquifer groundwater monitoring and updated Water Level and Chloride Metrics. Final results, including water levels and results from the first water and upper aquifer monitoring, will be included in the 2021 Annual Report.

Financial Considerations

Budget items 5 in the adopted calendar year 2021 budget address monitoring. At this time, no budget adjustments are recommended.

Water Quality Results - Lower Aquifer Monitoring

Station ID	Well Name	Basin Plan Well ID	Aquifer Zone	Date	HCO3	Total Hardness	Cond	pH	TDS	Cl	NO3-N	SO4	Ca	Mg	K	Na
					mg/l	mg/l	umhos/cm		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
30S/10E-11A2	Sand Spit #1 East	LA2	D	3/14/2005	180	4600	16000	7.3	8900	5400	ND	430	770	640	20	1300
				10/21/2015	150	6640	17700	7.4	13100	6300	ND	740	1030	990	31	1560
				11/5/2020	220	6700	18000	7.7	15300	5890	ND	777	1140	936	38	1560
30S/10E-12J1	MBO5 DWR Obs.	LA11	E	2/14/2005	350	370	1300	8.1	840	77	ND	190	51	58	6.1	110
				11/20/2009	300	360	1150	7.5	732	83	ND	190	51	58	4.4	95
				7/24/2014	360	489	1290	7.7	780	105	ND	212	69	77	5	88
				4/22/2015	360	475	1290	7.8	810	112	ND	189	65	76	5	88
				10/1/2015	250	486	1280	7.3	840	117	ND	188	68	77	4	85
				4/20/2016	330	524	1370	n/a	840	151	ND	193	73	40	5	83
				10/10/2016	350	497	1370	7.1	930	173	ND	189	69	79	4	81
				4/11/2017	350	541	1380	7.5	880	167	ND	186	75	86	4	81
				10/4/2017	300	543	1370	7	850	162	ND	191	76	86	5	90
				4/10/2018	350	595	1390	7.6	820	173	ND	192	85	93	5	97
				10/2/2018	350	497	1340	7.4	870	160	ND	160	69	79	3	87
				4/9/2019	350	539	1430	7.4	860	196	ND	189	76	85	4	85
				10/2/2019	250	290	1520	7.6	1000	187	ND	189	80	90	5	91
				4/14/2020	350	667	1580	7	950	222	ND	187	81	113	5	83
10/1/2020	350	763	1650	7.1	1040	242	ND	183	85	134	5	88				
4/5/2021	345	612	1630	7.6	1050	256	ND	192	88	96	5	91				
30S/10E-13Bb	Lupine Zone D	LA41	D	11/7/2019	210	312	1310	7.7	760	136	3.1	188	69	34	4	140
				4/8/2020	310	204	943	7.1	560	68	0.3	109	44	23	2	101
				10/8/2020	340	263	920	7.1	490	52	0.1	89	51	33	2	72
				4/14/2021	333	289	855	7.9	505	66	ND	86	53	38	2	60
30S/10E-13Ba	Lupine Zone E	LA40	E	11/6/2019	210	2090	5330	7	4750	1460	1.3	224	388	272	6	182
				4/7/2020	240	3300	7360	7.6	6340	2190	0.3	202	569	458	7	203
				10/7/2020	270	4100	8220	6.9	7930	2220	ND	192	720	560	8	217
				4/15/2021	274	3760	8590	7.4	6760	2510	ND	217	558	576	7	210
30S/10E-13J1* Highlighted chloride values have been adjusted for wellbore leakage	GSWC Rosina	LA10	D,E	12/20/2004	72	230	720	7.1	410	150	1.6	14	38	33	1.4	29
				1/14/2010	35	260	778	6	435	200	1.6	13	41	38	1.5	33
				7/24/2014	80	418	1200	7.3	910	303	1.7	16	67	61	2	39
				4/22/2015	80	431	1230	7.1	750	331	1.9	20	69	63	2	39
				10/5/2015	70	460	1280	7	950	329	1.7	19	74	67	2	41
				4/26/2016	80	412	1170	7.1	840	299	1.8	18	66	60	2	37
				10/12/2016	60	509	1430	6.8	1100	389	1.8	27	82	74	2	44
				4/10/2017	80	327	957	6.9	720	300	2.6	15	52	48	2	35
				10/12/2017	80	245	702	6.9	510	220	3.4	13	39	36	2	33
				4/24/2018	70	188	620	7.4	400	190	4.3	12	29	28	1	29
				10/9/2018	70	265	730	7.1	450	210	3.2	13	42	39	2	34
				4/15/2019	80	251	744	7	600	174	1.9	10	38	38	2	31
				10/14/2019	80	332	961	7.1	830	229	2	13	54	48	1	33
4/21/2020	80	353	1310	6.4	970	250	2.1	14	59	50	2	32				
10/7/2020	70	183	618	7.6	430	310	4.6	11	29	27	1	33				
4/6/2021	81	405	1110	7.6	815	258	2.1	16	66	58	2	36				

Water Quality Results - Lower Aquifer Monitoring

Station ID	Well Name	Basin Plan Well ID	Aquifer Zone	Date	HCO3	Total Hardness	Cond	pH	TDS	Cl	NO3-N	SO4	Ca	Mg	K	Na				
					mg/l	mg/l	umhos/cm		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l					
30S/10E-13M2 4/1/2021 sample results show Upper Aquifer influence due to reduced pumping	Howard East	LA31	C,D	11/22/2004	51	810	2900	7.3	1500	810	0.5	140	60	120	4.7	210				
				12/9/2009	55	1100	3740	7.1	2170	1100	0.5	220	160	160	4.8	370				
				8/4/2014	60	757	3340	7.1	2450	990	0.6	178	117	113	5	382				
				4/21/2015	60	739	3430	7.3	1930	950	0.6	178	117	113	5	382				
				10/6/2015	30	756	3370	7.1	2140	960	0.5	185	115	114	5	342				
				4/20/2016	50	726	3520	7.2	2190	941	0.7	179	113	108	5	400				
				10/19/2016	70	722	3420	7.4	2190	943	0.6	182	113	107	4	398				
				4/17/2017	60	733	3380	6.8	2060	907	0.6	178	114	109	4	413				
				10/5/2017	60	738	3350	7.5	2190	960	0.7	160	116	109	5	411				
				4/24/2018	70	664	3370	7.2	2020	946	0.6	2.8	103	99	4	367				
				10/17/2018	60	740	3400	7.3	2180	834	0.6	153	115	110	5	414				
				4/3/2019	70	640	3290	7.8	2010	940	0.6	179	103	93	4	341				
				10/3/2019	70	574	3120	7.4	2120	827	0.7	169	90	85	4	340				
4/9/2020	70	519	2970	7.8	1740	738	0.6	152	86	74	4	258								
10/1/2020	70	774	3330	8	2080	844	0.7	169	94	131	5	495								
4/1/2021	218	187	1010	8.3	581	161	2.9	47	31	27	20	113								
30S/10E-13N	S&T #5	LA8	D	11/23/2004	42	80	390	6.9	200	67	5.9	9.2	13	12	1.7	38				
				11/19/2009	41	89	386	6.8	267	73	6.1	11	15	13	1.4	38				
				7/24/2014	50	100	438	7.4	270	76	7	10	17	14	2	38				
				4/21/2015	50	98	445	6.9	280	77	7.7	11	16	14	2	38				
				10/6/2015	40	98	422	7.2	310	75	6.8	10	16	14	1	38				
				4/20/2016	20	97.5	446	7	320	76	7.2	12	16	14	1	38				
				10/13/2016	50	104	470	8	320	79	7.2	12	17	15	1	40				
				4/11/2017	50	100	434	7.4	270	77	7.3	12	17	14	1	38				
				10/2/2017	30	95	438	7.2	290	78	7.6	13	15	14	1	36				
				4/11/2018	60	104	440	7	260	79	7.9	14	17	15	1	39				
				10/3/2018	60	107	430	6.5	340	66	6.7	13	18	15	2	40				
				4/3/2019	50	100	434	6.3	250	75	7.3	13	17	14	1	36				
				10/7/2019	60	95	446	7.6	250	77	7.7	14	15	14	1	37				
				4/13/2020	60	104	443	8	300	75	7.4	15	17	15	2	37				
10/1/2020	60	108	464	7.9	300	76	7.5	14	17	16	1	40								
4/6/2021	63	103	438	7.4	302	78	7.8	13	17	15	1.4	38								
30S/10E-14B2	Sand Spit #3 Deep	LA3	D	3/15/2005	100	3600	30000	8	17000	8500	ND	960	1200	130	34	4300				
				10/21/2015	ND	7140	29500	11	24700	10000	ND	530	2830	20	80	4040				
30S/10E-24C1	GSWC Cabrillo	LA9	D	12/20/2004	64	130	610	7	310	110	4.5	19	22	19	1.6	50				
				11/20/2009	60	150	611	7.1	347	130	4.1	22	23	22	1.6	52				
				7/24/2014	40	69	339	7.6	240	46	8.4	6	11	10	1	32				
				4/22/2015	70	117	530	7.3	320	95	5.5	16	19	17	2	45				
				10/5/2015	50	75	349	7.6	270	50	7.6	7	12	11	1	34				
				4/26/2016	70	115	499	7	300	90	5.6	16	18	17	2	44				
				10/12/2016	70	111	506	7.1	320	93	5.5	15	18	16	1	44				
				4/10/2017	70	111	490	7	310	89	5.7	16	18	16	1	43				
				10/12/2017	70	117	484	7	270	89	6	16	19	17	2	46				
				4/24/2018	70	115	486	7.8	300	90	6.2	17	18	17	1	43				
				10/9/2018	60	135	477	6.9	280	76	5.8	17	21	20	2	50				
				4/15/2019	70	112	488	7.1	310	92	5.7	16	17	17	2	45				
				10/14/2019	no sample (off-line)															
				4/21/2020	300	75.2	674	6.71	370	37	0.2	28	3	35	2	42				
10/7/2020	60	102	460	7.4	270	75	6.6	13	16	15	1	40								
4/6/2021	63	98.6	443	7.89	287	78	6.8	12	16	15	1	39								

Water Quality Results - Lower Aquifer Monitoring

Station ID	Well Name	Basin Plan Well ID	Aquifer Zone	Date	HCO3	Total Hardness	Cond	pH	TDS	Cl	NO3-N	SO4	Ca	Mg	K	Na
					mg/l	mg/l	umhos/cm		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
30S/11E-7Q3	LOCSD 8th St.	LA12	D	11/18/2004	250	270	790	7.5	410	73	ND	39	44	40	2.3	48
				11/19/2009	220	290	782	7.4	465	92	ND	46	46	42	1.9	53
				7/23/2014	290	303	876	7.6	460	91	ND	43	49	44	2	54
				4/21/2015	290	305	897	7.7	500	101	ND	55	48	45	2	59
				10/6/2015	280	298	828	7.4	490	91	ND	46	47	44	2	55
				4/20/2016	190	307	907	7.7	520	91	ND	49	49	45	2	54
				10/11/2016	280	278	827	4.9	490	93	ND	46.2	44	41	2	52
				4/10/2017	300	294	839	7.3	480	91	ND	49.5	47	43	2	54
				10/4/2017	220	305	826	6.5	470	92	ND	45	48	45	2	56
				4/10/2018	300	319	814	7.7	440	93	ND	46.2	52	46	2	56
				10/2/2018	290	283	822	7.3	470	78	ND	50.1	46	41	1	53
				4/9/2019	300	301	844	7.5	480	94	ND	49.7	48	44	2	53
				10/2/2019	290	312	877	8	530	91	ND	50.9	49	46	2	56
				4/16/2020	310	301	883	7.8	500	94	ND	54.7	48	44	2	52
10/5/2020	300	321	891	7.9	510	89	ND	49.6	51	47	2	57				
4/5/2021	305	297	849	7.7	504	94	ND	54.1	48	43	2	54				
30S/11E-17E8	So. Bay Obs. Middle	LA22	D	1/14/2005	150	150	440	7.5	290	34	2.2	11	24	22	1.4	28
				11/20/2009	120	160	455	7.3	255	42	4.3	12	25	23	1.3	29
				7/23/2014	150	166	500	7.6	270	43	6.3	10	27	24	2	28
				4/21/2015	150	157	481	7.6	270	49	7.1	13	25	23	1	28
				10/1/2015	120	164	475	7.4	290	44	6.6	10	26	24	1	28
				4/19/2016	150	164	476	6.9	290	45	6.9	12	26	24	1	29
				10/13/2016	140	161	521	7.3	290	46	6.9	11.9	25	24	1	29
				4/13/2017	150	164	466	7.3	300	46	6.7	13.2	26	24	1	29
				10/11/2017	150	168	476	7.7	260	47	7.2	14	26	25	1	29
				4/16/2018	150	165	473	6.4	310	47	6.7	14.2	25	25	1	29
				10/10/2018	150	160	471	7.5	250	43	6.1	15	26	23	1	28
				4/10/2019	180	153	466	7.2	290	46	5.8	13.6	25	22	1	28
				10/9/2019	150	155	485	7.3	270	49	7	14.9	24	23	1	28
				4/14/2020	160	164	482	8	280	48	6.3	14.9	26	24	1	27
10/6/2020	160	181	506	7.5	340	47	6.7	14.7	28	27	1	30				
4/8/2021	159	154	470	7.5	329	46	5.8	12.5	24	23	1	27				
30S/11E-17N10	GSWC So. Bay #1	LA20	C,D,E	Jan 2003	250	--	510	7.1	290	37	ND	21	41	25	1.3	35
				11/20/2009	230	220	638	7.3	357	41	0.5	30	35	33	1.7	37
				7/24/2014	280	232	646	7.7	370	37	0.5	24	37	34	2	41
				4/22/2015	290	234	653	7.4	360	43	0.6	27	36	35	2	42
				10/5/2015	280	227	614	7.2	370	38	0.5	23	35	34	2	41
				4/26/2016	230	227	629	7.1	360	39	0.6	27	35	34	2	40
				10/12/2016	290	221	631	7	370	40	0.6	25.2	34	33	2	40
				4/10/2017	280	227	624	7.2	380	39	0.6	26.7	35	34	2	40
				10/12/2017	260	240	583	6.6	320	41	0.7	27.9	37	36	2	43
				4/24/2018	200	166	515	7.4	330	43	3.2	23.2	27	24	2	31
				10/9/2018	290	273	632	7.2	340	38	0.6	29.2	42	41	3	47
				4/15/2019	200	181	559	7.4	310	42	3.1	21.7	28	27	2	34
				10/14/2019	290	221	626	7.2	380	41	0.7	29	34	33	2	40
				4/21/2020	300	230	705	7	400	50	0.7	26.9	36	34	2	42
				10/7/2020	290	227	654	7.5	350	40	0.7	27	35	34	2	42
				4/6/2021	204	178	529	7.9	329	43	3	21.1	29	26	2	33

Water Quality Results - Lower Aquifer Monitoring

Station ID	Well Name	Basin Plan Well ID	Aquifer Zone	Date	HCO3	Total Hardness	Cond	pH	TDS	Cl	NO3-N	SO4	Ca	Mg	K	Na
					mg/l	mg/l	umhos/cm		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
30S/11E-18K8	10th St. Obs. East (Deep)	LA18	E	1/19/2005	260	290	650	7.5	370	33	ND	38	62	33	2.5	28
				11/20/2009	230	220	620	7.5	378	32	ND	40	51	24	1.8	23
				7/24/2014	290	271	647	7.5	380	28	ND	34	56	32	2	27
				4/21/2015	290	265	634	7.7	400	33	ND	39	55	31	2	27
				10/19/2015	230	256	621	7.3	370	29	ND	33	53	30	2	26
				4/20/2016	190	265	700	7.5	390	31	ND	38	55	31	2	26
				10/18/2016	290	256	615	6.8	370	31	ND	35.9	53	30	2	26
				4/12/2017	290	274	616	7.5	450	31	ND	38	57	32	2	27
				10/10/2017	220	271	619	7.8	350	30	ND	35.5	56	32	2	27
				4/17/2018	290	260	625	7.3	390	33	ND	39.9	53	31	2	27
				10/10/2018	290	254	608	7.5	360	31	ND	39.8	54	29	2	26
				4/10/2019	290	245	620	7.6	380	32	ND	37.4	52	28	2	25
				10/9/2019	290	253	647	7.9	390	33	ND	40.5	52	30	2	26
				4/14/2020	290	269	629	7.5	400	33	ND	40.2	55	32	2	26
10/22/2020	300	247	669	7.5	370	32	ND	38.2	51	29	3	26				
4/12/2021	298	267	621	7.6	389	32	ND	41.2	54	32	2	27				
30S/11E-18K9	LOCSD 10th St.	LA32	C,D	May 2002	250	--	550	6.9	320	37	0.2	26	31	32	--	39
				11/20/2009	180	160	539	7.2	307	36	1	27	27	24	1.3	32
				7/23/2014	220	190	546	7.7	300	32	1	20	30	28	1	35
				4/21/2015	190	108	504	7.6	270	38	1.6	20	17	16	1	27
				10/6/2015	50	62	248	7.2	190	31	5.9	3	10	9	ND	21
				4/20/2016	130	121	382	7.5	220	32	3.3	12	19	18	1	27
				10/11/2016	200	168	511	6.6	270	36	1.2	21.5	26	25	1	34
				4/10/2017	190	155	461	7.3	270	35	1.9	19.1	24	23	1	31
				10/9/2017	200	168	493	7.6	270	36	1.4	23.1	26	25	1	33
				4/10/2018	50	75.2	256	7.7	150	35	6.5	28.6	12	11	ND	23
				10/2/2018	210	168	492	7.3	270	36	1.3	22	26	25	ND	33
				4/9/2019	200	172	474	7.6	270	34	1.6	21.5	26	26	1	33
				10/2/2019	200	185	531	7.4	310	36	1.4	24.7	28	28	1	35
				4/16/2020	60	72.7	272	8.1	190	35	6	5.4	11	11	ND	20
				10/6/2020	60	68.6	246	8	180	30	4	4.9	11	10	ND	21
4/5/2021	143	128	390	7.8	247	34	2.1	15.7	20	19	1	27				
30S/11E-18K	GSWC Los Olivos #5	LA39	D	4/15/2019	290	230	619	8.1	350	38	ND	27.4	33	36	2	41
				10/14/2019	300	225	628	7.2	370	37	ND	28.6	34	34	1	41
				4/21/2020	300	236	674	6.9	370	37	0.2	28.4	37	35	2	42
				10/7/2020	300	227	657	7.4	360	37	ND	28.2	35	34	2	43
				4/6/2021	301	226	629	8.0	382	38	ND	25.8	34	34	2	40

Water Quality Results - Lower Aquifer Monitoring

Station ID	Well Name	Basin Plan Well ID	Aquifer Zone	Date	HCO3	Total Hardness	Cond	pH	TDS	Cl	NO3-N	SO4	Ca	Mg	K	Na
					mg/l	mg/l	umhos/cm		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
30S/11E-18L2**	LOCSD Palisades	LA15	D,E	11/18/2004	220	330	880	7.3	420	120	ND	31	54	48	2.2	40
				11/19/2009	200	590	1460	7.2	890	360	0.4	39	94	86	2	44
			D	7/23/2014	250	293	783	7.8	390	90	0.4	26	48	42	2	40
				4/29/2015	80	78	348	7.4	230	43	5	10	13	11	ND	30
				10/28/2015	230	288	782	7.4	420	104	0.6	29	46	42	ND	36
				4/27/2016	230	264	796	7.3	450	93	0.9	28	43	38	2	43
				10/11/2016	200	221	694	7	380	91	1.7	25.5	36	32	1	35
				10/5/2017	180	306	768	7.6	400	102	0.7	27	50	44	2	40
				4/10/2018	250	311	767	7.3	420	100	0.8	32.4	52	44	2	40
				10/23/2018	250	288	772	7.7	440	83	0.6	30.7	48	41	1	38
				4/9/2019	250	301	774	7.4	460	102	0.8	29.2	48	44	1	38
				11/14/2019	210	303	806	7.8	430	107	0.7	32.9	49	44	2	39
				4/16/2020	260	299	832	7.7	460	109	0.8	32.5	49	43	2	37
				10/5/2020	250	319	841	7.8	450	109	0.7	29.7	52	46	2	41
4/6/2021	234	290	780	7.7	444	108	1	27.2	47	42	2	38				

ND = Not Detected

Chloride Metric Wells in Green (13J1 weighted x2); current chloride concentrations in red

*Chloride concentrations at 13J1 can vary seasonally by 100+ mg/l and are affected by well production and borehole leakage, so fluctuations are expected.

**Water from 18L2 affected by wellbore leakage/upper aquifer influence when inactive

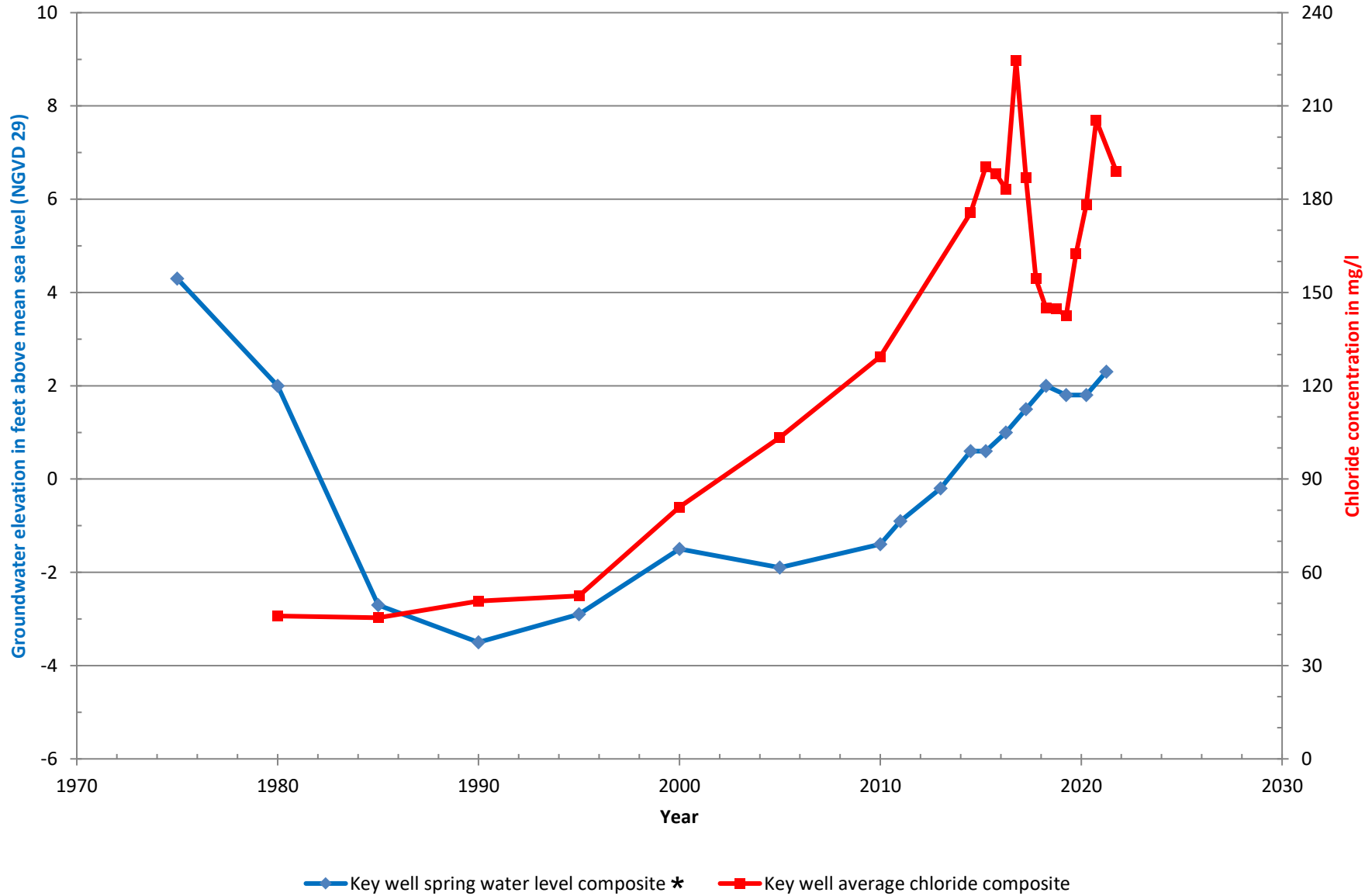
Legend and Detection Limits

Constituent	Description	Practical Quantitation Limit*
HCO3	Bicarbonate Alkalinity in mg/L CaCO3	10.0
Total Hardness	Total Hardness in mg/L CaCO3	--
Cond	Electrical Conductance in umhos/cm	1.0
pH	pH in pH units	--
TDS	Total Dissolved Solids in mg/L	20.0
Cl	Chloride concentration in mg/L	1.0
NO3-N	Nitrate as Nitrogen concentration in mg/L	0.1
SO4	Sulfate concentration in mg/L	2.0
Ca	Calcium concentration in mg/L	1.0
Mg	Magnesium concentration in mg/L	1.0
K	Potassium concentration in mg/L	1.0
Na	Sodium concentration in mg/L	1.0

*where dilution not required

Spring 2021 DRAFT

Chloride and Water Level Metric Lower Aquifer



*Spring 2021 water levels not available at Morro Bay sand spit wells (used Spring 2020 values for metric calculation)