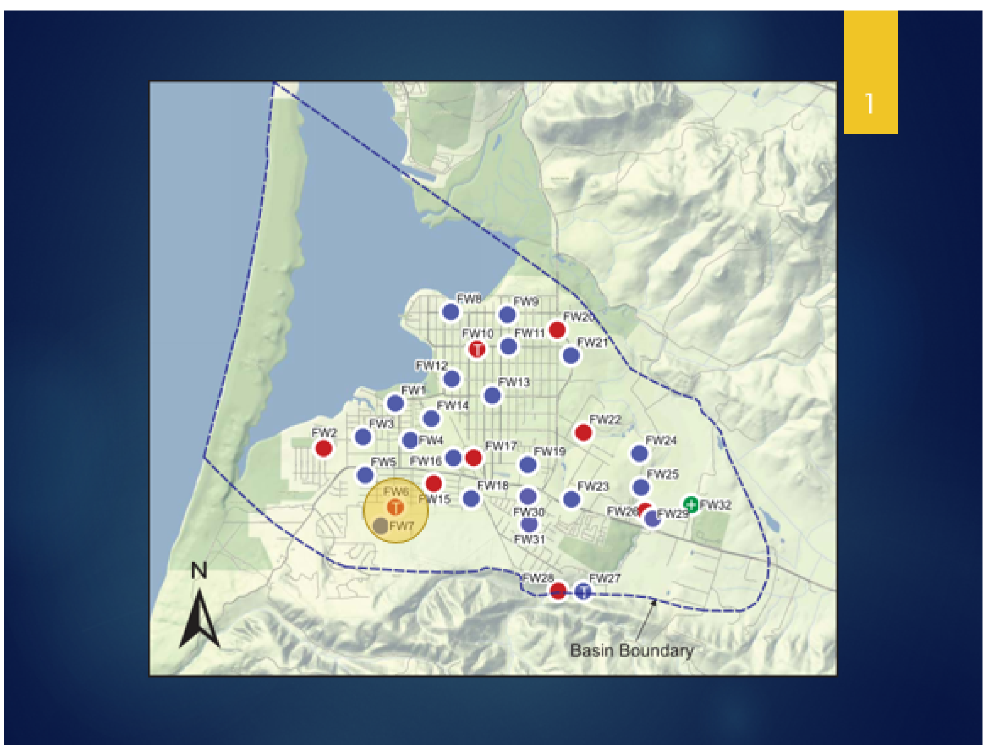
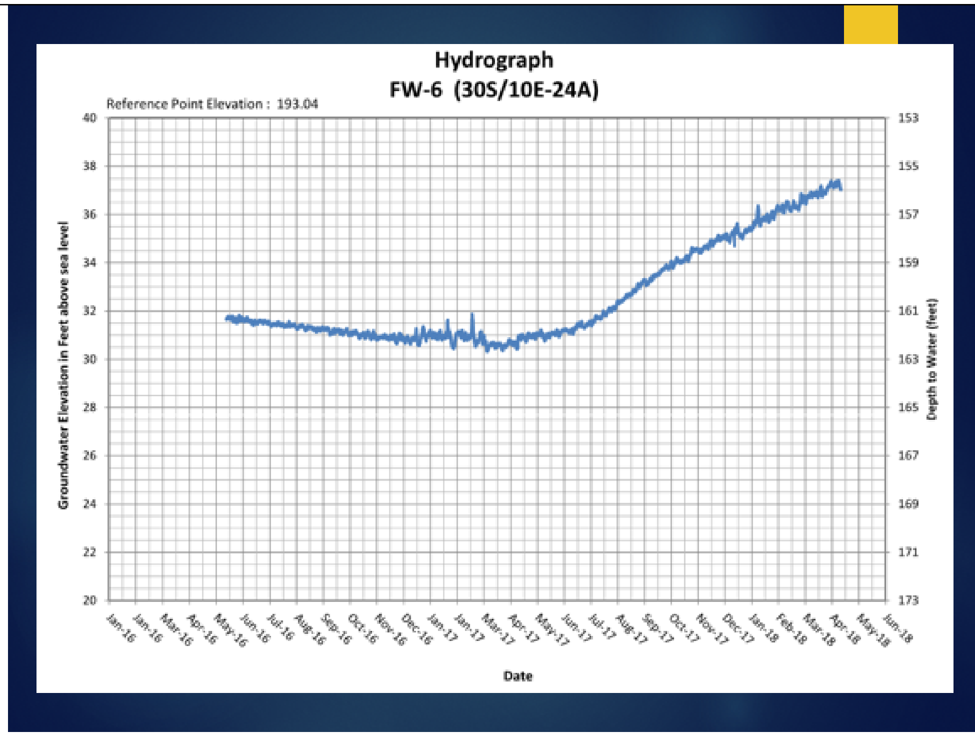
BASIN MANAGEMENT COMMITTEE BOARD OF DIRECTORS

Agenda Item 5a: Minutes of the Meeting of May 16th, 2018

Agenda Item	Discussion or Action
1. CALL TO ORDER **2. PLEDGE OF ALLIGANCE** **3. ROLL CALL**	Director Zimmer serving as chair called the meeting to order at 1:35 pm and led the Pledge of Allegiance. Mr. Miller, acting Clerk, called roll to begin the meeting. Alternative Director Cesena, Alternative Director Cote, and Alternative Chairperson Zimmer were all present, the County is absent.
4. Board Member Comments	No board member comments.
5a. Minutes of the Meeting of May 16th, 2018 **5b. Approval of Budget update and Invoice Register through December 2017**	No Board or Public comment. Director Cesena: Motion to accept the consent agenda. Director Cote: Second the Motion. **Ayes: Director Cesena, Director Cote, and Chairperson Zimmer** **Nays: None** **Abstain: None** **Absent: The County**
6. Executive Director's Report	Executive Director, Rob Miller, provided a verbal overview of the written content of the Executive Director's report. 



<u>Questions from the Board</u>
Director Cesena: Rob You mentioned 7 ft. of mounding at the Broderson Site. What do we expect at maximum capacity?

Mr. Miller: I don't have that number off the top my head, but we might have someone in the audience who might know that.

Director Cesena: I'm looking for a scale for this, are we half way there, can we expect 3 times as much?

Mr. Harris: I don't think we're halfway there. The initial mounding will be at a greater rate, and then over time due to it's cone shape it will start to mound slower. Original projections were that it would not reach the shallower lenses. The deepest is at 40 ft or so below surface, right now were at 155 ft. below surface. I don't anticipate it getting up to that 40 ft. level.

Director Cote: Can you describe the Zone of Benefit Analysis that we're deciding not to do because of the expense?

Mr. Miller: In the early years of the Management Committee the approach was going to be that there would be a community wide special tax measure of some kind to fund both monitoring and the day to day operating of the Basin Management Committee and potentially some of the projects. We had an analysis done by a consultant as to how those costs might be managed and spread. At that time, it was thought that the electorate may not be in a position to support such a measure (that would require a 2/3 supermajority) and the CSD began to analyze its own internal water rates and was able to build into its rates the Program C Project that we need to accomplish. It could come back in the future, but it seemed like it was not the best time to bring something forward to the electorate.

Director Cote: These Program C projects are being funded by the management group in general or are they funded by individual purveyors?

	Mr. Miller: At this point the only Program C well that's been done was funded solely by Golden State, and the CSD is looking to fund the next Program C well, though that might eventually become a shared asset. Director Cote: Under your heading "Los Osos Wastewater Project Flow and Connection Update", you talk about a possible amendment to the County Code in your second bullet point, can you describe that in more detail? Mr. Miller: That's primarily looking to compel unconnected properties to connect. It's for the enforcement of unconnected properties to connect to the sewer project. County staff is here and could go into more detail if they wish but since it's an August item at the Board of Supervisor's there's probably not a lot of draft language available on that topic. Director Cote: So, it's saying that some people feel the current County Code isn't sufficient. Mr. Miller: Yes, that is how I would read that item. Director Zimmer: Going back to the Zone of Benefit Analysis, were we looking at revisiting the projects to see if we are still on track? Mr. Miller: At your last meeting you did retain Cleath Harris to do a study looking at the assets that were in place and the current water demands. The study is not complete yet but that will be coming back at a later date. Director Zimmer: Will that be in June? Mr. Miller: Probably not, June is going to be full, it will most likely be in a subsequent meeting. Director Zimmer: With regards to talking to Morro Bay about their wastewater, there has been a lot of public interest in that, is there a way that we could initiate a letter of interest for a working relationship with Morro Bay? Mr. Miller: I think we could do that staff to staff without formal direction since we've had that conversation before, but I agree it is important to keep that dialog open. I believe Morro Bay is in the middle of a comprehensive water supply study. I don't know where they are with that. The last I checked they had not yet completed that study. That may be a good time to reach out and let them know we are still interested in talking about opportunities. <u>Public Comment</u> Public Commenter: Is the Broderson field receiving all of the wastewater from the sewer plant at this time? Mr. Miller: No not all of it. Ms. Owen: The Broderson and Bayridge disposal is currently taking all of the recycled water but it is doing nothing to offset the groundwater pumping which is the one way to keep that water on the record for ourselves. Do you have current studies to see if saltwater intrusion is below the area that the water will be perking down through

	eventually? If it is, I'd like to know what good that does us. I'd also be curious about the energy cost of pumping water that far. I worry about the urgency of taking a look at closer areas for energy savings as well as offsetting ground pumping. If Morro Bay does have their new wastewater plant put in the area that they're discussing, where will they be putting the treated water? Also, you talked briefly about the fringe areas, I would like to know why removing the fringe areas benefits our basin management? Mr. Best: Regarding the monitoring well and reviewing the mounding at that well, there will be additional saturation of that area increasing the static water pressure level that will be diminishing the natural filtering process of the soils as it goes into the aquifer. This will increase the CEC's and endocrine disrupters that make it into the lower aquifer and at what point will that area be over saturated? Regarding the Morro Bay issue, I feel like it would be buying into someone else's problems. Increasing the production will reduce the life cycle of plant and puts the plant at greater risk. I think we should also look at having the plant discharge potable water. Mr. Eckles: I wanted to commend the board for the direction given to staff to express an interest in in coordinating and cooperating with Morro Bay. There may be opportunities and there may not be, but we wouldn't know unless we extend a hand to one another. Up to this point there has been a lack of an overarching regional approach, so I applaud that action. Mr. Edwards: I'm concerned the Creek Discharge Project has lost momentum. It is a low tech, low energy project that has potential for a high seawater intrusion mitigation factor. I think we need to discuss it again and find ways to fund that project. I think we need to elevate its priority. <u>Board Comments</u> Mr. Miller: To the Broderson question, it currently receives about 95% of the effluent. Bayridge is also receiving some to keep environmental demands and downstream wetlands acceptably mitigated. Regarding the perking area under the mound at Broderson, we will see some slides later that identifies the seawater front as being further to than west of the mounds, so we do expect some benefit. Regarding the energy costs, once it's at Broderson it percolates using gravity and is roughly equivalent to providing pressurized recycle water to our westerly schools. Regarding ongoing discussions with Morro Bay, I think at this point they are trying to decide whether they're going to put the water into the Morro Creek Valley and do an indirect potable reuse project or give it to some of the agricultural interests to offset pumping within their aquifers. The ongoing dialogue is a good idea. With regard to the fringe areas, the primary benefit of the boundary modification is to line up the official boundary as the Department of Water Resources sees it with the boundary as this committee has established at the court level. Mr. Best talked about water filtration through the aquifer, I think that's a good comment to keep in mind and we will have ongoing reports on monitoring down gradient. Mr. Edwards mentioned the IRWM process, and we are a listed project for the Creek Discharge Project, but we have not received any notification of further progress on that grant application. Chairperson Zimmer: Regarding the agreements for the recycled water deliveries, we are very close to getting those all worked out. Rob you mentioned that the Creek Discharge Project is a listed project with the IRWM. When do you expect that we would hear back about the application and what would be the next course of action?

	Mr. Miller: Within the next 6 months. A lot of those costs we have are monitoring costs, so we are always looking for partners to help us and help reduce our costs. Chairperson Zimmer: Looking at that 6 months wait, is there anything we can be doing in the meantime? Mr. Miller: We do have a work plan and a budget item this year that is very modest, so it won't get you too far. We also are planning to continue to pursue some ideas that staff has about recycling some shallow perched water and storm water in the community to augment our recycled water volume to make more available for the overall recycled water management plan. Chairperson Zimmer: My thought is if we weren't successful in the IRWM process we'd still want to continue down that path of looking at that as a potential project. It's an important aspect of recharging the groundwater basin.
7a. Presentation of Draft 2017 Annual Report	Mr. Miller: Gave a detailed Presentation of the Draft 2017 Annual Report. Director Cote: I'm concerned about the next draft of the document and having enough time to actually do a review of it beforehand. There are a lot of spelling and grammatical errors, should I present those directly with Cleath Harris? Mr. Miller: Yes please. Director Cote: I have questions about the Ag water production mentioned in a few places within the document. There are some pretty high-level figures that were mentioned, and I wonder how we know if these wells are not metered? Mr. Miller: There are a couple different ways that you can estimate Ag production, those are estimated numbers. Having seen many master planning documents at the County, I can say it's one of the more extensive estimates in the County. It looks at actual cropping patterns, planting area, crop types, number of rotations, and it goes to a field by field level. There is no substitute for a good calibrated water meter. That's something that has been talked about here and probably needs to be talked about again in the future. Director Cote: I would prefer that within the document, when there are estimates like that, it should state that they are an estimate and also include an error range as well. They are presented as facts that are based on solid data, so it should mention in the document that they are estimates. Also, on page 58 when it mentions the 2017 Sustainable Yield Figure, it's presented as fact as well and not as an estimate. I think we should describe where these figures are coming from a little better with the error ranges. I think we should discuss ways to improve the document in this way. Mr. Miller: This document comes out the same time every year so if we have items that we think are of significance, that should be addressed, let's get those listed under adaptive management for the following year's annual report so the document is ever improving. Director Zimmer: I agree, it's a working piece and we should work on it. We started out the first year and spent a lot of time, energy, and cost in preparing this document. Now in these subsequent years we can maintain the same structure of document and fill it in with the details. So, if it's helpful, I think we should add that in as a project. Looking at the

	document, I think we do have some work ahead of us to fill in some of this information. Do we have a date in which we plan to complete the new monitoring well and begin acquiring data? Could you give us an update on that project? Mr. Miller: There is a challenging permit process for that well. We just received a proposal for some wetlands delineations in the vicinity of the well. We've reached out to some of the property owner's whose land we'll need to be on temporarily for the well construction. I'm hoping we can drill it this year, but we'll need great participation from the permitting agencies to get that done. Director Zimmer: And if we get moving along and realize it's not a viable location we should get that discussion as soon as possible on what should be our next steps. <u>Public Comment</u> Ms. Owen: You said it will be a while before we can determine what the available water volume is in the upper aquifer might be. I would like to get a number of years we have left with the current amount of water we have. I still think we should be monitoring individual wells usage and is some place in the County doing that already. Also, what is the nitrate change at the golf course monitoring well? Regarding the Palisades Well, are we going to abandon that soon? Mr. Best: Regarding the presentation of the contour lines of the aquifer, in Zone D, the lines did not extend out completely, is this because it is a pocket between clay lenses? If so, are the clay diaphragms static or dynamic? If you're reducing the size of the aquifer level. How is that affecting the capacity of Zone D and the Upper Aquifer? Mr. Margetson: The original Wastewater Project's main purpose was to reduce nitrates. I'd like you to elaborate on what you think is causing it to go up to 32? The discharge from the plant, if it's at 3, septic tanks are offline, in addition to late rainfall in the year, how are these leading to an increase of nitrate levels. Nitrates are just as important of a problem as the seawater intrusion. Also, what impact did the rainfall have on the basin? Consumption for the CSD is up this year as well as production. The chart shows that production and consumption went down but we know for the CSD it actually rose. <u>Board Comments</u> Mr. Miller: Regarding knowing how much water is left in it aquifer at this point, it is frustrating to not know what that number is. We can't give that number to you with certainty because we do not have a transient model. We can talk about the development of the transient model at some point, even though it is costly. As for the golf course monitoring well, it looks like that is sitting at about 19 mg per liter of nitrate, about twice the drinking water limit. The only use of the District's Palisades Well is when we have to turn it on because the tank levels are low, primarily in the summer. We try to use that well sparingly, but it does look like we are seeing a relaxation of chlorides in that area. Regarding the limits of contouring, generally we are contouring to the edges of the Basin, if the contours are clipped short it is because we don't have data in those areas. We did try to contour as much of the Basin as we were able. Those clay layers are static as a fixed barrier to flow at a fixed elevation. Regarding pumping regimes, the purveyor production was static with the exception of the CSD which went up 50 acre-feet. It was the agricultural production that was estimated to be less. If you look at the previous 2016 Report you will see significant decline in what was projected in the Ag area, that is the reason the aggregated amount went down. In regard to the nitrates, if you look at the

	amount of storage that sits in our upper aquifer it's quite significant. You have tens of thousands of acre-feet in comparison to the wastewater discharge, which is about 400-500 acre-feet. So, there is already a massive amount of nitrate already dissolved in the water, that is why this was modeled to take decades and not years to be corrected. Director Cote: At S&T, we were very concerned about nitrates. Our most used well #5 is screened as a lower aquifer well and our nitrates are climbing to the point that we are faced with having to do some high-level treatment. I also feel the discussion of nitrates have been deemphasized here, and I think it is important to keep that as something nearly as important as seawater intrusion. I also think we should work to identify a specific volume of water that is available in these aquifers. I think it's also important that we talk about the quality of the water that is in the aquifers. The quality decreases as we are producing from it. Director Cesena: Rob, can you explain to me the difference between this annual report here and the annual report mentioned in the CDP that the County files with the Coastal Commission? Mr. Miller: I think that report is a wastewater-oriented report. It would focus on a subset of what this report covers. I have seen the other report, it's been awhile, I should go back and look at it to be able to compare the two. Director Cesena: It seems like something the committee should be looking at as well. Chairperson Zimmer: Under this item we had a special meeting date? Mr. Miller: We have our regularly scheduled meeting here on June 20th at 1:30. Let's make sure we have a good solid quorum on that date. If we needed to do a special meeting, staff will ask for feedback from the other committee meeting members whether the 27th might be a possible date to do a follow-up meeting on just this item. Chairperson Zimmer: I agree that it is important to have the proper representation for that meeting to approve the annual report and make sure the content is complete. Let's go with the original date of the 20th, pending any feedback from the other Board members about a different date.

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<td>7b. Water Conservation Program Update</td>
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Mr. Miller: Gave a detailed overview of the Water Conservation Program Update.

Chairperson Zimmer: The draft of the postcard is out for comments and it's nearing its final version. It's important for staff to put that on their calendars and make sure that we get that done. We will need that feedback by the 21st.

<u>Public Comment</u>

Ms. Owen: There was $2.5 Million that was mandated by the Coastal Commission to be implemented at the beginning of the sewer project, and I am wondering where that money is. I would like the committee to write a letter to the County and the Coastal Commission verifying that money was spent on what it was meant to be spent on. I think that would help the purveyors with some of costs they are facing.

<u>Board Comments</u>

Mr. Miller: I think that will come back at another time when the County is present.

Chairperson Zimmer: I agree, I think that is a topic we should discuss when the County is here.

Director Cote: I agree, the County should have a chance to address the question, but the issue has been going on a long time without a resolution.
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<td>7c. Review Initial Water Quality Data from Spring, 2018 Deep Aquifer Monitoring</td>
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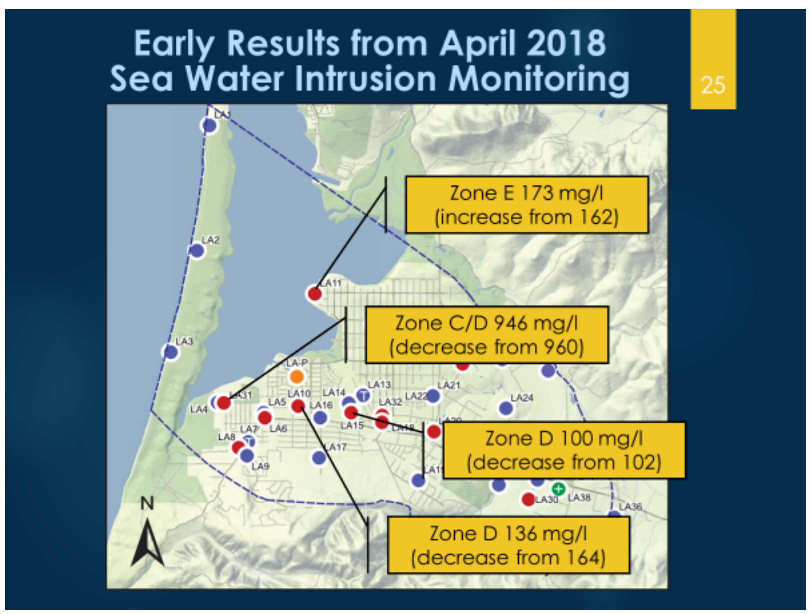
Mr. Miller: Gave a detailed overview of the Review Initial Water Quality Data from Spring, 2018 Deep Aquifer Monitoring.



<u>Public Comment</u>

Mr. Best: You said there are no published reports on Zone E for saltwater intrusion? I was interested in the relationship between Zone E and D.

Mr. Margetson: The rain event we had in spring had an impact on these numbers, do you have an idea of what the results would be without the rain event?
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	<u>Board Comments</u> Mr. Miller: Our Zone E monitoring is sparse. We have the well we call LA 11 that we monitor. The Palisades well is no longer active in Zone E. We have a Golden State well that partially taps Zone E. There was no change that I could detect from the historical background. There is also a Zone E well near 10th St., which didn't change much. It is at the same level as it was in 2005. So, the desire to have the Cuesta by the Sea Monitoring well to further monitor those Zones would be a great benefit. Regarding the rain event in the spring, certainly there'd be more irrigation that occurred in March, less creek flow, and less recharge. I'm not sure it would help the spring readings, but it should help us come the fall.
8. PUBLIC COMMENTS ON ITEMS NOT APPEARING ON THE AGENDA	Ms. Owen: Is there any fear of liquefaction from the Broderson disposal site, the flow is half of what it was projected to be. Mr. Margetson: There are a list of projects that we were hoping to accomplish in the future. I believe the CSD is going to have the resources in the future to pay their portion of those projects. I would like to see that list of projects revisited and see if some of those projects can't be moved up a little bit? If we're able to move them up, it would be better to do them now then to put them off. Mr. Best: Regarding the creek injection zone, it needs to be done not with treated water but with potable water. Without the filtration of natural soils that water will contain the most contaminants, and impact the aquifer in such a way could risk the whole aquifer. I have some other ideas as well such as a saltwater pool, or park could really help the community. I think another good idea would be for our community to only have one single purveyor. Mr. Edwards: I think it's important to talk about the numbers in regard to water and wastewater management. I deal a lot with the County's Resource Management System and have the reviewed the Los Osos Community Plan, the Recycled Water Management Plan that the County has, as well as the Basin Management Plan and none of those documents dovetail with one another. There are whole cross sections of numbers that differ dramatically. It's important to have these documents harmonize together. <u>Board Comments</u> Mr. Miller: Regarding liquefaction, there have been extensive studies on that topic as part of the original Environmental Review as well as the County's Environmental Review. They all concluded there was no increased potential in liquefaction and those studies are available if you're interested. I think Richard's comments about our capital improvements are germane. We've authorized Cleath Harris to look at our current assets, the capital that we're about to put into service, current water demands, and see based on the model where we sit today. We will revisit whether we do need two expansion wells under Program C. We'll bring back detailed budgets when we have them prior to construction. Director Cesena: Mr. Edwards, if you could come up with a list of differences that would help us look into that issue. It sounds like you've looked into this and may have some ideas where we can start.

	Chairperson Zimmer: I agree with that. Mr. Edwards, I know you've mentioned that before and if you could submit that in writing maybe that is something we could investigate. I think that would be helpful when we develop the Basin Plan. Having that fresh data in front of us will help us make better decisions. We should bring that back at and have it on our agenda at a subsequent meeting. Director Cote: I motion to adjourn the meeting. Director Cesena: I second that motion.
9. ADJOURNMENT	Meeting was adjourned at 3:25 pm. The next meeting will be on June 20th at the South Bay Community Center in Los Osos at 1:30 pm.

TO: Los Osos Basin Management Committee

FROM: Rob Miller, Interim Executive Director

DATE: June 20, 2018

SUBJECT: Item 5b – Approval of Budget Update and Invoice Register through June 20, 2018

Recommendations

Staff recommends that the Committee review and approve the report.

Discussion

Staff has prepared a summary of costs incurred as compared to the adopted budget through June 20, 2018 (see Attachment 1). A running invoice register is also provided as Attachment 2. Staff recommends that the Committee approve the current invoices, outlined in Attachment 3. Payment of invoices will continue to be processed through Brownstein Hyatt as noted in previous meetings.

Attachment 1: Cost Summary (Year to Date) for Calendar Year 2018

Item	Description	Budget Amount	Costs Incurred	Percent Incurred	Remaining Budget
1	Monthly meeting administration, including preparation, staff notes, and attendance	$50,000	$21,801.24	43.6%	$28,199
2	Meeting expenses - facility rent (if SBCC needed for larger venue)	$1,000	$240.00	24.0%	$760
3	Meeting expenses - audio and video services	$6,000	$750.00	12.5%	$5,250
4	Adaptive Management - Groundwater Modeling	$10,000	$0.00	0.0%	$10,000
5	Semi annual seawater intrusion monitoring	$26,400	$10,511.30	39.8%	$15,889
6	Annual Report - not including Year 1 start up costs	$29,600	$29,565.00	99.9%	$35
7	Grant writing (outside consultant)	$5,000	$0.00	0.0%	$5,000
8	Creek Recharge and Replenishment Studies	$15,000	$0.00	0.0%	$15,000
9	Cuesta by the Sea Monitoring well	$115,000	$840.00	0.7%	$114,160
10	Conservation programs (not including member programs)	$10,000	$0.00	0.0%	$10,000
	Subtotal	$268,000	$0.00		$204,292
	10% Contingency	$26,800			
	Total	**$294,800**	**$63,707.54**	**21.6%**	**$231,092**
	LOCSD (38%)	$112,024			
	GSWC (38%)	$112,024			
	County of SLO (20%)	$58,960			
	S&T Mutual (4%)	$11,792			
Notes	Last update June 18, 2018				

Attachment 2: Invoice Register for Los Osos BMC for Calendar Year 2018 (through June 20, 2018)						
Vendor	**Invoice No.**	**Amount**	**Month of Service**	**Description**	**Budget Item**	**Previously Approved**
CHG	20180203	$11,095.00	Feb-18	Annual Report	6	Yes
Wallace Group	45523	$5,325.00	Jan-18	Administration	1	Yes
CHG	20180303	$10,260.00	Mar-18	Annual Report	6	Yes
CHG	20180304	$1,320.00	Mar-18	Semi-annual groundwater monitoring	5	Yes
CHG	20180305	$840.00	Mar-18	Cuesta-By-The-Sea Monitoring Well	9	Yes
Wallace Group	45731	$3,475.47	Feb-18	Administration	1	Yes
Wallace Group	45911	$4,456.16	Mar-18	Administration	1	Yes
SBCC	99	$120.00	Jul-18	Meeting Expenses-Facility Rent	2	Yes
SBCC	113	$120.00	Mar-18	Meeting Expenses-Facility Rent	2	Yes
AGP	7383	$750.00	May-18	Meeting expenses - audio and video services	3	
CHG	20180402	$5,340.00	Apr-18	Annual Report	6	
CHG	20180403	$5,874.80	Apr-18	Semi-annual groundwater monitoring	5	
CHG	20180504	$2,870.00	May-18	Annual Report	6	
CHG	20180505	$3,316.50	May-18	Semi-annual groundwater monitoring	5	
Wallace Group	46110	$2,033.00	Apr-18	Administration	1	
Wallace Group	46301	$6,511.61	May-18	Administration	1	
Total		**$63,707.54**				
				Not yet approved		

ATTACHMENT 3

Current Invoices Subject to Approval for Payment (Warrant List as of June 20, 2018):

Vendor	Invoice #	Amount of Invoice	Date of Services
AGP	7383	$750.00	May-18
CHG	20180402	$5,340.00	Apr-18
CHG	20180403	$5,874.80	Apr-18
CHG	20180504	$2,870.00	May-18
CHG	20180505	$3,316.50	May-18
Wallace Group	46110	$2,033.00	Apr-18
Wallace Group	46301	$6,511.61	May-18

TO: Los Osos Basin Management Committee

FROM: Rob Miller, Interim Executive Director

DATE: June 20, 2018

SUBJECT: Item 6 – Executive Director's Report

Recommendations

Staff recommends that the Committee receive and file the report, and provide staff with any direction for future discussions.

Discussion

The June 20 agenda is intended to be focused so that two major business items can be accomplished. A full Executive Director's report was provided in the May 2018 meeting to provide status updates and detail on the typical reporting items. Staff will return to this format at the next meeting. Key items that are critical to the June meeting include the following:

- The conservation symposium discussed in previous meetings will take place on Thursday, June 21st from 7 to 9 pm at the SBCC. All purveyors and the County are welcome, and customers of the three water purveyors have received post card notification of the meeting. Given the limited number of rebates provided so far under the new program, staff is hoping for a strong turnout.

- The Cuesta by the Sea monitoring well is progressing. Two property owners have been contacted to provide access for environmental studies and construction of the well. Both seemed receptive, and we are waiting for signed access agreements from both parties before completing the required wetlands delineation. We will then apply for a Coastal Development Permit to construct the monitoring well.

- The adaptive management study that CHG is preparing should be ready in time for the August meeting.

- Staff will be asking the BMC to review calendars for the August meeting, due to a scheduling conflict. If available, August 29th would be a good date (5th Wednesday).

TO: Los Osos Basin Management Committee

FROM: Rob Miller, Interim Executive Director

DATE: June 20, 2018

SUBJECT: Item 7a – Presentation of 2017 Annual Report

Recommendations

Recommendations:
1. Approve the 2017 Annual Report and direct staff to file it with DWR and the Court; or
2. Direct staff to make changes and then file the Report without further BMC review; or
3. Direct staff to make changes and then set a special meeting to review and approve the final Report

Discussion

Section 5.8.3 of the Final Judgment requires that the preparation of an Annual Report by June 30 of each year. The BMC retained Cleath Harris Geologists (CHG) to prepare the second Annual Report for calendar year 2017. The draft work product prepared by CHG was provided in the May 2018 meeting, and comments and suggestions were received from the Committee and the purveyors. The final draft is attached for Committee review. Please note that the development of an upper aquifer monitoring tool has been provided and will be covered by staff in the meeting (Section 7.5.4). Chapter 10 and the Executive Summary have also been updated.

Financial Considerations

Budget items 5 and 6 in the adopted calendar year 2018 to $56,000 for monitoring and preparation of the annual report. At this time, no budget adjustments are recommended.

<u>FINAL DRAFT</u>

LOS OSOS BASIN PLAN
GROUNDWATER MONITORING PROGRAM
2017 ANNUAL MONITORING REPORT

Prepared for the

BASIN MANAGEMENT COMMITTEE

JUNE 2018

CLEATH-HARRIS GEOLOGISTS
71 Zaca Lane, Suite 140
San Luis Obispo, California 93401

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EXECUTIVE SUMMARY

The 2017 Annual Report describes Basin activities related to the Los Osos Basin Plan (LOBP) Groundwater Monitoring Program, and provides results and interpretation of these activities in calendar year 2017. The LOBP Groundwater Monitoring Program is necessary to accomplish the following continuing goals set forth in Section 2.4 of the LOBP (ISJ Group, 2015):

1. Provide for a continuously updated hydrologic assessment of the Basin, its water resources and sustainable yield.

2. Create a water resource accounting which is able to meet the information needs for planning, monitoring, trading, environmental management, utility operations, land development and agricultural operations.

The LOBP Groundwater Monitoring Program is also necessary to support other goals of the LOBP, including prevention of seawater intrusion, establishing a long-term environmentally and economically sustainable and beneficial use of the Basin, and the equitable allocation of costs associated with Basin management.

<u>Groundwater Production</u>

Groundwater production for calendar year 2017 is summarized in Table ES-1 below. Purveyor production has increased by 5 percent compared to 2016, while total basin production has decreased by 4 percent compared to 2016 due to lower estimated production for community facilities and agriculture.

Table ES-1. Groundwater Production for Calendar Year 2017

Description	Production in Acre-Feet
Los Osos Community Services District	570
Golden State Water Company	450
S&T Mutual Water Company	30
Purveyor Subtotal	**1,050**
Domestic wells	220
Community facilities	130
Agricultural wells	670
Total Estimated Production	**2,070**

Basin Status

The status of the Basin in terms of key parameters and metrics are as follows:

Precipitation. The basin received above normal rainfall in 2017. The drought condition for San Luis Obispo County improved from exceptional drought (the highest intensity) to abnormally dry (the lowest intensity) during 2017 (NDMC/USDA/NOAA, 2017).

Seawater intrusion front movement. The seawater intrusion front retreated toward the coast between Fall 2016 and Fall 2017 (an improvement), although a portion of the retreat may be due to wellbore flow at metric well LA10, pending further evaluation.

Basin Yield Metric. The Basin Yield Metric decreased between 2016 and 2017 (an improvement), and has met the LOBP goal for two consecutive years.

Water Level Metric. The Water Level Metric increased between Spring 2016 and Spring 2017 (an improvement), but has not reached the target value.

Chloride Level Metric. The Chloride Metric decreased between Fall 2016 and Fall 2017 an improvment), but has not reached the target value.

Nitrate Metric. The Nitrate Metric increased between Winter 2016 and Winter 2017 (a deterioration), and has not reached the target value.

Recommendations for improving the quality and availability of data are contained in Chapter 9 of the Annual Report. The recommendations include developing a rating curve for the stream gage on Los Osos Creek, developing specific yield values for individual aquifers to improve groundwater storage estimates, re-evaluating the Water Level Metric target, and further evaluation of wellbore flow and Upper Aquifer influence at Chloride Metric well LA10.

LOBP Metrics

As described in Section 7 ("Data Interpretation") of this Annual Report, the LOBP established several metrics to measure nitrate impacts to the Upper Aquifer, seawater intrusion into the Lower Aquifer, and the effect of management efforts of the Basin Management Committee (BMC). These metrics allow the Parties, the BMC, regulatory agencies, and the public to evaluate the status of nitrate levels and seawater intrusion, and the impact of implementation of the LOBP programs in the Basin through objective, numerical criteria that can be tracked over time. The status of key Basin metrics is summarized in Table ES-2.

Table ES-2. LOBP Metric Summary			
Metric	**LOBP Goal**	**Calculated Value from 2017 Data**	**Recommended Actions in Addition to LOBP Programs**
Basin Yield Metric	80 or less	75	Implement additional conservation measures to reduce indoor and outdoor demands (See Section 10.3.2)
Water Level Metric	8 feet above mean sea level or higher	1.5 feet above mean sea level	Implement additional conservation measures to reduce indoor and outdoor demands (See Section 10.3.2)
Chloride Level Metric	100 mg/L or lower	132 mg/L	Implement additional conservation measures to reduce indoor and outdoor demands (See Section 10.3.2)
Nitrate Metric	10 mg/L or lower	32 mg/L (NO3-N)	None recommended

<u>Adaptive Management Program</u>

In addition to the programs described in the LOBP, the following additional measures are recommended in the context of adaptive management. Details regarding each program are provided in Section 10 of this Annual Report:

> **Potential Adaptation of Urban Water Use Efficiency Program.** The BMC plans to evaluate the status and the effectiveness of the program throughout the year. The County has implemented a new series of rebates as described in Chapter 10.
>
> **Development of Contingency Plan.** The BMC plans to develop a contingency plan and related actions in the event Basin Metric trends fail to demonstrate progress toward LOBP goals, including defined schedules and milestones.
>
> **Discussion and Development of Metrics for Future Growth.** The BMC plans to provide input into the Los Osos Community Plan, including consideration of Basin Metrics and defined goals as they relate to the timing of future growth.
>
> **Additional Water Quality Metrics.** The BMC intends to consider developing additional metrics and/or numerical goals as appropriate to protect the upper aquifer from water quality threats, such as seawater intrusion and chromium-6 contamination. An Upper Aquifer Water Level Profile has been developed as described in Section 7.5 for this annual report.

LOBP Infrastructure Programs

The status of LOBP infrastructure programs is summarized Table ES- 3.

Table ES-3. Basin Infrastructure Projects				
Project Name	**Parties Involved**	**Funding Status**	**Capital Cost**	**Status**
Program A				
Water Systems Interconnection	LOCSD/ GSWC	Fully Funded	Construction Value: $103,550	Project completed February 2017, with final approval in March 2017
Upper Aquifer Well (8th Street)	LOCSD	Fully Funded	$250,000	Well was drilled and cased in December 2016. Budget remaining $250,000 to equip the well. Design RFP was issued in April, and a consultant was retained in June 2017. Bid documents are currently being prepared by the consultant. Project to be completed by the first quarter of 2019 or earlier if possible.
South Bay Well Nitrate Removal	LOCSD	Completed		
Palisades Well Modifications	LOCSD	Completed		
Blending Project (Skyline Well)	GSWC	Fully Funded	Previously funded through rate case	Completed - the Rosina Nitrate Unit was brought on-line on October 9, 2017 and it is currently producing 160 gallons per minute of treated water.
Water Meters	S&T	Completed		
Program B				
LOCSD Wells	LOCSD	Not Funded	BMP: $2.7 mil	Project not initiated
GSWC Wells	GSWC	Not Funded	BMP: $3.2 mil	Project not initiated
Community Nitrate Removal Facility	LOCSD/GSWC	Partial	First phase combined with GSWC Program A	GSWC's Program A Blending Project allows for incremental expansion of the nitrate facility and can be considered a first phase in Program B.

Project Name	Parties Involved	Funding Status	Capital Cost	Status
Program C				
Expansion Well No. 1 (Los Olivos)	GSWC	Completed		
Expansion Well No. 2	GSWC/LOCSD	Cooperative Funding	BMP: $2.0 mil	Property acquisition phase is on-going through efforts of LOCSD. Four sites are currently being reviewed, and all appear to be potentially viable for new east side Lower Aquifer wells, Environmental studies were initiated in December 2016 for expansion well #2.
Expansion Well 3 and LOVR Water Main Upgrade	GSWC/LOCSD	Cooperative Funding	BMP: $1.6 mil	Property acquisition phase is on-going through efforts of LOCSD. The BMC is also evaluating the need for Expansion Well 3 for the current population given the decline in water demands.
LOVR Water Main Upgrade	GSWC	May be deferred	BMP: $1.53 mil	Project may not be required, depending on the pumping capacity of the drilled Program C wells. It may be deferred to Program D.
S&T/GSWC Interconnection	S&T/ GSWC	Pending	BMP: $30,000	Conceptual design
Program M				
New Zone D/E Lower Aquifer monitoring well in Cuesta by the Sea	All Parties	Funded through BMC Budget	$115,000 (2018 BMC Budget Item 9)	Cleath-Harris scope was approved in September 2017 meeting, and staff is currently working through right of way and permitting issues for the selected site. Construction is expected in late 2018, or early 2019.

1. INTRODUCTION

The Los Osos groundwater basin was adjudicated in October 2015 (*Los Osos Community Services District v. Southern California Water Company [Golden State Water Company] et al.* (San Luis Obispo County Superior Court Case No. CV 040126) and is managed by the Los Osos Groundwater Basin Management Committee (BMC), consisting of representatives from Los Osos Community Services District (LOCSD), Golden State Water Company (GSWC), S&T Mutual Water Company (S&T), and the County of San Luis Obispo (County). This is the third Annual Report for the basin.

The 2017 Annual Report describes basin activities related to the Los Osos Basin Plan (LOBP) Groundwater Monitoring Program, and provides results and interpretation of these activities. The LOBP Groundwater Monitoring Program is necessary to accomplish the following continuing goals set forth in Section 2.4 of the LOBP (ISJ Group, 2015):

1. Provide for a continuously updated hydrologic assessment of the Basin, its water resources and sustainable yield.

2. Create a water resource accounting which is able to meet the information needs for planning, monitoring, trading, environmental management, utility operations, land development and agricultural operations.

The LOBP Groundwater Monitoring Program is also necessary to support other LOBP goals, including prevention of seawater intrusion, establishing a long-term environmentally and economically sustainable and beneficial use of the basin, and the equitable allocation of costs associated with basin management (ISJ Group, 2015). The program will provide significant overlap with several regulatory requirements, including:

- Senate Bill 1168, Senate Bill 1319, and Assembly Bill 1739 which collectively establish the Sustainable Groundwater Management Act (SGMA)

- California Statewide Groundwater Elevation Monitoring (CASGEM) Program

- State Water Resource Control Board's (SWRCB) salt and nutrient monitoring guidelines as adopted in the state Recycled Water Policy

- Recycled Water Management Plan requirements for the Los Osos Water Recycling Facility (LOWRF)

This report was prepared by Cleath-Harris Geologists (CHG). Wallace Group contributed to the Executive Summary and produced Chapter 10 (Adaptive Management). BMC member agency staff provided assistance during field monitoring activities and with Annual Report review.

2. BACKGROUND

In August 2008, the Superior Court of the State of California for the County of San Luis Obispo (Court) approved an Interlocutory Stipulated Judgment (ISJ) between LOCSD, GSWC, S&T, and the County. Under the ISJ, these Parties formed a working group, undertaking technical studies and management discussions that produced the LOBP in January 2015. The LOBP presents a comprehensive groundwater management strategy and serves as the cornerstone of a physical solution to address the significant problems facing the basin, including seawater intrusion and elevated nitrate concentrations, and for restoration of basin water resources, while respecting existing water rights. The LOBP Groundwater Monitoring Program is a key component of the LOBP, providing water level and water quality data that serve as measures of effectiveness for LOBP programs and activities with respect to the restoration of basin water resources. A final Stipulated Judgment was approved by the Court on October 14, 2015.

The Sustainable Groundwater Management Act (SGMA) took effect on January 1, 2015, and requires that certain actions be taken in groundwater basins designated as either high or medium priority by the California Department of Water Resources (DWR), including the Los Osos Basin. DWR identified the Los Osos Basin as a high priority basin subject to critical conditions of overdraft due to seawater intrusion and nitrate impairment (DWR, 2014, 2016). SGMA does not apply to the LOBP plan areas covered by the Stipulated Judgment, which are shown in Figure 1. In order to comply with SGMA, the County formed the Groundwater Sustainability Agency (GSA) to cover groundwater basin areas between the Bulletin 118 Basin boundaries (Basin 3-8) and the LOBP area boundary, which are designated as "fringe areas". Hydrogeologic characterization of the fringe areas in support of a Basin Boundary Modification Request was initiated in 2017 (see Section 2.2.4).

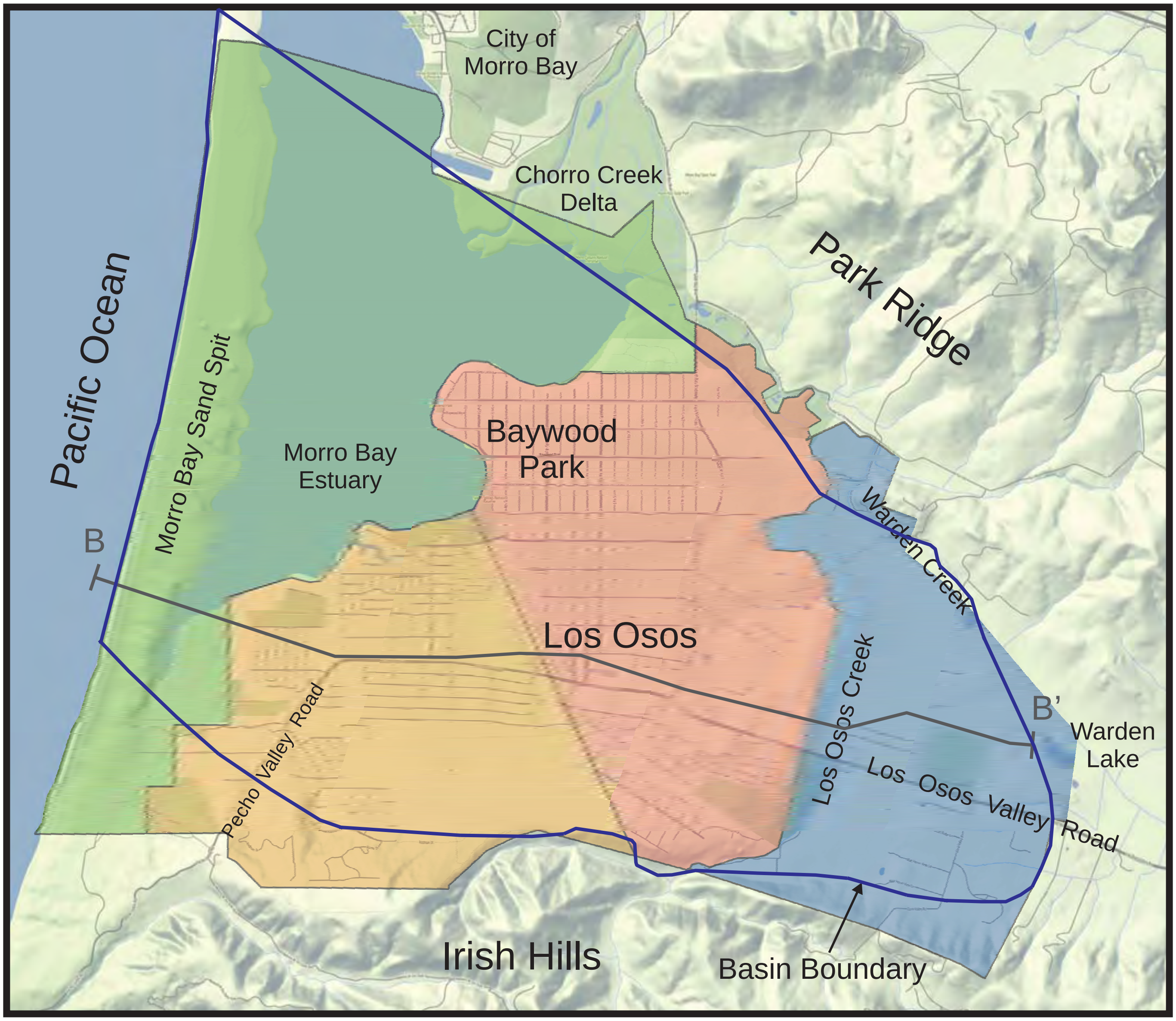
2.1 Groundwater Monitoring History

Groundwater monitoring has been performed by public agencies, water purveyors, and consultants for various basin studies and programs over several decades. A list of historical investigations, monitoring reports, and monitoring programs with a major focus on basin water levels and water quality through 2017 is included in Appendix A.

2.2 Groundwater Monitoring Program Design

The purpose of the LOBP Groundwater Monitoring Program is to collect and organize groundwater data on a regular basis for use in management of the basin. Design of the LOBP Groundwater Monitoring Program is detailed in Chapter 7 of the LOBP. The basic elements of the program are as follows:

- Monitor long-term groundwater level trends in a network of wells for three monitoring groups within the basin: First Water (FW), Upper Aquifer (UA), and Lower Aquifer (LA).



Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

Basin Plan Areas:

Dunes and Bay Area

Western Area

Central Area

Eastern Area

B B'

Cross-section alignment (Figures 5 and 19). Labeled B-B' to be consistent with Basin Plan.

Basin Boundary from Basin Plan

Figure 1
Basin Location and Plan Areas
Los Osos Groundwater Basin
2017 Annual Report

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- Monitor seasonal fluctuations and long-term water quality trends at selected wells in each of the three monitoring groups.
- Compile hydrologic data pertinent to basin management, including groundwater production from the two principal water supply aquifers (Upper Aquifer and Lower Aquifer), wastewater disposal and recycled water use, local precipitation data and County stream gage records for Los Osos Creek.
- Organize historical and ongoing water production, water level and water quality monitoring data into three comprehensive databases, facilitating access and analysis.
- Collect data sufficient to evaluate the effectiveness of basin management strategies adopted in the LOBP via established metrics.

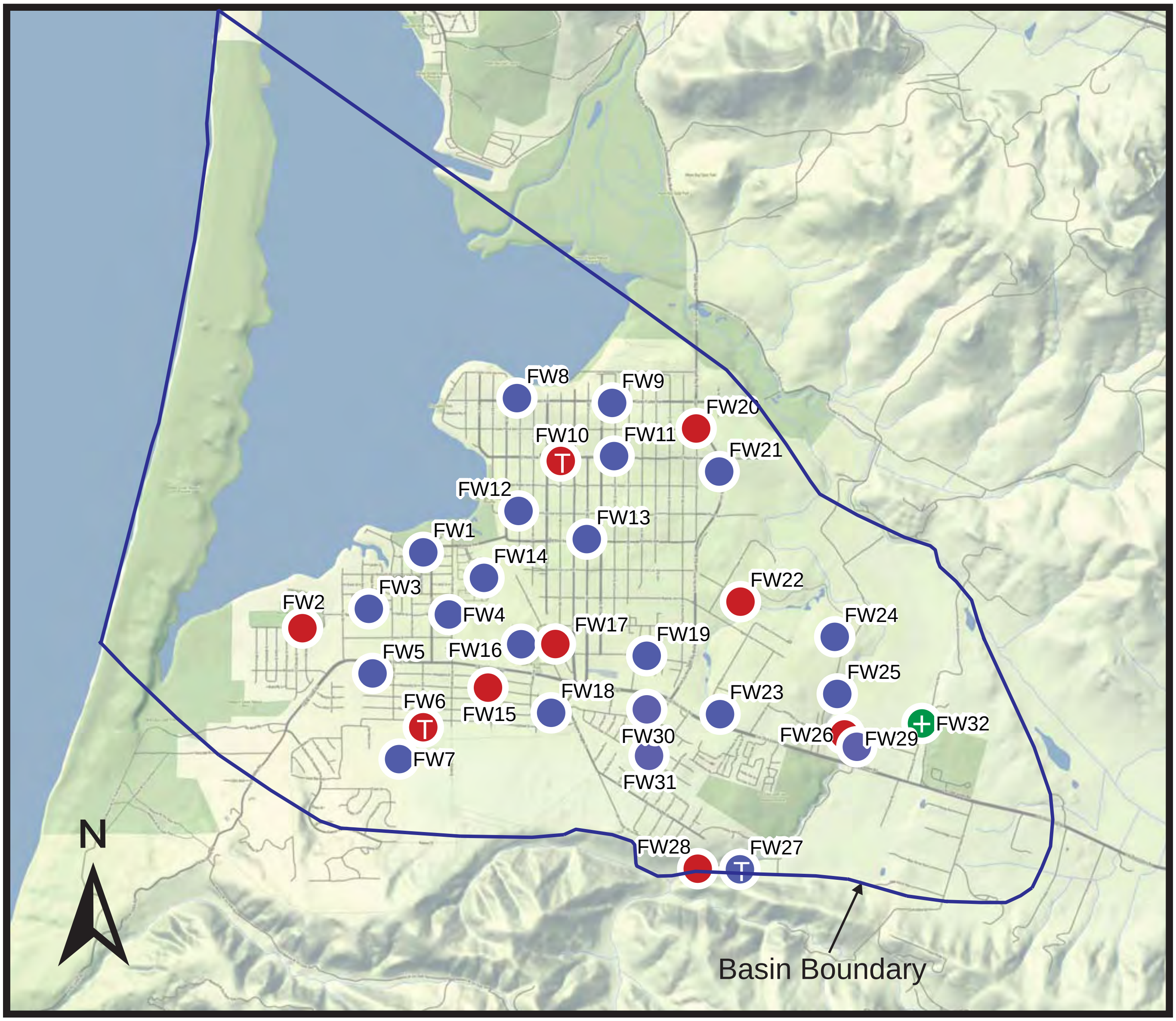
There were a total of 85 wells in the LOBP Groundwater Monitoring Program in 2016, including 37 BMC member agency monitoring wells, 17 municipal wells (active and inactive) and 31 private wells (CHG, 2017a). Two private wells and one agency monitoring well have been added to the monitoring program, for a total of 88 network wells in 2017. Private well participation in the monitoring program during 2017 was 82 percent (27 out of 33 wells).

Existing groundwater monitoring wells were chosen for their specific characteristics and to achieve, to the degree possible, horizontal and vertical coverage throughout the basin. The LOBP Groundwater Monitoring Program coverage within the basin is shown in Figures 2, 3, and 4. Correlation between LOBP Groundwater Monitoring Program well numbers and state well numbers, along with well construction information and monitoring tasks are included in Appendix B. Construction of a nested Upper Aquifer and Lower Aquifer monitoring wells near the bay was recommended in the LOBP and approved in 2017 (budgeted for 2018).

2.2.1 Water Level Monitoring

Groundwater elevations in wells are measures of hydraulic head at certain locations in an aquifer. Groundwater moves in the direction of declining head, and groundwater elevation contours can be used to show the general direction of, and hydraulic gradient associated with, groundwater movement. Changes to the amount of groundwater in storage within an aquifer can also be estimated by using changes in the hydraulic head with other parameters. Water level monitoring is a fundamental tool in characterizing basin hydrology, and is performed at LOBP Groundwater Monitoring Program locations. Equipping of eight monitoring locations with water level transducers was planned to provide an efficient and high level of resolution for tracking dynamic changes in Basin groundwater levels. Seven of the eight locations have been equipped with transducers (see Section 7.2).

Of the 88 wells currently in the groundwater monitoring network, 32 are representative of First Water, 18 are representative of the Upper Aquifer, and 38 are representative of the Lower Aquifer. Spatially, 5 water level monitoring wells are located in the Dunes and Bay Area, 25 wells are located in the Western Area, 38 are located in the Central Area, and 20 are located in the Eastern Area.



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Scale: 1 inch ≈ 4,000 feet

Explanation

- LOBP Water Level Monitoring Well
- Water Level Monitoring Well Addition (existing well)
- Water Level Transducer
- Water Level and Water Quality Monitoring Well
- Water Level Transducer and Water Quality Monitoring Well

Note: First Water wells refers to wells screened within the first 50 feet of saturated sediments across the basin, regardless of the aquifer.

Figure 2
Groundwater Monitoring Program
First Water Wells
Los Osos Groundwater Basin
2017 Annual Report

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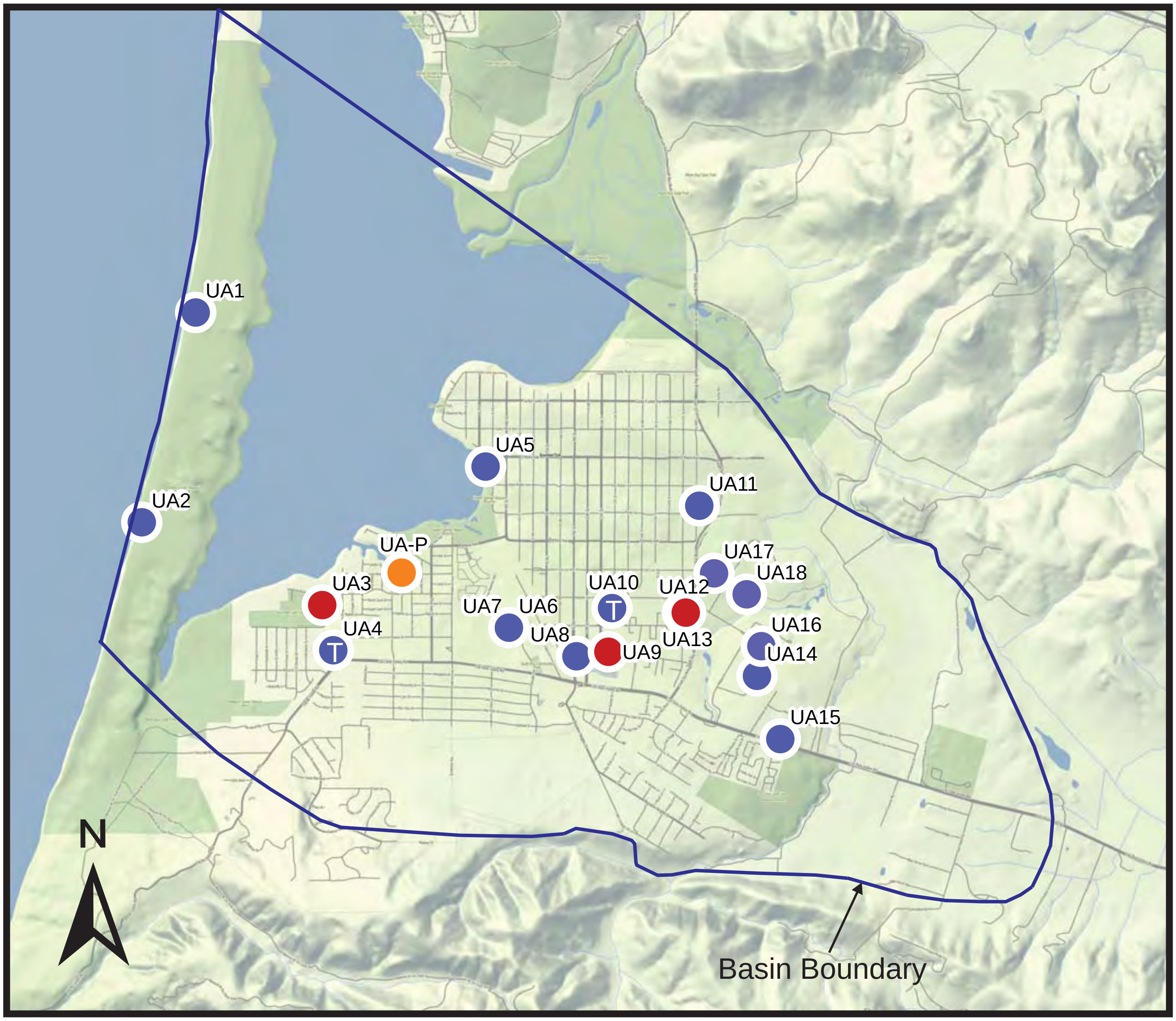

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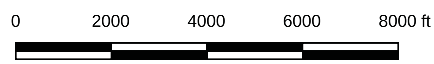

Scale: 1 inch ≈ 4,000 feet

Explanation

- LOBP Water Level Monitoring Well
- Water Level Monitoring Well Addition (existing well)
- Water Level Transducer
- Water Level and Water Quality Monitoring Well
- Water Level Transducer and Water Quality Monitoring Well
- Planned New Monitoring Well Construction

Figure 3
Groundwater Monitoring Program
Upper Aquifer Wells
Los Osos Groundwater Basin
2017 Annual Report

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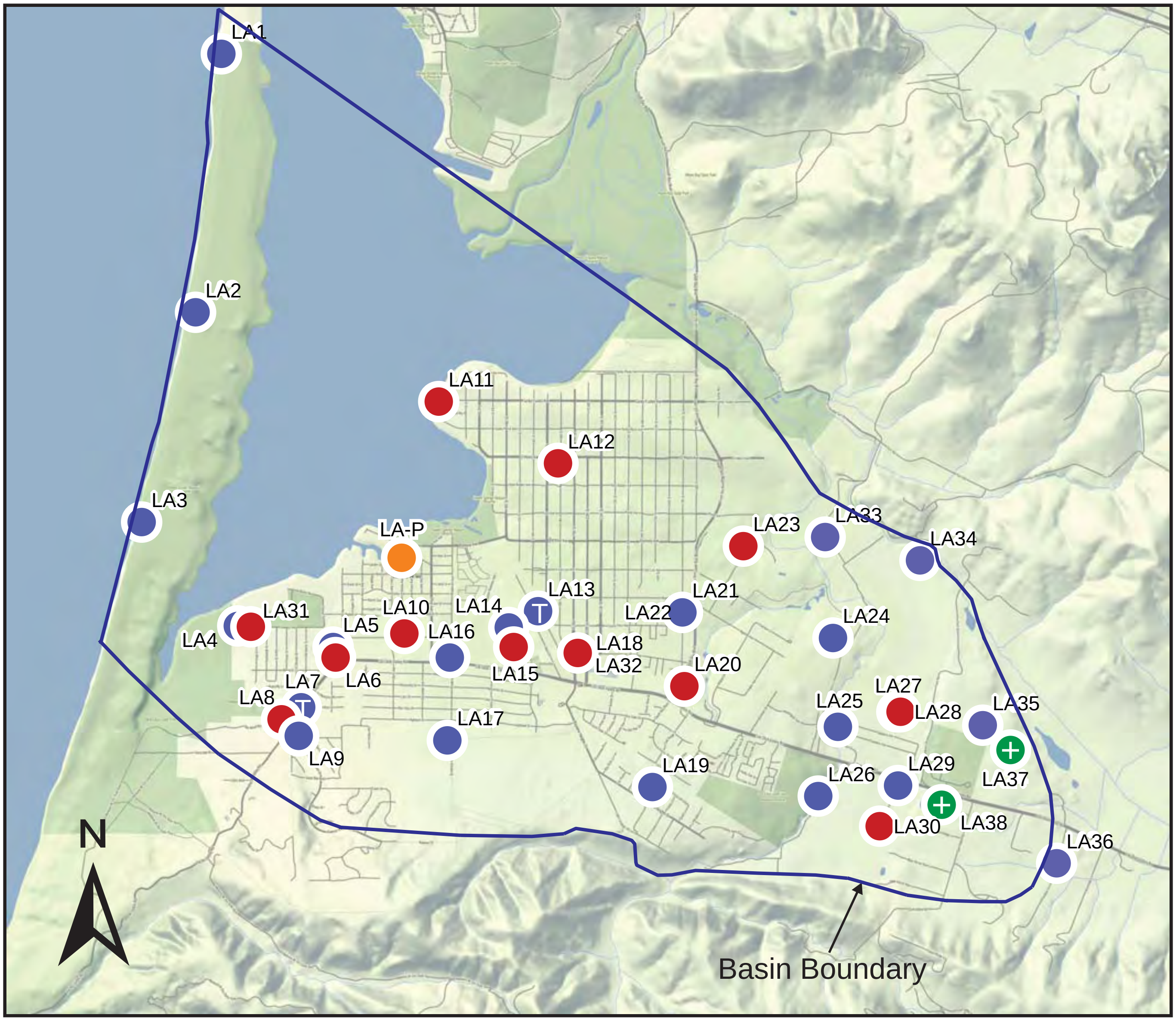

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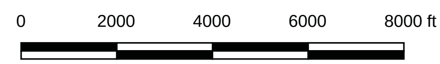

Scale: 1 inch ≈ 4,000 feet

Explanation

- LOBP Water Level Monitoring Well
- Water Level Monitoring Well Addition (existing well)
- Water Level Transducer
- Water Level and Water Quality Monitoring Well
- Water Level Transducer and Water Quality Monitoring Well
- Planned New Monitoring Well Construction

Note: LA24 and FW24 are nested wells (same borehole)

LA18 and LA32 at same site (two symbols used in 2016 Annual Report figure to indicate LA32 was a program addition).

Figure 4
Groundwater Monitoring Program
Lower Aquifer Wells
Los Osos Groundwater Basin
2017 Annual Report

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First Water

The First Water group refers to wells screened within the first 50 feet of saturated sediments across the basin, regardless of the aquifer (Figure 5). First Water is the interface where percolating waters, including precipitation and return flows from irrigation and wastewater, mix with basin waters. This 50-foot thick interface occurs within unconfined sediments and would rise and fall seasonally with water level fluctuations. Where First Water is close to ground surface, it also impacts drainage and is associated with flooding issues in low-lying areas. First Water extends areally throughout the basin, and may be present in dune sands, Paso Robles Formation deposits, or Los Osos Creek alluvium (Figure 5). Selected First Water wells, including those in downtown Los Osos are used to represent the perched aquifer (Zones A and B) and Alluvial Aquifer for water level contouring.

Upper Aquifer

The Upper Aquifer (Zone C) refers to the non-perched aquifer above the regional aquitard (Figure 5). As noted above, a portion of the Upper Aquifer may also be considered first water in certain basin areas. Historically, the Upper Aquifer was developed as the main water supply for the community, and is still the main source of water for rural residential parcels. A significant increase in Upper Aquifer production is planned under infrastructure program B . Monitoring the Upper Aquifer in the urban area, those properties contained within the Urban Reserve Line as shown in Figure 10 of the LOBP, is important to both local purveyors and rural residential parcels.

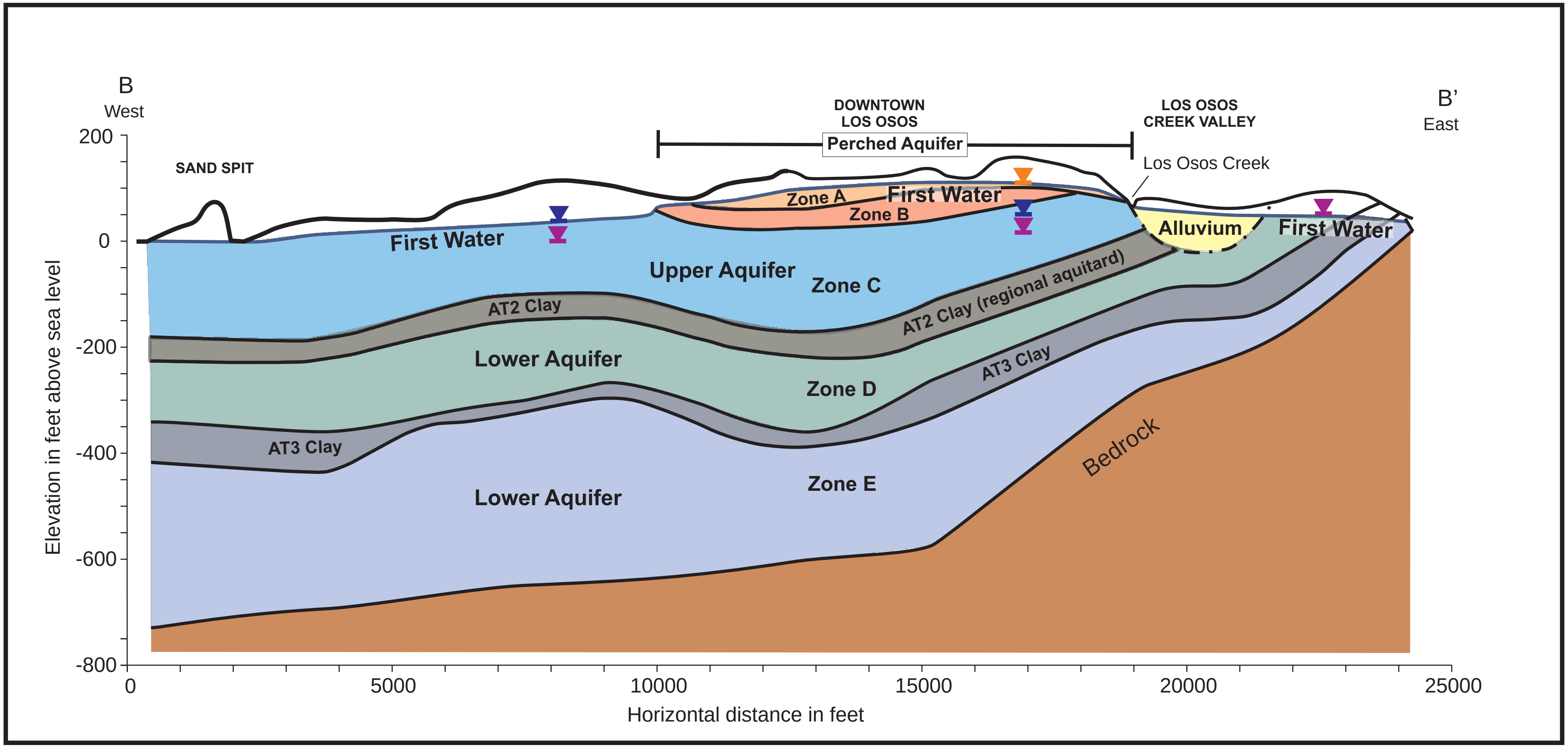
Lower Aquifer

The Lower Aquifer refers to water bearing sediments below the regional aquitard. There are both Paso Robles Formation and Careaga Formation deposits in the Lower Aquifer. The base of the Lower Aquifer is claystone and sandstone bedrock, although the effective base of fresh water lies above bedrock at the western edge of the basin. There are two generalized aquifer zones within the Lower Aquifer. Zone D lies between the regional aquitard (AT2 clay) and a deeper aquitard (AT3 clay). Zone E is below the AT3 clay (Figure 5).

Lower Aquifer Zone D is currently the main water supply source for the community. The seawater intrusion front has been advancing inland at increasing rates over time, and a significant reduction in Lower Aquifer production, together with other LOBP programs, is necessary to halt, slow and/or reverse intrusion.

2.2.2 Groundwater Quality Monitoring

Groundwater quality monitoring refers to the periodic collection and analysis of groundwater from wells. The analytical requirements are highly variable, depending on the purpose of monitoring. General minerals and nitrate are common water quality constituents of analysis for groundwater basin investigations. There are many other classes of water quality constituents of concern, however, such as volatile organic compounds, inorganic compounds (metals), petroleum



Cross-section alignment shown in Figure 1

Explanation

Perched Aquifer Water level

Upper Aquifer Water level

Lower Aquifer Water level

Figure 5
Basin Aquifers
Los Osos Groundwater Basin
2017 Annual Report

Cleath-Harris Geologists

hydrocarbons or emerging contaminants. Hexavalent Chromium has also been a concern in several shallow wells as described in the 2015 Annual Groundwater Monitoring Report (CHG, 2015). Many of these constituents are regulated and have drinking water standards. The purveyors monitor many of these constituents and data from those monitoring efforts will be incorporated into the LOBP Groundwater Monitoring Program, as described below.

Monitoring Constituents

Constituents of analysis for the LOBP Groundwater Monitoring Program have been selected to evaluate salt loading and associated nitrate impacts, seawater intrusion and wastewater disposal. Table 1 lists the general mineral constituents, including nitrate, which will be monitored as part of the program, although additional constituents are quantified in the general minerals suite performed by the analytical laboratory (See Appendix C). Total Dissolved Solids (TDS) and specific conductance are standard measures for groundwater mineralization and salinity. Temperature and pH are parameters that are routinely measured during sampling to confirm that the groundwater samples represent the aquifer. Table 1 presents constituents to be tested in the wells designated for water quality monitoring, which are distributed laterally and vertically across the basin (Figures 2, 3 and 4). Sampling at private wells will be pending private well owner participation in the LOBP Groundwater Monitoring Program.

Table 1. Water Quality Monitoring Constituents[1]

Constituent	Reporting Limit	Units
Specific Conductance	1.0	µS/cm
pH (field)	0.01	pH units
Temperature (field)	0.1	°F
TDS	20	mg/L
Carbonate Alkalinity	10	mg/L
Bicarbonate Alkalinity	10	mg/L
Total Alkalinity as $CaCO_3$	10	mg/L
Chloride	1.0	mg/L
Nitrate - Nitrogen	0.1	mg/L
Sulfate	2.0	mg/L
Boron	0.1	mg/L
Calcium	1.0	mg/L
Magnesium	1.0	mg/L
Potassium	1.0	mg/L
Sodium	1.0	mg/L

[1]From LOBP (ISJ Group, 2015)

The Lower Aquifer (via Well LA4 and Well LA14) will also be monitored using down hole geophysics once every three years (natural gamma and induction logs) to provide a unique measure of seawater intrusion over time in one location within the basin. Vertical movement of the freshwater-seawater interface has historically averaged 2-3 feet per year between 1985 and 2015 (CHG, 2015). The practical resolution of the methodology for measuring vertical interface movement is close to 5 feet, so a three-year monitoring frequency provides sufficient time to identify movement, based on the historical data. LA4 is located near the Sea Pines Golf Course in the Western Area, and LA14 is located at the north end of Palisades Avenue. Seawater is highly conductive, compared to fresh water, and an induction log performed in a borehole penetrating the fresh water/seawater interface shows the vertical transition from fresh water to seawater. The next scheduled geophysical logging is for October 2018.

Constituents of Emerging Concern

Monitoring Constituents of Emerging Concern (CECs) is a requirement of salt and nutrient management plans adopted pursuant to the State Water Resources Control Board Recycled Water Policy (SWRCB, 2009). Such monitoring can measure potential dilution and soil-aquifer treatment of recycled water constituents, and travel time and movement of recycled water. As part of LOWRF operation, the County is also required by the Regional Water Quality Control Board Monitoring and Reporting Program (MRP) Order No. R3-2011-0001 to monitor recycled water for CECs on an annual basis.

The initial CECs to be monitored are listed in Table 2, and were selected based on the Recycled Water Policy. There are three types of CECs, each of which has a different function. Health-based indicators directly monitor the presence of classes of constituents in groundwater, while performance-based and surrogate indicators measure the effectiveness of the wastewater treatment process. The list of CECs is not intended to be comprehensive, but meant to be representative. CECs may be added to (or removed from) the monitoring list once data has been collected and analyzed, subject to approval by the BMC.

Table 2. CEC Monitoring Constituents[1]			
Constituent or Parameter	**Type of Constituent**	**Type of Indicator**	**Reporting Limit (µg/L)**
17β-estradiol	Steroid Hormones	Health	0.001
Triclosan	Antimicrobial		0.050
Caffeine	Stimulant		0.050
NDMA (Nitroso-dimethylamine)	Disinfection Byproduct		0.002
Gemfibrozil	Pharmaceutical Residue	Performance	0.010
DEET (Diethyl-meta-toluamide)	Personal Care Product		0.050
Iopromide	Pharmaceutical Residue		0.050
Sucralose	Food additive		0.100
Ammonia	N/A	Surrogate	N/A
Nitrate-Nitrogen	N/A		N/A
Total Organic Carbon	N/A		N/A
UV Light Absorption	N/A		N/A
Specific Conductance	N/A		N/A

[1]From LOBP (ISJ Group, 2015)

2.2.3 Monitoring Frequency

Monitoring frequency is the time interval between data collection. Seasonal fluctuations relating to groundwater levels or quality are typically on quarterly or semi-annual cycles, correlating with seasonal precipitation, recharge, water levels, and often well production. The monitoring schedule for groundwater levels collected under the LOBP Groundwater Monitoring Program will coincide with seasonal water level fluctuations, with higher levels (i.e. elevations) in April (Spring) and lower levels in October (Fall). Spring water levels collected under the LOWRF Baseline Groundwater Monitoring Program (First Water and Upper Aquifer groups) may extend beyond April into June, and Fall water levels may extend beyond October into December. A semi-annual monitoring frequency provides a measure of these seasonal cycles, which can then be distinguishable from the long-term trends. At the transducer-monitored locations, water level measurements will be recorded automatically on a daily basis and downloaded during the regular semi-annual water level monitoring events.

The monitoring frequency for water quality sampling and analyses performed under the LOBP Groundwater Monitoring Program will generally be once per year in October (Fall), when groundwater levels (i.e. elevations) are seasonally low and many water quality constituents have historically been at a higher concentrations than their corresponding Spring measurement. Lower Aquifer groundwater monitoring will also be performed in April (Spring) as a means of tracking seawater intrusion in greater detail. The schedule for Fall water quality testing performed under the LOWRF Groundwater Monitoring Program (First Water and Upper Aquifer) has been moved by San Luis Obispo County from October to December.

2.2.4 SGMA Activities

In June 2017, San Luis Obispo County authorized a basin characterization study for the Basin fringe areas with Basin Boundary Modification Request (BBMR) preparations. These fringe areas, which lie outside of the Basin Plan Areas but within the DWR Bulletin 118 basin boundary, were the subject of a BBMR in 2016 that was denied by the DWR due to lack of supporting scientific evidence. A new BBMR is planned for 2018 that includes scientific evidence from the fringe area characterization study.

2.2.5 Additional Basin Studies

CHG delivered a Technical Memorandum to the BMC and Morro Bay National Estuary Program in March 2017 on the Basin Yield Metric response to reduced long-term precipitation in the Los Osos Groundwater Basin (CHG, 2017b). The purpose of the study was to understand how reduced precipitation would affect estimated basin sustainable yield, and what the corresponding level of groundwater production would be at 80 percent of the Basin Yield Metric, which is the target for safe operation of the basin, as recommended in the LOBP. A link to the Technical Memorandum is included in the References section.

3. CONDUCT OF WORK

This Groundwater Monitoring Program Annual Report covers monitoring activities performed during the 2017 calendar year. While information from prior years is included in data presentation and interpretation, the conduct of work and detailed groundwater monitoring results are reported for 2017.

3.1 Services Provided

All 2017 groundwater monitoring data compiled for this report, unless described otherwise, comes from the following monitoring programs:

- San Luis Obispo County Public Works, Semi-Annual Water Level Monitoring Program: water level data.
- Purveyor water supply well monitoring: water level, water quality and production data.
- LOWRF Waste Discharge Order R3-2011-0001 Groundwater Monitoring Program (CCRWQCB, 2011): water level and water quality data.
- LOBP Groundwater Monitoring Program: water level and water quality data.

3.2 Field Methods

Groundwater level measurement and groundwater sampling are the primary field activities performed for the LOBP Groundwater Monitoring Program. Field activities include measuring and recording water levels in wells and collecting groundwater samples for laboratory analytical testing. The field methods approved for use in the LOBP Groundwater Monitoring Program are presented in Appendix D. These methods are recommended for services performed directly for the BMC and for other monitoring programs that contribute data to the LOBP Groundwater Monitoring Program.

3.2.1 Elevation Datum

The original survey for wells in the County's Semi-Annual Water Level Monitoring Program was likely based on the National Geodetic Vertical Datum of 1929 (NGVD 29), which has been replaced in land surveying practice by the North American Vertical Datum of 1988 (NAVD 88). Several wells were re-surveyed in 2003 and 2005 using NAVD 88, but there are still wells with elevations based on NGVD 29, along with wells with no known elevation survey. For the 2017 Annual Report, wellhead elevations reported in tables are from the latest available survey or estimated from topographic maps (with datum given). For water level contouring and storage calculations, the NGVD 29 reference point elevation have been adjusted to NAVD 88 datum using a 2.8 feet upward shift, based on North American Vertical Datum Conversion (VERTCON) data reviewed for the Los Osos area, as published by the National Geodetic Society. A review of all reference points by a licensed surveyor is recommended, after which all data may be expressed in the current NAVD 88 standard, including the Water Level Metric.

3.2.2 Water Level Monitoring Procedures

Groundwater level monitoring typically uses an electric sounder or steel tape. If the well is equipped and active, monitoring would take place when the pump is off and the water level is relatively static. Seven monitoring network wells are currently equipped with a pressure transducer, allowing for automatic water level data collection between regular (manual) monitoring events. These devices are placed below water in a well and record changes in pressure that occur in response to changes in the height of the water column above the transducer. Detailed water level monitoring procedures are included in Appendix D.

3.2.3 Groundwater Sampling Procedures

Groundwater sampling procedures ensure collection of a representative groundwater sample from an aquifer for water quality analysis. Unused or unequipped wells are purged of standing or stagnant water prior to sampling. Stabilization of field measurements for conductivity, pH, and temperature, along with minimum purge volumes, are included in the approved methods.

Sampling procedures for general mineral and nitrate sampling (with additional procedures for wastewater indicator compounds) are presented in Appendix D.

An induction electric log, which is used periodically at Wells LA4 and LA14, measures formation specific conductance using high frequency alternating currents that are induced into the formation. The technique may be used in open boreholes or wells cased with PVC, but not in steel-cased wells. Seawater is highly conductive, compared to fresh water, and an induction log performed in a borehole penetrating the fresh water/seawater interface will show the vertical transition from fresh water to seawater. By convention, conductivity measurements from the induction tool are put through an electrical reciprocator and converted to a resistivity curve on the log. The gamma ray log, which is also performed periodically at Wells LA4 and LA14, measures naturally occurring gamma emissions from the formation surrounding the borehole. These emissions can penetrate both PVC and steel-cased wells, and are typically used to measure clay content when gamma active clays are present (Welenco, 1996). Since natural gamma emissions are not affected by changes in water quality, the gamma ray log can be used as a depth calibration tool when comparing induction logs from different monitoring events.

3.3 Monitoring Staff Affiliations

Monitoring services that contributed data to the 2017 Annual Report were performed by staff or consultants affiliated with the following agencies:

- San Luis Obispo County Department of Public Works, Water Resources Division. County staff performed semi-annual water level monitoring, collected and maintained precipitation and stream gage records. Rincon Consultants performed semi-annual (June and December) water level monitoring and water quality sampling at selected private wells and monitoring wells for the LOWRF Groundwater Monitoring Program.

- Los Osos Water Purveyors (LOCSD, GSWC, S&T). Water agency staff performed semi-annual water level monitoring and water quality sampling at municipal water supply wells.

- Los Osos BMC (LOCSD, GSWC, S&T, and County). CHG performed semi-annual (April and October) water level monitoring, water quality sampling at private wells, monitoring wells, and municipal supply wells for the LOBP Groundwater Monitoring Program.

4. MONITORING RESULTS

The results of groundwater monitoring activities performed in 2017 for the various basin monitoring programs are summarized below. Overlap between the LOBP Groundwater Monitoring Program and other ongoing monitoring programs are shown in Appendix B. Laboratory analytical reports of groundwater samples collected for the LOWRF Groundwater

Monitoring Program are contained in their respective June and December 2017 monitoring program reports (Rincon Consultants, 2017b, 2018).

4.1 Water Level Monitoring Results

Tables 3 through 8 present the results of groundwater level measurements at LOBP Groundwater Monitoring Program wells, as reported by the various monitoring programs. Available water levels for wells labeled "Private" are not reported herein, but those listed as measured have been used for aggregated water level contour maps. "Private" wells refer to domestic wells, agricultural irrigation wells, and monitoring wells that are not controlled by BMC member agencies.

Spring water levels were measured in April 2017 for the County Semi-Annual Water Level Monitoring Program and the Lower Aquifer Monitoring Program, and in April and May for the LOWRF Groundwater Monitoring Program. Fall water levels were measured in October 2017 for the County Semi-Annual Water Level Monitoring Program and the LOBP Groundwater Monitoring Program. The LOWRF Groundwater Monitoring Program schedule moved from October to December beginning in Fall 2016. For consistency with the LOBP and County programs, however, CHG also monitored water levels at selected LOWRF monitoring program wells in October 2016, rather than using the December 2016 LOWRF monitoring event values.

Table 3. Spring 2017 Water Levels - First Water					
Well ID	**State Well Number**	**R. P. Elevation and Datum (feet)**	**Date**	**Water Level (Feet)**	
				Depth	**Elevation**
FW1	30S/10E-13A7	PRIVATE (not measured)			
FW2	30S/10E-13L8	32.63 [1]	4/11/2017	21.49	11.14
FW3	30S/10E-13G	50.95 [1]	4/10/2017	42.3	8.65
FW4	30S/10E-13H	49.33 [1]	4/11/2017	23.46	25.87
FW5	30S/10E-13Q2	101.27 [1]	4/10/2017	86.72	14.55
FW6	30S/10E-24A	193.04 [1]	4/10/2017	162.29	30.75
FW7	30S/10E-24Ab	Not measured (damaged)			
FW8	30S/11E-7L4	45.76 [1]	4/11/2017	35.6	10.16
FW9	30S/11E-7K3	90.71 [1]	4/17/2017	51.63	39.08
FW10	30S/11E-7Q1	25.29 [1]	4/10/2017	6.94	18.35
FW11	30S/11E-7R2	61.93 [1]	4/13/2017	20.92	41.01
FW12	30S/11E-18C2	34.55 [1]	4/13/2017	18.29	16.26
FW13	30S/11E-18B2	79.89 [1]	4/13/2017	18.26	61.63
FW14	30S/11E-18E1	PRIVATE (measured)			
FW15	30S/11E-18N2	125.53 [1]	4/10/2017	83.94	41.59
FW16	30S/11E-18L11	88.02 [1]	4/13/2017	46.31	41.71
FW17	30S/11E-18L12	103.85 [1]	4/13/2017	17.9	85.95
FW18	30S/11E-18P	150 [2]	not measured		
FW19	30S/11E-18J7	125.74 [1]	4/12/2017	19.53	106.21
FW20	30S/11E-8Mb	95 [2]	4/13/2017	42.4	52.6
FW21	30S/11E-8N4	95.99 [1]	4/13/2017	36.2	59.79
FW22	30S/11E-17F4	PRIVATE (measured)			
FW23	30S/11E-17N4	PRIVATE (measured)			
FW24	30S/11E-17J2	PRIVATE (measured)			
FW25	30S/11E-17R1	PRIVATE (not measured)			
FW26	30S/11E-20A2	PRIVATE (not measured)			
FW27	30S/11E-20L1	134.07 [3]	4/20/2017	32.2	101.9
FW28	30S/11E-20M2	PRIVATE (measured)			
FW29	30S/11E-20A1	PRIVATE (measured)			
FW30	30S/11E-18R1	PRIVATE (not measured)			
FW31	30S/11E-19A	213 [2]	4/20/2017	31.6	181.4
FW32+	30S/11E-21D14	PRIVATE (measured)			

NOTES: 1 NAVD88 elevation as reported by licensed land surveyor
2 estimated elevation (NAVD88)
3 elevation as reported by County (datum unknown, likely NGVD29)
+ added for current reporting year

Table 4. Spring 2017 Water Levels - Upper Aquifer					
Well ID	**State Well Number**	**R. P. Elevation and Datum (feet)**	**Date**	**Water Level (Feet)**	
				Depth	**Elevation**
UA1	30S/10E-11A1	16.01 [1]	5/24/2017	12.39	3.6
UA2	30S/10E-14B1	19.48 [1]	5/24/2017	15.9	3.6
UA3	30S/10E-13F4	19 [2]	4/4/2017	10	9.0
UA4	30S/10E-13L1	38.68 [3]	4/11/2017	31.6	7.1
UA5	30S/11E-7N1	9.13 [3]	4/13/2017	3.5	7.5
UA6	30S/11E-18L8	79.18 [1]	4/17/2017	56.9	22.3
UA7	30S/11E-18L7	79.16 [1]	4/17/2017	64.5	14.7
UA8	30S/11E-18K7	135.65 [3]	4/12/2017	118.7	17.0
UA9	30S/11E-18K3	121.18 [3]	4/17/2017	108	13.2
UA10	30S/11E-18H1	107.10 [3]	4/10/2017	93	14.1
UA11	30S/11E-17D	PRIVATE (not measured)			
UA12	30S/11E-17E9	105.85 [3]	4/13/2017	88.17	17.7
UA13	30S/11E-17E10	106 [2]	4/13/2017	92.1	13.9
UA14	30S/11E-17P4	PRIVATE (not measured)			
UA15	30S/11E-20B7	PRIVATE (not measured)			
UA16	30S/11E-17L4	PRIVATE (measured)			
UA17	30S/11E-17E1	PRIVATE (measured)			
UA18	30S/11E-17F2	PRIVATE (measured)			

NOTES:
1 NAVD88 elevation as reported by licensed land surveyor
2 estimated elevation (assume NAVD88)
3 elevation as reported by County (datum unknown, likely NGVD 29)
All NGVD 29 elevations are converted to NAVD 88 prior to contouring

Table 5. Spring 2017 Water Levels - Lower Aquifer					
Well ID	**State Well Number**	**R. P. Elevation and Datum (feet)**	**Date**	**Water Level (Feet)**	
				Depth	**Elevation**
LA1	30S/10E-2A1	23.13 [1]	5/24/2017	15.83	7.3
LA2	30S/10E-11A2	16.07 [1]	5/24/2017	11.49	4.6
LA3	30S/10E-14B2	19.47 [1]	5/24/2017	17.54	1.9
LA4	30S/10E-13M1	41.20 [3]	4/17/2017	44.53	-3.3
LA5	30S/10E-13L7	37 [2]	4/11/2017	33	4.0
LA6	30S/10E-13L4	68 [2]	5/17/2017	63.5	4.5
LA7	30S/10E-13P2	PRIVATE (not measured)			
LA8	30S/10E-13N	138.50 [2]	4/11/2017	134	4.5
LA9	30S/10E-24C1	178.32 [3]	4/17/2017	176	2.3
LA10	30S/10E-13J1	95.31 [3]	4/17/2017	79	16.3
LA11	30S/10E-12J1	8.43 [1]	4/11/2017	5.26	3.2
LA12	30S/11E-7Q3	24.30 [3]	4/13/2017	35.3	-11.0
LA13	30S/11E-18F2	100 [3]	4/11/2017	104.47	-4.5
LA14	30S/11E-18L6	79.36 [1]	4/17/2017	78.1	1.3
LA15	30S/11E-18L2	85 [2]	4/13/2017	106.2	-21.2
LA16	30S/11E-18M1	106.82 [3]	4/17/2017	99.01	7.8
LA17	30S/11E-24A2	210.40 [3]	not measured		
LA18	30S/11E-18K8	135.74 [3]	4/12/2017	137.83	-2.1
LA19	30S/11E-19H2	256.20 [3]	4/18/2017	271.31	-15.1
LA20	30S/11E-17N10	140 [2]	4/17/2017	164	-24.0
LA21	30S/11E-17E7	105.85 [3]	4/18/2017	111.14	-5.3
LA22	30S/11E-17E8	105.85 [3]	4/18/2017	124.9	-19.1
LA23 to LA30		PRIVATE (measured LA24, LA26, LA27, LA29)			
LA31	30S/10E-13M2	(Mixed aquifer - used for water quality only)			
LA32	30S/11E-18K9	(Mixed aquifer - used for water quality only)			
LA33	30S/11E-17A1	PRIVATE (measured)			
LA34	30S/11E-8F	26.15 [1]	4/27/2017	3.5	22.7
LA35	30S/11E-21Bb	96 [2]	4/4/2017	64	32
LA36	30S/11E-21Ja	PRIVATE (not measured)			
LA37+	30S/11E-21B1	81.4 [2]	4/17/2017	59.92	21.08
LA38+	30S/11E-21E	PRIVATE (not measured)			

NOTES:
1 NAVD88 elevation as reported by licensed land surveyor
2 estimated elevation (assume NAVD 88)
3 elevation as reported by County (datum unknown, likely NGVD 29)
+ added for current reporting year
All NGVD 29 elevations are converted to the NAVD 88 datum prior to contouring

Table 6. Fall 2017 Water Levels - First Water					
Well ID	State Well Number	R. P. Elevation and Datum (feet)	Date	Water Level (Feet)	
				Depth	Elevation
FW1	30S/10E-13A7	PRIVATE (not measured)			
FW2	30S/10E-13L8	32.63 [1]	10/2/2017	23.34	9.3
FW3	30S/10E-13G	50.95 [1]	10/2/2017	41.46	9.5
FW4	30S/10E-13H	49.33 [1]	10/2/2017	25.9	23.4
FW5	30S/10E-13Q2	101.27 [1]	10/10/2017	86.4	14.9
FW6	30S/10E-24A	193.04 [1]	10/5/2017	159.16	33.9
FW7	30S/10E-24Ab	Not measured (damaged)			
FW8	30S/11E-7L4	45.76 [1]	10/3/2017	37.54	8.2
FW9	30S/11E-7K3	90.71 [1]	10/2/2017	52.86	37.9
FW10	30S/11E-7Q1	25.29 [1]	10/5/2017	8.19	17.1
FW11	30S/11E-7R2	61.93 [1]	10/2/2017	22.96	39.0
FW12	30S/11E-18C2	34.55 [1]	10/12/2017	19.61	14.9
FW13	30S/11E-18B2	79.89 [1]	10/12/2017	21.2	58.7
FW14	30S/11E-18E1	PRIVATE (measured)			
FW15	30S/11E-18N2	125.53 [1]	10/2/2017	83.38	42.2
FW16	30S/11E-18L11	88.02 [1]	10/3/2017	45.69	42.3
FW17	30S/11E-18L12	103.85 [1]	10/4/2017	21.02	82.8
FW18	30S/11E-18P	150 [2]	10/2/2017	24.61	125.4
FW19	30S/11E-18J7	125.74 [1]	10/12/2017	24.7	101.0
FW20	30S/11E-8Mb	95 [2]	10/12/2017	42.99	52.0
FW21	30S/11E-8N4	95.99 [1]	10/12/2017	36.97	59.0
FW22	30S/11E-17F4	PRIVATE (not measured)			
FW23	30S/11E-17N4	PRIVATE (measured)			
FW24	30S/11E-17J2	PRIVATE (measured)			
FW25	30S/11E-17R1	PRIVATE (not measured)			
FW26	30S/11E-20A2	PRIVATE (measured)			
FW27	30S/11E-20L1	134.07 [3]	10/31/2017	55.59	78.5
FW28	30S/11E-20M2	PRIVATE (measured)			
FW29	30S/11E-20A1	PRIVATE (measured)			
FW30	30S/11E-18R1	PRIVATE (measured)			
FW31	30S/11E-19A	213 [2]	10/3/2017	30.0	183
FW32+	30S/11E-21D14	PRIVATE (measured)			

NOTES: 1 NAVD88 elevation as reported by licensed land surveyor
2 estimated elevation (NAVD 88)
3 elevation as reported by County (datum unknown, likely NGVD 29)
+ added for current reporting year

Table 7. Fall 2017 Water Levels - Upper Aquifer					
Well ID	State Well Number	R. P. Elevation and Datum (feet)	Date	Water Level (Feet)	
				Depth	Elevation
UA1	30S/10E-11A1	16.01 [1]	11/2/2017	12.03	4.0
UA2	30S/10E-14B1	19.48 [1]	11/1/2017	15.85	3.6
UA3	30S/10E-13F4	19 [2]	10/10/2017	15	4.0
UA4	30S/10E-13L1	38.68 [3]	10/5/2017	31.96	6.7
UA5	30S/11E-7N1	9.13 [2]	10/8/2017	4.5	6.5
UA6	30S/11E-18L8	79.18 [1]	10/25/2017	59.2	20.0
UA7	30S/11E-18L7	79.16 [1]	10/25/2017	67.81	11.4
UA8	30S/11E-18K7	135.65 [3]	10/9/2017	122.12	13.5
UA9	30S/11E-18K3	121.18 [3]	10/10/2017	110	11.2
UA10	30S/11E-18H1	107.10 [3]	10/5/2017	96.06	11.0
UA11	30S/11E-17D	PRIVATE (not measured)			
UA12	30S/11E-17E9	105.85 [3]	10/11/2017	92.65	13.2
UA13	30S/11E-17E10	106 [2]	10/18/2017	94.4	11.6
UA14	30S/11E-17P4	PRIVATE (not measured)			
UA15	30S/11E-20B7	PRIVATE (not measured)			
UA16	30S/11E-17L4	PRIVATE (measured)			
UA17	30S/11E-17E1	PRIVATE (measured)			
UA18	30S/11E-17F2	PRIVATE (measured)			

NOTES: 1 NAVD88 elevation as reported by licensed land surveyor

2 estimated elevation (assume NAVD88)

3 elevation as reported by County (datum unknown, likely NGVD 29)

All NGVD 29 elevations are converted to the NAVD 88 prior to contouring.

Table 8. Fall 2017 Water Levels - Lower Aquifer					
Well ID	State Well Number	R. P. Elevation and Datum (feet)	Date	Water Level (Feet)	
				Depth	Elevation
LA1	30S/10E-2A1	23.13 [1]	11/1/2017	15.71	7.4
LA2	30S/10E-11A2	16.07 [1]	11/2/2017	11.18	5.2
LA3	30S/10E-14B2	19.47 [1]	11/1/2017	17.8	-1.0
LA4	30S/10E-13M1	41.20 [3]	10/5/2017	45.17	-4.0
LA5	30S/10E-13L7	37 [2]	10/4/2017	33.9	3.1
LA6	30S/10E-13L4	68 [2]	10/25/2017	77	-9.0
LA7	30S/10E-13P2	PRIVATE (not measured)			
LA8	30S/10E-13N	138.50 [2]	10/2/2017	135	3.5
LA9	30S/10E-24C1	178.32 [3]	10/12/2017	174	4.3
LA10	30S/10E-13J1	95.31 [3]	10/10/2017	87	8.3
LA11	30S/10E-12J1	8.43 [1]	10/4/2017	6.99	1.4
LA12	30S/11E-7Q3	24.30 [3]	10/19/2018	39.3	-15.0
LA13	30S/11E-18F2	100 [3]	10/5/2017	108.36	-8.4
LA14	30S/11E-18L6	79.36 [1]	10/25/2017	81.52	-2.2
LA15	30S/11E-18L2	85 [2]	10/19/2017	96.8	-11.8
LA16	30S/11E-18M1	106.82 [3]	10/25/2017	101.71	5.1
LA17	30S/11E-24A2	210.40 [3]	not measured		
LA18	30S/11E-18K8	135.74 [3]	10/9/2017	141.75	-6.0
LA19	30S/11E-19H2	256.20 [3]	10/26/2017	274.21	-18.0
LA20	30S/11E-17N10	140 [2]	10/13/2017	168	-28.0
LA21	30S/11E-17E7	105.85 [3]	10/26/2017	118.4	-12.6
LA22	30S/11E-17E8	105.85 [3]	10/11/2017	128.8	-23.0
LA23 to LA30		PRIVATE (measured LA24, LA25, LA29, LA30)			
LA31	30S/10E-13M2	(Mixed aquifer - used for water quality only)			
LA32	30S/11E-18K9	(Mixed aquifer - used for water quality only)			
LA33	30S/11E-17A1	PRIVATE (measured)			
LA34	30S/11E-8F	26.15 [1]	10/12/2017	6.64	19.5
LA35	30S/11E-21Bb	96 [2]	10/3/2017	78	8.8
LA36	30S/11E-21Ja	PRIVATE			
LA37+	30S/11E-21B1	81.4 [2]	10/5/2017	66.93	14.1
LA38+	30S/11E-21E	PRIVATE (measured)			

NOTES: 1 NAVD88 elevation as reported by licensed land surveyor

2 estimated elevation (assume NAVD88)

3 elevation as reported by County (datum unknown, likely NGVD 29)

All NGVD 29 elevations are converted to the NAVD 88 prior to contouring.

+ added for current reporting year

4.2 Water Quality Results

Available Fall 2017 water quality results for First Water and Upper Aquifer monitoring wells designated for water quality reporting in the LOBP Groundwater Monitoring Program are presented in Table 9. The LOBP Groundwater Monitoring Program does not include Spring 2017 water quality monitoring at First Water or Upper Aquifer Wells. Available Spring and Fall 2017 water quality for Lower Aquifer monitoring wells designated for water quality reporting in the LOBP Groundwater Monitoring Program are presented in Tables 10 and 11. Groundwater monitoring field logs and laboratory analytical reports for the 2017 LOBP Groundwater Monitoring Program are included in Appendix C.

"Private" wells refer to domestic wells, agricultural irrigation wells, and monitoring wells that are not controlled by BMC member agencies. Private well participation in the monitoring program during 2017 was 82 percent (27 out of 33 wells).

Some of the constituents of analysis that are part of the LOBP Groundwater Monitoring Program listed in Table 1 are not included in the LOWRF Groundwater Monitoring Program. The missing constituents include specific conductance, alkalinity (bicarbonate, carbonate, and total), calcium, magnesium, and potassium.

Lower Aquifer wells LA2 and LA3 were not sampled in 2017. These are Morro Bay sand spit wells that are scheduled for water quality monitoring every five years to track changes in salinity at the coast (2015 LOBP). The next scheduled water quality sampling event on the sand spit will be in 2020.

4.2.3 Nitrate and Chloride Results

Results for First Water wells indicate elevated nitrate concentrations across much of the urban area. A more extensive compilation of shallow water quality, including nitrate and TDS concentration maps, are presented for June and December 2017 in the County's LOWRF Groundwater Monitoring Program reports (Rincon Consultants, 2017b, 2018). Nitrate concentration trends are tracked using the Nitrate Metric (see Section 7.5.3).

Lower Aquifer water quality results for 2017 show one water supply well (LA31) impacted by seawater intrusion, based on chloride concentrations over 250 mg/L. The overall trend in chloride concentration and seawater intrusion is tracked using the Chloride Metric (see Section 7.5.3).

4.2.4 CEC Results

CEC sampling was conducted at well FW5 and FW26 in October 2017 (Table 12). Well FW5 is hydraulically downgradient of the Broderson leach field site. Well FW26 is located in the Los Osos Creek Valley (Figure 2). CEC results are presented in Table 12, with laboratory reports included in Appendix C.

Table 9. Fall 2017 Water Quality Results - First Water and Upper Aquifer																	
LOBP Well	State Well Number	Date	SC	pH (field)	TDS	Alkalinity CO3	Alkalinity HCO3	Alkalinity Total as CaCO3	Cl	NO3-N	SO4	B	Ca	Mg	K	Na	T (field)
			µS/cm	pH units	----------	----------	----------	----------	mg/L	----------	----------	----------	----------	----------	----------	----------	°F
FW2*	30S/10E-13L8	12/14/17	*928*[1]	6.32	650	--	--	--	120	44	31	0.14	--	--	--	150	64.6
FW6*	30S/10E-24A	12/19/17	*550*[1]	7.04	440	--	--	--	120	10	19	<0.05	--	--	--	47	58.1
FW10*	30S/11E-7Q1	Bi-annual schedule (not sampled in 2017)															
FW15*	30S/11E-18N2	12/14/17	*685*[1]	6.43	530	--	--	--	93	27	39	0.24	--	--	--	62	66.9
FW17*	30S/11E-18L12	12/14/17	*882*[1]	6.53	540	--	--	--	81	48	74	0.17	--	--	--	58	70.7
FW20*	30S/11E-8Mb	Bi-annual schedule (not sampled in 2017)															
FW22*	30S/11E-17F4	12/14/17	*680*[1]	6.94	420	--	--	--	140	1.3	24	<0.05	--	--	--	62	61.5
FW26	30S/11E-20A2	10/3/17	673	6.93	370	<10	210	170	82	<0.5	41.2	<0.1	35	35	<1	35	56.7
FW28	30S/11E-20M2	10/3/17	836	7.70	490	<10	240	200	47	<0.5	89.9	<0.1	63	48	<1	30	67.3
UA3	30S/10E-13F4	10/12/2017	607	6.5	390	<10	100	80	73	19.2	29.5	<0.1	26	19	2	64	--
UA9	30S/11E-18K3	10/12/2017	319	6.7	220	<10	60	50	42	9.3	7.6	<0.1	15	11	<1	27	--
UA13	30S/11E-17E10	10/12/2017	506	6.88	310	<10	110	90	58	14	23.3	<0.1	24	23	1	40	65.8

NOTES: "--" = no result available; SC = specific conductance; TDS = total dissolved solids; CO3 = carbonate; HCO3= bicarbonate; CaCO3 = total alkalinity as calcium carbonate; Cl = chloride; NO3-N = nitrate as nitrogen; SO4 = sulfate; B = boron; Ca = calcium; Mg = magnesium; K = potassium; Na = sodium; T = temperature; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; °F = degrees Fahrenheit; < indicates less than Practical Quantitation Limit as listed in laboratory report.

* = readings from LOWRF Groundwater Monitoring Program sampling event in December 2017 (Rincon Consultants, 2018)

[1] *Field measurements*

Table 10. Spring 2017 Water Quality Results - Lower Aquifer

LOBP Well	State Well Number	Date	SC	pH (field)	TDS	Alkalinity			Cl	NO3-N	SO4	B	Ca	Mg	K	Na	T (field)
						CO3	HCO3	Total as CaCO3									
			µS/cm	pH units	mg/L												°F
LA8	30S/10E-13N	04/11/17	434	6.45	270	<10	50	40	77	7.3	12.4	<0.1	17	14	1	38	64.8
LA9	30S/10E24C1	04/10/17	490	7.0	310	<10	70	50	89	5.7	15.9	<0.1	18	16	1	43	65.6
LA10	30S/10E-13J1	04/10/17	957	7.5	720	<10	80	60	231	2.6	14.7	<0.1	52	48	2	35	68.5
LA11	30S/10E-12J1	04/11/17	1380	7.29	880	<10	350	280	167	<0.5	186	0.2	75	86	4	81	69.3
LA12	30S10E-7Q3	04/10/17	839	7.78	480	<10	300	240	91	<0.5	49.5	0.2	47	43	2	54	70.9
LA15	30S/11E-18L2	WELL OFFLINE															
LA18	30S/11E-18K8	04/12/17	616	7.5	450	<10	290	240	31	<0.5	38	<0.1	57	32	2	27	72.0
LA20	30S/11E-17N10	04/10/17	624	7.0	380	<10	280	230	39	0.6	26.7	0.1	35	34	2	40	68.7
LA22	30S/11E-17E8	04/13/17	466	7.52	300	<10	150	120	46	6.7	13.2	<0.1	26	24	1	29	66.7
LA23	PRIVATE (not sampled)																
LA28	PRIVATE (not sampled)																
LA30	PRIVATE (not sampled)																
LA31+	30S/10E-13M2	04/17/17	3380	7.47	2060	<10	60	50	907	0.6	178	0.2	114	109	4	413	66.6
LA32+	30S/11E-18K9	04/10/17	461	7.16	270	<10	190	150	35	1.9	19.1	<0.1	24	23	1	31	72.0

NOTES: "--" = no result available; SC = specific conductance; TDS = total dissolved solids; CO3 = carbonate; HCO3= bicarbonate; CaCO3 = total alkalinity as calcium carbonate; Cl = chloride; NO3-N = nitrate as nitrogen; SO4 = sulfate; B = boron; Ca = calcium; Mg = magnesium; K = potassium; Na = sodium; T = temperature; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; °C = Celsius (some values converted from degrees Fahrenheit as reported on field logs); + indicates proposed addition to monitoring program; < indicates less than Practical Quantitation Limit as listed in laboratory report.

Table 11. Fall 2017 Water Quality Results - Lower Aquifer

Basin Plan Well	State Well Number	Date	SC	pH (field)	TDS	Alkalinity CO3	Alkalinity HCO3	Alkalinity Total as CaCO3	Cl	NO3-N	SO4	B	Ca	Mg	K	Na	T (field)
			µS/cm	pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	°F
LA8	30S/10E-13N	10/02/17	438	7.94	290	<10	30	30	78	7.6	13.2	<0.1	15	14	1	36	65.3
LA9	30S/10E-24C1	10/12/17	484	6.7	270	<10	70	60	89	6	16.3	<0.1	19	17	2	46	--
LA10	30S/10E-13J1	10/12/17	702	6.8	510	<10	80	60	164	3.4	12.5	<0.1	39	36	2	33	--
LA11	30S/10E-12J1	10/04/17	1370	7.59	850	<10	300	250	162	<0.5	191	0.3	76	86	5	90	69.6
LA12	30S10E-7Q3	10/04/17	826	7.76	470	<10	220	180	92	<0.5	45	0.2	48	45	2	56	70.7
LA15	30S/11E-18L2	10/05/17	768	7.75	400	<10	180	150	102	0.7	27	<0.1	50	44	2	40	70.2
LA18	30S/11E-18K8	10/09/17	619	7.69	350	<10	220	180	30	<0.5	35.5	<0.1	56	32	2	27	70.0
LA20	30S/11E-17N10	10/12/17	583	6.8	320	<10	260	210	41	0.7	27.9	0.2	37	36	2	43	--
LA22	30S/11E-17E8	10/11/17	476	7.5	260	<10	150	120	47	7.2	14	<0.1	26	25	1	29	70.3
LA23	PRIVATE (not sampled)																
LA28	PRIVATE (not sampled)																
LA30	30S/11E-20H1	10/3/17	876	7.69	500	<10	350	280	56	<0.5	74.5	0.1	60	52	1	36	64.9
LA31	30S/10E-13M2	10/5/2017	3350	7.66	2190	<10	60	50	960	0.7	160	0.2	116	109	5	411	66.7
LA32	30S/11E-18K9	10/9/2017	493	7.51	270	<10	200	160	36	1.4	23.1	<0.1	26	25	1	33	70.0

NOTES: "--" = no result available; SC = specific conductance; TDS = total dissolved solids; CO3 = carbonate; HCO3= bicarbonate; CaCO3 = total alkalinity as calcium carbonate; Cl = chloride; NO3-N = nitrate as nitrogen; SO4 = sulfate; B = boron; Ca = calcium; Mg = magnesium; K = potassium; Na = sodium; T = temperature; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; °F = degrees Fahrenheit

Table12. CEC Monitoring Results						
Constituent or Parameter	**Units**	**FW5**	**FW26**	**QA1 Travel Blank**	**QA2 Equipment Blank**	**LOWRF Recycled Water[1]**
		October 18, 2017				**Sep. 5, 2017**
Health-based						
17β-estradiol	ng/L	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<5)[2]
Triclosan	ng/L	ND (<2)	ND (<2)	ND (<2)	ND (<2)	ND (<10)
Caffeine[3]	ng/L	1.6	1	2.5	2.1	ND (<5)
NDMA	ng/L	ND (<2)	ND (<2)	--	--	4.7
Performance-based						
Gemfibrozil	ng/L	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND(<5)
DEET	ng/L	1.3	1.7	2	1.4	280
Iopromide	ng/L	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)
Sucralose	ng/L	260	16	17	8.2	87,000
Surrogate						
Ammonia	mg/L	ND (<0.10)	0.19	--	--	--
Nitrate-Nitrogen	mg/L	40	ND (<0.2)	--	--	2[4]
Total Organic Carbon	mg/L	0.57	1.2	--	--	--
UV Light Absorption	1/cm	0.028	0.026	--	--	--
Specific Conductance	µmhos/cm	960	680	--	--	--

[1] 2017 LOWRF CEC Blue Ribbon Report and Annual Report (SLO Co. 2017a, 2017b).
[2] As 17-alpha Ethinyl Estradiol
[3] Blank Contamination. Analyte also detected in the laboratory method blank.
[4] 30-day average for Total Nitrogen
ng/L = nanograms per liter; mg/L = milligrams per liter, µmhos/cm = micromhos per centimeter; : "--" = no result available
ND (<) = indicates less than Method Reporting Limit as listed in laboratory report ("not detected")

Caffeine, one of the health-based class indicators of CEC indicators, was detected in both groundwater samples (FW5 and FW26), in both field blanks (QA1 and QA2), and in the laboratory method blank (see page 9 of the laboratory results in Appendix C). The laboratory blank contained more caffeine than the submitted samples, which indicates that the caffeine reported was likely due to sample/equipment contamination at the laboratory.

DEET (Diethyl-meta-toluamide), a personal care product used for insect repellent, was also detected in the groundwater samples and field blanks at concentrations close to the method reporting limit, but not in the laboratory blank. DEET sample/equipment contamination in the laboratory blank was reported in the prior October 2016 sampling event (CHG, 2017a).

Sucralose, an artificial sweetener, was detected at 260 nanograms per liter (ng/L) in groundwater from FW5, and is an indicator of wastewater influence. FW5 is hydraulically downgradient of the Broderson leach field. Sucralose was also detected in groundwater from FW26 (Los Osos Creek Valley) and in the field blanks at levels close to the method reporting limit, but not in the laboratory blank. Discussion with Weck Laboratory staff, however, indicates that sucralose is commonly found in their laboratory method blanks at levels between 10-20 mg/L, which is the range reported for the field blanks and FW26. Changing the laboratory used for analyzing CEC's in Fall 2018 should be considered. Comparative costs and available information on laboratory blank contamination should be reviewed for the alternate laboratory prior to making a decision.

Nitrate-nitrogen was reported at 40 mg/L in groundwater from FW5, and not detected in groundwater from FW26. Available CEC-constituent quality of recycled water from LOWRF is also provided in Table 12 for comparison.

Results of the CEC testing indicate a wastewater influence at FW5, but not at FW26. The sucralose detection at FW5 in October 2017 (260 ng/L) is similar to the prior concentration measured in October 2016 (280 ng/L), while the nitrate-nitrogen concentration is greater (40 mg/L in 2017 compared to 26 mg/L in 2016). The wastewater influence at FW5 is interpreted to be a residual from septic tank discharges, rather than from recycled water discharges at the Broderson leach field. Groundwater mounding in the Upper Aquifer associated with Broderson discharges was not observed off-site until mid-2017, based on the hydrograph for FW6.

4.3 Geophysics

Induction and natural gamma logging has been performed at Lower Aquifer monitoring well LA4 (30S/10E-13M1) and LA14 (30S/11E-18L6). Seawater is highly conductive, compared to fresh water, and an induction log performed in a borehole penetrating the fresh water/seawater interface will show the vertical transition from fresh water to seawater. Because natural gamma emissions are not affected by changes in water quality, the gamma ray log can be used as a depth calibration tool when comparing induction logs from different monitoring events. Geophysical monitoring events were performed in 1985, 2004, 2009, 2014, and 2015. Results and interpretation are included in the 2015 Annual Report (CHG, 2016). The next scheduled geophysical logging is in October 2018.

5. GROUNDWATER PRODUCTION

Annual basin groundwater production between 1970 and 2013 was reported in the LOBP (ISJ Group, 2015. Tables 13 and 14 present municipal and basin production beginning in calendar year 2013.

Table 13. Municipal Groundwater Production (2013-2017)				
Year	**LOCSD**	**GSWC**	**S&T**	**Total**
	Acre-Feet			
2013	730	690	50	1,470
2014	630	560	50	1,240
2015	510	470	30	1,010
2016	520	450	30	1,000
2017	570	450	30	1,050

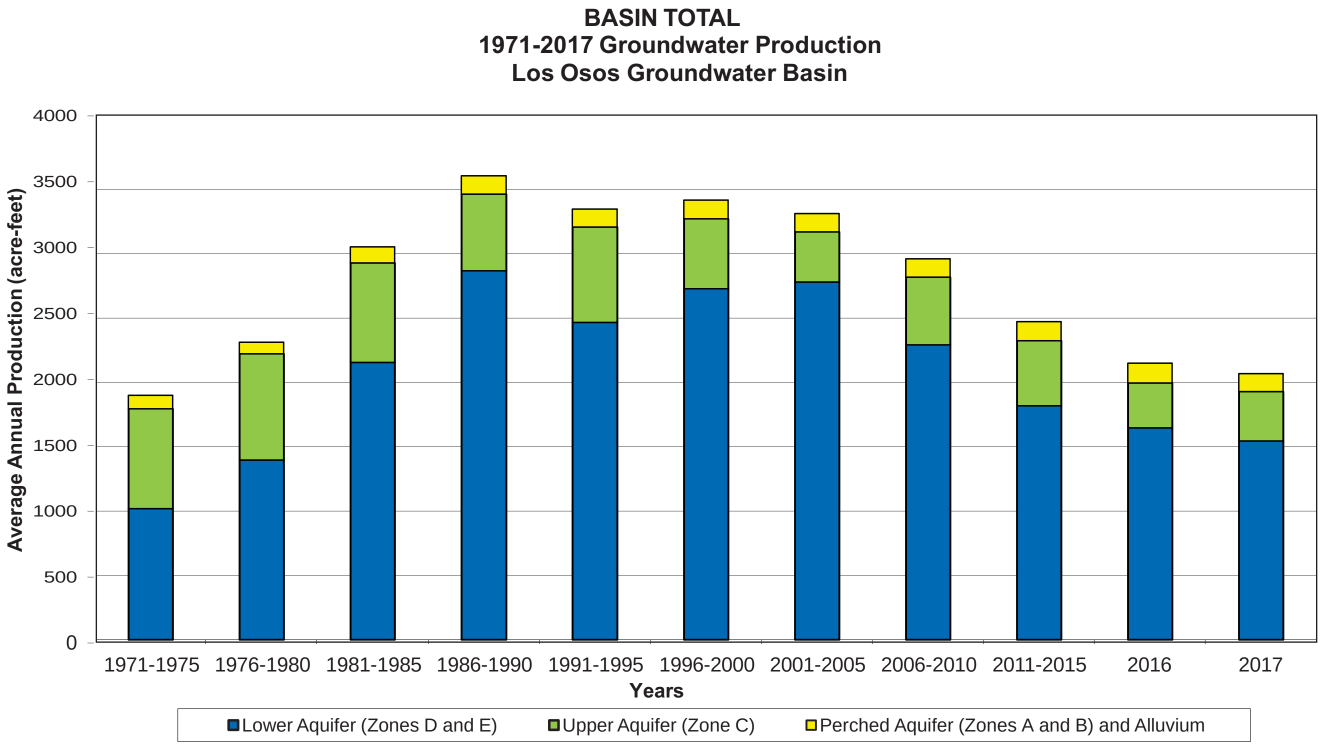
Note: All figures rounded to the nearest 10 acre-feet

Table 14. Basin Groundwater Production (2013-2017)					
Year	**Purveyors**	**Domestic**	**Community**	**Agriculture**	**Total**
	Acre-Feet				
2013	1,470	200	140	750	2,560
2014	1,240	220	140	800	2,400
2015	1,010	220	140	800	2,170
2016	1,000	220	140	800	2,160
2017	1,050	220	130	670	2,070

Note: All figures rounded to the nearest 10 acre-feet

Figure 6 shows the historical pumping distribution between basin aquifers since 1970, along with the pumping distribution in the Western Area. Figure 7 show the historical pumping distribution for the Central and Eastern areas. There has been a 34 percent reduction in basin production over the last 10 years, with current production similar to the values reported for the mid-1970s. The largest reduction in pumping has occurred in the Lower Aquifer Western Area (Figure 6).

Land use and water use areas overlying the basin, including purveyor service areas, agricultural parcels, domestic parcels, and community facilities are included in Appendix E. Purveyor municipal production data are based on meter readings. Domestic groundwater production estimates are based on the last reported water use estimates for 2013 from the LOBP, with minor adjustments in 2016 for the inclusion of additional residences in the Eastern Area (CHG, 2016). Production estimates for community facilities and agricultural wells are based on a soil-moisture budget using local precipitation, land use, and evapotranspiration data (Appendix F). All groundwater production estimates are reported to closest 10 acre-feet, which is considered within the accuracy of metered production, but not unmetered production. Unmetered production estimates account for approximately half of the total production in the basin, of which agricultural irrigation is the greatest unmetered component. Potential uncertainty in basin production has been estimated at 5 percent of the Sustainable Yield of the basin (LOBP; ISJ Group, 2015).



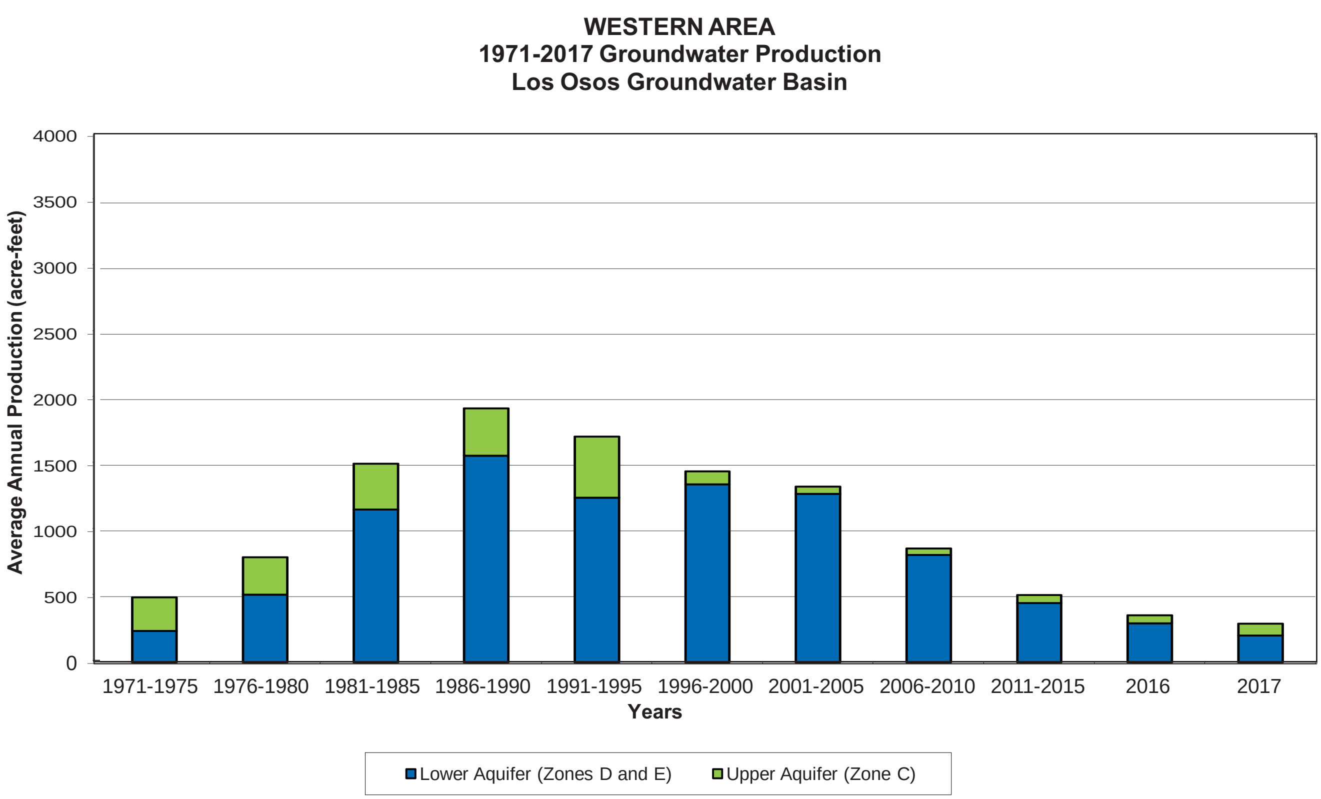


Figure 6
Basin Production 1971-2017
Basin Total and Western Area
Los Osos Goundwater Basin
2017 Annual Report

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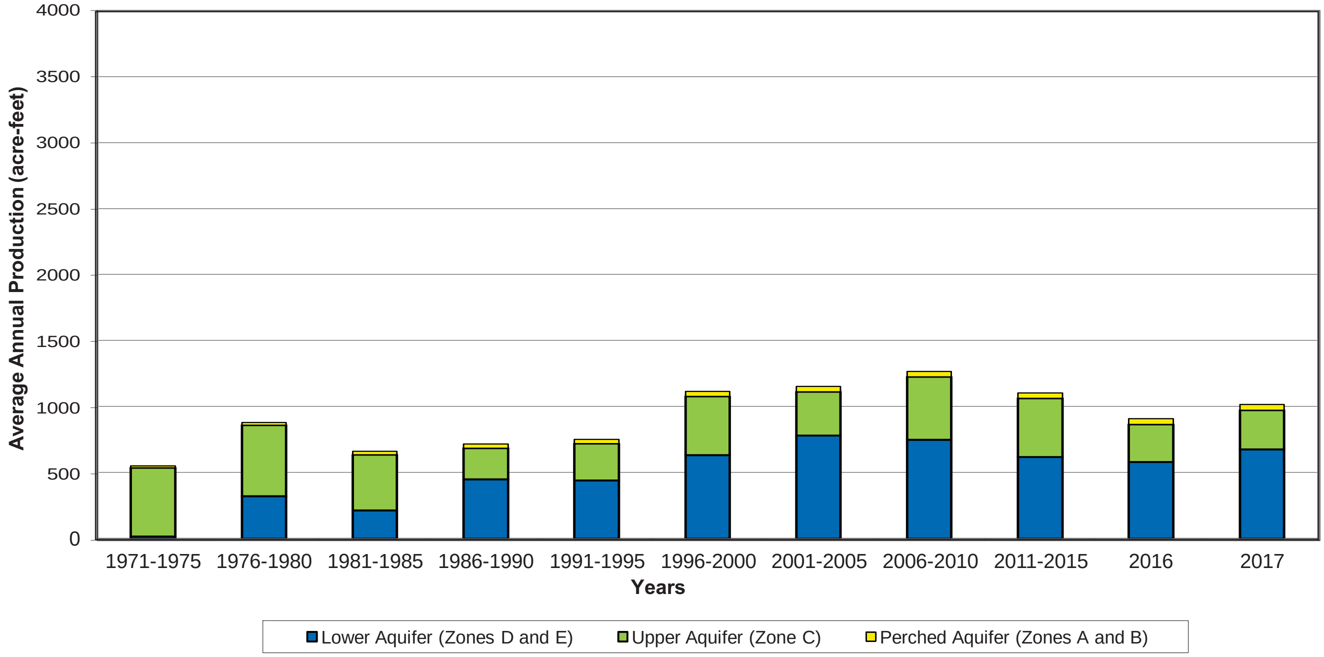
CENTRAL AREA
1971-2017 Groundwater Production
Los Osos Groundwater Basin



EASTERN AREA
1971-2017 Groundwater Production
Los Osos Groundwater Basin

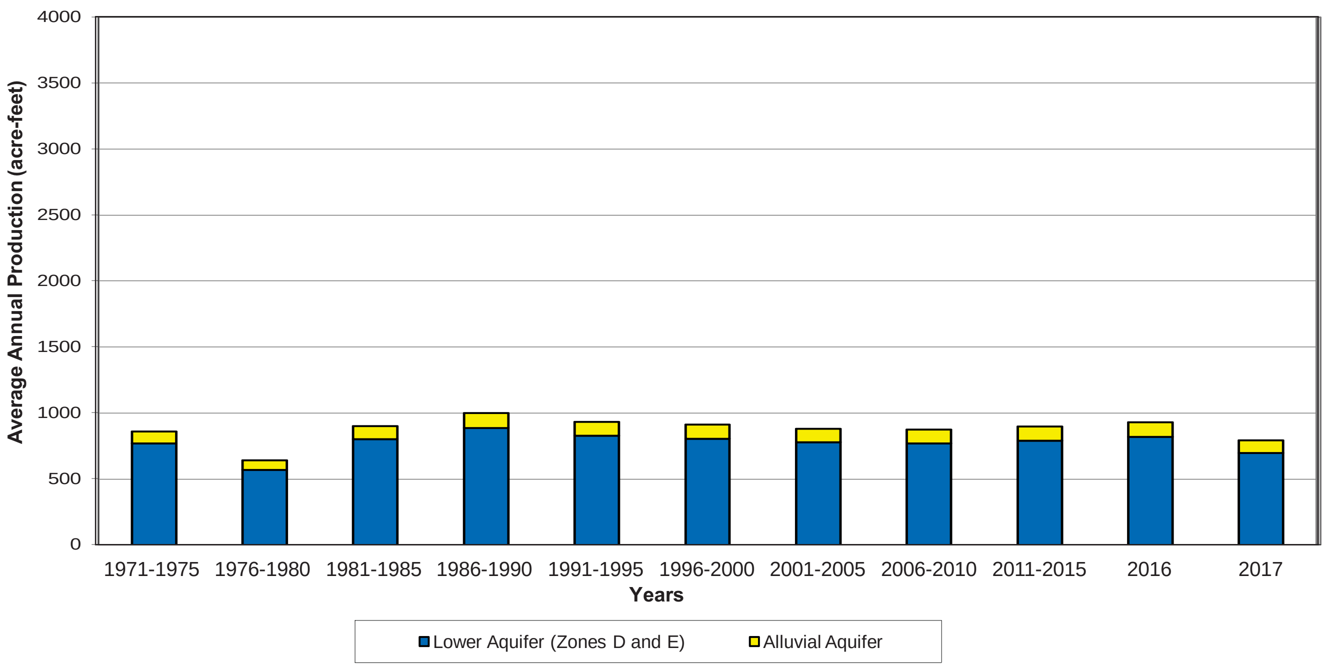


Figure 7
Basin Production 1971-2017
Central and Eastern Areas
Los Osos Groundwater Basin
2017 Annual Report

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6. PRECIPITATION AND STREAMFLOW

Precipitation data are currently available from a County gage located at the former Los Osos landfill (Station #727). Continuous precipitation records for Station #727 are available beginning with the 2006 rainfall year (July 2005 through June 2006), and show that rainfall has averaged 15.79 inches, with a minimum of 6.81 inches in the 2014 rainfall year and a maximum of 31.77 inches in the 2011 rainfall year. Precipitation for the 2017 rainfall year was reported at 26.63 inches. Records for Station #727 through the calendar year 2017 are included in Appendix G. The average rainfall at Station #727 is lower compared to other local rain gages due to a short period of record that includes six years of below average rainfall.

Historically, precipitation records at rain gage stations were compiled by the County for the LOCSD maintenance yard on 8th Street (Station #177), at the South Bay fire station on 9th Street (Station #197), and at two private volunteer stations (Station #144.1 in the Los Osos Creek Valley and Station #201.1 on Broderson Avenue). The longest active period of record in the vicinity is at the Morro Bay fire department (Station #152). A summary of precipitation data for these stations is presented in Table 15.

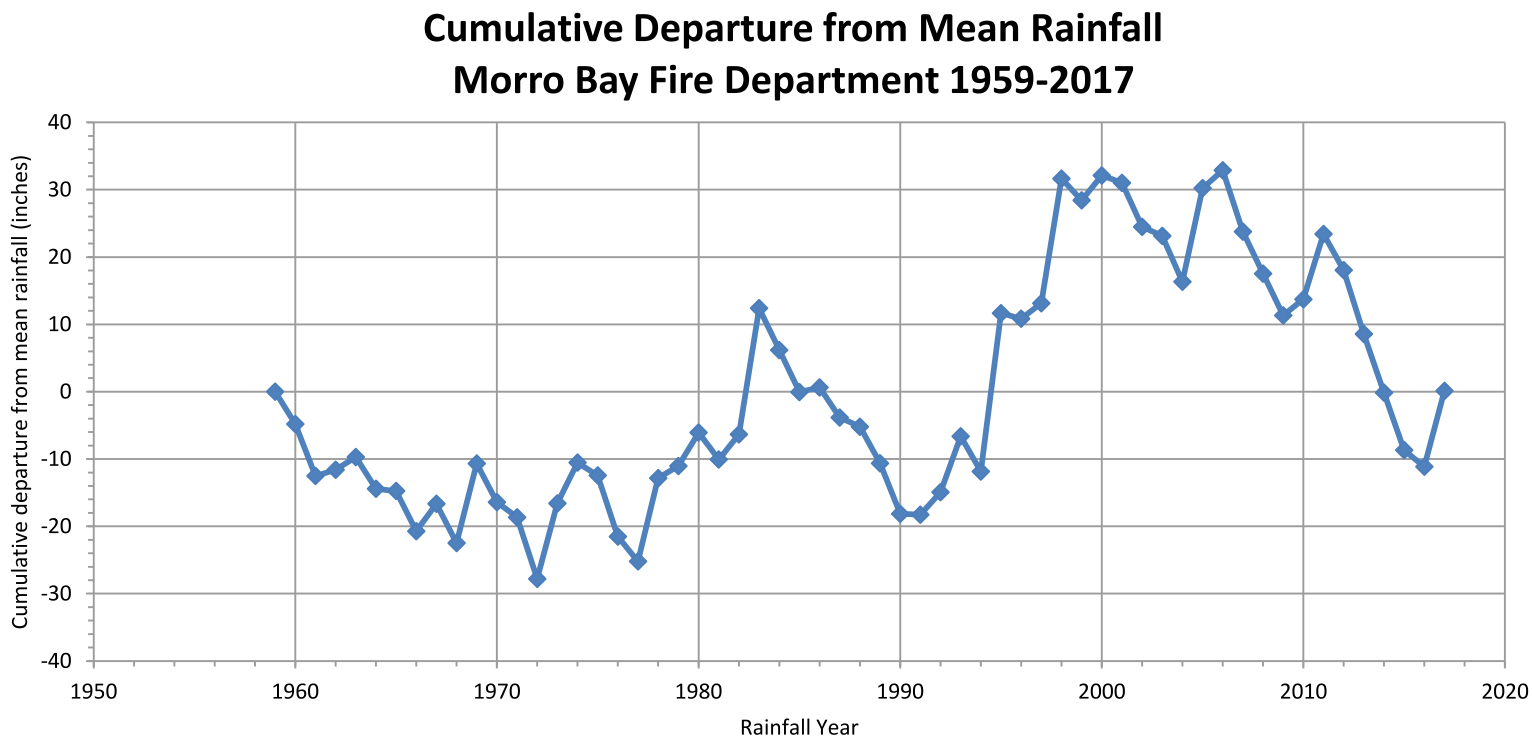
Table 15. Active and Former Precipitation Stations

Station No.	Name	Period of Record (rainfall years)	Average Annual Precipitation (inches)
144.1	Bender	1955-1987	19.17
152	Morro Bay Fire Dept.	1959-2017 (active)	16.29
177	CSA9 Baywood Park	1967-1980	17.49
197	South Bay Fire	1975-2001	19.52
201.1	Simas	1976-1983	21.16
727	Los Osos Landfill	2006-2017 (active)	15.79*

NOTE: *lower average due to short period of record that includes six years of below normal rainfall.

Figure 8 shows the long term cumulative departure from mean precipitation at Station #152. Once data for Los Osos Landfill Station #727 becomes representative of long-term climatic conditions, it would be appropriate to use the gage in the cumulative departure from mean precipitation graph.

San Luis Obispo County had been in exceptional drought conditions (D4 - the greatest intensity level) between 2014 and 2016, based on information from the U.S. Drought Monitor, a partnership of federal agencies (NDMC/USDA/NOAA, 2014-2016). In 2017, local drought conditions were relieved by above-normal rainfall. Between the end of February and December 2017, San Luis Obispo County was ranked as abnormally dry, the lowest drought intensity level (NDMC/USDA/NOAA, 2017).



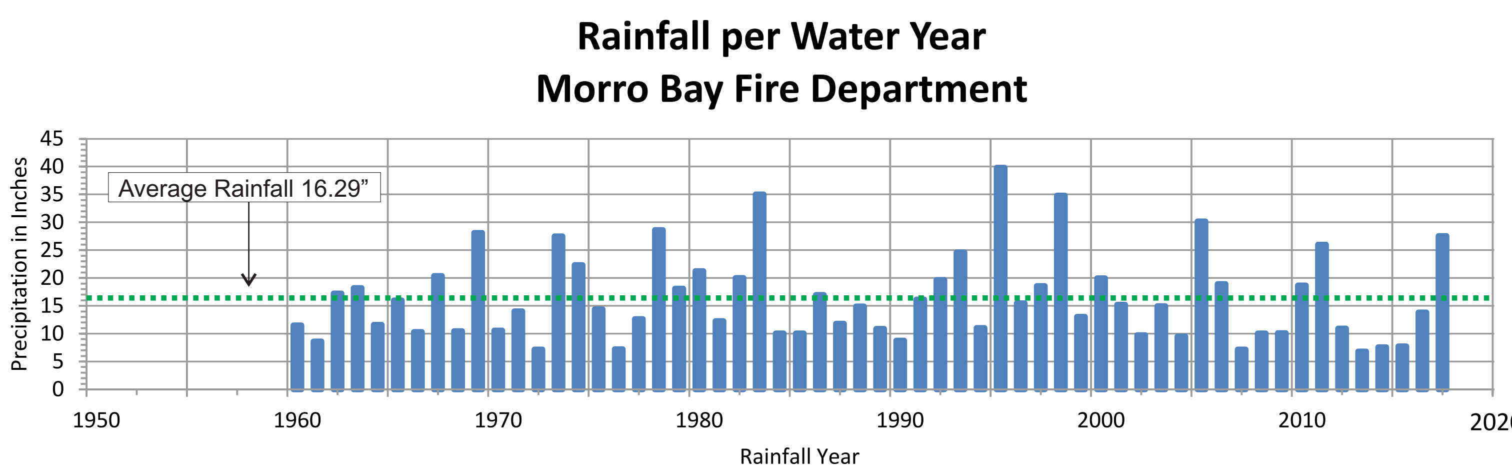


Figure 8
Cumulative Departure from
Mean Rainfall at Morro Bay Fire Department
Los Osos Groundwater Basin
2017 Annual Report

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Los Osos Creek drains the Clark Valley watershed. Streamflow on Los Osos Creek is monitored by a County gage (formerly Gage #6, now Sensor 751) at the Los Osos Valley Road bridge. The location has been gaged intermittently since 1976, with 18 years of flow records through 2001. The average measured flow on Los Osos Creek at the gage (drainage area of 7.6 square miles) was 3,769 acre-feet per year between 1976 and 2001 (San Luis Obispo County, 2005). A summary of the available annual streamflow data is in Appendix G.

Streamflow was recorded at the gage on 133 days during the 2017 water year (October 1, 2016 to September 30, 2017), including 131 days of continuous flow between January 4 and May 15, 2017. The dates and maximum stage value from Station #727 for the peak flow days in each month are listed below in Table 16.

Table 16. Maximum Stream Stage for Los Osos Creek, 2017 Water Year

Date	Maximum Stream Stage County Sensor #751 (feet)
12/16/2016	2.87
1/20/2017	5.06
2/17/2017	5.62
3/1/2017	3.77
4/7/2017	2.64
5/1/2017	2.30

There is no current rating curve for Sensor 751. A rating curve is needed to correlate stage records to streamflow volume records; therefore, no streamflow volumes are reported. Development of a rating curve for Sensor 751 is recommended. Graphs of the available stream stage data over time for water years 2011 through 2017 are included in Appendix G.

Warden Creek (Figure 1) drains approximately 9 square miles of the eastern Los Osos Valley. This creek flows along 3,700 feet of the northern basin boundary, at low invert elevations (less than 20 feet above sea level) in an area underlain by shallow bedrock. The U.S. Geological Survey reported winter flows in Warden Creek similar to Los Osos Creek, but with larger baseflow during the summer, because Warden Creek serves as a drain (point of groundwater discharge) for shallow groundwater at the north end of the Los Osos Creek floodplain (Yates and Wiese, 1988).

7. DATA INTERPRETATION

Groundwater level and groundwater quality data for 2017, together with selected historical data, have been used to develop the following information:

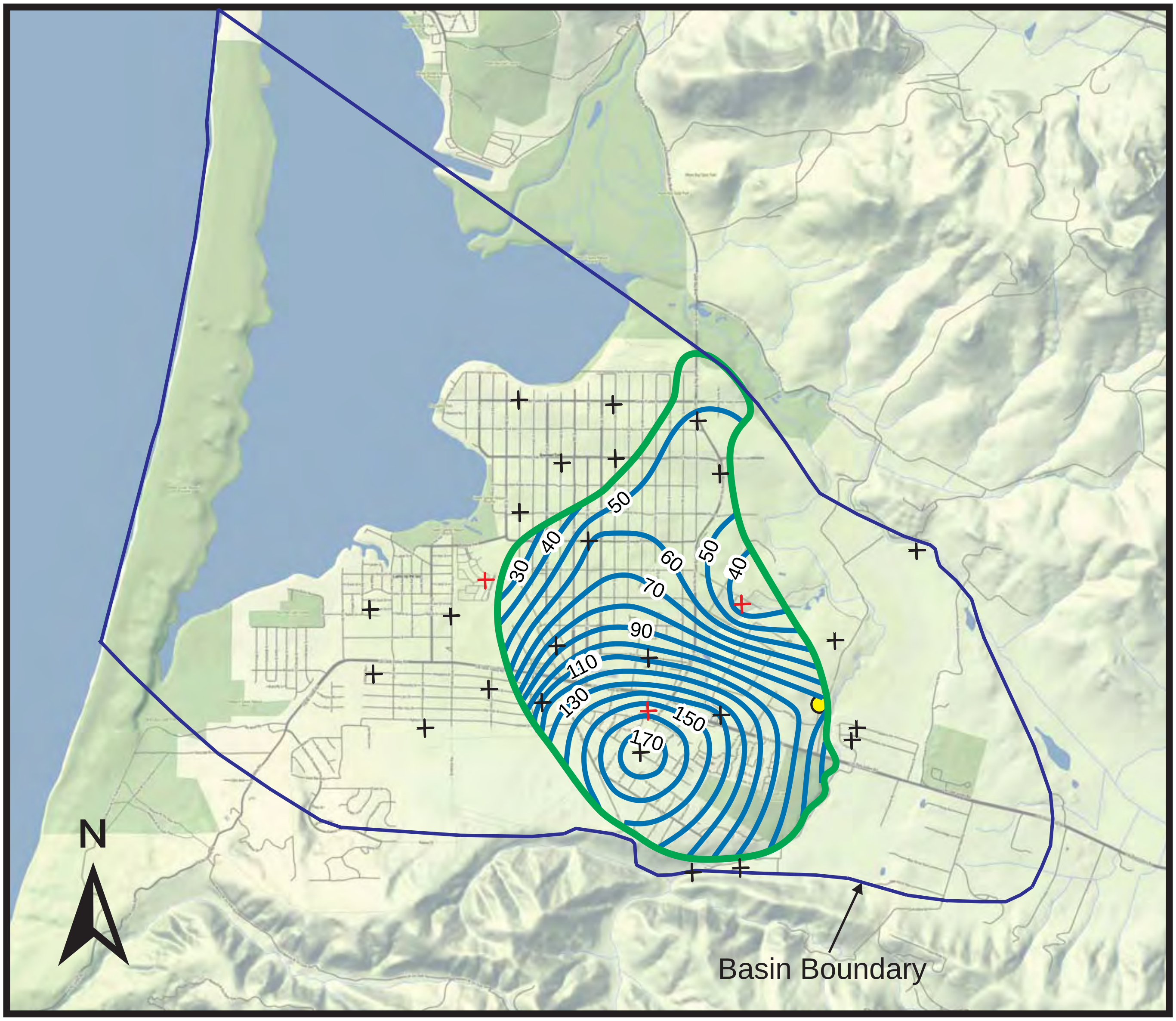
- Groundwater elevation contour maps for the Perched Aquifer, Upper Aquifer (with Alluvial Aquifer), and Lower Aquifer for both Spring and Fall 2017 conditions.
- Water level hydrographs for wells representative of aquifers in the Western, Central, and Eastern Areas of the basin.
- The lateral extent of seawater intrusion and the Fall 2017 position of the seawater intrusion front.
- Estimates of groundwater in storage for Spring and Fall 2017, including amount above mean sea level.
- Estimates of changes to groundwater in storage from Spring 2016 to Spring 2017, including the volume of seawater intrusion.
- Basin Yield Metric, Basin Development Metric, Water Level Metric, Chloride Metric, and Nitrate Metric.

7.1 Water Level Contour Maps

Water level contour maps for Spring 2017 are presented in Figures 9, 10, and 11 for the Perched Aquifer, Upper Aquifer with Alluvial Aquifer, and Lower Aquifer, respectively. Corresponding water level contour maps for Fall 2017 are presented in Figures 12, 13, and 14. The water level elevations are shown at a 5-foot contour interval based on the ordinary kriging interpolation method, which provides a best (least-squares) estimate of values at unmeasured points based on the mapped values.

Water level data available from private irrigation and domestic wells were used in the development of the water level contour maps, although these water levels are not listed in the data tables in this report (Table 3 through 8). To continue the development of contour maps useful for groundwater storage estimates, three wells located in the Eastern Area were added to the monitoring network, along with one additional first water control point (spring seep) in the Western Area. Water levels from alternate dates (not from Spring or Fall 2017) were included in the contour maps at three locations. All groundwater elevations were adjusted to a common datum (NAVD 88) prior to contouring and groundwater storage calculations. These adjustments are approximate, pending a review of all reference point elevations by a licensed land surveyor.

Perched Aquifer water level contour maps (Figures 9 and 12) show the highest groundwater elevations at Bayridge Estates (Well FW31 at the Bayridge Estates wastewater disposal field), with a radial direction of groundwater flow from the higher topographic elevations to lower elevations. Although the fall measurement at FW31 was slightly higher elevation than the spring measurement due to recycled water discharge operations, overall Perched Aquifer groundwater levels declined approximately 2.3 feet from spring to fall.



Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

40 Groundwater elevation contour in feet above sea level (NAVD 88 datum)

Approximate limits of Perched Aquifer

+ Spring 2017 groundwater elevation data point (contours not applicable outside of Perched Aquifer limits)

+ Alternate date groundwater elevation data point

Spring seep used for groundwater elevation

Figure 9
Spring 2017 Water Level Contours
Perched Aquifer
Los Osos Groundwater Basin
2017 Annual Report

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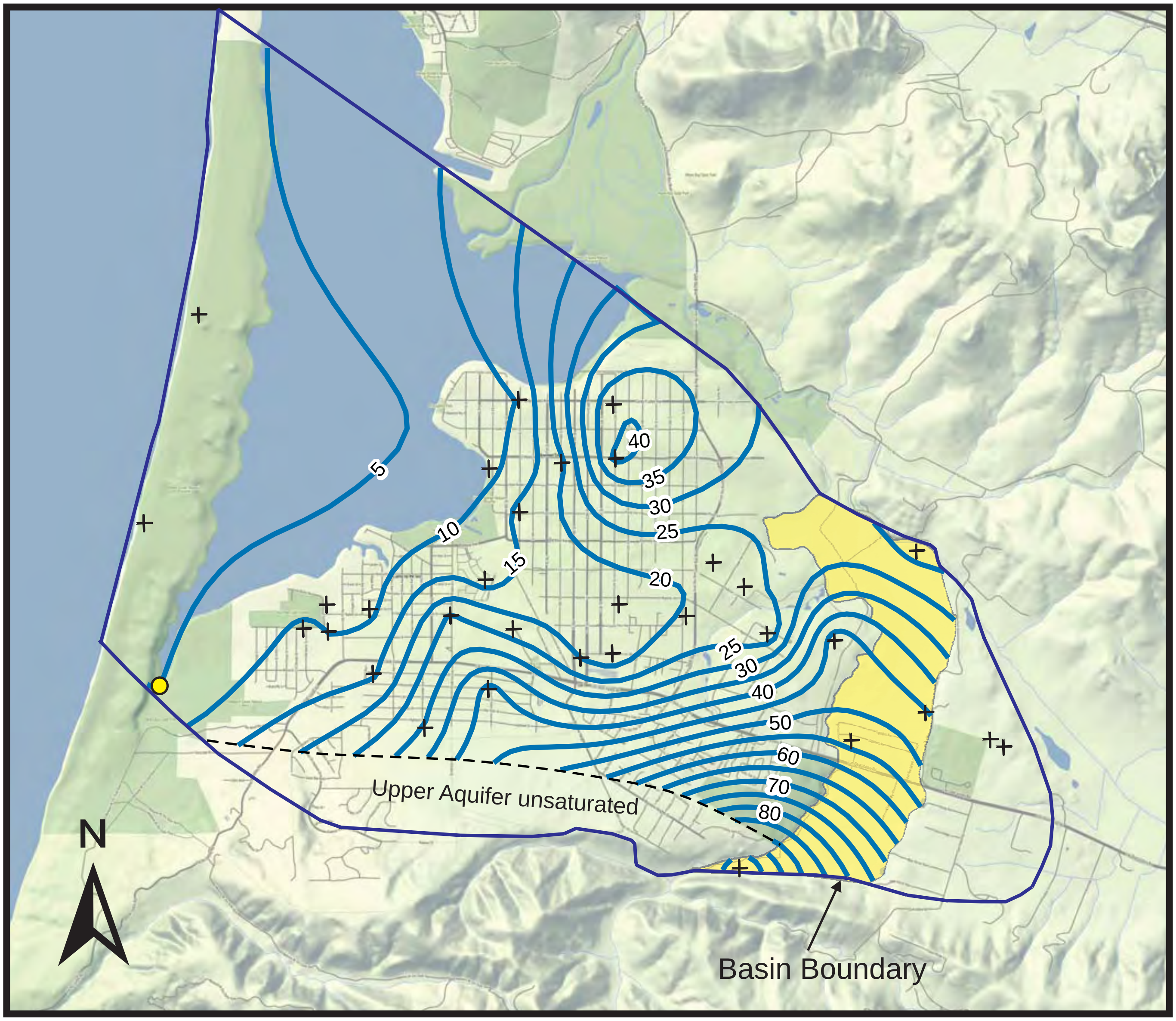

Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

40 — Groundwater elevation contour in feet above sea level (NAVD 88 datum)

Limits of Alluvial Aquifer

+ Spring 2017 groundwater elevation data point (contours not applicable outside of Upper Aquifer and Alluvial Aquifer limits)

Spring seep used for groundwater elevation

NOTE: Area where Upper Aquifer is unsaturated along southern Basin boundary determined from comparison of water levels with aquifer base contours. This condition was present in 2015 but not shown in 2015 Annual Report.

Figure 10
Spring 2017 Water Level Contours
Upper Aquifer and Alluvial Aquifer
Los Osos Groundwater Basin
2017 Annual Report

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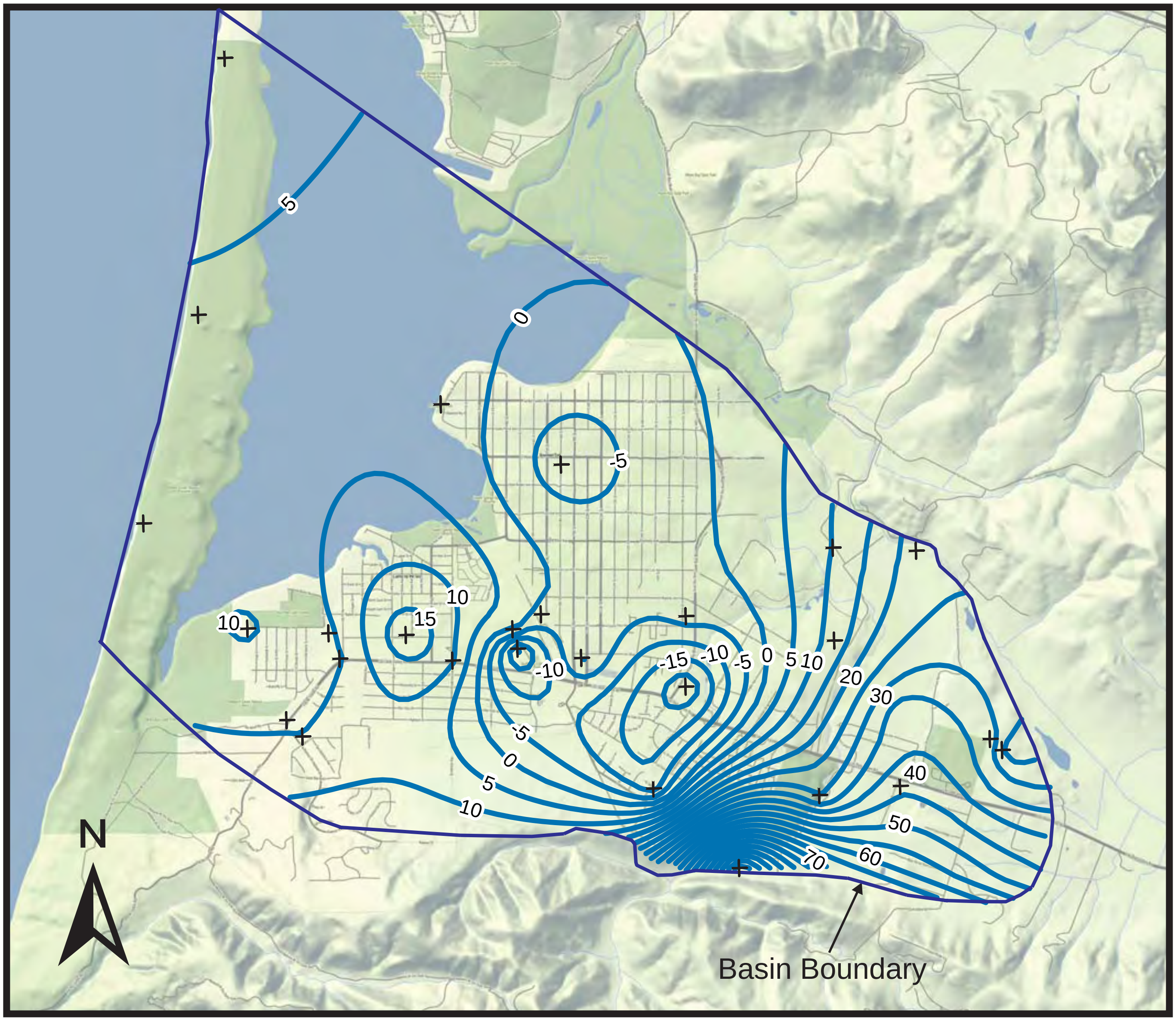

Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

40 Groundwater elevation contour in feet above sea level (NAVD 88 datum)

+ Spring 2017 groundwater elevation data point

Figure 11
Spring 2017 Water Level Contours
Lower Aquifer
Los Osos Groundwater Basin
2017 Annual Report

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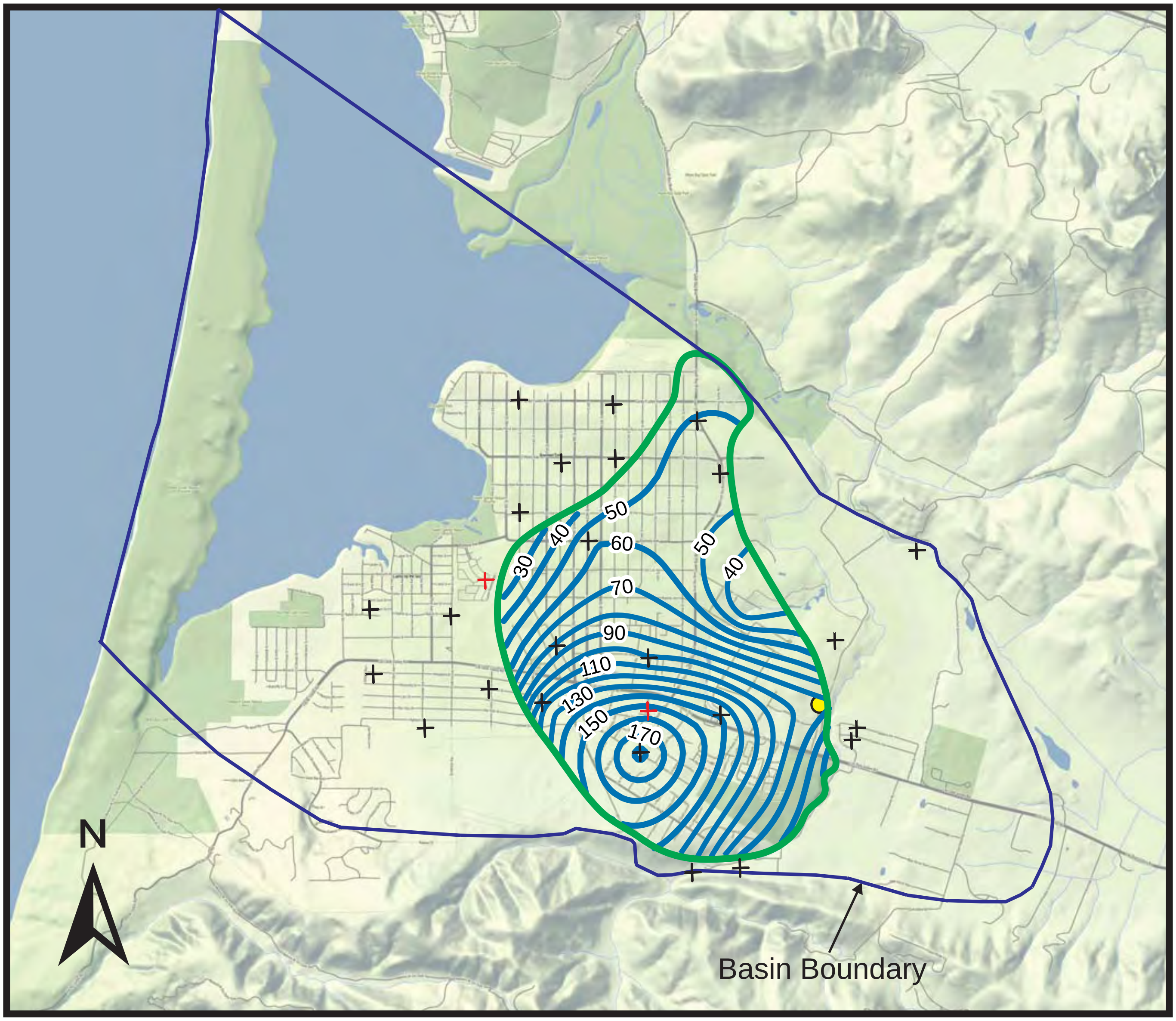

Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

40 Groundwater elevation contour in feet above sea level (NAVD 88 datum)

Approximate limits of Perched Aquifer

\+ Fall 2017 groundwater elevation data point (contours not applicable outside of Perched Aquifer limits)

\+ Alternate date groundwater elevation data point (December 2017 for LOWRF program private wells)

Spring seep used for groundwater elevation

Figure 12
Fall 2017 Water Level Contours
Perched Aquifer
Los Osos Groundwater Basin
2017 Annual Report

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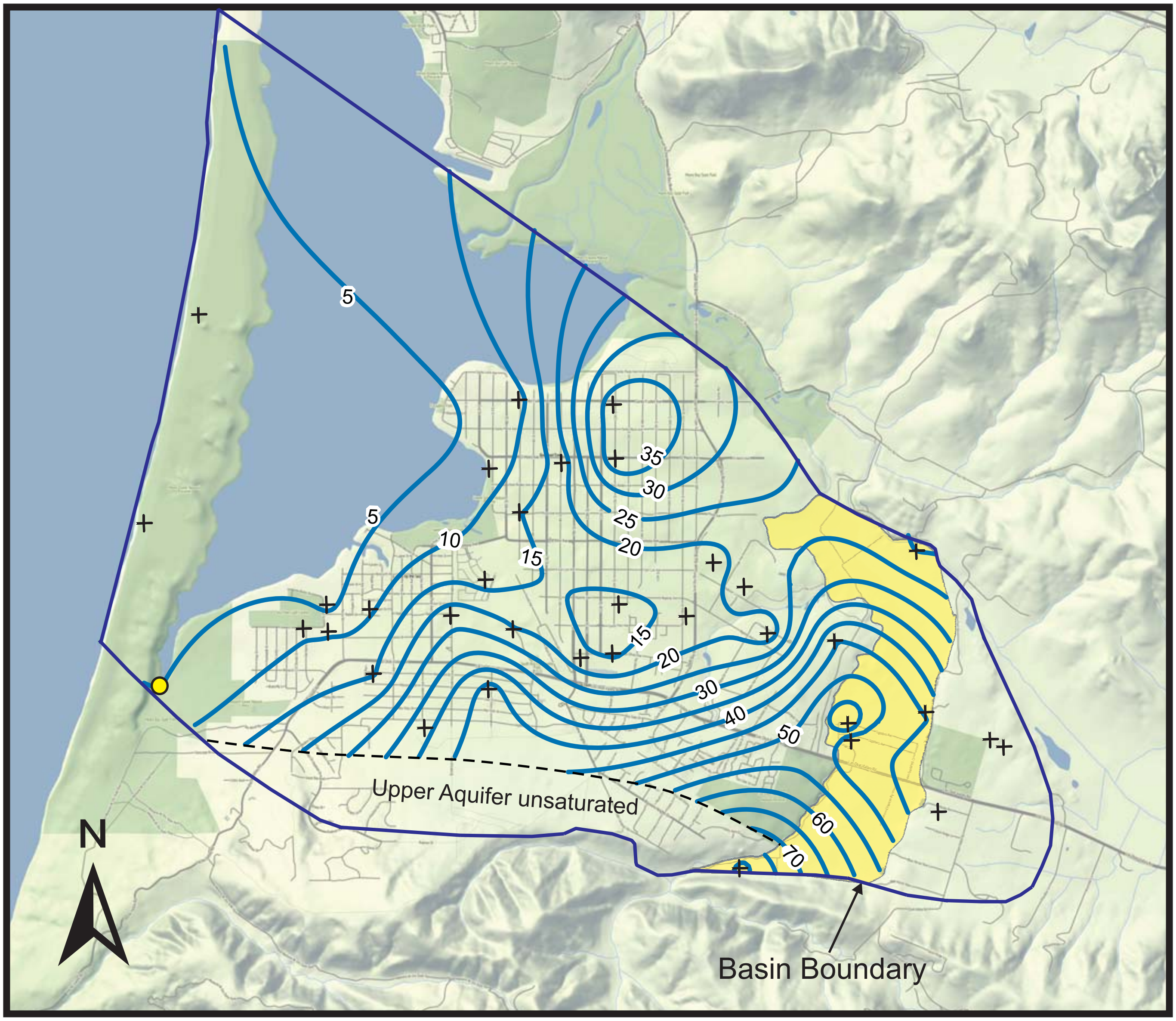

Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

40 — Groundwater elevation contour in feet above sea level (NAVD 88 datum)

Limits of Alluvial Aquifer

+ Fall 2017 groundwater elevation data point (contours not applicable outside of Upper Aquifer and Alluvial Aquifer limits)

Spring seep used for groundwater elevation

NOTE: Area where Upper Aquifer is unsaturated along southern Basin boundary determined from comparison of water levels with aquifer base contours. This condition was present in 2015 but not shown in 2015 Annual Report.

Figure 13
Fall 2017 Water Level Contours
Upper Aquifer and Alluvial Aquifer
Los Osos Groundwater Basin
2017 Annual Report

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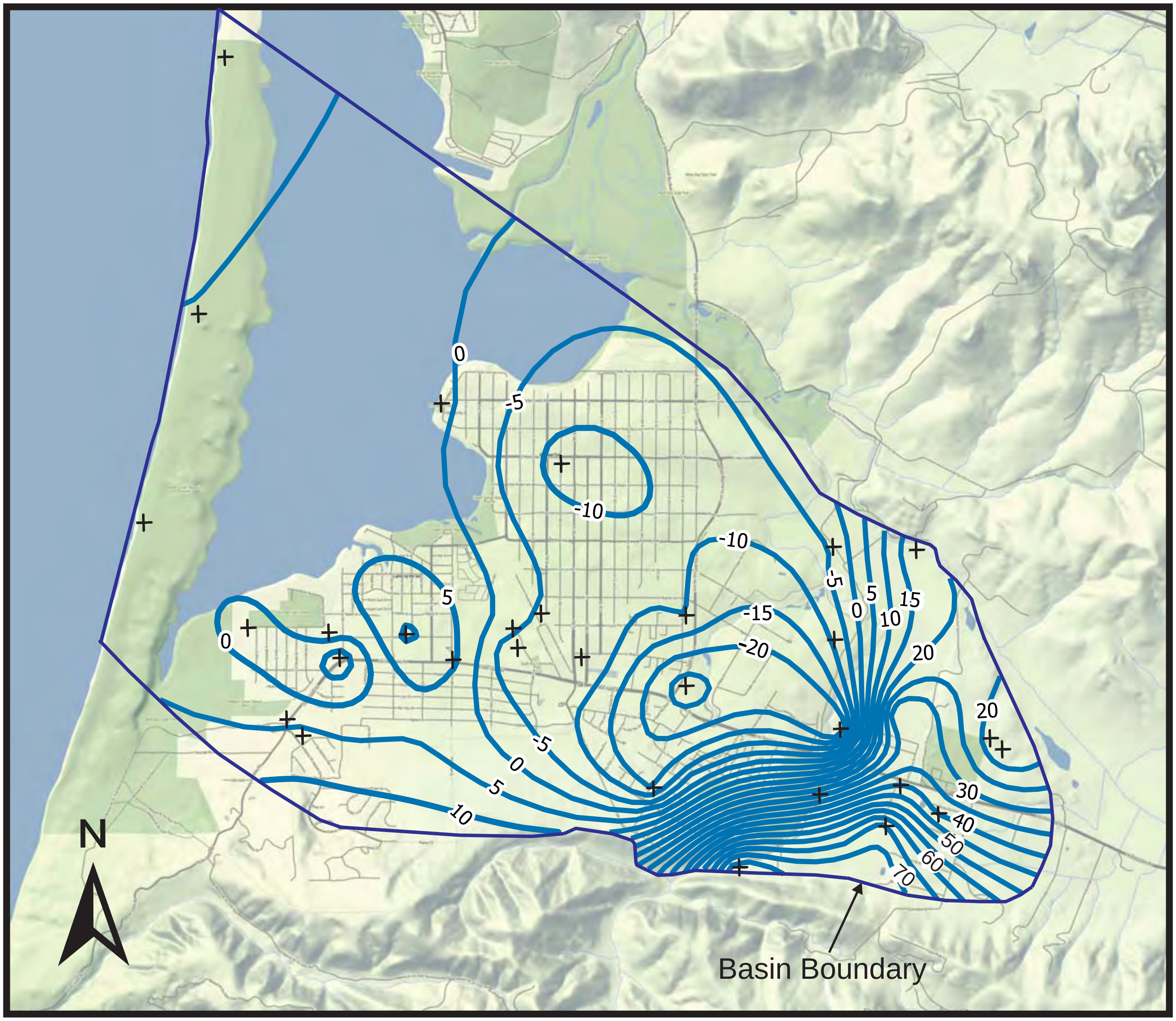

Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

40 Groundwater elevation contour in feet above sea level (NAVD 88 datum)

+ Fall 2017 Groundwater elevation data point

Figure 14
Fall 2017 Water Level Contours
Lower Aquifer
Los Osos Groundwater Basin
2017 Annual Report

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Contour maps for the Upper Aquifer and Alluvial Aquifer (Figures 10 and 13) show the highest groundwater elevations are at the southern edge of the Los Osos Creek valley. The general direction of groundwater flow is to the northeast along the creek valley and to the northwest toward the Morro Bay estuary. Significant features include a pumping depression interpreted to be present in the area of downtown Los Osos, and a groundwater high interpreted to be present beneath dune sand ridges in Baywood Park. Upper Aquifer groundwater elevation contours averaged approximately 2.5 feet of water level decline from Spring 2017 to Fall 2017.

Contour maps for the Lower Aquifer (Figures 11 and 14) show the highest groundwater elevations are at the southern edge of the Los Osos Creek valley and near the eastern basin boundary. The steep hydraulic gradient between the upper Los Osos Creek valley and downtown Los Osos suggests significant permeability restrictions between the two areas, possibly fault related (Yates and Weise, 1988; Cleath & Associates, 2005). Groundwater flow in the Lower Aquifer is generally toward Central Area pumping depressions which are below sea level. Lower Aquifer groundwater elevations averaged approximately 4.5 feet of water level decline from Spring 2017 to Fall 2017.

7.2 Water Level Hydrographs

Water levels hydrographs for representative First Water, Upper Aquifer, and Lower Aquifer wells have been compiled for the Western and Central basin areas, including one of the Lower Aquifer wells in the Dunes and Bay area. These wells present the general water level trends. The hydrographs are shown in Figures 15, 16, and 17, respectively.

In previous reports, trends for the first water wells have been analyzed in ten-year spans. There was a lapse in monitoring between 2006 and 2012 for three of the five representative first water wells, however, so beginning this year a five-year trend will be analyzed, increasing by one year with each subsequent report until the first water trend analysis returns to a ten-year span.

The spring to spring water level trend for the last 5 years (2012-2017), based on first water hydrographs in Western and Central area wells was 0.2 feet of decline per year (Figure 15). The spring to spring water level trend over the last ten years (2007-2017), based on Central and Western wells in the hydrographs was 0.05 feet of decline per year (relatively flat) in the Upper Aquifer, and 0.47 feet of rise per year in Lower Aquifer water levels (Figures 16 and 17, respectively).

The trend of water level declines in First Water and Upper Water hydrographs has diminished compared to prior years, which is attributable to above-normal rainfall for 2017 (Figure 8). The continued trend of rising water levels in Lower Aquifer wells is interpreted to be mainly in response to an average annual decline of over 3 percent per year in Lower Aquifer groundwater production in the Western and Central areas between 2007 and 2017.

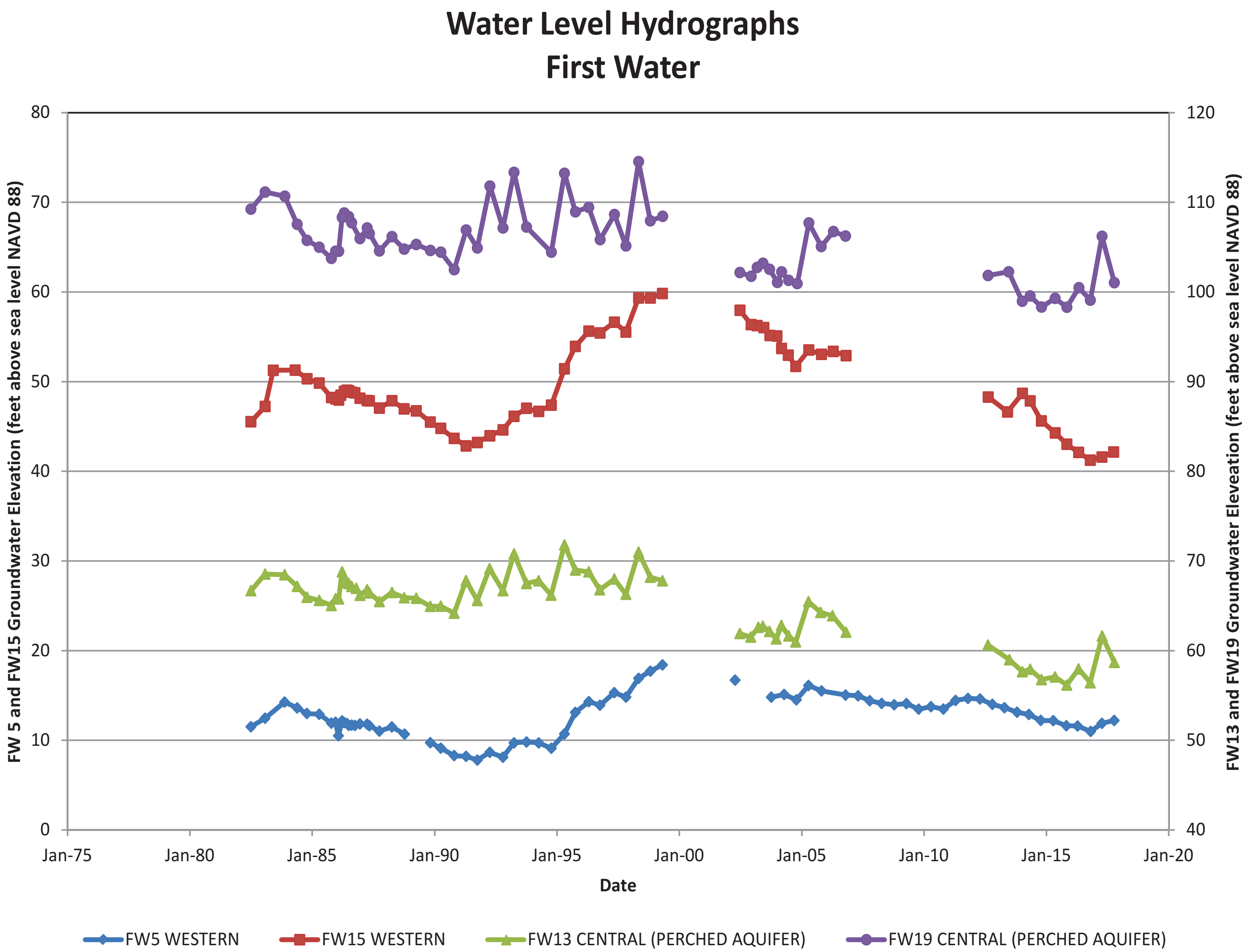

Figure 15
Water Level Hydrographs
Perched Aquifer/First Water
Los Osos Groundwater Basin
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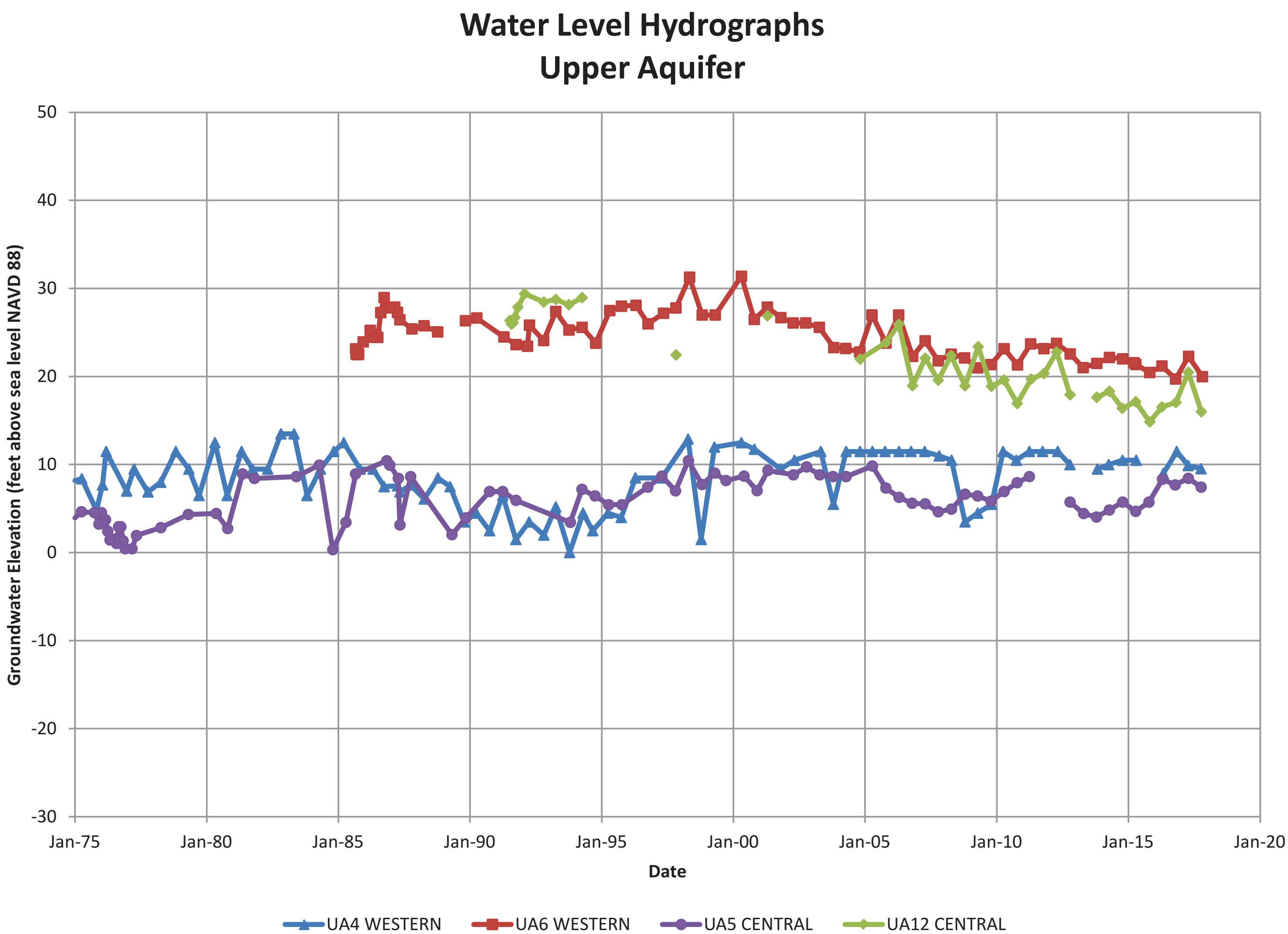

NOTE: Constant water level elevations over a few years (2004-2007 and 2010-2012) at well UA4 may indicate measuring equipment problem due to obstruction or cascading water.

Figure 16
Water Level Hydrographs
Upper Aquifer
Los Osos Groundwater Basin
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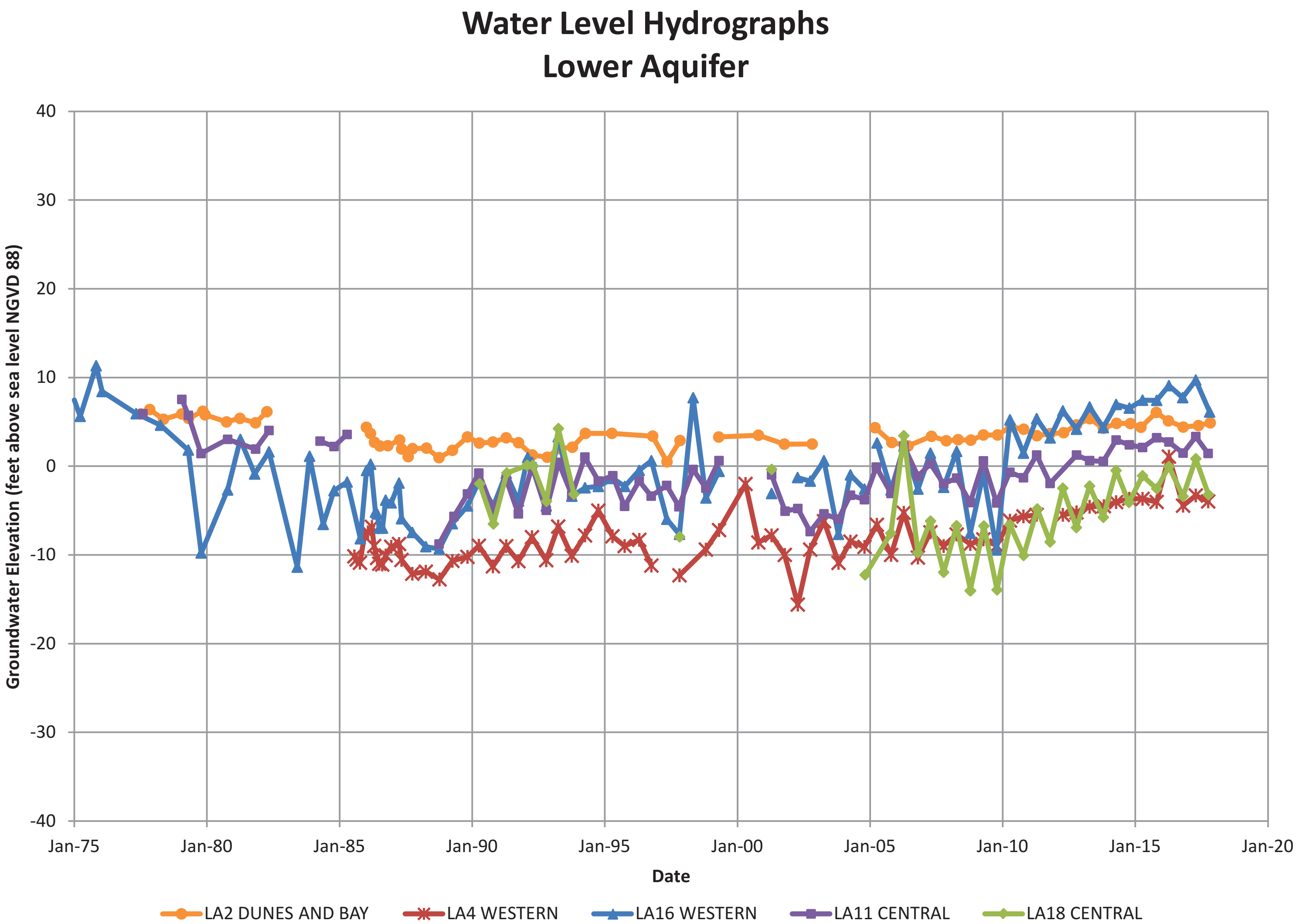

Figure 17
Water Level Hydrographs
Lower Aquifer
Los Osos Groundwater Basin
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Hydrographs for seven wells equipped with pressure transducers are shown in Appendix H. The transducers have been installed to provide greater detail of water level trends and fluctuations. There are three First Water wells, two Upper Aquifer wells, and two Lower Aquifer wells equipped with transducers.

The transducer hydrographs have been interpreted to show the following short-term trends:

- FW6 is screened in the top of the Upper Aquifer near the Broderson leach field in the Western Area of the basin. The hydrograph showed a relatively flat water level trend between January and June of 2017, followed by a water level increase of four feet through December 2017. The rise in water level is credited to groundwater mounding on the regional aquitard beneath the Broderson leach field. This mounding is expected to increase the downward hydraulic gradient and promote leakage through the regional aquitard, which will help to mitigate seawater intrusion in the Western Area.

- FW10 is screened at the top of the Upper Aquifer in the Central Area of the basin, while UA4 and UA10 are screened at the bottom of the Upper Aquifer in the Western Area and Central Area of the basin respectively. These wells displayed seasonal fluctuations of 2-4 feet (i.e., lower elevations during the summer and higher elevations during the winter and spring), including 1-2 feet of interference related to nearby pumping wells.

- FW27 is screened in the Alluvial Aquifer in the Eastern Area of the basin. The well was equipped with a transducer in April of 2017, near the seasonal high water period, and has shown a steady water level decrease of nearly 30 feet from mid-May through December 2017. The relatively large seasonal fluctuation is attributable to the well's location in the upper Los Osos Creek valley (Figure 2), where the majority of seasonal recharge from stream seepage in the basin occurs.

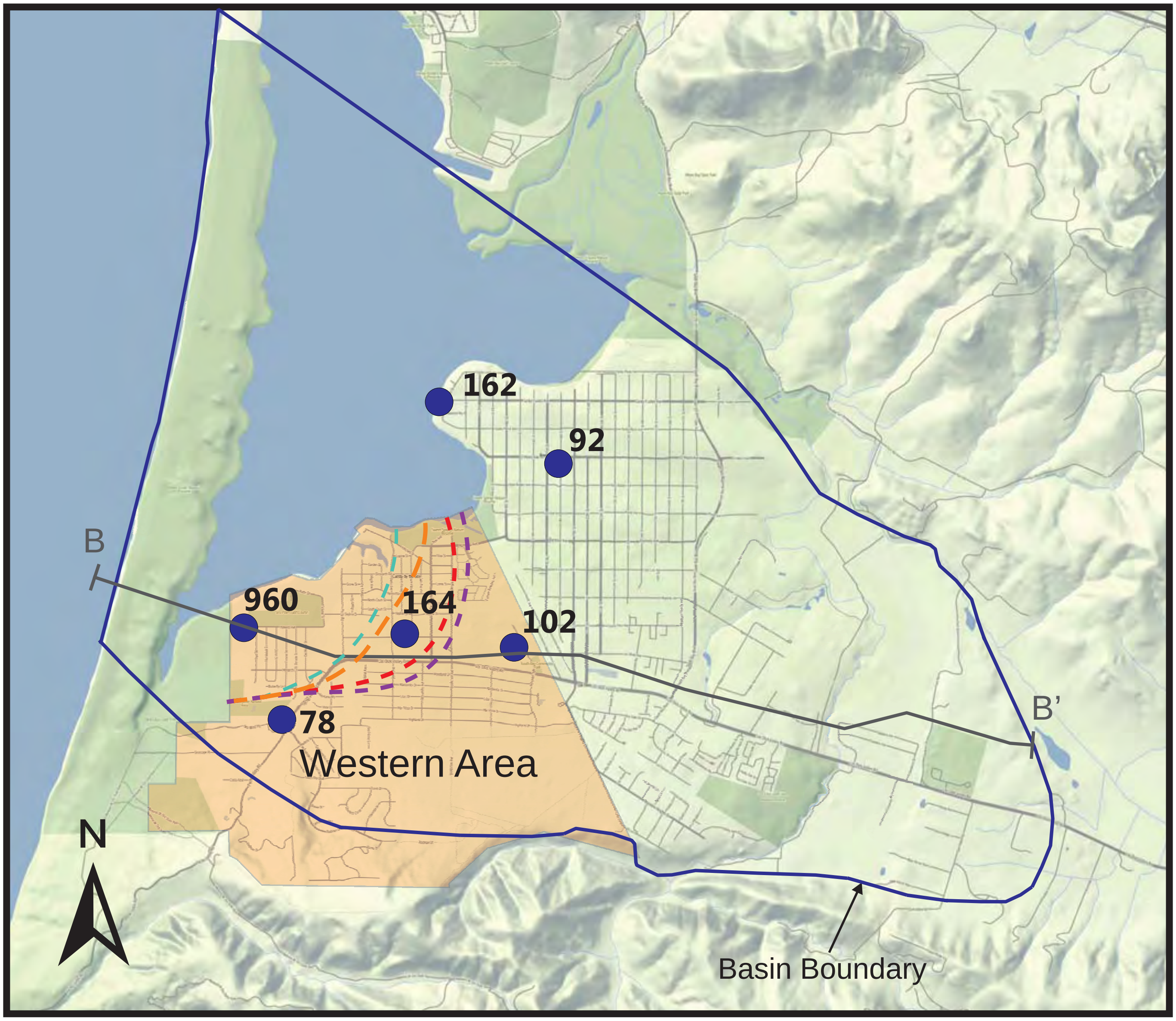
- LA13 and LA37 are screened in Lower Aquifer in the Central Area and Eastern Area of the basin, respectively. These wells displayed a seasonal fluctuation of approximately 7-9 feet, including interference related to nearby pumping wells.

7.3 Seawater Intrusion

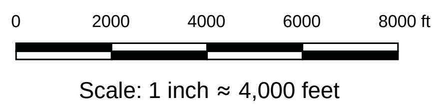
The position of the Fall 2016 and Fall 2017 seawater intrusion front in Lower Aquifer Zone D is shown in Figure 18, along with the corresponding 2005 seawater intrusion front. The seawater intrusion front corresponds to the position of the 250 mg/L chloride isopleth, based on water quality samples from six Lower Aquifer wells: LA8, LA10, LA11, LA12, LA15, and LA32 The intrusion front retreated toward the coast up to 1,500 feet between Fall 2016 and Fall 2017, which represents a major reversal of seawater intrusion. However, it is worth noting that Figure 18 is a simplification of basin conditions, and the calculated position of the intrusion front and associated velocity of the intrusion front movement can vary significantly from year to year, and from Spring to Fall due to localized chloride fluctuations, particularly at well LA10. Furthermore, the decline in chloride concentrations during 2017 at LA10 was accompanied with an increase in nitrate concentrations at the well (Tables 10 and 11) and lower production in 2017, which suggests wellbore flow from the Upper Aquifer may be influencing LA10 water quality (see Section 7.5.3).

Contouring for the intrusion front (250 mg/L chloride isopleth) shown in Figure 18 uses the ordinary kriging interpolation method, which provides a best (least-squares) estimate of values at unmeasured points based on the mapped values. Chloride concentrations at Dunes and Bay Area wells LA2 and LA3 are two orders of magnitude greater than the Western Area wells and were not used for contouring the intrusion front in the Western Area. The ordinary kriging interpolation method involves weighted linear interpolation, whereas the chloride concentrations approaching wells LA2 and LA3 on the sandspit do not appear to follow linear gradients.

The location of the intrusion front is also shown in cross-section on Figure 19. Lower Aquifer Zone D intrusion is discussed above. There is insufficient information to represent Lower Aquifer Zone E intrusion in a plan view figure. The only Western Area well which represents Zone E water quality is LA4, located near Sea Pines Golf Course. Water quality at LA4 has been close to seawater since first sampled in 1985 (Cleath & Associates, 2005). Other control points for Zone E water quality along the B-B' cross-section orientation in Figure 19 are LA15 and LA18 in the Central Area. The seawater front reached LA15 in 2009, but there has been no evidence of further inland movement toward LA18, and geophysics in 2015 at nearby deep monitoring well LA14 continues to show no sign of intrusion. This is interpreted as an indication that historical Zone E intrusion toward the Well LA15 was through a relatively narrow preferential pathway. In 2013, LA15 was modified to remove Zone E production (CHG, 2014).



Base Image: Stamen-Terrain



Explanation

164

Groundwater with Fall 2017 Lower Aquifer Chloride Concentration in milligrams per liter (mg/L).

2017 seawater intrusion front in Western Area (250 mg/l chloride isopleth)
A portion of the seawater intrusion front retreat toward the coast between 2016 and 2017 may be due to wellbore flow at metric well LA10, pending further evaluation.

2016 seawater intrusion front in Western Area (250 mg/l chloride isopleth)

2015 seawater intrusion front in Western Area (250 mg/l chloride isopleth)

2005 seawater intrusion front in Western Area (250 mg/l chloride isopleth)

B B'

Cross-section alignment (Figures 5 and 19)

Figure 18
Seawater Intrusion Front
Western Area Lower Aquifer Zone D
Los Osos Groundwater Basin
2017 Annual Report

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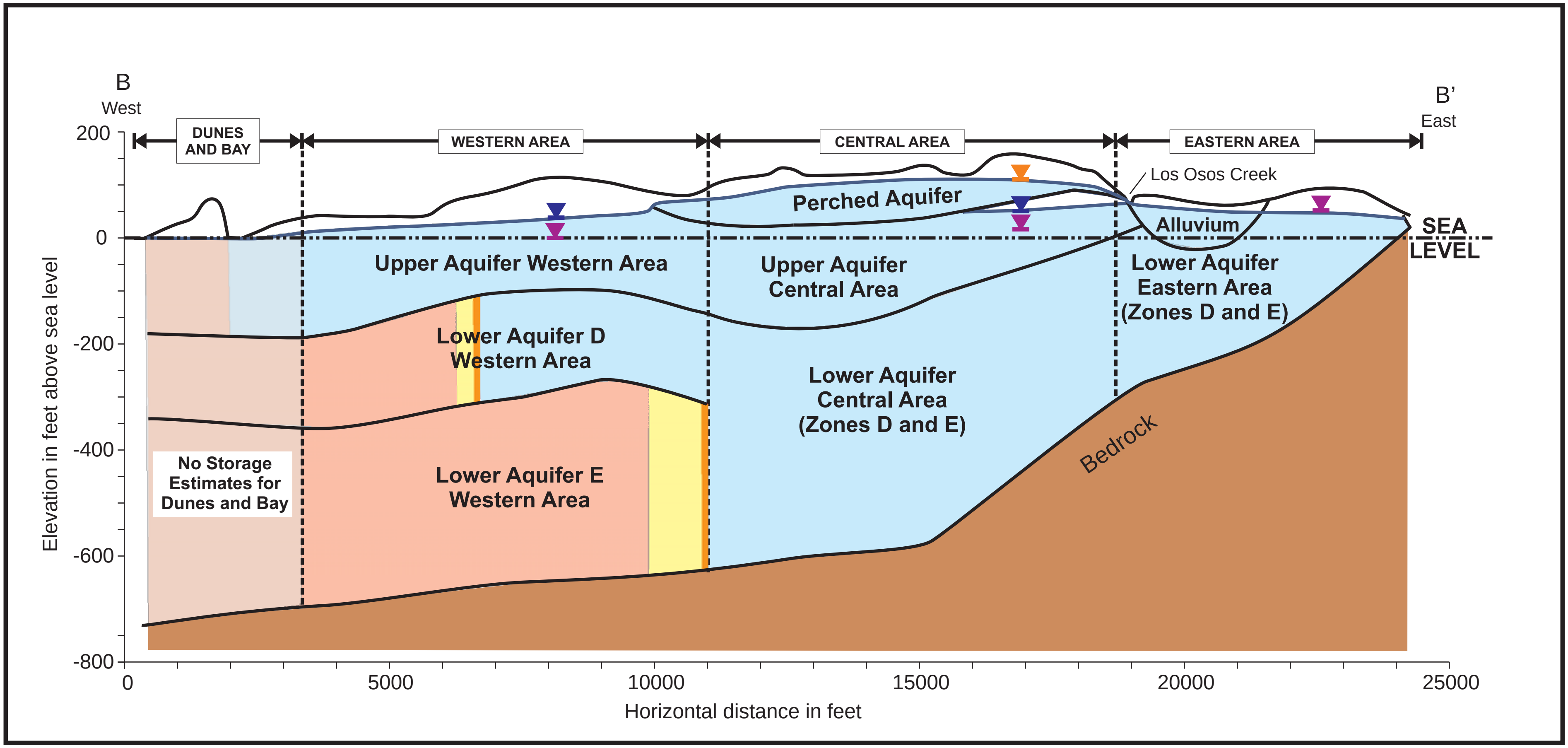

Cross-section alignment shown in Figure 18

Explanation

Groundwater in Storage <250 mg/l Chloride 2016

Groundwater in Storage >250 mg/l Chloride 2005

Change in Groundwater in Storage >250 mg/l Chloride Winter 2005-2017

Fall 2017 seawater intrusion front

Perched Aquifer Water level

Upper Aquifer Water level

Lower Aquifer Water level

NOTE: Inland movement of intrusion front between Fall 2016 and Fall 2017 shown in Figure 18 is for Lower Aquifer Zone D. There is no evidence of further inland movement of the intrusion front in Zone E.

Figure 19
Basin Storage Compartments
Los Osos Groundwater Basin
2017 Annual Report

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7.4 Groundwater in Storage

Groundwater in storage for basin areas and aquifers has been estimated through a systematic approach of water level contouring, boundary definition, volume calculations, and aquifer property estimation. The methodology was developed to facilitate change in storage calculations from year to year. An example storage calculation for the Eastern Area is shown in Appendix I. Storage estimates were performed for Spring and Fall 2017 and included separate estimates for the following areas and aquifers shown in Figure 19:

- Perched Aquifer
- Western Area Upper Aquifer
- Western Area Lower Aquifer
- Central Area Upper Aquifer
- Central Area Lower Aquifer
- Eastern Area Alluvial and Lower Aquifer

The various storage compartments are shown conceptually in Figure 19. Storage estimates for the Lower Aquifer in the Western and Central basin combine fixed pore space volume and confined pore space volume components. The fixed volume component of storage is based on the specific yield of the aquifer sediments, and is fixed because the Lower Aquifer is never dewatered in the Western and Central areas. The confined component adds a relatively small volume of transient storage associated with the aquifer pressure, and is based on the storativity of the aquifer. Confined and semi-confined aquifer storativity values are typically orders of magnitude less than the specific yield. The average specific yield for basin sediments is estimated at 0.1 (Appendix I). The storativity value used for the confined aquifer in the Western and Central areas is estimated at 0.0008 (Cleath & Associates, 2005).

The storage component of the Lower Aquifer in the Western Area Zone D represents the groundwater volume with a chloride concentration of 250 mg/L or less. Zone E in the Western Area is excluded from the storage calculations, because chloride concentrations are mostly above 250 mg/L (Figure 19).

All storage calculations were based on upper and lower contoured surfaces specific to the aquifer (fixed volume and confined volume were combined). For example, elevation contours on the base of the Perched Aquifer were used as the lower bounding surface for Perched Aquifer storage calculations, so no storage was assigned to unsaturated pore space between the base of the perched aquifer and saturated Upper Aquifer sediments (Figure 19). Appendix I includes a list of wells used for 2017 groundwater elevation contours and associated upper surfaces for storage calculations. Fixed upper and lower surfaces used for storage calculations (base of perched aquifer, top and bottom of regional clay aquitard, and base of permeable sediments were developed from existing contour maps and control points presented in prior reports (Cleath & Associates, 2003, 2005; CHG, 2015). Table 17 summarizes the estimates of fresh groundwater in storage for 2017.

Table 17. Groundwater in Storage Spring and Fall 2017 (<250 mg/L Chloride)						
Basin Area	Aquifer	Zone	Spring 2017		Fall 2017	
			Total	Above Sea Level	Total	Above Sea Level
			ACRE-FEET			
Western and Central	Perched	A, B	4,700	4,700	4,500	4,500
	Upper	C	27,900	6,000	27,100	5,300
Western	Lower[1]	D[2]	15,700	<10	16,400	<10
Central	Lower[1]	D, E	56,200	<10	56,200	<10
Eastern	Alluvial and Lower	Alluvial, D, E	19,000	4,500	18,200	3,700
TOTAL			123,500	15,200	122,400	13,500

NOTES: [1] Includes fixed and confined storage.
[2] Western Area Zone E not included due to chloride >250 mg/L.

Total estimated fresh groundwater in storage for the basin (excluding Dunes and Bay area) averaged 123,500 acre-feet in Spring 2017, with an estimated 15,200 acre-feet above sea level (Table 17). There was a calculated net seasonal storage decline of 1,100 acre-feet between Spring 2017 and Fall 2017, although there was an estimated gain of 700 acre-feet of freshwater storage in Lower Aquifer Zone D due to a retreating seawater intrusion front in the western Lower Aquifer. The gain of freshwater storage from Spring to Fall is based on movement of the 250 mg/L chloride isopleth in Zone D, similar to what is shown in Figure 18. A portion of the seawater intrusion front retreat and associated increase in freshwater storage may be due to wellbore flow at metric well LA10, pending further evaluation.

There is approximately 72,000 acre-feet of fresh groundwater in storage within the Lower Aquifer in the Western Area Zone D and Central Area Zones D and E (Table 17). Because groundwater levels in the Lower Aquifer within the Western and Central areas average more than 100 feet above the top of the aquifer, dewatering is unlikely, and this volume of storage will only change with movement of the seawater intrusion front. The Lower Aquifer storage includes a relatively small component (less than 200 acre-feet) of confined pore space volume, representing water that is available without dewatering any portion of the Lower Aquifer (the pressure component). Water is relatively incompressible, so once the pore spaces of an aquifer have been filled, substantial confining pressure is required to further increase the storage volume. Conversely, there is a much greater drop in aquifer water levels for storage withdrawals under confined conditions, compared to unconfined conditions. This smaller storage volume assumes a confined aquifer storativity of 0.0008, compared to the unconfined specific yield of 0.1. Table 18 compares Spring 2016 groundwater in storage with Spring 2017.

Table 18. Change in Storage Spring 2016 to Spring 2017 (<250 mg/L Chloride)						
Basin Area	**Aquifer**	**Zone**	**Spring 2016**		**Change from Spring 2016 to Spring 2017**	
			Total	**Above Sea Level**	**Total**	**Above Sea Level**
			ACRE-FEET			
Western and Central	Perched	A, B	4,300	4,300	400	400
	Upper	C	27,000	5,100	900	900
Western	Lower[1]	D[2]	14,800	<10	900	0
Central	Lower[1]	D, E	56,200	<10	0	0
Eastern	Alluvial and Lower	Alluvial, D, E	18,000	3,500	1,000	1,000
TOTAL			120,300	12,900	3,200	2,300

NOTES: [1] Includes fixed and confined storage.
[2] Western Area Zone E not included due to chloride >250 mg/L.

The values in Table 18 reflect an increase in freshwater storage between Spring 2016 and Spring 2017 of 3,200 acre-feet (as compared to the seasonal storage loss of 1,000 acre-feet between Spring and Fall 2017). The annual change in storage includes an increase in fresh groundwater storage (<250 mg/L chloride) of 900 acre-feet in the Lower Aquifer (including a seasonal gain of 700 acre-feet during 2016). The increased spring storage is consistent with the increased precipitation in Los Osos, compared to the prior four years (26.63 inches of precipitation at Station #727 in the 2017 rainfall year, compared to an average of 9.7 inches from 2013 to 2016).

Freshwater storage in the Western Area of Lower Aquifer Zone D increased by 2,000 acre-feet between Fall 2016 and Spring 2017, then increased by another 700 acre-feet through Fall 2017. The change in Zone D freshwater storage between Fall 2016 and Fall 2017 was a net gain of 2,700 acre-feet, as shown by the westerly retreat of the seawater intrusion front in Figure 18. As previously noted, a portion of the seawater intrusion front retreat and associated increase in freshwater storage may be due to wellbore flow at metric well LA10, pending further evaluation.

A sensitivity analysis was performed to evaluate the potential range of error associated with groundwater storage estimates and change in groundwater storage estimates to support future data interpretation. Three sources of potential error were considered:

- Tape Bias/Survey Error
- Specific Yield Error
- Data Gaps

The sensitivity analysis evaluated how storage calculations are affected by variables (elevation, specific yield, and spatial data) associated with the above sources of error. Storage volumes calculated after applying changes to these variables were compared to the baseline volumes for each storage compartment.

Potential error for storage estimates and change in storage estimates is within 20 percent of baseline for most variables and storage compartments. The data gap sensitivity showed the greatest range in potential error is due to a missing Fall 2017 water level, which resulted in a projected gain in storage from spring to fall in the perched aquifer, rather than a decline. That type of error, however, is screened for during report preparation and was mitigated with a substituted elevation. Specific yield would be considered the most significant source of error, compared to survey/tape bias error or mitigated data gaps.

The estimated change in groundwater storage between Spring 2016 and Spring 2017 is 3,000 acre-feet, compared to basin storage estimates for Spring 2016 and Spring 2017 of 120,300 acre-feet and 123,300 acre-feet respectively (Tables 17 and 18). Based on the sensitivity analysis, the potential range of error for total basin storage would be 25,000 acre-feet, while the potential range of error for the change in storage would be 600 acre-feet. Change in storage estimates have the same potential error ratio (20 percent) as the storage estimates themselves, despite being much lower values, which allows the correlation of relatively small changes in groundwater storage to basin conditions (such as drought) or basin activities (increased or reduced pumping).

Storage calculations would be improved by assigning a specific yield to each individual aquifer. Correlating specific yields to a more robust sample set of logs for the individual aquifers would be recommended. Detailed results of the sensitivity analysis are presented in Appendix J.

7.5 Basin Metrics

The LOBP established two methods for measuring progress in management of seawater intrusion (ISJ Group, 2015): one based on comparing annual groundwater extractions with the estimated sustainable yield of the basin as calculated by the basin numerical groundwater model, and one based on evaluating water level and water quality data from the LOBP Groundwater Monitoring Program. The first method involves the Basin Yield Metric (BYM) and the Basin Development Metric (BDM), while the latter method involves the Water Level Metric, The Chloride Metric, and the Nitrate Metric.

7.5.1 Basin Yield Metric

The Basin Yield Metric compares the actual amount of groundwater extracted in a given year with the estimated sustainable yield of the basin under then-current conditions. Sustainable yield is estimated using the basin model as the maximum amount of water that may be extracted from the basin with none of the active wells producing water with chloride concentration in excess of 250 mg/L (ISJ Group, 2015). A chloride concentration of 250 mg/L is the recommended limit for drinking water (one-half of the Secondary Maximum Contaminant Level Upper Limit of 500 mg/L). The Basin Yield Metric for 2017 is a ratio expressed as follows:

$$\frac{\text{2017 Groundwater Production}}{\text{2017 Sustainable Yield}} * 100$$

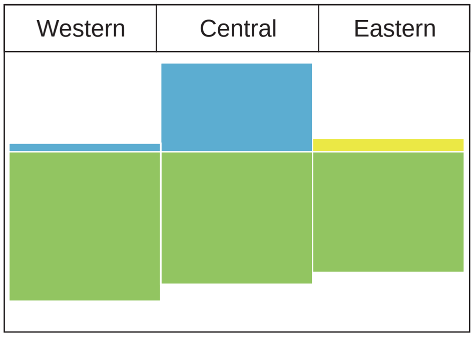
Groundwater production in 2017 was 2,070 acre-feet. The sustainable yield of the basin with the infrastructure in place at year-end 2016 was estimated using the basin model to be 2,760 acre-feet per year (CHG, 2017b). The 2016 estimate included the first Program C well and is applicable to year-end 2017, therefore, the Basin Yield Metric in 2017 is 75. The corresponding Basin Yield Metric was 78 in 2016, which was the first year the metric has been below 80 since the early 1970's. The LOBP objective for the Basin Yield Metric is 80 or less, and has been met in 2016 and 2017.

Figure 20 compares the Basin Yield Metric and area production in the basin since 2005. The Basin Yield Metric has dropped from an average of 128 between 2005 and 2009 to 75 in 2017. Two development scenarios from the LOBP are also provided for comparison in Figure 20.

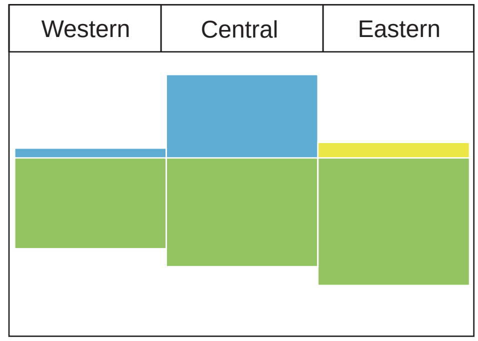
Estimated sustainable yield in the equation above is not simply a volume of water, however, but is also the distribution of groundwater pumping across the basin that maintains a stationary seawater front, with no active well producing water with chloride concentrations above 250 mg/L. Long-term climatic conditions are assumed for the estimated sustainable yield.

The estimated sustainable yield of the basin has been reported to the closest 10 acre-feet, similar other water balance components estimated using the basin model (LOBP, 2015). This level of rounding is based on the precision, not the accuracy, of the basin model. Estimating the sustainable yield of the basin is directly associated with mitigating seawater intrusion. The ability of the basin model to accurately simulate seawater intrusion was evaluated during model conversion to Equivalent Freshwater Head (EFH) in 2005 (Cleath & Associates 2005) and again during model conversion to SEAWAT in 2009 (CHG, 2009a). In 2005, the EFH model estimated 620 acre-feet per year of seawater intrusion along the coast under long-term climatic conditions with 1999-2001 basin pumping, while an analytical approach using available hydrogeologic data and Darcy's Law estimated 500 acre-feet per year of intrusion, indicating the numerical analysis (flow model) was more conservative as a basin management tool than the analytical approach. A subsequent comparison of seawater intrusion at the coast between the EFH model and upgraded SEAWAT model of seawater intrusion at the coast showed the two models were within 2 percent of each other. The SEAWAT model also matched the historical average velocity of sea water intrusion into the lower aquifer of 50-60 feet per year (from water quality data), although the simulated velocity was higher in Zone D (80 feet per year) and lower in Zone E (40 feet per year).

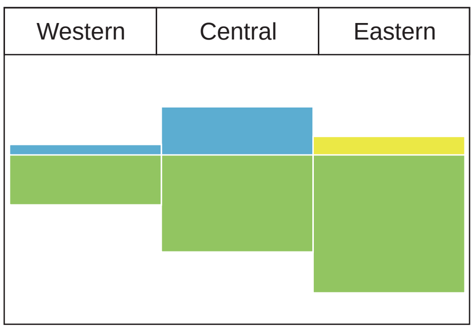
2005-2009
Average Production 3,060 AFY
Basin Yield Metric = 128



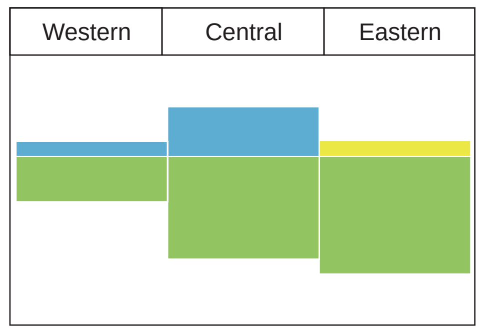
2010-2014
Average Production 2,600 AFY
Basin Yield Metric = 106



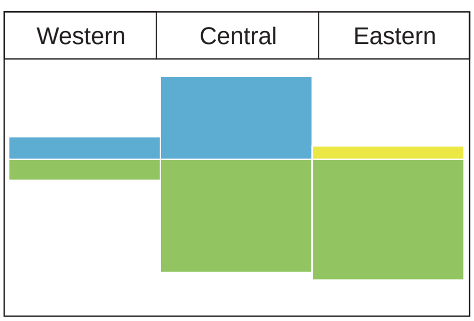
2015-2016
Average Production 2,160 AF
Basin Yield Metric = 78



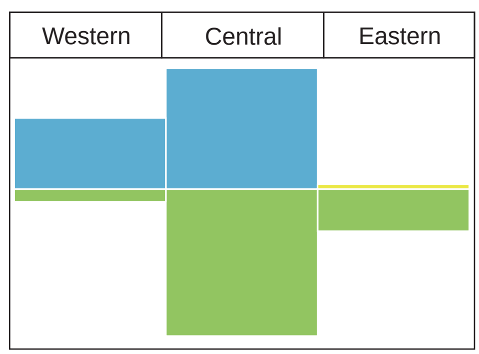
Year 2017
Average Production 2,070 AF
Basin Yield Metric = 75



E+AC+U (No Further Development Scenario)
refer to Basin Plan for full description
Average Production 2,230 AFY
Basin Yield Metric = 74



E+UG+ABC (Buildout Scenario)
refer to Basin Plan for full description
Average Production 2,380 AFY
Basin Yield Metric = 71



Explanation:

Size of rectangle is proportional to groundwater production

Alluvial Aquifer

Upper and Perched Aquifer

Lower Aquifer

Note: historical (pre-2015) and future/projected Basin Yield Metrics are from LOBP

Figure 20
Basin Yield Metric Comparison
Los Osos Groundwater Basin
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7.5.2 Basin Development Metric

The Basin Development Metric compares the estimated sustainable yield of the basin in a given year with the estimated maximum sustainable yield of the basin with all potential LOBP Projects implemented (ISJ Group, 2015) (see Section 10 for brief overview of LOBP Programs). The Basin Development Metric for 2017 is a ratio expressed as follows:

$$\frac{\text{2017 Sustainable Yield}}{\text{Maximum Sustainable Yield}} * 100$$

The 2017 sustainable yield is estimated at 2,760 acre-feet. The maximum sustainable yield with all LOBP projects implemented is estimated at 3,500 acre-feet. Therefore, the Basin Development Metric in 2017 is 79, which is the same value as 2016. The purpose of the metric is to inform the BMC on the percentage of the basin's maximum sustainable yield that has been developed. There is no LOBP objective for the Basin Development Metric.

As presented in the LOBP, the estimated sustainable yield of the basin will increase beginning with urban water reinvestment Program U and basin infrastructure Programs A and C, both of which are currently in progress.

7.5.3 Water Level, Chloride, and Nitrate Metrics

The Water Level, Chloride, and Nitrate Metrics are measurements of the effectiveness of basin management. The Water Level and Chloride Metrics address changes in the Lower Aquifer related to seawater intrusion mitigation, while the Nitrate Metric addresses changes in First Water and the Upper Aquifer related to nitrate contamination mitigation.

<u>Water Level Metric</u>

The Water Level Metric is defined as the average Spring groundwater elevation, measured in feet above mean sea level, in five Lower Aquifer wells. These wells are LA2, LA3, LA11, LA14, and LA16 (Figure 4).

Two Water Level Metric wells (LA14 and LA16) are positioned in the Western Area near the current seawater intrusion front (250 mg/L chloride isopleth) and one well is in the Central Area on the bay front (LA11). As basin production is redistributed through the basin infrastructure program, these Water Level Metric wells will monitor Lower Aquifer groundwater levels in critical areas near the seawater intrusion front.

The last two Water Level Metric wells are located on the Morro Bay sand spit (LA2 and LA3), where monitoring will help evaluate regional effects, rather than just localized water level rebound. Figure 21 graphs historical trends in the metric. Table 19 presents the 2017 Water Level Metric.

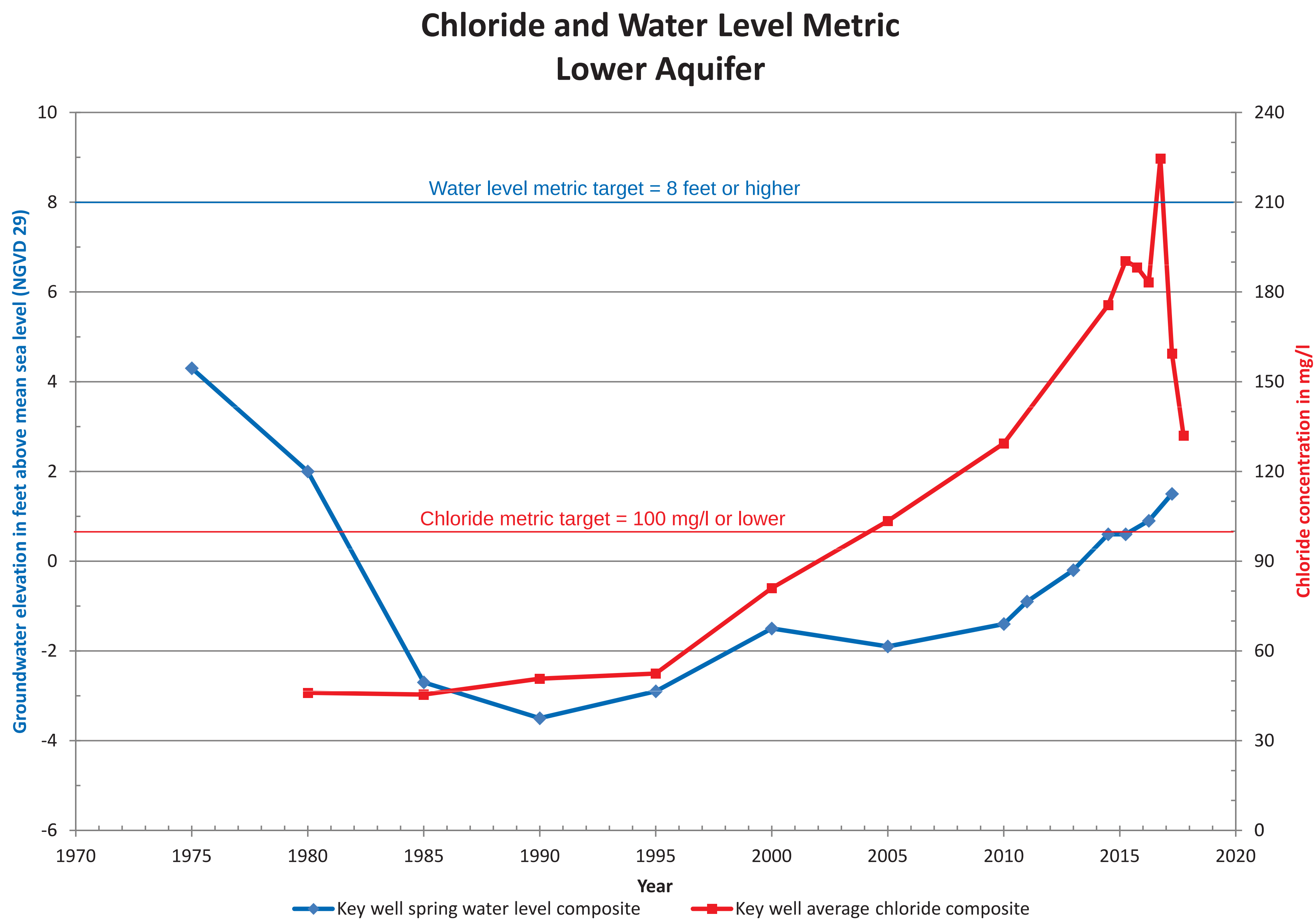

Figure 21
Chloride and Water Level Metric
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Table 19. 2017 Water Level Metric	
Metric Well	**Spring 2017 Groundwater Elevation (feet above sea level - NGVD 29 Datum)**
LA2	1.8[1]
LA3	-0.9[1]
LA11	0.4[1]
LA14	-1.5[1]
LA16	7.8
Water Level Metric (average)	1.5 feet

Data Source: LOBP and County Groundwater Monitoring Programs
[1]Subtracted 2.8 feet from NAVD 88 elevations in Table 5 to convert to NGVD 29 datum for metric.

The Spring 2017 Water Level Metric is 1.5 feet NGVD 29 (approximately 4.3 feet NAVD 88). Mean sea level is approximately 0 feet in the NGVD 29 datum, and 2.8 feet in the NAVD 88 datum for the central coast of California, where the basin is located. The metric was rising from 2005 through 2014, likely in response to a decrease in Lower Aquifer production, did not change between 2014 and 2015, and has begun rising again (Figure 21). The LOBP objective for the Water Level Metric is 8 feet or higher (ISJ Group, 2015). Removal of the density correction at the sandspit wells, and adjustment of reference point elevations to the NGVD 29 datum has lowered the metric compared to prior calculations (CHG 2016b). Reevaluation of the metric objective may be appropriate. A review of all well elevation reference points by a licensed surveyor is recommended prior to considering a change in the water level metric objective.

<u>Chloride Metric</u>

The Chloride Metric is defined as the weighted average concentration of chlorides in four key Lower Aquifer wells. One key well (LA10) is within the historical path of seawater intrusion (Cleath & Associates, 2005). Reduction in pumping from the Lower Aquifer should result in measurable declines in chloride concentrations at this well, as the hydraulic head in the Lower Aquifer increases and the hydraulic gradient toward land decreases or is reversed. The LOBP Groundwater Monitoring Program schedule for measuring the Chloride metric is in the Spring and Fall.

There are also three key wells on the perimeter of the seawater intrusion front (LA8, LA11, and LA12). Wells LA11 and LA12 monitor Lower Aquifer chloride concentrations in the northern portion of the basin, while LA8 monitors chloride concentrations in the southern portion. When calculating the Chloride Metric, the concentration of Well LA10 is given twice the weight of the other three wells, in order to increase the sensitivity of the metric to management actions (Refer to the LOBP for a description of the development of the Metric). Table 20 presents the Spring and Fall 2016 Chloride Metric. Figure 21 graphs historical values in the metric. The Chloride Metric is a simplification of basin conditions, and can vary significantly from year to year due to localized chloride fluctuations, particularly at well LA10. The Chloride Metric target level is 100 mg/L or lower.

Table 20. 2017 Chloride Metric		
Metric Well	**Spring 2017 Chloride Concentrations**	**Fall 2017 Chloride Concentrations**
LA8	77 mg/L	78 mg/L
LA10	231 mg/L (double counted for average)	164 mg/L (double counted for average)
LA11	167 mg/L	162 mg/L
LA12	91 mg/L	92 mg/L
Chloride Metric (weighted average)	159 mg/L	132 mg/L

Data Source: LOBP Groundwater Monitoring Program (Appendix C)

The 2017 water quality monitoring results indicate a retreat of the seawater intrusion front. Seawater intrusion is typically greatest in the fall, when water level are lowest. Unlike 2016, when a significant increase in the Chloride Metric was observed, a comparison between Spring 2017 and Fall 2017 shows continued decline in the metric. The Chloride Metric has decreased relative to the target value between Fall 2016 (225 mg/L) and Fall 2017 (132 mg/L), indicating improvement in 2017 (Figure 21).

Increasing nitrate concentrations at LA10 suggest wellbore flow from the Upper Aquifer may be influencing the chloride concentration and lowering the Chloride Metric more than would otherwise occur. Wellbore flow refers to water moving vertically through the annual space between a well casing and the borehole wall. In the Western Area, the direction of wellbore flow is downward (from the Upper Aquifer to the Lower Aquifer). Wellbore flow reaching a pumping well moves toward the pump. When a well is not actively pumping, wellbore flow moves into the aquifer zones that are under the lower pressure head. The less a well is pumped, the greater potential there is for wellbore flow (with different water quality from the screened aquifer) to collect in the lower pressure zones and impact water quality when the well is finally turned on. An analysis of wellbore flow in basin wells, based on annular cross-sectional area, hydraulic gradient, filter pack hydraulic conductivity and vertical hydraulic gradients estimated up to 10 acre-feet per year of flow through an average inactive borehole (Cleath & Associates, 2005).

The amount of influence from wellbore flow on LA10 water quality was evaluated based on mixing Upper Aquifer water from Fall 2017 (represented by Western Area municipal well UA3) with water from LA10. A mixture of 2 parts Lower Aquifer water (from LA10) with one part Upper Aquifer water (from UA3) would be needed to dilute the chloride at LA10 from the Fall 2016 concentration of 389 mg/L to the Fall 2017 concentration of 164 mg/l. This mixture, however, would produce a much greater nitrate concentration (60 mg/L) than measure at LA10 in Fall 2017 (15 mg/L). In order to produce a nitrate concentration of 15 mg/L, only 10 percent of the water at LA10 would need to come from wellbore flow, which would account for approximately 30 mg/L of the 225 mg/L decline in the Chloride Metric between Fall 2016 and Fall 2017.

Based on preliminary mixing calculations, it appears that the chloride concentration at LA10 is partially influenced by Upper Aquifer wellbore flow, but that the majority of the decline in chloride concentration at LA10 is occurring in the Lower Aquifer zone screened by LA10. Further evaluation of wellbore flow and Upper Aquifer influence at LA10 is recommended as new data becomes available.

Nitrate Metric

The Nitrate Metric is defined as the average concentration of nitrate in five First Water key wells located in areas of the basin that have been impacted by elevated nitrate concentrations. Focusing on shallow, adversely impacted wells provides a sensitive method of tracking changes in nitrate concentrations in groundwater over time. The Nitrate Metric was historically calculated as the average annual nitrate concentration measured in key wells. Beginning with LOBP implementation in 2015, the recommended annual monitoring schedule included water sampling in October. Lower Aquifer seawater intrusion would typically be at a seasonal maximum in October, while nitrate concentrations in the First Water group of wells would be close to average annual levels based on past monitoring results.

The LOWRF Groundwater Monitoring Program, however, which collects the nitrate data, moved to a June and December schedule in the Fall of 2016. CHG evaluated the potential effect of this monitoring schedule change on the metric. Table 21 presents nitrate concentration averages for each season through 2017. A complete list of nitrate-nitrogen concentrations and seasonal averages is included in Appendix K.

Table 21. Seasonal Nitrate-Nitrogen Averages			
Season	Year	Metric Wells	All Wells
		Average NO_3-N (mg/L)	
SPRING MAR-APR-MAY	2003	17	11.1
	2004	19.6	11.9
	2005	15.7	10.4
	2006	18	12.3
	2014	18.6	14.3
	2015	24.2	16.1
	2016	24.1	15.7
SPRING AVERAGE		19.6	13.1
SUMMER JUN-JUL-AUG	2002	16.6	11.1
	2003	20	12.1
	2004	19.6	10.4
	2012	18.9	13.2
	2013	21.1	16
	2017	21	15.8
SUMMER AVERAGE		19.5	13.1
FALL SEP-OCT-NOV	2003	21.6	12.5
	2004	16.8	11
	2005	18	13.1
	2006	15.4	10.5
	2014	24.8	15.4
	2015	25.4	16.7
FALL AVERAGE		20.3	13.2
WINTER DEC-JAN-FEB	2002	18.2	11.1
	2003-04	22.2	12.7
	2014	17.8	15
	2016	26	16.2
	2017	32.3	18.8
WINTER AVERAGE		23.3	14.8
AVERAGE (ALL SEASONS)		20.7	13.6

As shown in Table 21, average nitrate-nitrogen concentrations in groundwater measured during monitoring events in the fall are closest to the average for all seasons, both for the Nitrate Metric wells and for all nitrate monitoring program wells. The winter monitoring events have the highest nitrate-nitrogen average concentrations, while spring and summer events have the lowest nitrate concentrations. Shifting the monitoring schedule for Nitrate Metric calculation to winter (December) increases the average Nitrate Metric by roughly 10-15 percent, compared to fall (October) monitoring or average (all seasons) monitoring, based on averaging the available historical data.

Nitrate Metric data is not available for each season of every year, but data for two or three seasons are available most years. Winter nitrate-nitrogen concentrations for metric wells were greater than other seasonal concentrations in 80 percent of the years that included Winter sampling (4 out of 5 years), which is the higher percentage of any season. Fall nitrate-nitrogen concentrations were greater than other seasonal concentrations in 50 percent of the years that included Fall sampling (3 out of 6 years), with the remaining seasons having a greater nitrate-nitrogen concentrations in less than 20 percent of applicable years (2 out of 13 years combined). The increased nitrate-concentration for Winter sampling events at metric wells shown in Table 21 is supported by individual year comparisons.

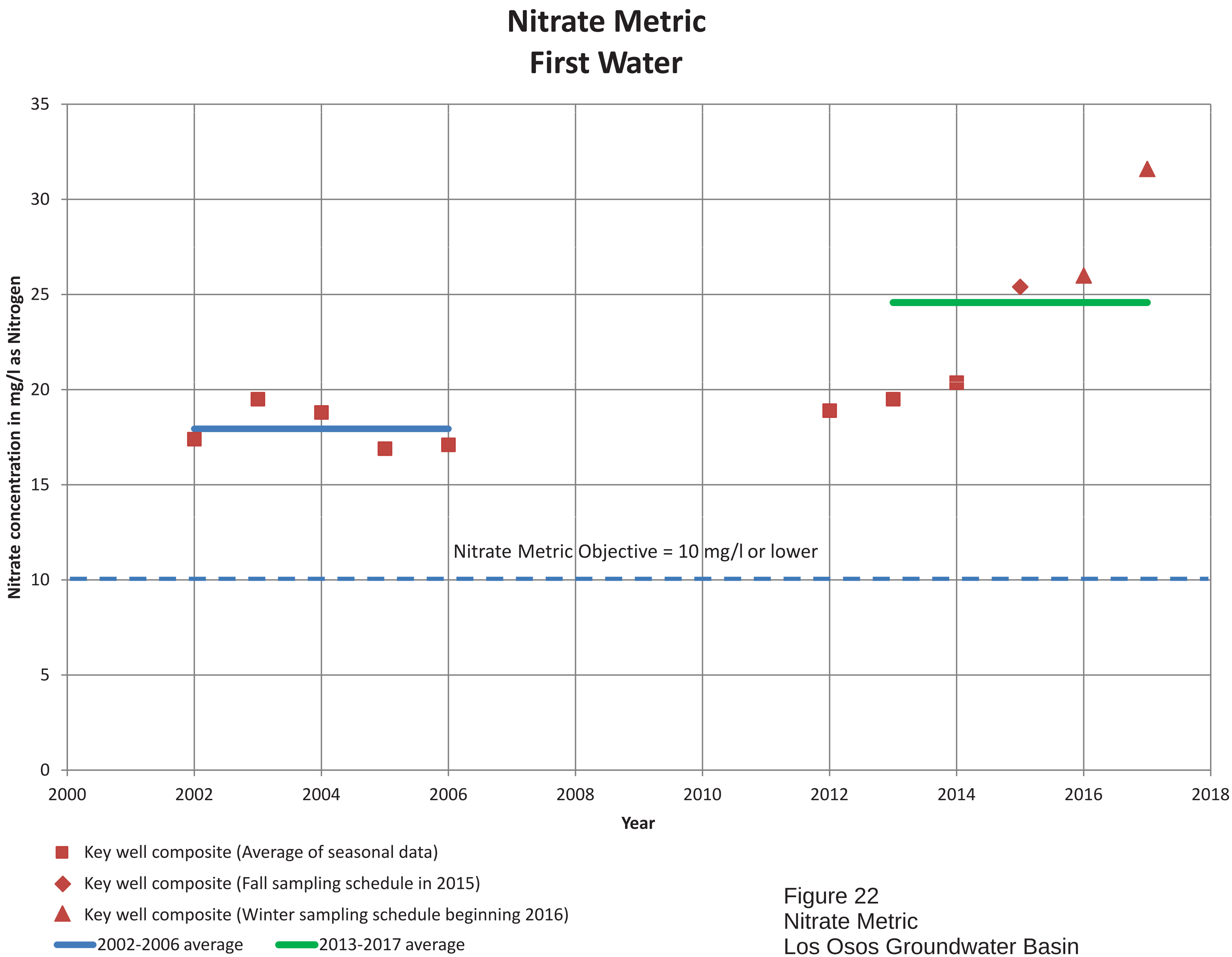
Table 22 presents the Nitrate Metric for 2017. Figure 22 graphs historical values in the metric, along with 5-year average for 2002-2006 and 2013-2017.

Table 22. 2017 Nitrate Metric

Metric Well	Winter 2017 Nitrate-Nitrogen (NO_3-N) Concentrations
FW2	44 mg/L
FW6	10 mg/L
FW10	29 mg/L*
FW15	27 mg/L
FW17	48 mg/L
Nitrate Metric (average)	32 mg/L

Data Source: LOWRF Groundwater Monitoring Program (Rincon Consultants, 2017, 2018)
*FW10 not sampled by LOWRF program in 2017, Winter 2016 result used for average

The Nitrate Metric was measured at 32 mg/L nitrate-nitrogen (NO3-N), which is more than three times the Maximum Contaminant Level of 10 mg/L (the drinking water standard). Independent of LOBP actions, construction and operation of the community sewer system and LOWRF will largely stop nitrate loading in the basin from septic disposal within the wastewater service area. Nitrate concentrations in the basin are expected to begin declining over the next decade, but are currently still rising (with some of the rise likely due to the change in monitoring schedule). The Nitrate Metric target is 10 mg/L or lower (ISJ Group, 2015). If nitrate-nitrogen concentrations in groundwater from the Nitrate Metric wells decrease to a 5-year running average of 10 mg/L or less,



NOTE: Nitrate metric plots for 2013 and 2014 corrected to apply January 2014 data set to Winter 2013 season.

Figure 22
Nitrate Metric
Los Osos Groundwater Basin
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it may reasonably be inferred that nitrate concentrations are generally lower across the Upper Aquifer, or will be in the reasonably foreseeable future.

7.5.4 Upper Aquifer Water Level Profile

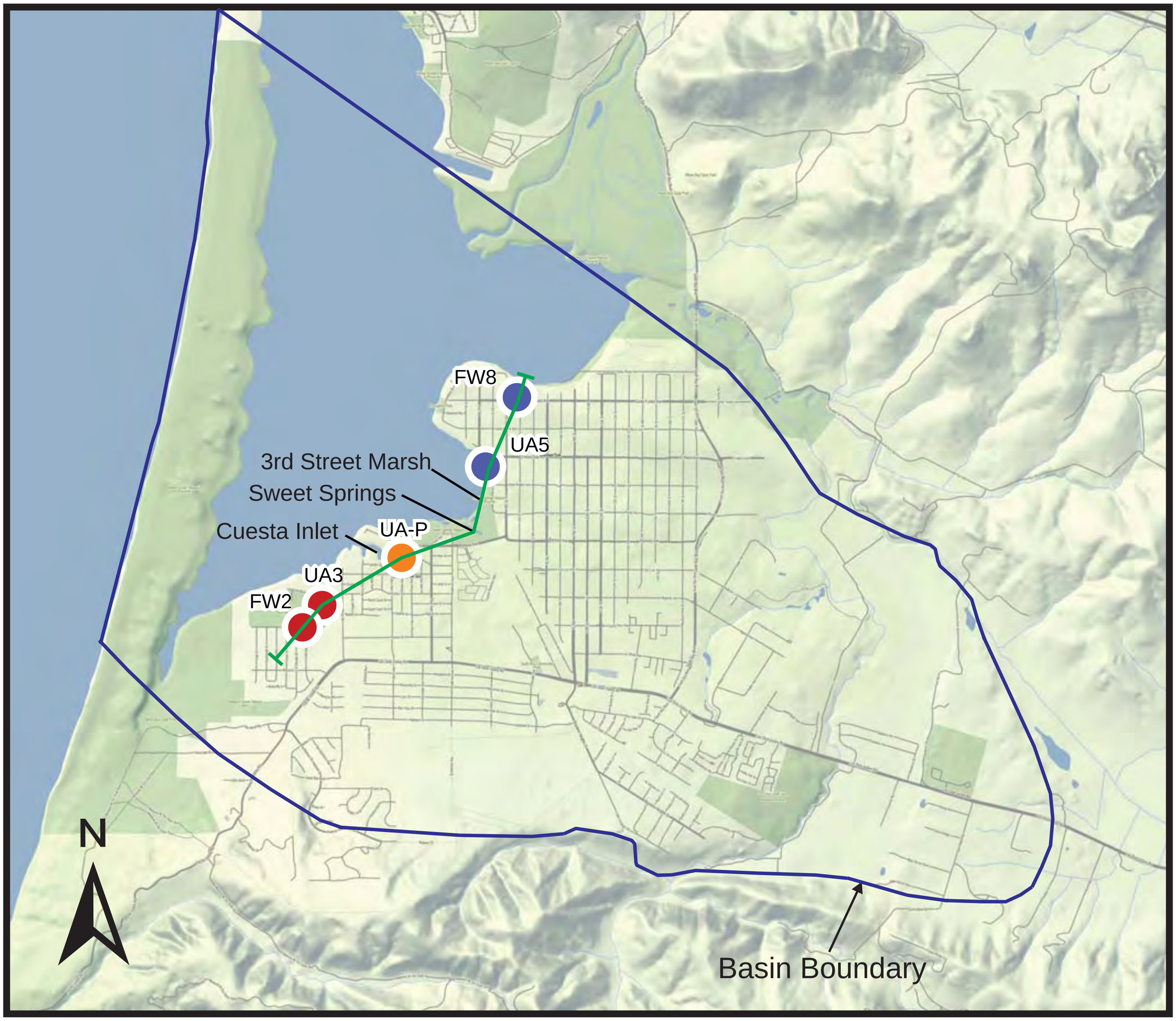
Metrics allow the BMC, regulatory agencies, and the public to evaluate the status of nitrate concentrations and seawater intrusion in the basin through objective, numerical criteria that can be tracked over time (LOBP, 2015). The Upper Aquifer has a Nitrate Metric, but does not have Water Level Metric or Chloride Metric because seawater intrusion is not occurring in the Upper Aquifer.

A Water Level Metric and Chloride Metric for the Upper Aquifer was recommended in the 2016 Annual Report to provide the BMC with a management tool for addressing the potential for seawater intrusion as Upper Aquifer production increases. There are only a few Upper Aquifer wells, however, along the shoreline of the Morro Bay estuary where seawater intrusion would be most likely to occur. An alternative management tool proposed for the Upper Aquifer is the Water Level Profile. The benefit of a profile, rather than a metric, is that spatial information is included. Conditions for seawater intrusion along the Water level Profile could occur before an equivalent metric-based threshold is reached, since there is no averaging in the Water Level Profile. Metrics were not designed for early detection, which is what is needed for Upper Aquifer seawater intrusion monitoring.

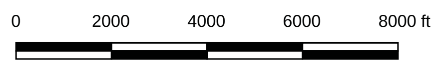
Seawater has a density that is 1.025 times greater than fresh water. For every foot of fresh water head above sea level, the seawater interface will be displaced 40 feet below sea level, according to the Gyhben-Herzberg relation (Freeze and Cherry, 1979). Using the Ghyben-Herzberg relation and elevation contours on the base of the Upper Aquifer, a profile showing the groundwater elevations needed to avoid seawater intrusion beneath the bay shoreline (the protective elevation) has been prepared, along with the Spring 2017 Upper Aquifer groundwater elevations along the same profile, adjusted to the NGVD 29 datum. The resulting Water Level Profile is shown in Figures 23 and 24.

Upper Aquifer water levels in Spring 2017 were above the protective elevation throughout the Water Level Profile (Figure 24). Spring water levels shown above ground surface in low-lying areas near the bay represent artesian pressures in the aquifer, not free-standing water above ground surface. Groundwater seeps and springs are common along the bay shoreline, including Sweet Springs and the 3rd Street marsh.

If water levels decline below the protective elevation, there would be a theoretical potential under hydrostatic conditions (zero hydraulic gradient) for seawater intrusion to occur at the base of the Upper Aquifer. Water levels have been below the protective elevation in the past along portions of the profile without any seawater intrusion detected, particularly during drought periods (e.g. mid 1970's at UA5 and early 1990's at UA3).



Base Image: Stamen-Terrain



Scale: 1 inch ≈ 4,000 feet

Explanation

- LOBP Water Level Monitoring Well
- Water Level and Water Quality Monitoring Well
- Planned New Monitoring Well Construction

Water Level Profile Alignment

Figure 23
Upper Aquifer
Water Level Profile Alignment
Los Osos Groundwater Basin
2017 Annual Report

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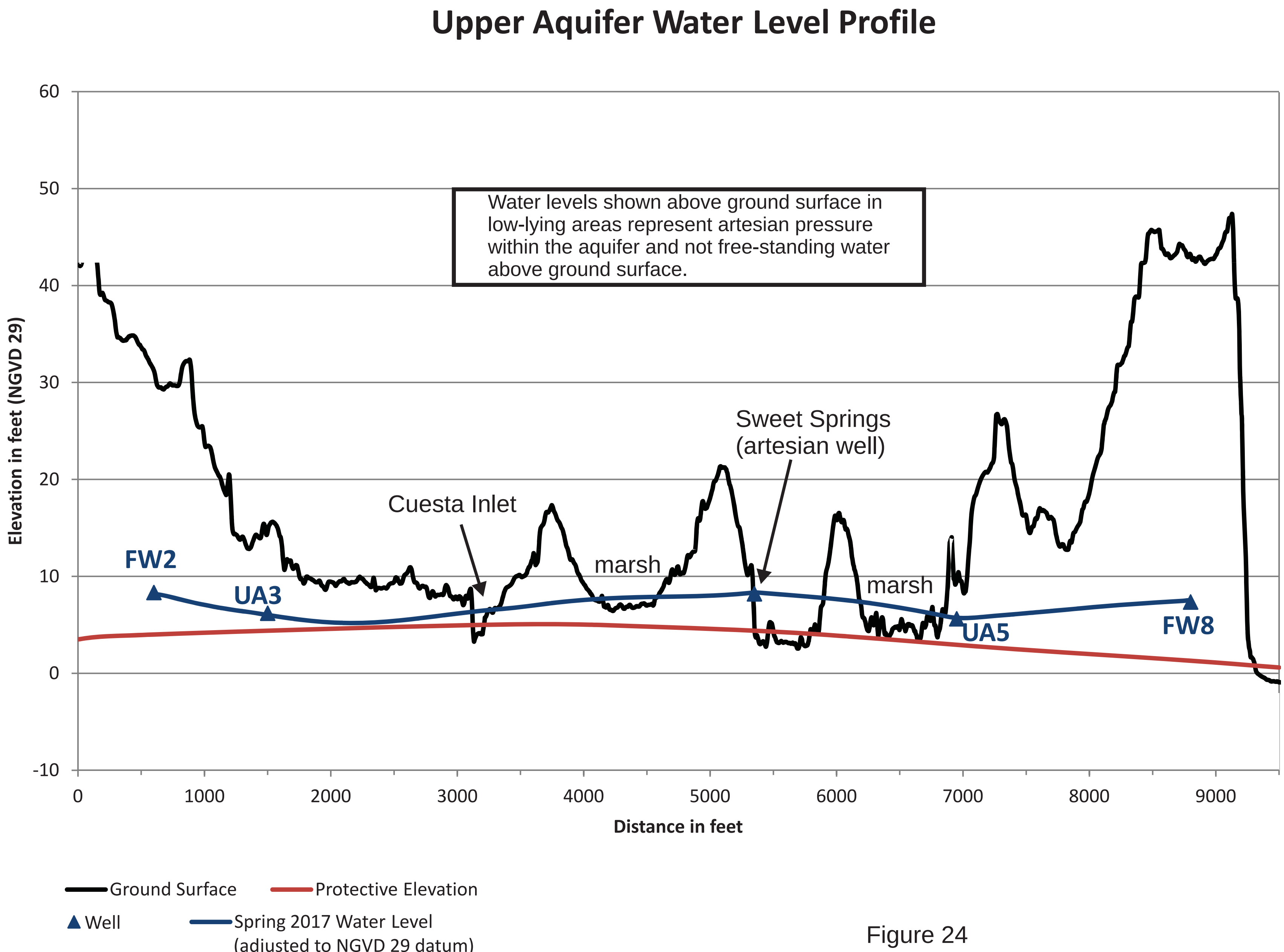

Figure 24
Upper Aquifer Water Level Profile
Los Osos Groundwater Basin
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8. BASIN STATUS

The status of the Los Osos Groundwater Basin in 2017 is summarized as follows:

- The basin received above normal rainfall in 2017. Drought conditions for San Luis Obispo County improved from exceptional drought (the highest intensity) to abnormally dry (the lowest drought intensity level) during 2017, based on information from the U.S. Drought Monitor, a partnership of federal agencies (NDMC/USDA/NOAA, 2017).

- Groundwater production for the basin totaled 2,070 acre-feet in the 2017 calendar year, compared to 2,160 acre-feet in 2016. Purveyor groundwater production increased by 50 acre-feet while community facilities and agricultural water use decreased by an estimated 140 acre-feet in 2017, compared to 2016.

- Long-term water level trends over the last 5 years in First Water wells averaged 0.5 feet of decline per year. Long-term water level trends over the last 10 years in Upper Aquifer wells averaged 0.1 feet of decline per year, and in Lower Aquifer wells averaged 0.5 feet of rise per year.

- The basin gained 3,000 acre-feet of fresh groundwater in storage between Spring 2016 and Spring 2017, and lost 1,000 acre-feet between Spring 2017 and Fall 2017. A portion of the seawater intrusion front retreat and associated increase in freshwater storage may be due to wellbore flow at metric well LA10, pending further evaluation.

- The seawater intrusion front retreated toward the coast up to 1,500 feet between Fall 2016 and Fall 2017. A portion of the seawater intrusion front retreat may be due to wellbore flow at metric well LAA portion of 10, pending further evaluation.

- The Basin Yield Metric has improved by decreasing from 78 in 2016 to 75 in 2017, and the metric has met the LOBP goal of 80 or less for two consecutive years.

- The Basin Development Metric in 2017 indicates that 79 percent of the estimated maximum potential sustainable yield of the basin has been developed. There is no LOBP objective for the Basin Development Metric, and there has been no change in the metric value from 2016.

- The Water Level Metric rose by 0.5 feet between Spring 2016 (1 foot) and Spring 2017 (1.5 feet), indicating improvement in 2017, although it remains several feet below the target value.

- The Chloride Metric decreased relative to the target value between Fall 2016 (225 mg/L) and Fall 2017 (132 mg/L), indicating improvement in 2017. Chloride concentrations at LA10 are interpreted to be influenced by wellbore flow from the Upper Aquifer, although the majority of decline in chloride concentration at the well appears to be occurring in the Lower Aquifer.

- The Nitrate Metric increased relative to the target value between 2016 (26 mg/L as N) and 2017 (32.0 mg/L as N), indicating a lack of improvement in 2017. The recent shift in the nitrate monitoring schedule from Fall to Winter may be influencing the nitrate results and increasing the metric compared to prior years.

9. RECOMMENDATIONS

The following LOBP Groundwater Monitoring Program recommendations from the 2016 Annual Report were completed, are in progress, or are planned for completion in 2018:

- Add a new Upper Aquifer and Lower Aquifer monitoring well near the bay, as recommended in the LOBP (ISJ Group, 2015). ***- In progress***

- Retain a licensed surveyor to review all available documentation on reference point elevations and to perform wellhead surveys as needed (Section 3.2.1). ***– In progress in coordination with County Public Works, with survey RFP release anticipated for 2018***

- Perform a sensitivity analysis to evaluate the potential range of error associated with groundwater storage estimates and change in groundwater storage estimates to support future data interpretation (Section 7.4). ***- Completed***

- Evaluate potential effects on the Nitrate Metric from changes to the LOWRF Groundwater Monitoring Program schedule (Section 7.5.3). ***- Completed***

- Metrics were recommended for the Upper Aquifer to allow year-to-year tracking of the seawater intrusion potential (Section 10.1). - ***Completed*** (modified from metrics to a Water Level Profile).

The following additional LOBP Groundwater Monitoring Program recommendations are provided for BMC consideration. Recommendations on Adaptive Management are provided in Section 10:

- Changing the laboratory used for analyzing CEC's in Fall 2018 should be considered. Comparative costs and available information on laboratory blank contamination should be reviewed for the alternate laboratory prior to making a decision (Section 4.2.4).

- Develop a rating curve for stream flow Sensor 751 on Los Osos Creek (Section 6).

- Develop specific yield values for individual aquifers to improve groundwater storage estimates (Section 7.4).

- Re-evaluate Water Level Metric target after completion of wellhead surveys (Section 7.5.3)

- Further evaluation of wellbore flow and Upper Aquifer influence at LA10 as new data becomes available (Section 7.5.3).

10. ADAPTIVE MANAGEMENT PROGRAM AND STATUS OF LOBP PROGRAM IMPLEMENTATION

The LOBP describes seven potential programs of action, each of which focuses on a different aspect of basin management (ISJ Group, 2015; see Section 10.3). Implementation of an identified combination of the LOBP Programs is expected to result in sustainable use of the basin.

The LOBP also provides for periodic review of the implementation of the LOBP through establishment of an Adaptive Management Plan that allows the BMC to do the following:

- Evaluate trends of key basin metrics;
- Identify additional data needs;
- Report the data analysis to various interested parties;
- Modify the LOBP programs and schedule, if necessary, in response to current conditions and observed trends in the groundwater basin;
- Modify procedures to utilize current best management practices; and
- Modify pumping, treatment, and/or water reuse procedures in response to groundwater basin conditions and trends that show signs of degradation of water quality, including increased levels of contamination and/or increased levels of seawater intrusion.

The Adaptive Management Program will provide a status update on the implementation of the LOBP Programs, assess the overall effectiveness of the LOBP, and offer a tool with which to modify the LOBP programs to better meet overall LOBP objectives.

10.1 Basin Metrics

As noted in Section 7 (“Data Interpretation”) of this Annual Report, the LOBP established several metrics to measure nitrate impacts to the Upper Aquifer, seawater intrusion into the Lower Aquifer, and the effect of management efforts to the BMC. These metrics allow the Parties, the BMC, regulatory agencies and the public to evaluate the status of nitrate levels and seawater intrusion, and the impact of implementation of the LOBP programs, in the Basin through objective, numerical criteria that can be tracked over time. The 2017 metric values are summarized in Table 23 for easy reference during discussion and evaluation of the LOBP programs.

As discussed in Section 7.5, an Upper Aquifer Water Level Profile curve has been developed to track the potential for sea water intrusion in the upper aquifer. This profile currently shows that water levels in the upper aquifer remain safely above the protection level, and the results will be evaluated annual as upper aquifer production increases under Program A.

10.2 Adaptations to LOBP Programs

Based on the basin status (Section 8) and recommendations (Section 9), the BMC intends to continuously develop and pursue additional measures related to the Groundwater Monitoring and Urban Water Use Efficiency programs. The following is an update on additional measures related to the Groundwater Monitoring and Urban Water Use Efficiency program:

Table 23. LOBP Metric Summary			
Metric	**LOBP Goal**	**Calculated Value from 2017 Data**	**Recommended Actions in Addition to LOBP Programs**
Basin Yield Metric: Comparison of current well production to sustainable yield	80 or less	75	Implement additional conservation measures to reduce indoor and outdoor demands (See Section 10.3.2)
Water Level Metric: Weighted average groundwater elevation in 5 key wells in the Lower Aquifer	8 feet above mean sea level or higher	1.5 feet above mean sea level	Implement additional conservation measures to reduce indoor and outdoor demands (See Section 10.3.2)
Chloride Level Metric: Average chloride concentration in 4 key wells in the Lower Aquifer	100 mg/L or lower	132 mg/L	Implement additional conservation measures to reduce indoor and outdoor demands (See Section 10.3.2)
Nitrate Metric: Average nitrate concentration in 5 key wells in the Upper Aquifer	10 mg/L or lower	32 mg/L (NO3-N)	None recommended

Additional Water Quality Metrics. In addition to the new Upper Aquifer Water Level Profile and chloride metrics, the BMC will continue to consider developing additional metrics and/or numerical goals to protect the Upper Aquifer from water quality threats.

Contingency Plan Development. As metric trends and basin response become better defined, the BMC intends to develop contingency plans to respond to unforeseen conditions. As funding and siting for Program C projects progress, detailed milestone schedules will also be developed.

Adaptation of Water Conservation Measures. Evaluate the Urban Water Use Efficiency Program to determine which conservation measures are the most efficient and effective to meet the LOBP's goals.

Discussion and Recommendation of Criteria for Future Growth. Provide input into the Los Osos Community Plan (LOCP), including consideration of Basin Metrics and defined goals as they relate to the timing of future growth within the basin. In its May 2017 meeting, the BMC authorized the release of a letter to the County Planning Department and Coastal Commission staff recommending that future development should be subject to the following provisions:

1. Any growth projections in the updated Los Osos Community Plan should be consistent with the water supply estimates provided in the Basin Management Plan.
2. The Community Plan should acknowledge any infrastructure projects contemplated by the Basin Plan that would require coastal planning action subject to the authority of the Coastal Commission. This provision would help expedite completion of any affected projects.
3. Amendments to the County's Growth Management Ordinance [separate from the Community Plan/LCP] should provide a growth rate for Los Osos consistent with the adaptive management provision of the Basin Plan. In particular, the rate of growth must be set so that the monitoring provisions of the Basin Plan confirms the adequacy of a sustainable water supply in support of any contemplated future growth.

10.3 LOBP Programs

The LOBP outlines a number of programs developed to meet the goals of the various metrics outlined above. The BMC has analyzed the impacts of implementing various combinations of programs on the Basin.[1] In particular, the BMC modeled the impact of each combination on the Basin Yield Metric, Water Level Metric and Chloride Metric. Based on this analysis, the LOBP recommends the following programs for immediate implementation:[2]

- Groundwater Monitoring Program;
- Urban Water Use Efficiency Program;
- Urban Water Reinvestment Program;
- Basin Infrastructure Programs A and C; and
- Wellhead Protection Program.

10.3.1 Groundwater Monitoring Program

In order to allow calculation of the above metrics with a higher degree of accuracy, the BMC has implemented the Groundwater Monitoring Program. The Groundwater Monitoring Program is

1 The LOBP analyzed the following seven potential programs: (1) Groundwater Monitoring Program; (2) Urban Water Use Efficiency Program: (3) Water Reinvestment Program; (4) Basin Infrastructure Program; (5) Supplemental Water Program; (6) Imported Water Program; (7) Wellhead Protection Program.

2 The LOBP also recommends the following programs for potential implementation if the County and the Coastal Commission were to allow future development in Los Osos as part of the LOCP and the Los Osos Habitat Conservation Plan (LOHCP): (1) Basin Infrastructure Program B; and (2) either Basin Infrastructure Program D or the Agricultural Water Reinvestment Program. Since additional development has not been authorized, these additional programs have not been included in this Annual Report.

designed to collect, organize and report data regarding the health of the Basin from a current network of 85 wells.[3] In addition to facilitating the calculation of metrics, this data provides information needed to manage the Basin for long-term sustainability. Implementation of the Groundwater Monitoring Program also satisfies various external monitoring requirements, such as the California Statewide Groundwater Elevation Monitoring Program (CASGEM) and waste discharge and recycled water permits for the LOWRF. Monitoring under the program began in 2014 and will continue to occur in the spring and fall of each year when water levels are typically at their highest and lowest. This Annual Report represents the third monitoring event under the Groundwater Monitoring Program. The BMC plans to continue to report the values for all Basin metrics and other relevant, non-proprietary data to the Parties, the Court and the public in its future Annual Reports. Additional recommendations and planned actions relating to the Groundwater Monitoring Program are described in Section 9. Table 24 summarizes the status of the various implementation tasks set forth in the LOBP that related to the Groundwater Monitoring Program.

10.3.2 Urban Water Use Efficiency Program

In order to reduce annual groundwater production from the Basin, and thus reduce the Basin Yield Metric, the LOBP recommends implementation of the Urban Water Use Efficiency Program. In October 2012, the San Luis Obispo County Board of Supervisors adopted a Water Conservation Implementation Plan ("County Water Conservation Plan"), the details of which are described in Table 25. The County Water Conservation Plan was configured to provide detailed financial and administrative structure, while substantially conforming to the LOBP. Under this program, all properties connecting to the sewer project are required to be retrofitted prior to connection, and the program is essentially complete with the exception of 177 unconnected properties. Table 26 shows the total fixtures retrofitted and the total rebates provided as of May 2017.

3 The wells are distributed laterally across the Western, Central and Eastern Areas and vertically among First Water and the Upper and Lower Aquifers. Twelve existing wells were added to the program since 2015.

Table 24. Basin Groundwater Monitoring Program Status			
Recommended Implementation Measure	**Current Status**	**Funding Status**	**Projected Completion**
Wellhead Surveys: Perform wellhead surveys to establish reference point elevations and locations	*Not initiated		
Protocols and Objectives: Establish well monitoring protocols and data quality objectives	Complete		
Water Level Monitoring: Assign water level monitoring responsibilities to the Parties or other stakeholders	Complete		
Access to Private Wells: Contact private well owners to request permission for participation in the groundwater elevation and water quality portions of the Groundwater Monitoring Program	Most contacts made as of April 2018.	Fully funded	Ongoing
Water Quality Monitoring: Assign water quality monitoring responsibilities. The BMC will adopt a set of procedures for recording groundwater elevations and sampling for water quality.	Complete		
Data: Assign data compilation, organization and reporting duties	Complete		

* The wellhead survey project requires approval of temporary access from private land owners. Obtaining this approval has been started, but is expected to be a complicated process.

Table 25. Summary from Adopted 2012 County Water Conservation Plan					
Implementation Program Plan Measure Number	**Measure**	**Customer Category**	**Program Length**	**Total Estimated Activities**	**Total Estimated Budget**
Category 1. Residential Programs					
1A	Subsidize Partial Community Retrofit, Residential	Single-Family Residential Toilets	3 Years	8,000	$2,061,375
		Single-Family Residential Showerheads	3 Years	8,000	$368,575
		Single-Family Residential Faucet Aerators	3 Years	13,500	$100,769
1B	Residential Clothes Washer Rebate	Single-Family Residential Washer	5 years	2,000	$385,000
1C	Options for Fully Retrofitted Residences	Hot Water on Demand; Dishwashers,	3 years	500	199,525
1D	Retrofit on Resale	Single-Family Residential: Owners complete retrofits through this ongoing water conservation measure.			$0
Category 2 - Commercial and Institutional					
2A	Subsidize Partial Community Retrofit, Commercial	Commercial	3 years	141	$192,223
2B	Replace Restaurant Spray Nozzles	Commercial	3 years	45	$3,649
2C	Institutional Building Retrofit	Institutional	3 years	13	$38,588
2D	Commercial High Efficiency Clothes Washer Rebate	Commercial	3 years	40	$14,280
Category 3 - Education and Outreach Program					
3A	Residential Water Surveys	Single-Family Residential	3years	5,000	$824,250
3B	Commercial, Industrial and	Commercial	3 years	141	$35,102

Table 25. Summary from Adopted 2012 County Water Conservation Plan					
Implementation Program Plan Measure Number	**Measure**	**Customer Category**	**Program Length**	**Total Estimated Activities**	**Total Estimated Budget**
	Institutional Surveys				
3C	Public Information Program	Single-Family Residential	10 years	23,000	$220,500
3D	Media Campaign	Single-Family Residential	10 years	7,000	$178,500
Category 4 - New Development (developer pays to implement water conservation measures)					$0
Contingency for Additional Measures in Years 4-10					$327,600
Plan Development Cost to Date					$50,000
Total Funding Commitment					$5,000,000

Table 25. Summary of Conservation Rebates Provided through May, 2017			
Fixture	**2016 Cumulative Total**	**2017 Cumulative Total**	**6/2016 through 5/2017**
Toilets	3,246	3,315	69
Showerheads	2,362	2,380	18
Faucet aerators	3,211	3,226	15
Clothes washers	101	109	8
Total Value of Provided Rebates	$907,270	$924,474	$17,204

In 2016 the BMC recommended programs to be added to the County Water Conservation Plan. The proposed BMC programs are outlined in Table 26. The County has included all of the proposed rebates within the Los Osos Wastewater Project rebate program with the exception of measures Outdoor 1 and Outdoor 2. The County has indicated that these two programs were not included due to a lack of nexus with the wastewater project. Table 27 shows the current rebates available to customers in the wastewater project service area.

Table 26. BMC Recommended Water Conservation Measures							
Item No.	**Conservation Measure Name**	**Draft Rebate Amount**	**Water Savings Potential and Assumptions (ac-ft/year)**	**Estimated Savings per Unit (gal/yr)**	**Fixture or Program Estimated Lifespan**	**Cost of rebate per acre-ft saved**	**Approximate Savings Potential (AFY)[4]**
Indoor-1	Hot water recirculation system	$300	EPA Water Sense estimates > 10,000 gal/year, assume 5,000 to 10,000 gal/year	7,000	10	$1,396	50 to 100
Indoor -2	High efficiency clothes washer	$250	3,000 to 5,000 gal/year, depending on household size	3,300	5	$4,936	40 to 60
Indoor - 3	Replace 1.6 gpf toilets with 1.28 or below	$250	1,000 to 2,000 gal/year, depending on use	1,500	20	$2,715	30 to 50 (See Note 5)
Indoor - 4	Replace 2.0 gpm showerheads with 1.5 gpm	$40	1,000 to 2,000 gal/year, depending on use	1,500	10	$869	30 to 50 (See Note 5)
Outdoor - 1	Septic tank repurpose - roof water only	$500 (see Note 3)	Assume 3 to 4 tank volumes, at 1,000 gallons each	3,500	20	$2,327	40 to 60 (See Note 1)
Outdoor - 2	Septic tank repurpose - with recycled water hauling	$500 (see Note 3)	Potentially eliminate outdoor potable usage	6,000	20	$1,358	70 to 90 (See Note 1)
Outdoor - 3	Gray water system	$500 (see Note 3)	Potentially eliminate outdoor potable usage	6,000	20	$1,358	70 to 90 (See Note 1)
Outdoor - 4	Laundry to landscape program	$50 (see Note 3)	1,000 to 1,500 gallons per year, depending on use	1,250	5	$2,606	10 to 20 (see Note 1)
Notes:	1. Total savings for outdoor programs are not additive. For example, outdoor use can be addressed through gray water or hauled recycled water. 2. All estimates depend on use patterns and other factors. Values are stated for comparison. 3. Only one $500 rebate will be provided per property under programs Outdoor -1, 2, and 3. Participants in these programs are not eligible for program Outdoor - 4. Property owners who have already backfilled their septic tank will receive a rebate of $500 for implementation of an alternative storage tank/basin with a minimum of 500 gallons of capacity. 4. Approximate Savings Potential assumes total 4,500 unit participation. 5. Assumes 2 replacement fixtures per household unit.						

Table 27. Updated County Water Conservation Plan Los Osos Wastewater Project Proposed Rebate Program			
Measures Required for Connection to the Wastewater System			
Fixture or Appliance	**Existing Fixture Flow Rate**	**New Fixture Flow Rate Eligible for Rebate**	**Rebates**
Toilets Residential & Commercial	Greater than 1.6 gpf	1.28 gpf or less	$250
Showerheads Residential & Commercial	Greater than 2.0 gpm	1.5 gpm or less	$40
Faucet Aerators Residential	Greater than 1.5 gpm	1.5 gpm or less	$5
Faucet Aerators Commercial	Greater than 0.5 gpm	0.5 gpm	$5
Urinals Commercial	Greater than 1.0 gpf	0.5 gpf or less	$500
Pre-rinse Spray valves Commercial	Greater than 1.15 gpm	1.15 gpm or less	N/A
Optional Measures Eligible for Rebates (Requires Connection to the Wastewater System and Compliance with Above Measures)			
Toilets Residential & Commercial	Equal to 1.6 gpf	1.28 gpf or less	$250
Washers Residential & Commercial	Less than Tier 3, Water Factor 4	Tier 3, Water Factor 4 or Less	$450[1]
Hot Water Recirc System Residential & Commercial	N/A	N/A	$350
Showerheads Residential & Commercial	1.5 gpm or more	Less than 1.5 gpm	$40
Complete Gray Water System	N/A	N/A	$500
Laundry only Gray Water System	N/A	N/A	$50
Recycled Water Irrigation Commercial & Institutional	N/A	N/A	Negotiated

gpf = gallons per flush
gpm = gallons per minute

Notes: [1] Rebate not retroactive to prior rebated or prior purchased appliances.

10.3.3 Urban Water Reinvestment Program

Implementation of the Urban Water Reinvestment Program was recommended in the LOBP to increase the sustainable yield of the Basin (and thus reduce the Basin Yield Metric). The Water Reinvestment Program will accomplish the LOBP's goal of reinvesting all water collected and treated by the LOWRF in the Basin, either through direct percolation to the aquifers or reuse. Water treated by the LOWRF will be of a sufficient quality to directly percolate into the Basin or to reuse for landscape or agricultural irrigation purposes. The planned uses of that water are listed in Table 29, along with the actual uses from 2017.[4]

Table 29. Planned Recycled Water Uses in the Urban Water Reinvestment Program

Potential Use	Estimated Annual Volume (AFY)	Actual Annual Volume in 2017 (AFY)
Broderson Leach Fields	448	445
Bayridge Estates Leach Fields	33	7
Urban Reuse	63	0
Sea Pines Golf Course	40	0
Los Osos Valley Memorial Park	50	0
Agricultural Reuse	146	0
Total	**780**	**452**

The LOWRF construction was completed in March 2016. As of January 4, 2018, the sewer service area had connected 95 percent of 4,583 parcels (excluding vacant lots and properties with no structures with sewer facilities) that are required to connect. Flows from the wastewater plant are averaging approximately 450,000 gallons per day, with weekend peaks of 470,000 gallons per day (approximately 504 AFY). With 95 percent of the required parcels connected, average wastewater flows are lower than anticipated. Projecting the actual average flow per connection through the remainder of the project results in a total estimated volume of 580 AFY, which is 200 AFY less than the anticipated 780 AFY.

Treated water in 2017 was conveyed to the Broderson and Bayridge Estates leach fields. The anticipated groundwater mound resulting from localized recharge of recycled water was detected hydraulically downgradient of the Broderson site beginning in June 2017. Recycled water for irrigation will be provided to the schools, parks, and various agricultural areas within the basin once flows at the wastewater plant approach anticipated volumes.

4 This Table was reproduced (with slight edits) from Table 2 of the LOBP.

The BMC is currently analyzing the feasibility, cost, and water supply benefits of a dry weather discharge to Los Osos Creek as a means of recharging the Lower Aquifer and enhancing basin yield. The results of the current study will be summarized in future Annual Reports.

10.3.4 Basin Infrastructure Programs

Implementation of the Basin Infrastructure Program is designed to reduce Purveyor groundwater production from the Lower Aquifer in the Western Area and replace it with additional pumping from the Upper Aquifer and Central and Eastern Areas. This shift will also increase the Basin's sustainable yield, which in turn will help to drive down the Basin Yield Metric.

The Program is divided into four parts, designated Programs A through D. Programs A and B shift groundwater production from the Lower Aquifer to the Upper Aquifer, and Programs C and D shift production within the Lower Aquifer from the Western Area to the Central and Eastern Areas, respectively. A fifth program, Program M, was also established in the Basin Management Plan for the development of a Groundwater Monitoring Program (See Chapter 7 of the BMP), and a new Lower Aquifer monitoring well in the Cuesta by the Sea area was recommended in the 2015 Annual Report. Table 30 provides an overview of status of the Projects that are currently moving forward or have been completed. Note, no projects are currently moving forward in Program D, thus they are not shown in Table 30.

10.3.5 Wellhead Protection Program

The Wellhead Protection Program is designed to protect water quality in the Basin by managing activities within a delineated source area or protection zone around drinking water wells. This program consists primarily of the Purveyors conducting Drinking Water Source Assessment and Protection surveys for each of their wells, as well as construction and operation of the LOWRF. The BMC will identify specific actions to protect water quality in the Basin as deemed appropriate in the future, though no specific actions are recommended at this time.

Table 30. Basin Infrastructure Projects				
Project Name	**Parties Involved**	**Funding Status**	**Capital Cost**	**Status**
Program A				
Water Systems Interconnection	LOCSD/ GSWC	Fully Funded	Construction Value: $103,550	Project completed February 2017, with final approval in March 2017
Upper Aquifer Well (8^{th} Street)	LOCSD	Fully Funded	$250,000	Well was drilled and cased in December 2016. Budget remaining $250,000 to equip the well. Design RFP was issued in April, and a consultant was retained in June 2017. Bid documents are currently being prepared by the consultant. Project to be completed by the first quarter of 2019 or earlier if possible.
South Bay Well Nitrate Removal	LOCSD	Completed		
Palisades Well Modifications	LOCSD	Completed		
Blending Project (Skyline Well)	GSWC	Fully Funded	Previously funded through rate case	Completed - the Rosina Nitrate Unit was brought on-line on October 9, 2017 and it is currently producing 160 gallons per minute of treated water.
Water Meters	S&T	Completed		
Program B				
LOCSD Wells	LOCSD	Not Funded	BMP: $2.7 mil	Project not initiated
GSWC Wells	GSWC	Not Funded	BMP: $3.2 mil	Project not initiated
Community Nitrate Removal Facility	LOCSD/GSWC	Partial	First phase combined with GSWC Program A	GSWC's Program A Blending Project allows for incremental expansion of the nitrate facility and can be considered a first phase in Program B.

Project Name	Parties Involved	Funding Status	Capital Cost	Status
Program C				
Expansion Well No. 1 (Los Olivos)	GSWC	Completed		
Expansion Well No. 2	GSWC/LOCSD	Cooperative Funding	BMP: $2.0 mil	Property acquisition phase is on-going through efforts of LOCSD. Four sites are currently being reviewed, and all appear to be potentially viable for new east side Lower Aquifer wells, Environmental studies were initiated in December 2016 for expansion well #2.
Expansion Well 3 and LOVR Water Main Upgrade	GSWC/LOCSD	Cooperative Funding	BMP: $1.6 mil	Property acquisition phase is on-going through efforts of LOCSD. The BMC is also evaluating the need for Expansion Well 3 for the current population given the decline in water demands.
LOVR Water Main Upgrade	GSWC	May be deferred	BMP: $1.53 mil	Project may not be required, depending on the pumping capacity of the drilled Program C wells. It may be deferred to Program D.
S&T/GSWC Interconnection	S&T/ GSWC	Pending	BMP: $30,000	Conceptual design
Program M				
New Zone D/E Lower Aquifer monitoring well in Cuesta by the Sea	All Parties	Funded through BMC Budget	$115,000 (2018 BMC Budget Item 9)	Cleath-Harris scope was approved in September 2017 meeting, and staff is currently working through right of way and permitting issues for the selected site. Construction is expected in late 2018, or early 2019.

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APPENDIX A

Groundwater Monitoring History

Groundwater Monitoring History

Groundwater monitoring has been performed by public agencies, water purveyors, and consultants for various basin studies and programs over several decades. The following lists include historical investigations, monitoring reports, and monitoring programs with a major focus on basin water levels and water quality through December 31, 2017, which is the end of the period covered by this Annual Report.

Historical Investigations

- *Los Osos-Baywood Ground Water Protection Study* (DWR, 1973);
- *Morro Bay Sandspit Investigation* (DWR, 1979);
- *Los Osos - Baywood Park Phase I Water Quality Management Study* (Brown & Caldwell, 1983);
- *Hydrogeology and Water Resources of the Los Osos Valley Ground-Water Basin, San Luis Obispo County, Water-Resources Investigation 88-4081* (U.S. Geological Survey, 1988);
- *Task F - Sanitary Survey and Nitrate Source Study* (Metcalf & Eddy, 1995);
- *Sea Water Intrusion Assessment and Lower Aquifer Source Investigation of the Los Osos Valley Groundwater Basin* (Cleath & Associates, 2005);
- *Task 3 Upper Aquifer Water Quality Characterization* (Cleath & Associates, 2006);

Monitoring Reports:

- *Baywood Groundwater Study - Fourth Quarter 1998 (San Luis Obispo County Engineering Department, 1999)*;
- *Quarterly and Semi-Annual Groundwater Monitoring Reports for the Los Osos Nitrate Monitoring Program* (Cleath & Associates, 2002-2006)
- *Water Quality Monitoring Results Summary, November 2009-January 2010, Los Osos Valley Groundwater Basin* (CHG, 2010);
- *Semi-Annual Groundwater Monitoring Reports for Los Osos Water Recycling Facility Baseline Groundwater Quality Monitoring* (CHG, 2012-2013);
- *Semi-Annual Groundwater Monitoring Reports for Los Osos Water Recycling Facility Baseline Groundwater Quality Monitoring* (Rincon Consultants, 2014a, 2014b, 2014c, 2017a, 2017b, 2018; CHG 2015a, CHG 2015b, CHG 2015c, 2015d);
- *Semi-Annual Groundwater Monitoring Reports for Lower Aquifer* (CHG, 2014-2015);

- *Annual Groundwater Monitoring Reports for Los Osos Basin Plan* (CHG, 2015);
- Consumer Confidence Reports (Water Quality Reports) published annually by the water purveyors.

Monitoring Programs:

- San Luis Obispo County Public Works, Semi-Annual Water Level Monitoring Program. Period of record for individual wells varies; most begin in 1970's and 1980's, and some end in 1999; program remains active.
- Purveyor Water Supply Well Monitoring per SWRCB-Division of Drinking Water requirements. Period of record for individual wells varies; program remains active.
- 2002-2006 Los Osos Nitrate Monitoring Program. Water levels measured quarterly to semi-annually; program ended October 2006.
- 2012-2017 Los Osos Water Recycling Facility Groundwater Monitoring Program. Water levels measured semi-annually, currently on a June and December schedule; program remains active.
- 2014-2015 Lower Aquifer Monitoring Program. Water levels measured semi-annually; program ended in 2015 (replaced by LOBP Groundwater Monitoring Program).

In addition to water quality and water level reporting, this 2017 Annual Report compiles groundwater production, precipitation, and stream flow data from the following sources:

- Water purveyors (LOCSD, GSWC, and S&T) provide metered production records.
- San Luis Obispo County Department of Public Works provides precipitation at the Los Osos Landfill and stream flow data for Los Osos Creek.

Purveyor municipal production data are based on meter readings. Domestic groundwater production estimates are based on the last reported water use estimates for 2013 from the LOBP, with minor adjustments in 2016 for the inclusion of additional residences in the Eastern Area (CHG, 2016). Production estimates for community facilities and agricultural wells are based on a soil-moisture budget using local precipitation, land use, and evapotranspiration data (Appendix F).

APPENDIX B

Los Osos Basin Plan
Groundwater Monitoring Program Well Information

Los Osos Basin Plan
Monitoring Well Network
First Water/Perched Aquifer Group

Program ID	State Well Number	Name/Location	Basin Area	Coordinates			Well Type	Current Well Owner	Well Data			Aquifer				
				Latitude	Longitude	RP Elevation* (feet amsl)			Screened Interval (feet bgs)	Well Depth (feet bgs)	Casing Diameter (inches)	Creek Valley Alluvium	Zone A/B	Zone C	Zone D	Zone E
FW1	30S/10E-13A7							PRIVATE								
FW2	30S/10E-13L8	Howard/ Del Norte	Western	35.3149	120.8552	32.63	MW	LOCSD	26-36	37	2			x		
FW3	30S/10E-13G	South Court	Western	35.3162	120.8498	50.95	MW	LOCSD	47-52	54	2			x		
FW4	30S/10E-13H	Broderson/Skyline	Western	35.3158	120.8432	49.33	MW	LOCSD	154-164	164	2			x		
FW5	30S/10E-13Q2	Woodland Dr.	Western	35.3119	120.8495	101.27	MW	LOCSD	97-100	105	2			x		
FW6	30S/10E-24A	Highland/Alexander	Western	35.3083	120.8453	193.04	MW	LOCSD	154-164	164	2			x		
FW7	30S/10E-24Ab	Broderson leach field	Western	35.3065	120.8460	255	MW	LOCSD	200-240	240	5			x		
FW8	30S/11E-7L4	Santa Ysabel/5th	Central	35.3302	120.8377	45.76	MW	LOCSD	40-50	50	2			x		
FW9	30S/11E-7K3	12th/ Santa Ysabel	Central	35.3299	120.8300	90.71	MW	LOCSD	55-65	70	2			x		
FW10	30S/11E-7Q1	LOCSD 8th Street - shallow	Central	35.3260	120.8342	25.29	MW	LOCSD	29-43, 54-75	75	8			x		
FW11	30S/11E-7R2	El Moro/12th St.	Central	35.3263	120.8298	61.93	MW	LOCSD	25-35	35	2			x		
FW12	30S/11E-18C2	Pismo Ave./ 5th St.	Central	35.3227	210.8376	34.55	MW	LOCSD	25-35	35	2			x		
FW13	30S/11E-18B2	Ramona/10th	Central	35.3208	120.8320	79.89	MW	LOCSD	25-35	35	2		x			
FW14	30S/11E-18E1							PRIVATE								
FW15	30S/11E-18N2	Manzanita/Ravenna	Central	35.3109	120.8401	125.53	MW	LOCSD	85-95	95	2		x			
FW16	30S/11E-18L11	Palisades Ave.	Western	35.3138	120.8374	88.02	MW	LOCSD	43-53	53	2		x			
FW17	30S/11E-18L12	Ferrell Ave.	Central	35.3138	120.8346	103.85	MW	LOCSD	25-35	35	2		x			
FW18	30S/11E-18P	Sunnyside #1	Western	35.3095	120.8352	150	MW	SLCUSD	15-35	35	2		x			
FW19	30S/11E-18J7	Los Olivos/Fairchild	Central	35.3130	120.8271	125.74	MW	LOCSD	25-35	35	2		x			
FW20	30S/11E-8Mb	Santa Maria/18th Street	Central	35.3287	120.8233	95	MW	LOCSD	37-47	47	2		x			
FW21	30S/11E-8N4	South Bay Blvd. OBS	Central	35.3253	120.8213	95.99	MW	LOCSD	40-50	50	2		x			
FW22	30S/11E-17F4							PRIVATE								
FW23	30S/11E-17N4							PRIVATE								
FW24	30S/11E-17J2	USGS Eto North - shallow	Eastern	35.3142	120.8119	87	MW	PRIVATE[1]	50-70	70	2			x		
FW25	30S/11E-17R1							PRIVATE								
FW26	30S/11E-20A2							PRIVATE								
FW27	30S/11E-20L1							PRIVATE								
FW28	30S/11E-20M2							PRIVATE								
FW29	30S/11E-20A1							PRIVATE								
FW30	30S/11E-18R1							PRIVATE								
FW31	30S/11E-19A	Bayridge Field #2	Central	35.3066	120.8276	213	MW	LOCSD	18-38	38	4		x			

[1] FW24 is former USGS monitorng well (information in public domain)

*Datum varies between NGVD 29 and NAVD 88 (see report Tables 4-8 for details).

MW = Monitoring Wel

State Well Numbers for Reconstructed Wells

	NEW (2002)	OLD (1982)
FW2	30S/10E-13L8	30S/10E-13L5
FW5	30S/10E-13Q2	30S/10E-13Q1
FW8	30S/11E-7L4	30S/11E-7L3
FW9	30S/11E-7K3	30S/11E-7K2
FW11	30S/11E-7R2	30S/11E-7R1
FW12	30S/11E-18C2	30S/11E-18C1
FW13	30S/11E-18B2	30S/11E-18B1
FW15	30S/11E-18N2	30S/11E-18N1
FW16	30S/11E-18L11	30S/11E-18L3
FW17	30S/11E-18L12	30S/11E-18L4
FW19	30S/11E-18J7	30S/11E-18J6
FW21	30S/11E-8N4	30S/11E-8N2

Los Osos Basin Plan
Monitoring Well Network
Upper Aquifer Group

Program ID	State Well Number	Name/Location	Basin Area	Coordinates: Latitude	Coordinates: Longitude	Coordinates: RP Elevation* (feet amsl)	Well Type	Current Well Owner	Well Data: Screened Interval (feet bgs)	Well Data: Well Depth (feet bgs)	Well Data: Casing Diameter (inches)	Aquifer: Creek Valley Alluvium	Aquifer: Zone A/B	Aquifer: Zone C	Aquifer: Zone D	Aquifer: Zone E
UA1	30S/10E-11A1	Sandspit #1 West	Dunes and bay	35.3358	120.8638	16.01	MW	SLO CO.	150-160	160	2			x		
UA2	30S/10E-14B1	Sandspit #3 Shallow	Dunes and bay	35.3219	120.8682	19.48	MW	SLO CO.	190-200	200	1.5			x		
UA3	30S/10E-13F4	GSWC Skyline #1	Western	35.3165	120.8533	19	M	GSWC	90-195	206	14			x		
UA4	30S/10E-13L1	S&T Mutual #1	Western	35.3148	120.8531	38.68	M	S&T	100-141	141	8			x		
UA5	30S/11E-7N1	LOCSD 3rd St. Well	Central	35.3256	120.8401	9.13	M	LOCSD	56-84	80	8			x		
UA6	30S/11E-18L8	USGS Palisades OBS East 2"	Western	35.3149	120.8381	79.18	MW	SLO CO.	100-140	140	2			x		
UA7	30S/11E-18L7	USGS Palisades OBS West 2"	Western	35.3149	120.8381	79.16	MW	SLO CO.	180-220	220	2			x		
UA8	30S/11E-18K7	LOCSD 10th St. Observation West	Central	35.3130	120.8326	135.65	MW	LOCSD	200-220	220	2			x		
UA9	30S/11E-18K3	GSWC Los Olivos #3	Central	35.3133	120.8300	121.18	M	GSWC	148-202, 222-232	232	8			x		
UA10	30S/11E-18H1	LOCSD - 12th St.	Central	35.3161	120.8297	107.10	M	LOCSD	112-125, 145-159, 172-186, 216-231	232	10			x		
UA11	30S/11E-17D							PRIVATE								
UA12	30S/11E-17E9	So. Bay Blvd OBS shallow	Central	35.3158	120.8240	105.85	MW	LOCSD	184-194	204	2			x		
UA13	30S/11E-17E10	LOCSD South Bay upper	Central	35.3159	120.8239	106	M	LOCSD	170-210	220	8			x		
UA14	30S/11E-17P4							PRIVATE								
UA15	30S/11E-20B7							PRIVATE								
UA16	30S/11E-17L4							PRIVATE								
UA17	30S/11E-17E10							PRIVATE								
UA18	30S/11E-17F2							PRIVATE								

*Datum varies between NGVD 29 and NAVD 88 (see report Tables 4-8 for details).

M = Municipal
MW = Monitoring Well

Los Osos Basin Plan
Monitoring Well Network
Lower Aquifer Group

Program ID	State Well Number	Name/Location	Basin Area	Coordinates			Well Type	Well Owner	Well Data			Aquifer				
				Latitude	Longitude	RP Elevation* (feet amsl)			Screened Interval (feet bgs)	Well Depth (feet bgs)	Casing Diameter (inches)	Creek Valley Alluvium	Zone A/B	Zone C	Zone D	Zone E
LA1	30S/10E-2A1	Sandspit #2 North	Dunes and Bay	35.3530	120.8617	23.13	MW	SLO CO.	220-230	230	2					x
LA2	30S/10E-11A2	Sandspit #1 East	Dunes and Bay	35.3358	120.8638	16.07	MW	SLO CO.	234-244	244	2				x	
LA3	30S/10E-14B2	Sandspit #3 Deep	Dunes and	35.3219	120.8682	19.47	MW	SLO CO.	270-280	280	2				x	
LA4	30S/10E-13M1	USGS Howard West	Western	35.3149	120.8597	41.20	MW	PRIVATE	477-537	820	6					x
LA5	30S/10E-13L7	S&T Mutual #4	Western	35.3146	120.8531	37	M	S&T	160-300	300	8					
LA6	30S/10E-13L4	GSWC Pecho #1	Western	35.3129	120.8522	68	M	GSWC	240-380	675	14				x	
LA7	30S/10E-13P2							PRIVATE								
LA8	30S/10E-13N	S&T Mutual #5	Western	35.3088	120.8565	138.50	M	S&T	260-340	350	8				x	
LA9	30S/10E-24C1	GSWC Cabrillo #1	Western	35.3077	120.8552	178.32	M	GSWC	250-500	508	10				x	
LA10	30S/10E-13J1	GSWC Rosina #1	Western	35.3145	120.8468	95.31	M	GSWC	290-406	409	10				x	x
LA11	30S/10E-12J1	Morro Bay Observation #5	Central	35.3299	120.8440	8.43	MW	SLO CO.	349-389	389	2					x
LA12	30S/11E-7Q3	LOCSD 8th St. Lower	Central	35.3259	120.8342	24.30	M	LOCSD	230-270	270	10				x	
LA13	30S/11E-18F2	LOCSD Ferrell #2	Central	35.3159	120.8358	100	M	LOCSD	425-620	625	12				x	x
LA14	30S/11E-18L6	USGS Palisades OBS 6"	Western	35.3149	120.8381	79.36	MW	SLO CO.	355-375, 430-480, 550-600	620	6				x	x
LA15	30S/11E-18L2	LOCSD Palisades	Western	35.3136	120.8377	85	M	LOCSD	340-380	394	12				x	
LA16	30S/11E-18M1	Former CCW #5 - Broderson OBS	Western	35.3128	120.8430	106.82	MW	PRIVATE	330-355, 395-415, 465-505, 530-575	577	10				x	x
LA17	30S/11E-24A2	USGS Broderson	Western	35.3074	120.8433	210.40	MW	SLO CO.	800-860	860	6				x	x
LA18	30S/11E-18K8	10th St. Observation East	Central	35.3130	120.8325	135.74	MW	LOCSD	630-650	650	2					x
LA19	30S/11E-19H2	USGS Bayview Heights 6"	Central	35.3043	120.8266	256.20	MW	SLO CO.	280-380	740	6				x	
LA20	30S/11E-17N10	GSWC South Bay #1	Central	35.3111	120.8240	140	M	GSWC	225-295, 325-395, 485-695	715	12			x	x	x
LA21	30S/11E-17E7	So. Bay Blvd OBS deep #3	Central	35.3158	120.8240	105.85	MW	LOCSD	480-490, 500-510	520	2					x
LA22	30S/11E-17E8	So. Bay Blvd OBS middle #2	Central	35.3158	120.8240	105.85	MW	LOCSD	270-280, 370-380	390	2				x	
LA23	30S/11E-17C1							PRIVATE								
LA24	30S/11E-17J1	USGS Eto North - deep	Eastern	35.3142	120.8119	71.62	I	PRIVATE[1]	160-190, 245-260	260	6				x	x
LA25	30S/11E-20Aa							PRIVATE								
LA26	30S/11E-20G2	USGS Eto South	Eastern	35.3037	120.8131	99.66	I	PRIVATE[1]	300-360	370	6					x
LA27	30S/11E-16Ma							PRIVATE								
LA28	30S/11E-16Mb							PRIVATE								
LA29	30S/11E-21E3							PRIVATE								
LA30	30S/11E-20H1							PRIVATE								
LA31	30S/11E-13M2							PRIVATE								
LA32	30S/11E-18K9	LOCSD 10th Street Production	Central	35.3103	120.8325	135	M	LOCSD	235-270, 350-49	490	14			x	x	
LA33	30S/11E-17A1							PRIVATE								
LA34	30S/11E-8F	Los Osos Landfill MW-11	Eastern	35.3201	120.8052	26.15	MW	SLO CO.	37.5-47.5	47.5					x	
LA35	30S/11E-21Bb	LOWRF South Well	Eastern	35.3076	120.7993	96	Ind	SLO CO.	180-230	230						x
LA36	30S/11E-21Ja							PRIVATE								
LA37+	30S/11E-21B1	Andre Windmill Well	Eastern	35.3069	120.7976	81.4	MW	SLO CO.			6					x
LA38+	30S/11E-21E							PRIVATE								

[1] LA24 amd LA26 are former USGS monitorng wells (information in public domain)

*Datum varies between NGVD 29 and NAVD 88 (see report Tables 4-8 for details).	M = Municipal
	MW = Monitoring Well
	Ind = Industrial Well
+ New for 2017 Reporting Year	I = Irrigation

Los Osos Basin Plan
Monitoring Well Network 2017
FIRST WATER

Program Well ID	CASGEM Program Reporting	Basin Plan Monitoring Code	County Water Level Program	LOWRF Groundwater Monitoring Program[1]	**Planned 2018 Monitoring Program[2]**
FW1	no	L			**L**
FW2	yes	L, G		L, G	**L**
FW3	yes	L		L	**L**
FW4	yes	L		L	**L**
FW5	yes	L		L	**L**
FW6	yes	TL, G, CEC		G	**TL, CEC**
FW7	yes	L			**L**
FW8	yes	L		L	**L**
FW9	yes	L		L	**L**
FW10	yes	TL, G		G	**TL**
FW11	yes	L		L	**L**
FW12	yes	L		L	**L**
FW13	yes	L		L	**L**
FW14	no	L		L	**L**
FW15	yes	L, G		L,G	**L**
FW16	yes	L		L	**L**
FW17	yes	L, G		L,G	**L**
FW18	no	L			**L**
FW19	yes	L		L	**L**
FW20	yes	L, G		L, G	**L**
FW21	yes	L		L	**L**
FW22	no	L, G		L, G	**L**
FW23	no	L		L	**L**
FW24	no	L	L		
FW25	no	L	L		
FW26	no	L, G, CEC			**L, G, CEC**
FW27	no	TL			**TL**
FW28	no	L, G	L		
FW29[3]	no	L	L		
FW30[3]	no	L		L	**L**
FW31[3]	no	L			**L**
FW32[3]	no	L			**L**

L = WATER LEVEL
G = GENERAL MINERAL
CEC = CONSTITUENTS OF EMERGING CONCERN
TL = TRANSDUCER WATER LEVEL

NOTES:
1 - Summer and winter monitoring schedule
2 - Spring and fall monitoring schedule
3 - Well added to LOBP program

Los Osos Basin Plan
Monitoring Well Network 2017
UPPER AQUIFER

Program Well ID	CASGEM Program Reporting	Basin Plan Monitoring Code	County Water Level Program	LOWRF Groundwater Monitoring	**Planned 2018 Monitoring Program[2]**
UA2	yes	L	L		
UA3	yes	L, G			**L, G**
UA4	no	TL			**TL**
UA5	no	L		L	**L**
UA6	no	L	L		
UA7	yes	L	L		
UA8	yes	L			**L**
UA9	no	L, G			**L, G**
UA10	no	TL			**TL**
UA11	no	L		L	**L**
UA12	no	L		L	**L**
UA13	no	L, G			**L, G**
UA14	no	L			**L**
UA15	no	L			**L**
UA16[3]	no	L	L		
UA17[3]	no	L	L		
UA18[3]	no	L	L		

L = WATER LEVEL
G = GENERAL MINERAL
TL = TRANSDUCER WATER LEVEL

NOTES:
1 - Summer and winter monitoring schedule
2 - Spring and fall monitoring schedule
3 - Well added to LOBP program

Los Osos Basin Plan
Monitoring Well Network 2017
LOWER AQUIFER

Program Well ID	CASGEM Program Reporting	Basin Plan Monitoring Code	County Water Level Program	**Planned 2018 Monitoring Program[2]**
LA2	yes	L	L	
LA3	yes	L	L	
LA4	yes	L, GL		**L, GL**
LA5	no	L	L	
LA6	no	L , G[1]	L	
LA7	no	TL		**TL**
LA8	no	L, G		**L , G**
LA9	no	L		**L, G[2]**
LA10	no	L, G		**L , G**
LA11	no	L, G		**L , G**
LA12	no	L, G		**L , G**
LA13	no	TL		**TL**
LA14	no	L, GL	L	**GL**
LA15	no	L, G		**L , G**
LA16	no	L	L	
LA17	no	L	L	
LA18	yes	L, G		**L , G**
LA19	yes	L	L	
LA20	no	L, G		**L , G**
LA21	no	L	L	
LA22	no	L	L	**G[2]**
LA23	no	L, G		**L, G**
LA24	no	L	L	
LA25	no	L		**L**
LA26	no	L	L	
LA27	no	TL		**TL**
LA28	no	L, G		**L, G**
LA29	no	L	L	
LA30	no	L, G		**L**
LA31[3]	no	G		**G**
LA32[3]	no	G		**G**
LA33[3]	no	L		**L**
LA34[3]	no	L	L	
LA35[3]	no	L		**L**
LA36[3]	no	L		**L**
LA37[3]	no	L		**L**
LA38[3]	no	L		**L**

L = WATER LEVEL
G = GENERAL MINERAL
GL = GEOPHYSICAL LOG (2018)
TL = TRANSDUCER WATER LEVEL

NOTES:
1 - Remove G from LA6 - out of service.
2 - Add G to LA9 and LA22
3 - Well added to LOBP program
Well IDs with both April and October water quality monitoring in Italics

APPENDIX C

Field Logs and Laboratory Analytical Reports for 2017 BMC Monitoring

Note: There are no Groundwater Monitoring Field Logs for Wells LA9, LA10, LA20, UA9, and UA3; These wells were sampled by owner (GSWC).

Spring 2017 Field Logs and Analytical Results

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 4/11/2017
Operator: A.Berge, W. Forbes
Well number and location: 30S/11E-13N (LA8)
Site and wellhead conditions: Damp cool. Chlorinated water purged from line for one minute @ 200 gpm
Static water depth (feet): 134
Well depth (feet): 350
Water column (feet): 216
Casing diameter (inches): 8
Minimum purge volume (gal) --
Purge rate (gpm): 200
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): --
Time begin purge: 9:38 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
9:39	200	425.6	6.45	18.2	Clear, colorless, odorless
					Sampled @ 9:40 am

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 4/11/2017
Operator: A.Berge, W. Forbes
Well number and location: 30S/11E-12J1 (LA11)
Site and wellhead conditions: Overcast, cool, cap secure, covered by ice plant.

Static water depth (feet): 5.26
Well depth (feet): 389
Water column (feet): 383.74
Casing diameter (inches): 2
Minimum purge volume (gal) 187.00
Purge rate (gpm): 1.6
Pumping water level (feet): 11.45
Pump setting (feet): 25
Minimum purge time (min): 100
Time begin purge: 10:25 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
10:24	1	1,114	7.45	18.8	Clear, colorless, odorless
10:26	5	1,101	7.40	18.7	Clear, colorless, odorless
10:29	10	1,094	7.35	18.6	Clear, colorless, odorless
10:34	20	1,091	7.35	18.9	Clear, colorless, odorless
10:49	45	1,086	7.34	20.2	Clear, colorless, odorless
11:05	75	1,272	7.28	20.9	Slightly cloudy, no odor
11:18	100	1,265	7.25	21	Slightly cloudy, no odor
11:29	120	1,262	7.30	21	Clear, colorless, odorless
11:45	145	1,254	7.33	20.9	Clear, colorless, odorless
11:58	170	1,243	7.33	20.6	Clear, colorless, odorless
12:08	190	1,238	7.29	20.7	Clear, colorless, odorless
					Sampled @ 12:08 pm

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 4/10/2017

Operator: A.Berge

Well number and location: 30S/11E-7Q3 (LA12)

Site and wellhead conditions: Sunny warm, gate unlocked and pump turned on at 10:30 am.

Static water depth (feet):	35.30 on 4/13/17
Well depth (feet):	270
Water column (feet):	234.7
Casing diameter (inches):	10
Minimum purge volume (gal)	NA
Purge rate (gpm):	NA
Pumping water level (feet):	NA
Pump setting (feet):	NA
Minimum purge time (min):	NA
Time begin purge:	10:30 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
10:34	10	753	7.78	21.6	Clear, colorless, odorless
					Sampled @ 10:38 am

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 4/12/2017

Operator: A.Berge, W. Forbes

Well number and location: 30S/11E-18K8 (LA18)

Site and wellhead conditions: overcast, cool, gate pre-opened, both monuments and caps secure and in place

Static water depth (feet):	137.83
Well depth (feet):	650
Water column (feet):	512.17
Casing diameter (inches):	2
Minimum purge volume (gal)	240
Purge rate (gpm):	0.9
Pumping water level (feet):	141.44
Pump setting (feet):	150
Minimum purge time (min):	240
Time begin purge:	9:28

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
9:29	1	424.4	8.13	19.8	Clear, colorless, odorless
9:34	5	553.0	7.46	20.4	Clear, colorless, odorless
9:40	10	573.8	7.47	20.2	Clear, colorless, odorless
9:52	20	572.9	7.60	20.2	Clear, colorless, odorless
10:04	30	586.0	7.48	20.5	Clear, colorless, odorless
10:27	50	588.0	7.45	20.8	Clear, colorless, odorless
11:05	80	586.1	7.49	20.9	Clear, colorless, odorless
12:11	120	587.5	7.35	20.9	Clear, colorless, odorless
1:10	170	583.0	7.64	22.3	Clear, colorless, odorless
2:14	220	588.0	7.40	22.5	Clear, colorless, odorless
2:38	240	589.6	7.50	22.2	Clear, colorless, odorless
					Sampled @ 2:38 pm

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 4/13/2017
Operator: A.Berge, W. Forbes
Well number and location: 30S11E-17E8 (LA22)
Site and wellhead conditions: Sunny- wet, just rained, gate open, cap on & secure.

Static water depth (feet):	123.89
Well depth (feet):	380
Water column (feet):	256.11
Casing diameter (inches):	2
Minimum purge volume (gal)	124.30
Purge rate (gpm):	0.83
Pumping water level (feet):	116.11
Pump setting (feet):	140
Minimum purge time (min):	141
Time begin purge:	9:30

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
9:30	1	414.0	8.79	18.5	Slightly cloudy, odorless
9:35	5	454.3	8.60	19.2	Clear, colorless, odorless
9:41	10	475.3	8.23	19.1	Clear, colorless, odorless
9:47	15	475.9	8.04	19.2	Clear, colorless, odorless
9:59	25	461.5	7.60	19.4	Clear, colorless, odorless
10:10	35	457.6	7.51	19.6	Clear, colorless, odorless
10:21	45	458.8	7.40	19.7	Clear, colorless, odorless
10:33	55	458.5	7.43	19.6	Clear, colorless, odorless
10:54	75	457.8	7.34	19.6	Clear, colorless, odorless
11:19	95	459.4	7.38	19.8	Clear, colorless, odorless
11:41	115	456.6	7.34	19.9	Clear, colorless, odorless
11:51	125	456.2	7.52	19.3	Clear, colorless, odorless
					Sampled at 11:59 am

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 4/17/2017
Operator: S. Harris, A.Berge
Well number and location: 30S/10E-13M2 (LA31)
Site and wellhead conditions: Overcast and misty. Gates secure, plug in place, water inside monument. Well is pumping.
Recovering water depth (feet): 44.3
Well depth (feet):
Water column (feet):
Casing diameter (inches): 8
Minimum purge volume (gal) --
Purge rate (gpm): --
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): --
Time begin purge: 11:04

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
11:05	1	3,070	7.75	19.5	Clear, colorless, odorless
11:10	10	3,080	7.58	19.1	Clear, colorless, odorless
11:15	15	3,090	7.47	19.2	Clear, colorless, odorless
					Sampled @ 11:20 AM

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 4/10/2017
Operator: A.Berge
Well number and location: 30S/11E-18K9 (LA32)
Site and wellhead conditions: sunny, warm, secure, gate open. Pump has been on 52 minutes.

Static water depth (feet): 149.3 on 4/13/17
Well depth (feet): --
Water column (feet): --
Casing diameter (inches): --
Minimum purge volume (gal) --
Purge rate (gpm): --
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): --
Time begin purge: 10:56 AM

Time	Gallons	EC (μS/cm)	pH	Temp. (°C)	Comments*
10:57	1	437.7	7.16	22.2	Clear, colorless, odorless
					Sampled @ 11:00 am

*Turbidity, color, odor, sheen, debris, etc.

April 18, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 13N (LA-8) LA-8
Project : Los Osos BMC Monitoring

Lab ID : CC 1781021-001
Customer ID : 8-514

Sampled On : April 11, 2017-09:40
Sampled By : Wolfgang Forbes / An
Received On : April 11, 2017-14:45
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	100	--	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Calcium	17	1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Magnesium	14	1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Potassium	1	1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Sodium	38	1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Total Cations	3.7	--	meq/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Boron	ND	0.1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Copper	40	10	ug/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Iron	ND	30	ug/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Manganese	ND	10	ug/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Zinc	20	20	ug/L		200.7	04/13/17:204285	200.7	04/13/17:205430
SAR	1.7	--	--		200.7	04/13/17:204285	200.7	04/13/17:205430
Total Alkalinity (as CaCO3)	40	10	mg/L		2320B	04/13/17:204281	2320B	04/13/17:205427
Hydroxide as OH	ND	10	mg/L		2320B	04/13/17:204281	2320B	04/13/17:205427
Carbonate as CO3	ND	10	mg/L		2320B	04/13/17:204281	2320B	04/13/17:205427
Bicarbonate as HCO3	50	10	mg/L		2320B	04/13/17:204281	2320B	04/13/17:205427
Sulfate	12.4	0.5	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Chloride	77	1	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Nitrate as NO3	32.4	0.5	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Nitrite as N	ND	0.2	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Nitrate + Nitrite as N	7.3	0.1	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Fluoride	ND	0.1	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Total Anions	3.8	--	meq/L		2320B	04/13/17:204281	2320B	04/13/17:205427
pH	7.4	--	units		4500-H B	04/12/17:204253	4500HB	04/12/17:205317
Specific Conductance	434	1	umhos/cm		2510B	04/14/17:204393	2510B	04/14/17:205475
Total Dissolved Solids	270	20	mg/L		2540CE	04/13/17:204297	2540C	04/14/17:205437
MBAS Screen	Negative	0.1	mg/L		5540C	04/12/17:204436	5540C	04/12/17:205513
Aggressiveness Index	10.6	--	--		4500-H B	04/12/17:204253	4500HB	04/12/17:205317
Langelier Index (20°C)	-1.2	--	--		4500-H B	04/12/17:204253	4500HB	04/12/17:205317
Nitrate Nitrogen	7.3	--	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 18, 2017

Lab ID : CC 1780991-003
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : Cabrillo LA-9
Project : Los Osos BMC Monitoring

Sampled On : April 10, 2017-11:25
Sampled By : Zac Reineke
Received On : April 10, 2017-14:49
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	111	--	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Calcium	18	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Magnesium	16	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Potassium	1	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Sodium	43	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Cations	4.1	--	meq/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Boron	ND	0.1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Copper	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Iron	ND	30	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Manganese	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Zinc	ND	20	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
SAR	1.8	--	--		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Alkalinity (as CaCO3)	50	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Hydroxide as OH	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Carbonate as CO3	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Bicarbonate as HCO3	70	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Sulfate	15.9	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Chloride	89	1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate as NO3	25.1	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrite as N	ND	0.2	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate + Nitrite as N	5.7	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Fluoride	ND	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Total Anions	4.4	--	meq/L		2320B	04/12/17:204223	2320B	04/12/17:205361
pH	7.0	--	units		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Specific Conductance	490	1	umhos/cm		2510B	04/12/17:204274	2510B	04/12/17:205339
Total Dissolved Solids	310	20	mg/L		2540CE	04/12/17:204259	2540C	04/13/17:205364
MBAS Screen	Negative	0.1	mg/L		5540C	04/11/17:204435	5540C	04/17/17:205511
Aggressiveness Index	10.4	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Langelier Index (20°C)	-1.5	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Nitrate Nitrogen	5.7	--	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 18, 2017

Lab ID : CC 1780991-003
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : April 10, 2017-11:25
Sampled By : Zac Reineke
Received On : April 10, 2017-14:49
Matrix : Ground Water

Description : Cabrillo LA-9
Project : Los Osos BMC Monitoring

Sample Result - Support

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
Field Test								
Temperature	65.6		°F			04/10/17 11:25	2550B	04/10/17 11:25

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 18, 2017

Lab ID : CC 1780991-004
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : April 10, 2017-12:00
Sampled By : Zac Reineke
Received On : April 10, 2017-14:49
Matrix : Ground Water

Description : Rosina LA-10
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	327	--	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Calcium	52	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Magnesium	48	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Potassium	2	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Sodium	35	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Cations	8.1	--	meq/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Boron	ND	0.1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Copper	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Iron	300	30	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Manganese	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Zinc	20	20	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
SAR	0.8	--	--		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Alkalinity (as CaCO3)	60	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Hydroxide as OH	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Carbonate as CO3	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Bicarbonate as HCO3	80	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Sulfate	14.7	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Chloride	231	5*	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate as NO3	11.7	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrite as N	ND	0.2	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate + Nitrite as N	2.6	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Fluoride	ND	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Total Anions	8.3	--	meq/L		2320B	04/12/17:204223	2320B	04/12/17:205361
pH	6.9	--	units		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Specific Conductance	957	1	umhos/cm		2510B	04/12/17:204274	2510B	04/12/17:205339
Total Dissolved Solids	720	20	mg/L		2540CE	04/12/17:204259	2540C	04/13/17:205364
MBAS Screen	Negative	0.1	mg/L		5540C	04/11/17:204435	5540C	04/17/17:205511
Aggressiveness Index	10.8	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Langelier Index (20°C)	-1.1	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Nitrate Nitrogen	2.6	--	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 18, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : Rosina LA-10
Project : Los Osos BMC Monitoring

Lab ID : CC 1780991-004
Customer ID : 8-514

Sampled On : April 10, 2017-12:00
Sampled By : Zac Reineke
Received On : April 10, 2017-14:49
Matrix : Ground Water

Sample Result - Support

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
Field Test								
Temperature	68.5		°F			04/10/17 12:00	2550B	04/10/17 12:00

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 18, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 12J1 (LA-11) LA-11
Project : Los Osos BMC Monitoring

Lab ID : CC 1781021-002
Customer ID : 8-514

Sampled On : April 11, 2017-12:08
Sampled By : Wolfgang Forbes / An
Received On : April 11, 2017-14:45
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	541	--	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Calcium	75	1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Magnesium	86	1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Potassium	4	1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Sodium	81	1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Total Cations	14.4	--	meq/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Boron	0.2	0.1	mg/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Copper	ND	10	ug/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Iron	70	30	ug/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Manganese	40	10	ug/L		200.7	04/13/17:204285	200.7	04/13/17:205430
Zinc	ND	20	ug/L		200.7	04/13/17:204285	200.7	04/13/17:205430
SAR	1.5	--	--		200.7	04/13/17:204285	200.7	04/13/17:205430
Total Alkalinity (as CaCO3)	280	10	mg/L		2320B	04/13/17:204281	2320B	04/13/17:205427
Hydroxide as OH	ND	10	mg/L		2320B	04/13/17:204281	2320B	04/13/17:205427
Carbonate as CO3	ND	10	mg/L		2320B	04/13/17:204281	2320B	04/13/17:205427
Bicarbonate as HCO3	350	10	mg/L		2320B	04/13/17:204281	2320B	04/13/17:205427
Sulfate	186	0.5	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Chloride	167	3*	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Nitrate as NO3	ND	0.5	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Nitrite as N	ND	0.2	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Nitrate + Nitrite as N	ND	0.1	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Fluoride	0.1	0.1	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598
Total Anions	14.3	--	meq/L		2320B	04/13/17:204281	2320B	04/13/17:205427
pH	7.5	--	units		4500-H B	04/12/17:204253	4500HB	04/12/17:205317
Specific Conductance	1380	1	umhos/cm		2510B	04/14/17:204393	2510B	04/14/17:205475
Total Dissolved Solids	880	20	mg/L		2540CE	04/13/17:204297	2540C	04/14/17:205437
MBAS Screen	Negative	0.1	mg/L		5540C	04/12/17:204436	5540C	04/12/17:205513
Aggressiveness Index	12.2	--	--		4500-H B	04/12/17:204253	4500HB	04/12/17:205317
Langelier Index (20°C)	0.3	--	--		4500-H B	04/12/17:204253	4500HB	04/12/17:205317
Nitrate Nitrogen	ND	--	mg/L		300.0	04/12/17:204398	300.0	04/12/17:205598

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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CA ELAP Certification No. 2810

April 18, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 7Q3 (LA12) LA-12
Project : Los Osos BMC Monitoring

Lab ID : CC 1780992-001
Customer ID : 8-514

Sampled On : April 10, 2017-10:38
Sampled By : Andrea Berge
Received On : April 10, 2017-14:48
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	294	--	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Calcium	47	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Magnesium	43	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Potassium	2	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Sodium	54	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Cations	8.3	--	meq/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Boron	0.2	0.1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Copper	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Iron	70	30	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Manganese	60	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Zinc	80	20	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
SAR	1.4	--	--		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Alkalinity (as CaCO3)	240	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Hydroxide as OH	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Carbonate as CO3	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Bicarbonate as HCO3	300	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Sulfate	49.5	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Chloride	91	1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate as NO3	ND	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrite as N	ND	0.2	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate + Nitrite as N	ND	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Fluoride	ND	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Total Anions	8.5	--	meq/L		2320B	04/12/17:204223	2320B	04/12/17:205361
pH	7.3	--	units		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Specific Conductance	839	1	umhos/cm		2510B	04/12/17:204274	2510B	04/12/17:205339
Total Dissolved Solids	480	20	mg/L		2540CE	04/12/17:204259	2540C	04/13/17:205364
MBAS Screen	Negative	0.1	mg/L		5540C	04/11/17:204435	5540C	04/17/17:205511
Aggressiveness Index	11.8	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Langelier Index (20°C)	-0.1	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Nitrate Nitrogen	ND	--	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 20, 2017

Lab ID : CC 1781078-001
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : April 12, 2017-14:38
Sampled By : Wolfgang Forbes
Received On : April 12, 2017-15:12
Matrix : Ground Water

Description : 18K8 (LA18) LA-18
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	274	--	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Calcium	57	1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Magnesium	32	1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Potassium	2	1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Sodium	27	1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Total Cations	6.7	--	meq/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Boron	ND	0.1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Copper	ND	10	ug/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Iron	50	30	ug/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Manganese	90	10	ug/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Zinc	ND	20	ug/L		200.7	04/17/17:204426	200.7	04/17/17:205605
SAR	0.7	--	--		200.7	04/17/17:204426	200.7	04/17/17:205605
Total Alkalinity (as CaCO3)	240	10	mg/L		2320B	04/14/17:204355	2320B	04/14/17:205584
Hydroxide as OH	ND	10	mg/L		2320B	04/14/17:204355	2320B	04/14/17:205584
Carbonate as CO3	ND	10	mg/L		2320B	04/14/17:204355	2320B	04/14/17:205584
Bicarbonate as HCO3	290	10	mg/L		2320B	04/14/17:204355	2320B	04/14/17:205584
Sulfate	38.0	0.5	mg/L		300.0	04/13/17:204399	300.0	04/13/17:205601
Chloride	31	1	mg/L		300.0	04/13/17:204399	300.0	04/13/17:205601
Nitrate as NO3	ND	0.5	mg/L		300.0	04/13/17:204399	300.0	04/13/17:205601
Nitrite as N	ND	0.2	mg/L		300.0	04/13/17:204399	300.0	04/13/17:205601
Nitrate + Nitrite as N	ND	0.1	mg/L		300.0	04/13/17:204399	300.0	04/13/17:205601
Fluoride	0.2	0.1	mg/L		300.0	04/13/17:204399	300.0	04/13/17:205601
Total Anions	6.4	--	meq/L		2320B	04/14/17:204355	2320B	04/14/17:205584
pH	7.5	--	units		4500-H B	04/13/17:204309	4500HB	04/13/17:205401
Specific Conductance	616	1	umhos/cm		2510B	04/14/17:204393	2510B	04/14/17:205475
Total Dissolved Solids	450	20	mg/L		2540CE	04/14/17:204385	2540C	04/17/17:205522
MBAS Screen	Negative	0.1	mg/L		5540C	04/13/17:204437	5540C	04/13/17:205514
Aggressiveness Index	12.0	--	--		4500-H B	04/13/17:204309	4500HB	04/13/17:205401
Langelier Index (20°C)	0.2	--	--		4500-H B	04/13/17:204309	4500HB	04/13/17:205401
Nitrate Nitrogen	ND	--	mg/L		300.0	04/13/17:204399	300.0	04/13/17:205601

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 18, 2017

Lab ID : CC 1780991-001
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : April 10, 2017-10:15
Sampled By : Zac Reineke
Received On : April 10, 2017-14:49
Matrix : Ground Water

Description : South Boy Well LA-20
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	227	--	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Calcium	35	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Magnesium	34	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Potassium	2	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Sodium	40	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Cations	6.3	--	meq/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Boron	0.1	0.1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Copper	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Iron	ND	30	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Manganese	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Zinc	ND	20	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
SAR	1.2	--	--		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Alkalinity (as CaCO3)	230	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Hydroxide as OH	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Carbonate as CO3	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Bicarbonate as HCO3	280	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Sulfate	26.7	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Chloride	39	1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate as NO3	2.7	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrite as N	ND	0.2	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate + Nitrite as N	0.6	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Fluoride	0.2	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Total Anions	6.3	--	meq/L		2320B	04/12/17:204223	2320B	04/12/17:205361
pH	7.2	--	units		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Specific Conductance	624	1	umhos/cm		2510B	04/12/17:204274	2510B	04/12/17:205339
Total Dissolved Solids	380	20	mg/L		2540CE	04/12/17:204259	2540C	04/13/17:205364
MBAS Screen	Negative	0.1	mg/L		5540C	04/11/17:204435	5540C	04/17/17:205511
Aggressiveness Index	11.5	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Langelier Index (20°C)	-0.3	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Nitrate Nitrogen	0.6	--	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 18, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : South Boy Well LA-20
Project : Los Osos BMC Monitoring

Lab ID : CC 1780991-001
Customer ID : 8-514

Sampled On : April 10, 2017-10:15
Sampled By : Zac Reineke
Received On : April 10, 2017-14:49
Matrix : Ground Water

Sample Result - Support

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
Field Test								
Temperature	68.7		°F			04/10/17 10:15	2550B	04/10/17 10:15

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 25, 2017

Lab ID : CC 1781093-001
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : (30SIIE)17E8-LA22 LA-22
Project : Los Osos BMC Monitoring

Sampled On : April 13, 2017-11:59
Sampled By : Wolfgang Forbes
Received On : April 13, 2017-14:24
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	164	--	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Calcium	26	1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Magnesium	24	1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Potassium	1	1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Sodium	29	1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Total Cations	4.6	--	meq/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Boron	ND	0.1	mg/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Copper	ND	10	ug/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Iron	ND	30	ug/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Manganese	ND	10	ug/L		200.7	04/17/17:204426	200.7	04/17/17:205605
Zinc	ND	20	ug/L		200.7	04/17/17:204426	200.7	04/17/17:205605
SAR	1.0	--	--		200.7	04/17/17:204426	200.7	04/17/17:205605
Total Alkalinity (as CaCO3)	120	10	mg/L		2320B	04/18/17:204480	2320B	04/18/17:205660
Hydroxide as OH	ND	10	mg/L		2320B	04/18/17:204480	2320B	04/18/17:205660
Carbonate as CO3	ND	10	mg/L		2320B	04/18/17:204480	2320B	04/18/17:205660
Bicarbonate as HCO3	150	10	mg/L		2320B	04/18/17:204480	2320B	04/18/17:205660
Sulfate	13.2	0.5	mg/L		300.0	04/14/17:204400	300.0	04/14/17:205610
Chloride	46	1	mg/L		300.0	04/14/17:204400	300.0	04/14/17:205610
Nitrate as NO3	29.7	0.5	mg/L		300.0	04/14/17:204400	300.0	04/14/17:205610
Nitrite as N	ND	0.2	mg/L		300.0	04/14/17:204400	300.0	04/14/17:205610
Nitrate + Nitrite as N	6.7	0.1	mg/L		300.0	04/14/17:204400	300.0	04/14/17:205610
Fluoride	ND	0.1	mg/L		300.0	04/14/17:204400	300.0	04/14/17:205610
Total Anions	4.5	--	meq/L		2320B	04/18/17:204480	2320B	04/18/17:205660
pH	7.3	--	units		4500-H B	04/19/17:204556	4500HB	04/19/17:205686
Specific Conductance	466	1	umhos/cm		2510B	04/18/17:204523	2510B	04/18/17:205642
Total Dissolved Solids	300	20	mg/L		2540CE	04/18/17:204489	2540C	04/19/17:205677
MBAS Screen	Negative	0.1	mg/L		5540C	04/14/17:204695	5540C	04/14/17:205850
Aggressiveness Index	11.2	--	--		4500-H B	04/19/17:204556	4500HB	04/19/17:205686
Langelier Index (20°C)	-0.6	--	--		4500-H B	04/19/17:204556	4500HB	04/19/17:205686
Nitrate Nitrogen	6.7	--	mg/L		300.0	04/14/17:204400	300.0	04/14/17:205610

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 25, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 30S10G-13M2 LA-31
Project : Los Osos BMC Monitoring

Lab ID : CC 1781113-001
Customer ID : 8-514

Sampled On : April 17, 2017-11:20
Sampled By : Andrea Berge
Received On : April 17, 2017-14:23
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	733	--	mg/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Calcium	114	1	mg/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Magnesium	109	1	mg/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Potassium	4	1	mg/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Sodium	413	2*	mg/L		200.7	04/19/17:204569	200.7	04/20/17:205807
Total Cations	32.7	--	meq/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Boron	0.2	0.1	mg/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Copper	ND	10	ug/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Iron	70	30	ug/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Manganese	ND	10	ug/L		200.7	04/19/17:204569	200.7	04/19/17:205741
Zinc	ND	20	ug/L		200.7	04/19/17:204569	200.7	04/19/17:205741
SAR	6.6	--	--		200.7	04/19/17:204569	200.7	04/19/17:205741
Total Alkalinity (as CaCO3)	50	10	mg/L		2320B	04/19/17:204542	2320B	04/19/17:205679
Hydroxide as OH	ND	10	mg/L		2320B	04/19/17:204542	2320B	04/19/17:205679
Carbonate as CO3	ND	10	mg/L		2320B	04/19/17:204542	2320B	04/19/17:205679
Bicarbonate as HCO3	60	10	mg/L		2320B	04/19/17:204542	2320B	04/19/17:205679
Sulfate	178	0.5	mg/L		300.0	04/18/17:204762	300.0	04/18/17:205627
Chloride	907	18*	mg/L		300.0	04/18/17:204762	300.0	04/19/17:205627
Nitrate as NO3	2.6	0.5	mg/L		300.0	04/18/17:204762	300.0	04/18/17:205627
Nitrite as N	ND	0.2	mg/L		300.0	04/18/17:204762	300.0	04/18/17:205627
Nitrate + Nitrite as N	0.6	0.1	mg/L		300.0	04/18/17:204762	300.0	04/18/17:205627
Fluoride	ND	0.1	mg/L		300.0	04/18/17:204762	300.0	04/18/17:205627
Total Anions	30.3	--	meq/L		2320B	04/19/17:204542	2320B	04/19/17:205679
pH	6.8	--	units		4500-H B	04/19/17:204556	4500HB	04/19/17:205686
Specific Conductance	3380	1	umhos/cm		2510B	04/19/17:204553	2510B	04/19/17:205682
Total Dissolved Solids	2060	20	mg/L		2540CE	04/19/17:204563	2540C	04/20/17:205747
MBAS Extraction	ND	0.1	mg/L		5540C	04/19/17:204612	5540C	04/19/17:205751
Aggressiveness Index	11.0	--	--		4500-H B	04/19/17:204556	4500HB	04/19/17:205686
Langelier Index (20°C)	-1.0	--	--		4500-H B	04/19/17:204556	4500HB	04/19/17:205686
Nitrate Nitrogen	0.6	--	mg/L		300.0	04/18/17:204762	300.0	04/18/17:205627

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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April 18, 2017

Lab ID : CC 1780992-002
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : April 10, 2017-11:00
Sampled By : Andrea Berge
Received On : April 10, 2017-14:48
Matrix : Ground Water

Description : 18K9 (LA32) LA-32
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	155	--	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Calcium	24	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Magnesium	23	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Potassium	1	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Sodium	31	1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Cations	4.5	--	meq/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Boron	ND	0.1	mg/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Copper	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Iron	ND	30	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Manganese	ND	10	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
Zinc	ND	20	ug/L		200.7	04/11/17:204198	200.7	04/11/17:205280
SAR	1.1	--	--		200.7	04/11/17:204198	200.7	04/11/17:205280
Total Alkalinity (as CaCO3)	150	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Hydroxide as OH	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Carbonate as CO3	ND	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Bicarbonate as HCO3	190	10	mg/L		2320B	04/12/17:204223	2320B	04/12/17:205361
Sulfate	19.1	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Chloride	35	1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate as NO3	8.4	0.5	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrite as N	ND	0.2	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Nitrate + Nitrite as N	1.9	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Fluoride	0.1	0.1	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413
Total Anions	4.6	--	meq/L		2320B	04/12/17:204223	2320B	04/12/17:205361
pH	7.3	--	units		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Specific Conductance	461	1	umhos/cm		2510B	04/12/17:204274	2510B	04/12/17:205339
Total Dissolved Solids	270	20	mg/L		2540CE	04/12/17:204259	2540C	04/13/17:205364
MBAS Screen	Negative	0.1	mg/L		5540C	04/11/17:204435	5540C	04/17/17:205511
Aggressiveness Index	11.3	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Langelier Index (20°C)	-0.6	--	--		4500-H B	04/11/17:204216	4500HB	04/11/17:205260
Nitrate Nitrogen	1.9	--	mg/L		300.0	04/11/17:204397	300.0	04/11/17:205413

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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Fall 2017 Field Logs and Analytical Results

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/3/2017
Operator: A.Berge, S.J. Harris
Well number and location: 30S/11E-20A2 (FW26)
Site and wellhead conditions: Cloudy, sunny, windy. Covering in place.

Static water depth (feet): 19.27
Well depth (feet): 65
Water column (feet): 45.73
Casing diameter (inches): 6
Minimum purge volume (gal) --
Purge rate (gpm): --
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): --
Time begin purge: 12:24 PM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
12:25	1	663.5	7.17	14.3	Cloudy, odorless.
12:28	20	651.8	6.93	13.7	Initially cloudy, odorless
					Sampled @ 12:29 pm

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/3/2017
Operator: A.Berge, S.J. Harris
Well number and location: 30S/11E-20M2 (FW28)
Site and wellhead conditions: Cloudy, windy, warm. Well secure. Active well.

Static water depth (feet): 27.77
Well depth (feet): 102
Water column (feet): 74.23
Casing diameter (inches): --
Minimum purge volume (gal) flush line
Purge rate (gpm): --
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): flush line
Time begin purge: 13:20

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
13:21	2	788	7.62	21.6	Slightly brown, odorless.
13:22	5	798	7.70	19.6	Clear, colorless, odorless.
					Sampled @ 13:23 pm

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/12/2017
Operator: A.Berge
Well number and location: 30S/11E-17E10 (UA13)
Site and wellhead conditions: Sunny, clear, gate pre-opened.

Static water depth (feet): (pumping)
Well depth (feet): 220
Water column (feet): --
Casing diameter (inches): --
Minimum purge volume (gal) flush line
Purge rate (gpm): --
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): flush line
Time begin purge: 9:24 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
9:24	1	509	7.78	19	Clear, colorless, odorless
9:26	5	516.8	6.88	18.8	Clear, colorless, odorless
					Sampled @ 9:27 AM

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/2/2017
Operator: A.Berge
Well number and location: 30S/11E-13N (LA8)
Site and wellhead conditions: Sunny warm, cleared waterline for 3 minutes at 200 gpm

Static water depth (feet):	135
Well depth (feet):	350
Water column (feet):	215
Casing diameter (inches):	8
Minimum purge volume (gal)	flush line
Purge rate (gpm):	--
Pumping water level (feet):	--
Pump setting (feet):	--
Minimum purge time (min):	flush line
Time begin purge:	10:05 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
10:08	600	436	7.94	18.5	Clear, colorless, odorless
					Sampled @ 10:09 am

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/4/2017
Operator: A.Berge
Well number and location: 30S/11E-12J1 (LA11)
Site and wellhead conditions: Sunny, warm. Cap on and secure, ice plant clear of cap.

Static water depth (feet): 6.99
Well depth (feet): 389
Water column (feet): 382.01
Casing diameter (inches): 2
Minimum purge volume (gal) 188.00
Purge rate (gpm): 1.60
Pumping water level (feet): 12.42
Pump setting (feet): 25
Minimum purge time (min): 120
Time begin purge: 9:46 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
9:47	1	1125	8.17	18.8	Clear, colorless, odorless
9:49	5	1121	7.96	18.4	Some plant fragments
9:51	10	1122	7.75	18.4	Clear, colorless, odorless
9:59	20	1120	7.65	19	Clear, colorless, odorless
10:14	45	1123	7.67	20.3	Slightly cloudy, odorless
10:33	75	1308	7.83	19.7	Clear, colorless, odorless
10:48	100	1288	8.05	20.3	Clear, colorless, odorless
10:59	120	1269	8.27	20.4	Clear, colorless, odorless
11:14	145	1252	7.89	20.9	Clear, colorless, odorless
11:29	170	1251	7.99	20.8	Clear, colorless, odorless
11:41	190	1225	7.59	20.9	Clear, colorless, odorless
					Sampled @11:42 am

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/4/2017
Operator: A.Berge
Well number and location: 30S/11E-7Q3 (LA12)
Site and wellhead conditions: Secure, pumping. Sampled from spigot.

Static water depth (feet):	(pumping)
Well depth (feet):	270
Water column (feet):	--
Casing diameter (inches):	10
Minimum purge volume (gal)	flush line
Purge rate (gpm):	--
Pumping water level (feet):	--
Pump setting (feet):	--
Minimum purge time (min):	flush line
Time begin purge:	12:39 PM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
12:40	5	807.8	7.76	21.5	Clear, colorless, odorless
					Sampled @ 12:41 pm

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/5/2017
Operator: A.Berge
Well number and location: 30S/11E-18L2 (LA15)
Site and wellhead conditions: Secure and pumping since 10:00 am

Static water depth (feet):	(pumping)
Well depth (feet):	394
Water column (feet):	--
Casing diameter (inches):	12
Minimum purge volume (gal)	flush line
Purge rate (gpm):	--
Pumping water level (feet):	--
Pump setting (feet):	--
Minimum purge time (min):	flush line
Time begin purge:	11:03 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
11:05	3	744.3	7.75	21.2	Clear, colorless, odorless
					Sampled @ 11:06 am

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/9/2017
Operator: A.Berge, W. Forbes
Well number and location: 30S/11E-18K8 (LA18)
Site and wellhead conditions: Sunny, warm. Gate opened

Static water depth (feet):	141.75
Well depth (feet):	630
Water column (feet):	488.25
Casing diameter (inches):	2
Minimum purge volume (gal)	239
Purge rate (gpm):	0.5
Pumping water level (feet):	144.87
Pump setting (feet):	160
Minimum purge time (min):	480
Time begin purge:	9:32 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
9:33	1	523.5	6.84	20.5	Some debris, clear, odorless
9:40	5	608.3	7.46	20.9	Clear, colorless, odorless
9:50	10	611.1	7.65	21.3	Clear, colorless, odorless
10:11	20	616.6	7.66	21.5	Clear, colorless, odorless
10:54	30	595.8	7.61	22.9	Pump reset to 145', delay
11:36	50	615.3	7.57	21.6	Clear, colorless, odorless
12:13	80	614.8	7.78	21.7	Clear, colorless, odorless
14:34	120	610	7.71	21.6	Clear, colorless, odorless
17:03	170	610.5	7.80	21.5	Clear, colorless, odorless
19:10	220	606	7.68	20.8	Clear, colorless, odorless
19:28	240	611	7.69	21.1	Clear, colorless, odorless
					Sampled at 19:30

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/11/2017
Operator: A.Berge, W. Forbes
Well number and location: 30S/11E-17E8 (LA22)
Site and wellhead conditions: Sunny, warm cap secure.

Static water depth (feet):	128.17
Well depth (feet):	380
Water column (feet):	251.83
Casing diameter (inches):	2
Minimum purge volume (gal)	123.00
Purge rate (gpm):	0.9
Pumping water level (feet):	129.40
Pump setting (feet):	135
Minimum purge time (min):	120
Time begin purge:	9:25 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
9:26	1	474.1	8.89	19.3	Clear, colorless, odorless
9:31	5	601.2	8.82	19.6	Clear, colorless, odorless
11:11	10	552.3	8.63	20.1	Pump down-replaced resumed @ 11:04
11:17	15	500.3	8.03	19.9	Clear, colorless, odorless
11:32	25	484.0	7.98	19.6	Clear, colorless, odorless
11:45	35	478.9	7.53	20.1	Clear, colorless, odorless
11:59	45	477.4	7.59	20.3	Clear, colorless, odorless
12:15	55	477.1	7.54	20.3	Clear, colorless, odorless
12:42	75	475.6	7.59	20.1	Clear, colorless, odorless
13:14	95	476.2	7.77	20.3	Clear, colorless, odorless
13:43	115	479.7	7.49	21	Clear, colorless, odorless
14:01	125	480.1	7.50	21.3	Clear, colorless, odorless
					Sampled @ 14:02

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/3/2017
Operator: A.Berge, S.J. Harris
Well number and location: 30S/11E-20H1 (LA30)
Site and wellhead conditions: Slightly overcast, windy. Active well.

Static water depth (feet): 19.72
Well depth (feet): 140
Water column (feet): 120.28
Casing diameter (inches): 6
Minimum purge volume (gal) flush line
Purge rate (gpm): --
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): flush line
Time begin purge: 14:39

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
14:40	3	832	7.78	18.9	Slight odor, slightly cloudy
14:42	5	808	7.69	18.3	Slightly cloudy, bubbles
					Sampled @ 14:43 pm

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/5/2017
Operator: A.Berge
Well number and location: 30S/11E-13M2 (LA 31)
Site and wellhead conditions: Sunny, breezy. Plug in place

Static water depth (feet): 38.23
Well depth (feet): 292
Water column (feet): 253.77
Casing diameter (inches): 6
Minimum purge volume (gal) flush line
Purge rate (gpm): --
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): flush line
Time begin purge: 12:07 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
12:08	1	3.33	7.68	20.9	Clear, colorless, odorless
12:10	5	3.33	7.66	19.3	Clear, colorless, odorless
					Sampled @ 12:11 pm

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/9/2017

Operator: W. Forbes

Well number and location: 30S/11E-18K9 (LA32)

Site and wellhead conditions: Sunny, warm, secure and locked.

Static water depth (feet): (pumping)

Well depth (feet): 490

Water column (feet): --

Casing diameter (inches): 14

Minimum purge volume (gal) flush line

Purge rate (gpm): --

Pumping water level (feet): --

Pump setting (feet): --

Minimum purge time (min): flush line

Time begin purge: 11:15 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
11:14	2	493.2	7.51	21.1	Clear, colorless, odorless
					Sampled @ 11:20 am

*Turbidity, color, odor, sheen, debris, etc.

October 23, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 20A2 (FW26)
Project : Los Osos BMC Monitoring

Lab ID : CC 1783799-001
Customer ID : 8-514

Sampled On : October 3, 2017-12:29
Sampled By : Spencer Harris / And
Received On : October 3, 2017-15:11
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	231	--	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Calcium	35	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Magnesium	35	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Potassium	ND	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Sodium	35	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Total Cations	6.1	--	meq/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Boron	ND	0.1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Copper	ND	10	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Iron	500	30	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Manganese	ND	10	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Zinc	60	20	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
SAR	1.0	--	--		200.7	10/04/17:211939	200.7	10/04/17:214974
Total Alkalinity (as CaCO3)	170	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Hydroxide as OH	ND	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Carbonate as CO3	ND	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Bicarbonate as HCO3	210	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Sulfate	41.2	0.5	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Chloride	82	1	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrate as NO3	ND	1.8	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrite as N	ND	0.2	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrate + Nitrite as N	ND	0.5	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Fluoride	ND	0.1	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Total Anions	6.6	--	meq/L		2320B	10/05/17:211964	2320B	10/05/17:214994
pH	6.7	--	units		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Specific Conductance	673	1	umhos/cm		2510B	10/05/17:211979	2510B	10/05/17:214992
Total Dissolved Solids	370	20	mg/L		2540CE	10/05/17:211995	2540C	10/06/17:215055
MBAS Screen	Negative	0.1	mg/L		5540C	10/04/17:211935	5540C	10/04/17:214939
Aggressiveness Index	10.9	--	--		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Langelier Index (20°C)	-1.0	--	--		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Nitrate Nitrogen	ND	--	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 23, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 20M2 (FW28)
Project : Los Osos BMC Monitoring

Lab ID : CC 1783799-002
Customer ID : 8-514

Sampled On : October 3, 2017-11:23
Sampled By : Spencer Harris / And
Received On : October 3, 2017-15:11
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	355	--	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Calcium	63	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Magnesium	48	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Potassium	ND	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Sodium	30	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Total Cations	8.4	--	meq/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Boron	0.1	0.1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Copper	ND	10	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Iron	ND	30	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Manganese	ND	10	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Zinc	20	20	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
SAR	0.7	--	--		200.7	10/04/17:211939	200.7	10/04/17:214974
Total Alkalinity (as CaCO3)	200	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Hydroxide as OH	ND	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Carbonate as CO3	ND	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Bicarbonate as HCO3	240	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Sulfate	89.9	0.5	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Chloride	47	1	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrate as NO3	ND	1.8	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrite as N	ND	0.2	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrate + Nitrite as N	ND	0.5	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Fluoride	0.2	0.1	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Total Anions	7.1	--	meq/L		2320B	10/05/17:211964	2320B	10/05/17:214994
pH	7.4	--	units		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Specific Conductance	836	1	umhos/cm		2510B	10/05/17:211979	2510B	10/05/17:214992
Total Dissolved Solids	490	20	mg/L		2540CE	10/05/17:211995	2540C	10/06/17:215055
MBAS Screen	Negative	0.1	mg/L		5540C	10/04/17:211935	5540C	10/04/17:214939
Aggressiveness Index	11.9	--	--		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Langelier Index (20°C)	0.03	--	--		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Nitrate Nitrogen	ND	--	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : Skyline Well 13F4 UA 3
Project : Los Osos BMC Monitoring

Lab ID : CC 1783961-005
Customer ID : 8-514

Sampled On : October 12, 2017-12:40
Sampled By : Zac Remeke
Received On : October 12, 2017-14:10
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	143	--	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Calcium	26	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Magnesium	19	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Potassium	2	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Sodium	64	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Cations	5.7	--	meq/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Boron	ND	0.1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Copper	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Iron	70	30	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Manganese	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Zinc	ND	20	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
SAR	2.3	--	--		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Alkalinity (as CaCO3)	80	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Hydroxide as OH	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Carbonate as CO3	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Bicarbonate as HCO3	100	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Sulfate	29.5	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Chloride	73	1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate as NO3	85.2	1.8	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrite as N	ND	0.2	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate + Nitrite as N	19.2	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Fluoride	ND	0.1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Total Anions	5.7	--	meq/L		2320B	10/16/17:212474	2320B	10/16/17:215667
pH	7.0	--	units		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Specific Conductance	607	1	umhos/cm		2510B	10/16/17:212403	2510B	10/16/17:215558
Total Dissolved Solids	390	20	mg/L		2540CE	10/17/17:212488	2540C	10/18/17:215749
MBAS Screen	Negative	0.1	mg/L		5540C	10/13/17:212622	5540C	10/13/17:215838
Aggressiveness Index	10.7	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Langelier Index (20°C)	-1.1	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Nitrate Nitrogen	19.2	--	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Lab ID : CC 1783961-003
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : October 12, 2017-10:25
Sampled By : Zac Remeke
Received On : October 12, 2017-14:10
Matrix : Ground Water

Description : Los Olivos #3 18K3 UA 9
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	82.7	--	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Calcium	15	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Magnesium	11	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Potassium	ND	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Sodium	27	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Cations	2.8	--	meq/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Boron	ND	0.1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Copper	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Iron	ND	30	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Manganese	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Zinc	ND	20	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
SAR	1.3	--	--		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Alkalinity (as CaCO3)	50	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Hydroxide as OH	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Carbonate as CO3	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Bicarbonate as HCO3	60	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Sulfate	7.6	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Chloride	42	1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate as NO3	41.1	1.8	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrite as N	ND	0.2	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate + Nitrite as N	9.3	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Fluoride	ND	0.1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Total Anions	3.0	--	meq/L		2320B	10/16/17:212474	2320B	10/16/17:215667
pH	7.1	--	units		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Specific Conductance	319	1	umhos/cm		2510B	10/16/17:212403	2510B	10/16/17:215558
Total Dissolved Solids	220	20	mg/L		2540CE	10/17/17:212488	2540C	10/18/17:215749
MBAS Screen	Negative	0.1	mg/L		5540C	10/13/17:212622	5540C	10/13/17:215838
Aggressiveness Index	10.4	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Langelier Index (20°C)	-1.5	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Nitrate Nitrogen	9.3	--	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 23, 2017

Lab ID : CC 1783960-001
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : October 12, 2017-09:27
Sampled By : Andrea Berge
Received On : October 12, 2017-14:04
Matrix : Ground Water

Description : 17E10 (VA-13)
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	155	--	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Calcium	24	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Magnesium	23	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Potassium	1	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Sodium	40	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Cations	4.9	--	meq/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Boron	ND	0.1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Copper	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Iron	ND	30	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Manganese	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Zinc	ND	20	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
SAR	1.4	--	--		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Alkalinity (as CaCO3)	90	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Hydroxide as OH	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Carbonate as CO3	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Bicarbonate as HCO3	110	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Sulfate	23.3	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Chloride	58	1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate as NO3	61.8	1.8	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrite as N	ND	0.2	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate + Nitrite as N	14.0	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Fluoride	ND	0.1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Total Anions	4.9	--	meq/L		2320B	10/16/17:212474	2320B	10/16/17:215667
pH	6.8	--	units		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Specific Conductance	506	1	umhos/cm		2510B	10/16/17:212403	2510B	10/16/17:215558
Total Dissolved Solids	310	20	mg/L		2540CE	10/17/17:212488	2540C	10/18/17:215749
MBAS Screen	Negative	0.1	mg/L		5540C	10/13/17:212622	5540C	10/13/17:215838
Aggressiveness Index	10.5	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Langelier Index (20°C)	-1.3	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Nitrate Nitrogen	14.0	--	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 17, 2017

Lab ID : CC 1783747-001
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : October 2, 2017-10:09
Sampled By : Andrea Berge
Received On : October 2, 2017-11:49
Matrix : Ground Water

Description : 13N (LA8)
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	95.0	--	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Calcium	15	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Magnesium	14	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Potassium	1	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Sodium	36	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Total Cations	3.5	--	meq/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Boron	ND	0.1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Copper	70	10	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Iron	ND	30	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Manganese	ND	10	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Zinc	30	20	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
SAR	1.6	--	--		200.7	10/04/17:211939	200.7	10/04/17:214974
Total Alkalinity (as CaCO3)	30	10	mg/L		2320B	10/04/17:211890	2320B	10/04/17:214976
Hydroxide as OH	ND	10	mg/L		2320B	10/04/17:211890	2320B	10/04/17:214976
Carbonate as CO3	ND	10	mg/L		2320B	10/04/17:211890	2320B	10/04/17:214976
Bicarbonate as HCO3	30	10	mg/L		2320B	10/04/17:211890	2320B	10/04/17:214976
Sulfate	13.2	0.5	mg/L		300.0	10/03/17:211960	300.0	10/03/17:214963
Chloride	78	1	mg/L		300.0	10/03/17:211960	300.0	10/03/17:214963
Nitrate as NO3	33.5	1.8	mg/L		300.0	10/03/17:211960	300.0	10/03/17:214963
Nitrite as N	ND	0.2	mg/L		300.0	10/03/17:211960	300.0	10/03/17:214963
Nitrate + Nitrite as N	7.6	0.5	mg/L		300.0	10/03/17:211960	300.0	10/03/17:214963
Fluoride	ND	0.1	mg/L		300.0	10/03/17:211960	300.0	10/03/17:214963
Total Anions	3.5	--	meq/L		2320B	10/04/17:211890	2320B	10/04/17:214976
pH	7.2	--	units		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Specific Conductance	438	1	umhos/cm		2510B	10/04/17:211920	2510B	10/04/17:214919
Total Dissolved Solids	290	20	mg/L		2540CE	10/03/17:211856	2540C	10/04/17:214920
MBAS Screen	Negative	0.1	mg/L		5540C	10/03/17:211868	5540C	10/03/17:214875
Aggressiveness Index	10.3	--	--		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Langelier Index (20°C)	-1.6	--	--		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Nitrate Nitrogen	7.6	--	mg/L		300.0	10/03/17:211960	300.0	10/03/17:214963

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : Cabrillo Well 24C1 LA 9
Project : Los Osos BMC Monitoring

Lab ID : CC 1783961-002
Customer ID : 8-514

Sampled On : October 12, 2017-11:20
Sampled By : Zac Remeke
Received On : October 12, 2017-14:10
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	117	--	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Calcium	19	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Magnesium	17	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Potassium	2	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Sodium	46	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Cations	4.4	--	meq/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Boron	ND	0.1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Copper	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Iron	ND	30	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Manganese	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Zinc	ND	20	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
SAR	1.8	--	--		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Alkalinity (as CaCO3)	60	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Hydroxide as OH	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Carbonate as CO3	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Bicarbonate as HCO3	70	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Sulfate	16.3	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Chloride	89	1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate as NO3	26.7	1.8	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrite as N	ND	0.2	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate + Nitrite as N	6.0	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Fluoride	ND	0.1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Total Anions	4.4	--	meq/L		2320B	10/16/17:212474	2320B	10/16/17:215667
pH	7.0	--	units		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Specific Conductance	484	1	umhos/cm		2510B	10/16/17:212403	2510B	10/16/17:215558
Total Dissolved Solids	270	20	mg/L		2540CE	10/17/17:212488	2540C	10/18/17:215749
MBAS Screen	Negative	0.1	mg/L		5540C	10/13/17:212622	5540C	10/13/17:215838
Aggressiveness Index	10.5	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Langelier Index (20°C)	-1.4	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Nitrate Nitrogen	6.0	--	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Lab ID : CC 1783961-004
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : October 12, 2017-12:01
Sampled By : Zac Remeke
Received On : October 12, 2017-14:10
Matrix : Ground Water

Description : Rosina Well 13J1 LA 10
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	245	--	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Calcium	39	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Magnesium	36	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Potassium	2	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Sodium	33	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Cations	6.4	--	meq/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Boron	ND	0.1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Copper	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Iron	430	30	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Manganese	10	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Zinc	20	20	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
SAR	0.9	--	--		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Alkalinity (as CaCO3)	60	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Hydroxide as OH	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Carbonate as CO3	ND	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Bicarbonate as HCO3	80	10	mg/L		2320B	10/16/17:212474	2320B	10/16/17:215667
Sulfate	12.5	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Chloride	164	3*	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate as NO3	15.0	1.8	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrite as N	ND	0.2	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate + Nitrite as N	3.4	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Fluoride	ND	0.1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Total Anions	6.4	--	meq/L		2320B	10/16/17:212474	2320B	10/16/17:215667
pH	6.9	--	units		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Specific Conductance	702	1	umhos/cm		2510B	10/16/17:212403	2510B	10/16/17:215558
Total Dissolved Solids	510	20	mg/L		2540CE	10/17/17:212488	2540C	10/18/17:215749
MBAS Screen	Negative	0.1	mg/L		5540C	10/13/17:212622	5540C	10/13/17:215838
Aggressiveness Index	10.7	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Langelier Index (20°C)	-1.2	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Nitrate Nitrogen	3.4	--	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 12J1 (La11)
Project : Los Osos BMC Monitoring

Lab ID : CC 1783810-001
Customer ID : 8-514

Sampled On : October 4, 2017-11:42
Sampled By : Andrea Berge
Received On : October 4, 2017-14:37
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	543	--	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Calcium	76	1	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Magnesium	86	1	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Potassium	5	1	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Sodium	90	1	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Total Cations	14.9	--	meq/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Boron	0.3	0.1	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Copper	ND	10	ug/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Iron	110	30	ug/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Manganese	40	10	ug/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Zinc	ND	20	ug/L		200.7	10/06/17:212031	200.7	10/06/17:215156
SAR	1.7	--	--		200.7	10/06/17:212031	200.7	10/06/17:215156
Total Alkalinity (as CaCO3)	250	10	mg/L		2320B	10/06/17:212025	2320B	10/06/17:215111
Hydroxide as OH	ND	10	mg/L		2320B	10/06/17:212025	2320B	10/06/17:215111
Carbonate as CO3	ND	10	mg/L		2320B	10/06/17:212025	2320B	10/06/17:215111
Bicarbonate as HCO3	300	10	mg/L		2320B	10/06/17:212025	2320B	10/06/17:215111
Sulfate	191	0.5	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Chloride	162	3*	mg/L		300.0	10/05/17:212138	300.0	10/06/17:215544
Nitrate as NO3	ND	1.8	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Nitrite as N	ND	0.2	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Nitrate + Nitrite as N	ND	0.5	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Fluoride	0.1	0.1	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Total Anions	13.5	--	meq/L		2320B	10/06/17:212025	2320B	10/06/17:215111
pH	7.0	--	units		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Specific Conductance	1370	1	umhos/cm		2510B	10/06/17:212027	2510B	10/06/17:215058
Total Dissolved Solids	850	20	mg/L		2540CE	10/06/17:212050	2540C	10/09/17:215157
MBAS Screen	Negative	0.1	mg/L		5540C	10/05/17:212118	5540C	10/05/17:215166
Aggressiveness Index	11.7	--	--		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Langelier Index (20°C)	-0.2	--	--		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Nitrate Nitrogen	ND	--	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Lab ID : CC 1783810-002
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : October 4, 2017-12:41
Sampled By : Andrea Berge
Received On : October 4, 2017-14:37
Matrix : Ground Water

Description : 7Q3 (LA12)
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	305	--	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Calcium	48	1	mg/L		200.7	10/27/17:212976	200.7	10/27/17:216353
Magnesium	45	1	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Potassium	2	1	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Sodium	56	1	mg/L		200.7	10/27/17:212976	200.7	10/27/17:216353
Total Cations	8.6	--	meq/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Boron	0.2	0.1	mg/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Copper	ND	10	ug/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Iron	70	30	ug/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Manganese	60	10	ug/L		200.7	10/06/17:212031	200.7	10/06/17:215156
Zinc	ND	20	ug/L		200.7	10/06/17:212031	200.7	10/06/17:215156
SAR	1.4	--	--		200.7	10/06/17:212031	200.7	10/06/17:215156
Total Alkalinity (as CaCO3)	180	10	mg/L		2320B	10/06/17:212025	2320B	10/06/17:215111
Hydroxide as OH	ND	10	mg/L		2320B	10/06/17:212025	2320B	10/06/17:215111
Carbonate as CO3	ND	10	mg/L		2320B	10/06/17:212025	2320B	10/06/17:215111
Bicarbonate as HCO3	220	10	mg/L		2320B	10/06/17:212025	2320B	10/06/17:215111
Sulfate	45	1*	mg/L		300.0	10/27/17:213023	300.0	10/27/17:216413
Chloride	92	2*	mg/L		300.0	10/27/17:213023	300.0	10/27/17:216413
Nitrate as NO3	ND	1.8	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Nitrite as N	ND	0.2	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Nitrate + Nitrite as N	ND	0.5	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Fluoride	ND	0.1	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544
Total Anions	7.1	--	meq/L		2320B	10/06/17:212025	2320B	10/06/17:215111
pH	6.5	--	units		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Specific Conductance	826	1	umhos/cm		2510B	10/06/17:212027	2510B	10/06/17:215058
Total Dissolved Solids	470	20	mg/L		2540CE	10/06/17:212050	2540C	10/09/17:215157
MBAS Screen	Negative	0.1	mg/L		5540C	10/05/17:212118	5540C	10/05/17:215166
Aggressiveness Index	10.8	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Langelier Index (20°C)	-1.0	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Nitrate Nitrogen	ND	--	mg/L		300.0	10/05/17:212138	300.0	10/05/17:215544

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 18L2 (LA15)
Project : Los Osos BMC Monitoring

Lab ID : CC 1783861-001
Customer ID : 8-514

Sampled On : October 5, 2017-11:06
Sampled By : Andrea Berge
Received On : October 5, 2017-14:38
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	306	--	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Calcium	50	1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Magnesium	44	1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Potassium	2	1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Sodium	40	1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Total Cations	7.9	--	meq/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Boron	ND	0.1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Copper	ND	10	ug/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Iron	ND	30	ug/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Manganese	ND	10	ug/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Zinc	ND	20	ug/L		200.7	10/10/17:212148	200.7	10/10/17:215321
SAR	1.0	--	--		200.7	10/10/17:212148	200.7	10/10/17:215321
Total Alkalinity (as CaCO3)	150	10	mg/L		2320B	10/07/17:212076	2320B	10/07/17:215142
Hydroxide as OH	ND	10	mg/L		2320B	10/07/17:212076	2320B	10/07/17:215142
Carbonate as CO3	ND	10	mg/L		2320B	10/07/17:212076	2320B	10/07/17:215142
Bicarbonate as HCO3	180	10	mg/L		2320B	10/07/17:212076	2320B	10/07/17:215142
Sulfate	27	1*	mg/L		300.0	10/27/17:213023	300.0	10/27/17:216413
Chloride	102	2*	mg/L		300.0	10/27/17:213023	300.0	10/27/17:216413
Nitrate as NO3	3.3	1.8	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545
Nitrite as N	ND	0.2	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545
Nitrate + Nitrite as N	0.7	0.5	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545
Fluoride	ND	0.1	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545
Total Anions	6.4	--	meq/L		2320B	10/07/17:212076	2320B	10/07/17:215142
pH	7.6	--	units		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Specific Conductance	768	1	umhos/cm		2510B	10/09/17:212100	2510B	10/09/17:215144
Total Dissolved Solids	400	20	mg/L		2540CE	10/10/17:212174	2540C	10/11/17:215338
MBAS Screen	Negative	0.1	mg/L		5540C	10/06/17:212119	5540C	10/06/17:215167
Aggressiveness Index	11.9	--	--		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Langelier Index (20°C)	0.02	--	--		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Nitrate Nitrogen	0.7	--	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Lab ID : CC 1783901-001
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 18K8 (LA 18)
Project : Los Osos BMC Monitoring

Sampled On : October 9, 2017-19:30
Sampled By : Spencer Harris
Received On : October 10, 2017-09:11
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	271	--	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Calcium	56	1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Magnesium	32	1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Potassium	2	1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Sodium	27	1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Total Cations	6.7	--	meq/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Boron	ND	0.1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Copper	ND	10	ug/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Iron	ND	30	ug/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Manganese	90	10	ug/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Zinc	ND	20	ug/L		200.7	10/12/17:212307	200.7	10/12/17:215483
SAR	0.7	--	--		200.7	10/12/17:212307	200.7	10/12/17:215483
Total Alkalinity (as CaCO3)	180	10	mg/L		2320B	10/12/17:212280	2320B	10/12/17:215474
Hydroxide as OH	ND	10	mg/L		2320B	10/12/17:212280	2320B	10/12/17:215474
Carbonate as CO3	ND	10	mg/L		2320B	10/12/17:212280	2320B	10/12/17:215474
Bicarbonate as HCO3	220	10	mg/L		2320B	10/12/17:212280	2320B	10/12/17:215474
Sulfate	35.5	0.5	mg/L		300.0	10/27/17:213023	300.0	10/27/17:216413
Chloride	30	1	mg/L		300.0	10/27/17:213023	300.0	10/27/17:216413
Nitrate as NO3	ND	1.8	mg/L		300.0	10/11/17:212382	300.0	10/11/17:215549
Nitrite as N	ND	0.2	mg/L		300.0	10/11/17:212382	300.0	10/11/17:215549
Nitrate + Nitrite as N	ND	0.5	mg/L		300.0	10/11/17:212382	300.0	10/11/17:215549
Fluoride	0.3	0.1	mg/L		300.0	10/11/17:212382	300.0	10/11/17:215549
Total Anions	5.2	--	meq/L		2320B	10/12/17:212280	2320B	10/12/17:215474
pH	7.8	--	units		4500-H B	10/12/17:212281	4500HB	10/12/17:215398
Specific Conductance	619	1	umhos/cm		2510B	10/12/17:212286	2510B	10/12/17:215401
Total Dissolved Solids	350	20	mg/L		2540CE	10/12/17:212314	2540C	10/13/17:215430
MBAS Screen	Negative	0.1	mg/L		5540C	10/11/17:212270	5540C	10/12/17:215433
Aggressiveness Index	12.2	--	--		4500-H B	10/12/17:212281	4500HB	10/12/17:215398
Langelier Index (20°C)	0.4	--	--		4500-H B	10/12/17:212281	4500HB	10/12/17:215398
Nitrate Nitrogen	ND	--	mg/L		300.0	10/11/17:212382	300.0	10/11/17:215549

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 27, 2017

Lab ID : CC 1783936-001
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 17E8 (LA22)
Project : Los Osos BMC Monitoring

Sampled On : October 11, 2017-14:02
Sampled By : Andrea Berge
Received On : October 11, 2017-14:57
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	168	--	mg/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Calcium	26	1	mg/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Magnesium	25	1	mg/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Potassium	1	1	mg/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Sodium	29	1	mg/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Total Cations	4.6	--	meq/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Boron	ND	0.1	mg/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Copper	ND	10	ug/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Iron	ND	30	ug/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Manganese	ND	10	ug/L		200.7	10/13/17:212366	200.7	10/13/17:215529
Zinc	ND	20	ug/L		200.7	10/13/17:212366	200.7	10/13/17:215529
SAR	1.0	--	--		200.7	10/13/17:212366	200.7	10/13/17:215529
Total Alkalinity (as CaCO3)	120	10	mg/L		2320B	10/16/17:212424	2320B	10/16/17:215665
Hydroxide as OH	ND	10	mg/L		2320B	10/16/17:212424	2320B	10/16/17:215665
Carbonate as CO3	ND	10	mg/L		2320B	10/16/17:212424	2320B	10/16/17:215665
Bicarbonate as HCO3	150	10	mg/L		2320B	10/16/17:212424	2320B	10/16/17:215665
Sulfate	14.0	0.5	mg/L		300.0	10/12/17:212383	300.0	10/12/17:215550
Chloride	47	1	mg/L		300.0	10/12/17:212383	300.0	10/12/17:215550
Nitrate as NO3	32.0	1.8	mg/L		300.0	10/12/17:212383	300.0	10/12/17:215550
Nitrite as N	ND	0.2	mg/L		300.0	10/12/17:212383	300.0	10/12/17:215550
Nitrate + Nitrite as N	7.2	0.5	mg/L		300.0	10/12/17:212383	300.0	10/12/17:215550
Fluoride	ND	0.1	mg/L		300.0	10/12/17:212383	300.0	10/12/17:215550
Total Anions	4.6	--	meq/L		2320B	10/16/17:212424	2320B	10/16/17:215665
pH	7.7	--	units		4500-H B	10/19/17:212596	4500HB	10/19/17:215812
Specific Conductance	476	1	umhos/cm		2510B	10/13/17:212345	2510B	10/13/17:215476
Total Dissolved Solids	260	20	mg/L		2540CE	10/16/17:212445	2540C	10/17/17:215662
MBAS Screen	Negative	0.1	mg/L		5540C	10/12/17:212977	5540C	10/27/17:210686
Aggressiveness Index	11.6	--	--		4500-H B	10/19/17:212596	4500HB	10/19/17:215812
Langelier Index (20°C)	-0.2	--	--		4500-H B	10/19/17:212596	4500HB	10/19/17:215812
Nitrate Nitrogen	7.2	--	mg/L		300.0	10/12/17:212383	300.0	10/12/17:215550

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : South Bay #1 17N10 LA 10
Project : Los Osos BMC Monitoring

Lab ID : CC 1783961-001
Customer ID : 8-514

Sampled On : October 12, 2017-10:40
Sampled By : Zac Remeke
Received On : October 12, 2017-14:10
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	240	--	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Calcium	37	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Magnesium	36	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Potassium	2	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Sodium	43	1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Cations	6.7	--	meq/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Boron	0.2	0.1	mg/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Copper	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Iron	ND	30	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Manganese	ND	10	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
Zinc	ND	20	ug/L		200.7	10/13/17:212369	200.7	10/13/17:215529
SAR	1.2	--	--		200.7	10/13/17:212369	200.7	10/13/17:215529
Total Alkalinity (as CaCO3)	210	10	mg/L		2320B	10/14/17:212388	2320B	10/14/17:215664
Hydroxide as OH	ND	10	mg/L		2320B	10/14/17:212388	2320B	10/14/17:215664
Carbonate as CO3	ND	10	mg/L		2320B	10/14/17:212388	2320B	10/14/17:215664
Bicarbonate as HCO3	260	10	mg/L		2320B	10/14/17:212388	2320B	10/14/17:215664
Sulfate	27.9	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Chloride	41	1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate as NO3	2.9	1.8	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrite as N	ND	0.2	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Nitrate + Nitrite as N	0.7	0.5	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Fluoride	0.2	0.1	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551
Total Anions	6.1	--	meq/L		2320B	10/14/17:212388	2320B	10/14/17:215664
pH	6.6	--	units		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Specific Conductance	583	1	umhos/cm		2510B	10/16/17:212403	2510B	10/16/17:215558
Total Dissolved Solids	320	20	mg/L		2540CE	10/17/17:212488	2540C	10/18/17:215749
MBAS Screen	Negative	0.1	mg/L		5540C	10/13/17:212622	5540C	10/13/17:215838
Aggressiveness Index	10.9	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Langelier Index (20°C)	-1.0	--	--		4500-H B	10/16/17:212434	4500HB	10/16/17:215597
Nitrate Nitrogen	0.7	--	mg/L		300.0	10/13/17:212399	300.0	10/13/17:215551

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 23, 2017

Lab ID : CC 1783799-005
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401

Sampled On : October 3, 2017-00:00
Sampled By : Spencer Harris / And
Received On : October 3, 2017-15:11
Matrix : Ground Water

Description : 20H1 (LA30)
Project : Los Osos BMC Monitoring

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	364	--	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Calcium	60	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Magnesium	52	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Potassium	1	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Sodium	36	1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Total Cations	8.9	--	meq/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Boron	0.1	0.1	mg/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Copper	ND	10	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Iron	460	30	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Manganese	230	10	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
Zinc	ND	20	ug/L		200.7	10/04/17:211939	200.7	10/04/17:214974
SAR	0.8	--	--		200.7	10/04/17:211939	200.7	10/04/17:214974
Total Alkalinity (as CaCO3)	280	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Hydroxide as OH	ND	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Carbonate as CO3	ND	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Bicarbonate as HCO3	350	10	mg/L		2320B	10/05/17:211964	2320B	10/05/17:214994
Sulfate	74.5	0.5	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Chloride	56	1	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrate as NO3	ND	1.8	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrite as N	ND	0.2	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Nitrate + Nitrite as N	ND	0.5	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Fluoride	0.3	0.1	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344
Total Anions	8.9	--	meq/L		2320B	10/05/17:211964	2320B	10/05/17:214994
pH	7.5	--	units		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Specific Conductance	876	1	umhos/cm		2510B	10/05/17:211979	2510B	10/05/17:214992
Total Dissolved Solids	500	20	mg/L		2540CE	10/05/17:211995	2540C	10/06/17:215055
MBAS Screen	Negative	0.1	mg/L		5540C	10/04/17:211935	5540C	10/04/17:214939
Aggressiveness Index	12.1	--	--		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Langelier Index (20°C)	0.3	--	--		4500-H B	10/05/17:211988	4500HB	10/05/17:214954
Nitrate Nitrogen	ND	--	mg/L		300.0	10/04/17:212137	300.0	10/04/17:215344

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 30, 2017	Lab ID : CC 1783861-002
	Customer ID : 8-514
Cleath-Harris Geologists	
Attn: Spencer Harris	Sampled On : October 5, 2017-12:11
71 Zaca Lane	Sampled By : Andrea Berge
Suite 140	Received On : October 5, 2017-14:38
San Luis Obispo, CA 93401	Matrix : Ground Water
Description : 13M2 (LA31)	
Project : Los Osos BMC Monitoring	

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral								
Total Hardness as CaCO3	738	--	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Calcium	116	1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Magnesium	109	1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Potassium	5	1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Sodium	411	2*	mg/L		200.7	10/28/17:213025	200.7	10/28/17:216375
Total Cations	32.8	--	meq/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Boron	0.2	0.1	mg/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Copper	ND	10	ug/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Iron	ND	30	ug/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Manganese	ND	10	ug/L		200.7	10/10/17:212148	200.7	10/10/17:215321
Zinc	ND	20	ug/L		200.7	10/10/17:212148	200.7	10/10/17:215321
SAR	6.6	--	--		200.7	10/10/17:212148	200.7	10/10/17:215321
Total Alkalinity (as CaCO3)	50	10	mg/L		2320B	10/07/17:212076	2320B	10/07/17:215142
Hydroxide as OH	ND	10	mg/L		2320B	10/07/17:212076	2320B	10/07/17:215142
Carbonate as CO3	ND	10	mg/L		2320B	10/07/17:212076	2320B	10/07/17:215142
Bicarbonate as HCO3	60	10	mg/L		2320B	10/07/17:212076	2320B	10/07/17:215142
Sulfate	160	10*	mg/L		300.0	10/27/17:213023	300.0	10/27/17:216413
Chloride	960	20*	mg/L		300.0	10/27/17:213023	300.0	10/27/17:216413
Nitrate as NO3	3.1	1.8	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545
Nitrite as N	ND	0.2	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545
Nitrate + Nitrite as N	0.7	0.5	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545
Fluoride	ND	0.1	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545
Total Anions	31.4	--	meq/L		2320B	10/07/17:212076	2320B	10/07/17:215142
pH	7.5	--	units		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Specific Conductance	3350	1	umhos/cm		2510B	10/09/17:212100	2510B	10/09/17:215144
Total Dissolved Solids	2190	20	mg/L		2540CE	10/11/17:212244	2540C	10/12/17:215414
MBAS Screen	Negative	0.1	mg/L		5540C	10/06/17:212119	5540C	10/06/17:215167
Aggressiveness Index	11.7	--	--		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Langelier Index (20°C)	-0.3	--	--		4500-H B	10/09/17:212124	4500HB	10/09/17:215184
Nitrate Nitrogen	0.7	--	mg/L		300.0	10/06/17:212139	300.0	10/06/17:215545

ND=Non-Detected. PQL=Practical Quantitation Limit. * PQL adjusted for dilution.

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October 19, 2017

Lab ID : CC 1783885-001
Customer ID : 8-514

Cleath-Harris Geologists
Attn: Spencer Harris
71 Zaca Lane
Suite 140
San Luis Obispo, CA 93401
Description : 18K9 (LA32)
Project : Los Osos BMC Monitoring

Sampled On : October 9, 2017-11:20
Sampled By : Wolfgang Forbes
Received On : October 9, 2017-12:36
Matrix : Ground Water

Sample Result - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation Method	Sample Preparation Date/ID	Sample Analysis Method	Sample Analysis Date/ID
General Mineral								
Total Hardness as CaCO3	168	--	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Calcium	26	1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Magnesium	25	1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Potassium	1	1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Sodium	33	1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Total Cations	4.8	--	meq/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Boron	ND	0.1	mg/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Copper	ND	10	ug/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Iron	ND	30	ug/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Manganese	ND	10	ug/L		200.7	10/12/17:212307	200.7	10/12/17:215483
Zinc	ND	20	ug/L		200.7	10/12/17:212307	200.7	10/12/17:215483
SAR	1.1	--	--		200.7	10/12/17:212307	200.7	10/12/17:215483
Total Alkalinity (as CaCO3)	160	10	mg/L		2320B	10/11/17:212218	2320B	10/11/17:215395
Hydroxide as OH	ND	10	mg/L		2320B	10/11/17:212218	2320B	10/11/17:215395
Carbonate as CO3	ND	10	mg/L		2320B	10/11/17:212218	2320B	10/11/17:215395
Bicarbonate as HCO3	200	10	mg/L		2320B	10/11/17:212218	2320B	10/11/17:215395
Sulfate	23.1	0.5	mg/L		300.0	10/10/17:212398	300.0	10/10/17:215548
Chloride	36	1	mg/L		300.0	10/10/17:212398	300.0	10/10/17:215548
Nitrate as NO3	6.3	1.8	mg/L		300.0	10/10/17:212398	300.0	10/10/17:215548
Nitrite as N	ND	0.2	mg/L		300.0	10/10/17:212398	300.0	10/10/17:215548
Nitrate + Nitrite as N	1.4	0.5	mg/L		300.0	10/10/17:212398	300.0	10/10/17:215548
Fluoride	0.1	0.1	mg/L		300.0	10/10/17:212398	300.0	10/10/17:215548
Total Anions	4.9	--	meq/L		2320B	10/11/17:212218	2320B	10/11/17:215395
pH	7.6	--	units		4500-H B	10/11/17:212245	4500HB	10/11/17:215355
Specific Conductance	493	1	umhos/cm		2510B	10/11/17:212220	2510B	10/11/17:215320
Total Dissolved Solids	270	20	mg/L		2540CE	10/12/17:212314	2540C	10/13/17:215430
MBAS Screen	Negative	0.1	mg/L		5540C	10/10/17:212319	5540C	10/10/17:215441
Aggressiveness Index	11.6	--	--		4500-H B	10/11/17:212245	4500HB	10/11/17:215355
Langelier Index (20°C)	-0.2	--	--		4500-H B	10/11/17:212245	4500HB	10/11/17:215355
Nitrate Nitrogen	1.4	--	mg/L		300.0	10/10/17:212398	300.0	10/10/17:215548

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CEC Testing

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/18/2017
Operator:
Well number and location: 30S/11E-13Q2 (FW5)
Site and wellhead conditions: Cloudy and cool. Monument and lock intact

Static water depth (feet): 86.35
Well depth (feet): 105
Water column (feet): 18.65
Casing diameter (inches): 2
Minimum purge volume (gal) 9.12
Purge rate (gpm): 1
Pumping water level (feet): --
Pump setting (feet): 100
Minimum purge time (min): 30
Time begin purge: 10:03 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
10:03	1	872.4	6.60	18.5	Turbid, cloudy orange, rusty odor
10:08	5	868.8	6.55	18.6	Slight yellow tinge, odorless
10:13	10	873.9	6.31	18.6	Slight yellowish tinge, odorless
10:18	15	877.9	6.33	18.7	Clear, colorless, odorless
10:23	20	881.6	6.35	18.6	Clear, colorless, odorless
10:28	25	884.5	6.35	18.6	Clear, colorless, odorless
10:33	30	884.8	6.25	18.5	Clear, colorless, odorless
					Sampled @ 10:33

*Turbidity, color, odor, sheen, debris, etc.

Groundwater Monitoring Field Log
LOBP Monitoring Program

Date: 10/18/2017
Operator: A. Berge and S.J. Harris
Well number and location: 30S/11E-20A2 (FW-26)
Sunny and breezy. Wood covering intact and in place

Static water depth (feet): 19.73
Well depth (feet): 65
Water column (feet): 45.27
Casing diameter (inches): 6
Minimum purge volume (gal) flush line
Purge rate (gpm): 15
Pumping water level (feet): --
Pump setting (feet): --
Minimum purge time (min): --
Time begin purge: 11:22 AM

Time	Gallons	EC (µS/cm)	pH	Temp. (°C)	Comments*
11:22	1	678.8	7.26	16.8	Slight gray color, sulfor odor
11:25	50	651.2	7.27	16.5	Clear, colorless, sulfur odor
11:27	80	645	7.26	16.9	Clear, colorless, faint sulfur odor
11:29	110	642.7	7.21	16.9	Clear, colorless, faint sulfur odor
11:31	140	638.6	7.20	16.9	Clear, colorless, very faint sulfur odor
11:33	170	636.5	7.18	16.9	Clear, colorless, very faint sulfur odor
11:35	200	637.2	7.16	16.6	Clear, colorless, very faint sulfur odor
					Sampled @ 11:40

*Turbidity, color, odor, sheen, debris, etc.

WECK LABORATORIES, INC.

Certificate of Analysis

FINAL REPORT

Work Orders:	7J19007	**Report Date:**	12/11/2017
		Received Date:	10/19/2017
Project:	LOS OSOS CEC MONITORING	**Turnaround Time:**	Normal
		Phones:	(805) 543-1413
		Fax:	-
Attn:	Spencer Harris	**P.O. #:**	
Client:	Cleath-Harris Geologists, Inc. 71 Zaca Lane, Suite 140 San Luis Obispo, CA 93401	**Billing Code:**	

DoD-ELAP #L2457 • ELAP-CA #1132 • EPA-UCMR #CA00211 • Guam-EPA #17-008R • HW-DOH # • ISO 17025 #L2457.01 • LACSD #10143 • NELAP-OR #4047 • NJ-DEP #CA015

This is a complete final report. The information in this report applies to the samples analyzed in accordance with the chain-of-custody document. Weck Laboratories certifies that the test results meet all requirements of TNI unless noted by qualifiers or written in the Case Narrative. This analytical report must be reproduced in its entirety.

Dear Spencer Harris,

Enclosed are the results of analyses for samples received 10/19/17 with the Chain-of-Custody document. The samples were received in good condition, at 4.8 °C and on ice. All analyses met the method criteria except as noted in the case narrative or in the report with data qualifiers.

Reviewed by:

Brandon Gee
Operations Manager/Senior PM

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FINAL REPORT

Cleath-Harris Geologists, Inc.
71 Zaca Lane, Suite 140
San Luis Obispo, CA 93401

Project Number: LOS OSOS CEC MONITORING

Project Manager: Spencer Harris

Reported: 12/11/2017 16:19

Sample Summary

Sample Name	Sampled By	Lab ID	Matrix	Sampled	Qualifiers
QA1 - Clean Water/Travel Blank	S.HARRIS	7J19007-01	Water	10/18/17 09:30	
QA2 - Equipment Blank	S.HARRIS	7J19007-02	Water	10/18/17 09:40	
FW5 (13Q2)	S.HARRIS	7J19007-03	Water	10/18/17 10:33	
FW26 (20A1)	S.HARRIS	7J19007-04	Water	10/18/17 11:40	

Not Certified Analyses Summary

Analyte	CAS #	Not Accredited By
SM 5910B in Water		
UV 254		NELAP

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Cleath-Harris Geologists, Inc.
71 Zaca Lane, Suite 140
San Luis Obispo, CA 93401

Project Number: LOS OSOS CEC MONITORING

Project Manager: Spencer Harris

Reported: 12/11/2017 16:19

Sample Results

Sample: QA1 - Clean Water/Travel Blank — 7J19007-01 (Water) — Sampled: 10/18/17 9:30 by S.HARRIS

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
PPCPs - Hormones by LC/MSMS-APCI						
Method: EPA 1694M-APCI	**Batch ID:** W7K0029	**Prepared:** 11/01/17 10:31				**Analyst:** kan
17-b-Estradiol	ND	1.0	ng/l	1	11/20/17 18:22	
PPCPs - Pharmaceuticals by LC/MSMS-ESI-						
Method: EPA 1694M-ESI-	**Batch ID:** W7K0030	**Prepared:** 11/01/17 10:33				**Analyst:** kan
Gemfibrozil	ND	1.0	ng/l	1	11/16/17 21:51	
Iopromide	ND	5.0	ng/l	1	11/16/17 21:51	
Triclosan	ND	2.0	ng/l	1	11/16/17 21:51	
PPCPs - Pharmaceuticals by LC/MSMS-ESI+						
Method: EPA 1694M-ESI+	**Batch ID:** W7L0476	**Prepared:** 11/01/17 10:28				**Analyst:** kan
Caffeine	**2.5**	1.0	ng/l	1	12/07/17 21:17	B
DEET	**2.0**	1.0	ng/l	1	12/07/17 21:17	
Sucralose	**17**	5.0	ng/l	1	12/07/17 21:17	

Sample: QA2 - Equipment Blank — 7J19007-02 (Water) — Sampled: 10/18/17 9:40 by S.HARRIS

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
PPCPs - Hormones by LC/MSMS-APCI						
Method: EPA 1694M-APCI	**Batch ID:** W7K0029	**Prepared:** 11/01/17 10:31				**Analyst:** kan
17-b-Estradiol	ND	1.0	ng/l	1	11/20/17 18:42	
PPCPs - Pharmaceuticals by LC/MSMS-ESI-						
Method: EPA 1694M-ESI-	**Batch ID:** W7K0030	**Prepared:** 11/01/17 10:33				**Analyst:** kan
Gemfibrozil	ND	1.0	ng/l	1	11/16/17 22:06	
Iopromide	ND	5.0	ng/l	1	11/16/17 22:06	
Triclosan	ND	2.0	ng/l	1	11/16/17 22:06	
PPCPs - Pharmaceuticals by LC/MSMS-ESI+						
Method: EPA 1694M-ESI+	**Batch ID:** W7L0476	**Prepared:** 11/01/17 10:28				**Analyst:** kan
Caffeine	**2.1**	1.0	ng/l	1	12/07/17 21:33	B
DEET	**1.4**	1.0	ng/l	1	12/07/17 21:33	
Sucralose	**8.2**	5.0	ng/l	1	12/07/17 21:33	

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FINAL REPORT

Cleath-Harris Geologists, Inc.
71 Zaca Lane, Suite 140
San Luis Obispo, CA 93401

Project Number: LOS OSOS CEC MONITORING

Project Manager: Spencer Harris

Reported: 12/11/2017 16:19

Sample Results

(Continued)

Sample: FW5 (13Q2) — Sampled: 10/18/17 10:33 by S.HARRIS

7J19007-03 (Water)

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Conventional Chemistry/Physical Parameters by APHA/EPA/ASTM Methods						
Method: EPA 350.1	**Batch ID:** W7J1388	**Prepared:** 10/24/17 10:14				**Analyst:** ymt
Ammonia as N	ND	0.10	mg/l	1	10/26/17 18:15	
Method: EPA 353.2	**Batch ID:** W7J1152	**Prepared:** 10/19/17 12:58				**Analyst:** AJK
Nitrate as N	**40**	2.0	mg/l	10	10/19/17 15:48	
Method: SM 2510B	**Batch ID:** W7J1285	**Prepared:** 10/23/17 10:45				**Analyst:** stg
Specific Conductance (EC)	**960**	2.0	umhos/cm	1	10/23/17 14:17	
Method: SM 5310B	**Batch ID:** W7J1195	**Prepared:** 10/20/17 06:42				**Analyst:** jlp
Total Organic Carbon (TOC)	**0.57**	0.10	mg/l	1	10/20/17 12:44	
Method: SM 5910B	**Batch ID:** W7J1209	**Prepared:** 10/20/17 09:32				**Analyst:** ajk
UV 254	**0.028**	0.009	1/cm	1	10/20/17 10:28	
Nitrosamines by isotopic dilution GC/MS CI Mode						
Method: EPA 1625M	**Batch ID:** W7J1397	**Prepared:** 10/24/17 11:40				**Analyst:** smr
N-Nitrosodimethylamine	ND	2.0	ng/l	1	10/25/17 18:15	
PPCPs - Hormones by LC/MSMS-APCI						
Method: EPA 1694M-APCI	**Batch ID:** W7K0029	**Prepared:** 11/01/17 10:31				**Analyst:** kan
17-b-Estradiol	ND	1.0	ng/l	1	11/20/17 19:02	
PPCPs - Pharmaceuticals by LC/MSMS-ESI-						
Method: EPA 1694M-ESI-	**Batch ID:** W7K0030	**Prepared:** 11/01/17 10:33				**Analyst:** kan
Gemfibrozil	ND	1.0	ng/l	1	11/16/17 22:22	
Iopromide	ND	5.0	ng/l	1	11/16/17 22:22	
Triclosan	ND	2.0	ng/l	1	11/16/17 22:22	
PPCPs - Pharmaceuticals by LC/MSMS-ESI+						
Method: EPA 1694M-ESI+	**Batch ID:** W7L0476	**Prepared:** 11/01/17 10:28				**Analyst:** kan
Caffeine	**1.6**	1.0	ng/l	1	12/07/17 21:50	B
DEET	**1.3**	1.0	ng/l	1	12/07/17 21:50	
Sucralose	**260**	5.0	ng/l	1	12/07/17 21:50	

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Project Number: LOS OSOS CEC MONITORING

Project Manager: Spencer Harris

Reported: 12/11/2017 16:19

Sample Results

(Continued)

Sample: FW26 (20A1) — Sampled: 10/18/17 11:40 by S.HARRIS

7J19007-04 (Water)

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Conventional Chemistry/Physical Parameters by APHA/EPA/ASTM Methods						
Method: EPA 350.1 — **Batch ID:** W7J1388 — **Prepared:** 10/24/17 10:14 — **Analyst:** ymt						
Ammonia as N	**0.19**	0.10	mg/l	1	10/26/17 18:15	
Method: EPA 353.2 — **Batch ID:** W7J1152 — **Prepared:** 10/19/17 12:58 — **Analyst:** AJK						
Nitrate as N	ND	0.20	mg/l	1	10/19/17 15:19	
Method: SM 2510B — **Batch ID:** W7J1285 — **Prepared:** 10/23/17 10:45 — **Analyst:** stg						
Specific Conductance (EC)	**680**	2.0	umhos/cm	1	10/23/17 14:17	
Method: SM 5310B — **Batch ID:** W7J1195 — **Prepared:** 10/20/17 06:42 — **Analyst:** jlp						
Total Organic Carbon (TOC)	**1.2**	0.10	mg/l	1	10/20/17 12:44	
Method: SM 5910B — **Batch ID:** W7J1209 — **Prepared:** 10/20/17 09:32 — **Analyst:** ajk						
UV 254	**0.026**	0.009	1/cm	1	10/20/17 10:28	
Nitrosamines by isotopic dilution GC/MS CI Mode						
Method: EPA 1625M — **Batch ID:** W7J1397 — **Prepared:** 10/24/17 11:40 — **Analyst:** smr						
N-Nitrosodimethylamine	ND	2.0	ng/l	1	10/25/17 18:43	
PPCPs - Hormones by LC/MSMS-APCI						
Method: EPA 1694M-APCI — **Batch ID:** W7K0029 — **Prepared:** 11/01/17 10:31 — **Analyst:** kan						
17-b-Estradiol	ND	1.0	ng/l	1	11/20/17 19:23	
PPCPs - Pharmaceuticals by LC/MSMS-ESI-						
Method: EPA 1694M-ESI- — **Batch ID:** W7K0030 — **Prepared:** 11/01/17 10:33 — **Analyst:** kan						
Gemfibrozil	ND	1.0	ng/l	1	11/16/17 22:37	
Iopromide	ND	5.0	ng/l	1	11/16/17 22:37	
Triclosan	ND	2.0	ng/l	1	11/16/17 22:37	
PPCPs - Pharmaceuticals by LC/MSMS-ESI+						
Method: EPA 1694M-ESI+ — **Batch ID:** W7L0476 — **Prepared:** 11/01/17 10:28 — **Analyst:** kan						
Caffeine	**1.0**	1.0	ng/l	1	12/07/17 22:06	B
DEET	**1.7**	1.0	ng/l	1	12/07/17 22:06	
Sucralose	**16**	5.0	ng/l	1	12/07/17 22:06	

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Quality Control Results

Conventional Chemistry/Physical Parameters by APHA/EPA/ASTM Methods

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W7J1152 - EPA 353.2										
Blank (W7J1152-BLK1)				**Prepared & Analyzed: 10/19/17**						
Nitrate as N	ND	0.20	mg/l							
LCS (W7J1152-BS1)				**Prepared & Analyzed: 10/19/17**						
Nitrate as N	1.08	0.20	mg/l	1.00		108	90-110			
Matrix Spike (W7J1152-MS1)	**Source: 7J18081-01**			**Prepared & Analyzed: 10/19/17**						
Nitrate as N	4.75	0.20	mg/l	2.00	2.76	100	90-110			
Matrix Spike (W7J1152-MS2)	**Source: 7J18082-04**			**Prepared & Analyzed: 10/19/17**						
Nitrate as N	6.12	0.20	mg/l	2.00	4.10	101	90-110			
Matrix Spike Dup (W7J1152-MSD1)	**Source: 7J18081-01**			**Prepared & Analyzed: 10/19/17**						
Nitrate as N	4.78	0.20	mg/l	2.00	2.76	101	90-110	0.7	20	
Matrix Spike Dup (W7J1152-MSD2)	**Source: 7J18082-04**			**Prepared & Analyzed: 10/19/17**						
Nitrate as N	6.12	0.20	mg/l	2.00	4.10	101	90-110	0.02	20	
Batch: W7J1195 - SM 5310B										
Blank (W7J1195-BLK1)				**Prepared & Analyzed: 10/20/17**						
Total Organic Carbon (TOC)	ND	0.10	mg/l							
LCS (W7J1195-BS1)				**Prepared & Analyzed: 10/20/17**						
Total Organic Carbon (TOC)	1.12	0.10	mg/l	1.00		112	85-115			
Duplicate (W7J1195-DUP1)	**Source: 7J09080-01**			**Prepared & Analyzed: 10/20/17**						
Total Organic Carbon (TOC)	1.92	0.10	mg/l		2.25			16	20	
Matrix Spike (W7J1195-MS1)	**Source: 7J09080-01**			**Prepared & Analyzed: 10/20/17**						
Total Organic Carbon (TOC)	7.22	0.10	mg/l	5.00	2.25	99	76-115			
Matrix Spike Dup (W7J1195-MSD1)	**Source: 7J09080-01**			**Prepared & Analyzed: 10/20/17**						
Total Organic Carbon (TOC)	7.23	0.10	mg/l	5.00	2.25	100	76-115	0.2	20	
Batch: W7J1209 - SM 5910B										
Blank (W7J1209-BLK1)				**Prepared & Analyzed: 10/20/17**						
UV 254	ND	0.009	1/cm							
LCS (W7J1209-BS1)				**Prepared & Analyzed: 10/20/17**						
UV 254	0.089	0.009	1/cm	0.0880		101	90-110			
Duplicate (W7J1209-DUP1)	**Source: 7J19007-03**			**Prepared & Analyzed: 10/20/17**						
UV 254	0.027	0.009	1/cm		0.028			4	10	
Duplicate (W7J1209-DUP2)	**Source: 7J19007-04**			**Prepared & Analyzed: 10/20/17**						
UV 254	0.025	0.009	1/cm		0.026			4	10	
Batch: W7J1285 - SM 2510B										
Blank (W7J1285-BLK1)				**Prepared & Analyzed: 10/23/17**						
Specific Conductance (EC)	ND	2.0	umhos/cm							
LCS (W7J1285-BS1)				**Prepared & Analyzed: 10/23/17**						
Specific Conductance (EC)	206	2.0	umhos/cm	200		103	95-105			

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Quality Control Results

(Continued)

Conventional Chemistry/Physical Parameters by APHA/EPA/ASTM Methods (Continued)

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W7J1285 - SM 2510B (Continued)										
Duplicate (W7J1285-DUP1)	**Source: 7J19007-03**			**Prepared & Analyzed: 10/23/17**						
Specific Conductance (EC)	960	2.0	umhos/cm		960			0	5	
Batch: W7J1388 - EPA 350.1										
Blank (W7J1388-BLK1)				**Prepared: 10/24/17 Analyzed: 10/26/17**						
Ammonia as N	ND	0.10	mg/l							
Blank (W7J1388-BLK2)				**Prepared: 10/24/17 Analyzed: 10/26/17**						
Ammonia as N	ND	0.10	mg/l							
LCS (W7J1388-BS1)				**Prepared: 10/24/17 Analyzed: 10/26/17**						
Ammonia as N	0.263	0.10	mg/l	0.250		105	90-110			
LCS (W7J1388-BS2)				**Prepared: 10/24/17 Analyzed: 10/26/17**						
Ammonia as N	0.264	0.10	mg/l	0.250		105	90-110			
Matrix Spike (W7J1388-MS1)	**Source: 7J17115-06**			**Prepared: 10/24/17 Analyzed: 10/26/17**						
Ammonia as N	0.263	0.10	mg/l	0.250	ND	105	90-110			
Matrix Spike (W7J1388-MS2)	**Source: 7J18033-01**			**Prepared: 10/24/17 Analyzed: 10/26/17**						
Ammonia as N	0.259	0.10	mg/l	0.250	ND	104	90-110			
Matrix Spike Dup (W7J1388-MSD1)	**Source: 7J17115-06**			**Prepared: 10/24/17 Analyzed: 10/26/17**						
Ammonia as N	0.267	0.10	mg/l	0.250	ND	107	90-110	1	15	
Matrix Spike Dup (W7J1388-MSD2)	**Source: 7J18033-01**			**Prepared: 10/24/17 Analyzed: 10/26/17**						
Ammonia as N	0.260	0.10	mg/l	0.250	ND	104	90-110	0.06	15	

Nitrosamines by isotopic dilution GC/MS CI Mode

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W7J1397 - EPA 1625M										
Blank (W7J1397-BLK1)				**Prepared: 10/24/17 Analyzed: 10/25/17**						
N-Nitrosodimethylamine	ND	2.0	ng/l							
LCS (W7J1397-BS1)				**Prepared: 10/24/17 Analyzed: 10/25/17**						
N-Nitrosodimethylamine	2.53	2.0	ng/l	3.00		84	50-150			
LCS Dup (W7J1397-BSD1)				**Prepared: 10/24/17 Analyzed: 10/25/17**						
N-Nitrosodimethylamine	3.05	2.0	ng/l	3.00		102	50-150	19	50	

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Quality Control Results

(Continued)

PPCPs - Hormones by LC/MSMS-APCI

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W7K0029 - EPA 1694M-APCI										
Blank (W7K0029-BLK1)				**Prepared: 11/01/17 Analyzed: 11/20/17**						
17-a-Ethynylestradiol	ND	1.0	ng/l							
17-b-Estradiol	ND	1.0	ng/l							
Estrone	ND	1.0	ng/l							
Progesterone	ND	1.0	ng/l							
Testosterone	ND	1.0	ng/l							
LCS (W7K0029-BS1)				**Prepared: 11/01/17 Analyzed: 11/20/17**						
17-a-Ethynylestradiol	8.23	1.0	ng/l	10.0		82	68-159			
17-b-Estradiol	9.02	1.0	ng/l	10.0		90	65-146			
Estrone	8.65	1.0	ng/l	10.0		86	59-141			
Progesterone	9.18	1.0	ng/l	10.0		92	58-154			
Testosterone	17.5	1.0	ng/l	10.0		175	60-172			Q-08
LCS Dup (W7K0029-BSD1)				**Prepared: 11/01/17 Analyzed: 11/20/17**						
17-a-Ethynylestradiol	9.27	1.0	ng/l	10.0		93	68-159	12	30	
17-b-Estradiol	12.2	1.0	ng/l	10.0		122	65-146	30	30	
Estrone	10.3	1.0	ng/l	10.0		103	59-141	17	30	
Progesterone	11.3	1.0	ng/l	10.0		113	58-154	21	30	
Testosterone	20.5	1.0	ng/l	10.0		205	60-172	16	30	Q-08

PPCPs - Pharmaceuticals by LC/MSMS-ESI-

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W7K0030 - EPA 1694M-ESI-										
Blank (W7K0030-BLK1)				**Prepared: 11/01/17 Analyzed: 11/16/17**						
Gemfibrozil	ND	1.0	ng/l							
Iopromide	ND	5.0	ng/l							
Triclosan	ND	2.0	ng/l							
LCS (W7K0030-BS1)				**Prepared: 11/01/17 Analyzed: 11/16/17**						
Gemfibrozil	9.50	1.0	ng/l	10.0		95	76-122			
Iopromide	59.5	5.0	ng/l	50.0		119	0.1-163			
Triclosan	8.94	2.0	ng/l	10.0		89	76-139			
LCS Dup (W7K0030-BSD1)				**Prepared: 11/01/17 Analyzed: 11/16/17**						
Gemfibrozil	11.3	1.0	ng/l	10.0		113	76-122	17	30	
Iopromide	69.8	5.0	ng/l	50.0		140	0.1-163	16	30	
Triclosan	12.1	2.0	ng/l	10.0		121	76-139	30	30	

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Certificate of Analysis

FINAL REPORT

Cleath-Harris Geologists, Inc.
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Project Manager: Spencer Harris

Reported: 12/11/2017 16:19

Quality Control Results

(Continued)

PPCPs - Pharmaceuticals by LC/MSMS-ESI+

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W7L0476 - EPA 1694M-ESI+										
Blank (W7L0476-BLK1)				**Prepared: 11/01/17 Analyzed: 12/07/17**						
Caffeine	5.98	1.0	ng/l							B
DEET	ND	1.0	ng/l							
Sucralose	ND	5.0	ng/l							
LCS (W7L0476-BS1)				**Prepared: 11/01/17 Analyzed: 12/07/17**						
Caffeine	11.6	1.0	ng/l	10.0		116	55-152			
DEET	10.2	1.0	ng/l	10.0		102	45-135			
Sucralose	50.2	5.0	ng/l	50.0		100	50-150			
LCS Dup (W7L0476-BSD1)				**Prepared: 11/01/17 Analyzed: 12/07/17**						
Caffeine	11.5	1.0	ng/l	10.0		115	55-152	0.9	30	
DEET	12.4	1.0	ng/l	10.0		124	45-135	19	30	
Sucralose	57.0	5.0	ng/l	50.0		114	50-150	13	30	

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Notes and Definitions

Item	Definition
B	Blank contamination. The analyte was found in the associated blank as well as in the sample.
Q-08	High bias in the QC sample does not affect sample result since analyte was not detected or below the reporting limit.
ND	NOT DETECTED at or above the Method Reporting Limit (MRL). If Method Detection Limit (MDL) is reported, then ND means not detected at or above the MDL.
Dil	Dilution
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
% Rec	Percent Recovery
Source	Sample that was matrix spiked or duplicated.
MDL	Method Detection Limit
MRL	The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The MRL is also known as Limit of Quantitation (LOQ) and Detection Limit for Reporting (DLR)
MDA	Minimum Detectable Activity
NR	Not Reportable
TIC	Tentatively Identified Compound (TIC) using mass spectrometry. The reported concentration is relative concentration based on the nearest internal standard. If the library search produces no matches at, or above 85%, the compound is reported as unknown.

Any remaining sample(s) will be disposed of one month from the final report date unless other arrangements are made in advance.
An Absence of Total Coliform meets the drinking water standards as established by the California State Water Resources Control Board (SWRCB)
All results are expressed on wet weight basis unless otherwise specified.
All samples collected by Weck Laboratories have been sampled in accordance to laboratory SOP Number MIS 002.

APPENDIX D

Field Methods

Groundwater Level Measurement Procedures for the Los Osos Basin Plan Groundwater Monitoring Program

Introduction

This document establishes procedures for measuring and recording groundwater levels for the Los Osos Basin Plan (LOBP) Groundwater Monitoring Program, and describes various methods used for collecting meaningful groundwater data.

Static groundwater levels obtained for the LOBP Groundwater Monitoring Program are determined by measuring the distance to water in a non-pumping well from a reference point that has been referenced to sea level. Subtracting the distance to water from the elevation of the reference point determines groundwater surface elevations above or below sea level. This is represented by the following equation:

$$E_{GW} = E_{RP} - D$$

Where:

E_{GW} = Elevation of groundwater above mean sea level (feet)
E_{RP} = Elevation above sea level at reference point (feet)
D = Depth to water (feet)

References

Procedures for obtaining and reporting water level data for the LOBP Groundwater Monitoring Program are based on a review of the following documents.

- State of California, Department of Water Resources, 2010, *Groundwater Elevation Monitoring Guidelines*, prepared for use in the California Statewide Groundwater Elevation Monitoring (CASGEM) program, December. http://www.water.ca.gov/groundwater/casgem/pdfs/CASGEM%20DWR%20GW%20Guidelines%20Final%20121510.pdf
- State of California, Department of Water Resources, 2014, *Addendum to December 2010 Groundwater Elevation Monitoring Guidelines for the Department of Water Resources' California Statewide Groundwater Elevation Monitoring (CASGEM) Program*, October 2. http://www.water.ca.gov/groundwater/casgem/pdfs/PSW_addendum.pdf
- U.S. Geological Survey, 1977, *National Handbook of Recommended Methods for Water-Data Acquisition*, a Unites States contribution to the International Hydrological Program. https://pubs.usgs.gov/chapter11/
- U.S. Geological Survey, Office of Ground Water, 1997, *Ground Water Procedure Document 1, Water-level measurement using graduated steel tape, draft stand-alone procedure document.* http://pubs.usgs.gov/tm/1a1/pdf/GWPD1.pdf

- U.S. Geological Survey, Office of Ground Water, 1997, *Ground Water Procedure Document 4, Water-level measurement using an electric tape, draft stand-alone procedure document.* http://pubs.usgs.gov/tm/1a1/pdf/GWPD4.pdf
- U.S. Geological Survey, Office of Ground Water, 1997, *Ground Water Procedure Document 13, Water-level measurement using an air line, draft stand-alone procedure document.* http://pubs.usgs.gov/tm/1a1/pdf/GWPD13.pdf
- U.S. Geological Survey, 2001, *Introduction to Field Methods for Hydrologic and Environmental Studies*, Open-File Report 2001-50, 241 p. https://pubs.er.usgs.gov/publication/ofr0150

Well Information

Table 1 below lists important well information to be maintained in a well file or in a field notebook. Additional information that should be available to the person collecting water level data include a description of access to the property and the well, the presence and depth of cascading water, or downhole obstructions that could interfere with a sounding cable.

Table 1
Well File Information

Well Completion Report	Hydrologic Information	Additional Information to be Recorded
Well name	Map showing basin boundaries and wells	Township, Range, and ¼ ¼ Section
Well Owner	Name of groundwater basin	Latitude and Longitude (Decimal degrees)
Drilling Company	Description of aquifer	Assessor's Parcel Number
Location map or sketch	Confined, unconfined, or mixed aquifers	Description of well head and sounding access
Total depth	Pumping test data	Reference point elevations
Perforation interval	Hydrographs	Well use and pumping schedule if known
Casing diameter	Water quality data	Date monitoring began
Date of well completion	Property access instructions/codes	Land use

Reference Points and Reference Marks

Reference point (RP) elevations are the basis for determining groundwater elevations relative to sea level. The RP is generally that point on the well head that is the most convenient place to measure the water level in a well. In selecting an RP, an additional consideration is the ease of surveying either by Global Positioning System (GPS) or by leveling.

The RP must be clearly defined, well marked, and easily located. A description, sketch, and photograph of the point should be included in the well file. Additional Reference Marks (RMs) may be established near the wellhead on a permanent object. These additional RMs can serve as a benchmark by which the wellhead RP can be checked or re-surveyed if necessary. All RMs should be marked, sketched, photographed, and described in the well file.

All RPs for Groundwater Monitoring Program wells should be reported based on the same horizontal and vertical datum by a California licensed surveyor to the nearest tenth of one foot vertically, and the nearest one foot horizontally. The surveyor's report should be maintained in the project file.

In addition to the RP survey, the elevation of the ground surface adjacent to the well should also be measured and recorded in the well file. Because the ground surface adjacent to a well is rarely uniform, the average surface level should be estimated. This average ground surface elevation is referred to in the U.S.G.S. Procedural Document (GWPD-1, 1997) and DWR guidelines as the Land Surface Datum (LSD).

Water Level Data Collection

Prior to beginning the field work, the field technician should review each well file to determine which well owners require notification of the upcoming site visit, or which well pumps need to be turned off to allow for sufficient water level recovery. Because groundwater elevations are used to construct groundwater contour maps and to determine hydraulic gradients, the field technician should coordinate water level measurements to be collected within as short a period of time as practical. Any significant changes in groundwater conditions during monitoring events should be noted in the Annual Monitoring Report. For an individual well, the same measuring method and the same equipment should be used during each sampling event where practical.

A static water level should represent stable, non-pumping conditions at the well. When there is doubt about whether water levels in a well are continuing to recover following a pumping cycle, repeated measurements should be made. If an electric sounder is being used, it is possible to hold the sounder level at one point slightly above the known water level and wait for a signal that would indicate rising water. If applicable, the general schedule of pump operation should be determined and noted for active wells. If the well is capped but not vented, remove the cap and wait several minutes before measurement to allow water levels to equilibrate to atmospheric pressure.

When lowering a graduated steel tape (chalked tape) or electric tape in a well without a sounding tube in an equipped well, the tape should be played out slowly by hand to minimize the chance of the tape end becoming caught in a downhole obstruction. The tape should be held in such a way that any change in tension will be felt. When withdrawing a sounding tape, it should also be brought up slowly so that if an obstruction is encountered, tension can be relaxed so that the tape can be lowered again before attempting to withdraw it around the obstruction.

Despite all precautions, there is a small risk of measuring tapes becoming stuck in equipped wells without dedicated sounding tubes. If a tape becomes stuck, the equipment should be left on-site and re-checked after the well has gone through a few cycles of pumping, which can free the tape due to movement/vibration of the pump column. If the tape remains stuck, a pumping contractor will be needed to retrieve the equipment. A dedicated sounding tube may be installed by the pumping contractor at that time.

All water level measurements should be made to an accuracy of 0.01 feet. The field technician should make at least two measurements. If measurements of static levels do not agree to within 0.02 feet of each other, the technician should continue measurements until the reason for the disparity is determined, or the measurements are within 0.02 feet.

Record Keeping in the Field

The information recorded in the field is typically the only available reference for the conditions at the time of the monitoring event. During each monitoring event it is important to record any conditions at a well site and its vicinity that may affect groundwater levels, or the field technician's ability to obtain groundwater levels. Table 2 lists important information to record, however, additional information should be included when appropriate.

Table 2
Information Recorded at Each Well Site

Well name	Changes in land use	Presence of pump lubricating oil in well
Name and organization of field technician	Changes in RP	Cascading water
Date & time	Nearby wells in use	Equipment problems
Measurement method used	Weather conditions	Physical changes in wellhead
Sounder used	Recent pumping info	Comments
Reference Point Description	Measurement correction(s)	Well status

Measurement Techniques

Four standard methods of obtaining water levels are discussed below. The chosen method depends on site and downhole conditions, and the equipment limitations. In all monitoring situations, the procedures and equipment used should be documented in the field notes and in final reporting. Additional detail on methods of water level measurement is included in the reference documents.

<u>Graduated Steel Tape</u>
This method uses a graduated steel tape with a brass or stainless steel weight attached to its end. The tape is graduated in feet. The approximate depth to water should be known prior to measurement.

- Estimate the anticipated static water level in the well from field conditions and historical information;
- Chalk the lower few feet of the tape by applying blue carpenter's chalk.
- Lower the tape to just below the estimated depth to water so that a few feet of the chalked portion of the tape is submerged. Be careful not to lower the tape beyond its chalked length.
- Hold the tape at the RP and record the tape position (this is the "hold" position and should be at an even foot);

- Withdraw the tape rapidly to the surface;
- Record the length of the wetted chalk mark on the graduated tape;
- Subtract the wetted chalk number from the "hold" position number and record this number in the "Depth to Water below RP" column;
- Perform a check by repeating the measurement using a different RP hold value;
- All data should be recorded to the nearest 0.01 foot;
- Disinfect the tape by wiping down the submerged portion of the tape with single-use, unscented disinfectant wipe, or let stand for one minute in a dilute chlorine bleach solution and dry with clean cloth.

The graduated steel tape is generally considered to be the most accurate method for measuring static water levels. Measuring water levels in wells with cascading water or with condensing water on the well casing causes potential errors, or can be impossible with a steel tape.

Electric Tape

An electric tape operates on the principle that an electric circuit is completed when two electrodes are submerged in water. Most electric tapes are mounted on a hand-cranked reel equipped with batteries and an ammeter, buzzer or light to indicate when the circuit is completed. Tapes are graduated in either one-foot intervals or in hundredths of feet depending on the manufacturer. Like graduated steel tapes, electric tapes are affixed with brass or stainless steel weights.

- Check the circuitry of the tape before lowering the probe into the well by dipping the probe into water and observe if the ammeter needle or buzzer/light signals that the circuit is completed;
- Lower the probe slowly and carefully into the well until the signal indicates that the water surface has been reached;
- Place a finger or thumb on the tape at the RP when the water surface is reached;
- If the tape is graduated in one-foot intervals, partially withdraw the tape and measure the distance from the RP mark to the nearest one-foot mark to obtain the depth to water below the RP. If the tape is graduated in hundredths of a foot, simply record the depth at the RP mark as the depth to water below the RP;
- Make all readings using the same needle deflection point on the ammeter scale (if equipped) so that water levels will be consistent between measurements;
- Make check measurements until agreement shows the results to be reliable;
- All data should be recorded to the nearest 0.01 foot;
- Disinfect the tape by wiping down the submerged portion of the tape with single-use, unscented disinfectant wipe, or let stand for one minute in a dilute chlorine bleach solution and dry with clean cloth;
- Periodically check the tape for breaks in the insulation. Breaks can allow water to enter into the insulation creating electrical shorts that could result in false depth readings.

The electric tape may give slightly less accurate results than the graduated steel tape. Errors can result from signal "noise" in cascading water, breaks in the tape insulation, tape stretch, or missing tape at the location of a splice. All electric tapes should be calibrated semi-annually against a steel tape that is maintained in the office and used only for calibration.

Air Line

The air line method is usually used only in wells equipped with pumps. This method typically uses a 1/8 or 1/4-inch diameter, seamless copper tubing, brass tubing, stainless steel tubing, or galvanized pipe with a suitable pipe tee for connecting an altitude or pressure gage. Plastic (i.e. polyethylene) tubing may also be used, but is considered less desirable because it can develop leaks as it degrades. An air line must extend far enough below the water level that the lower end remains submerged during pumping of the well. The air line is connected to an altitude gage that reads directly in feet of water, or to a pressure gage that reads pressure in pounds per square inch (psi). The gage reading indicates the length of the submerged air line.

The formula for determining the depth to water below the RP is: $\mathbf{d = k - h}$ where d = depth to water; k = constant; and h = height of the water displaced from the air line. In wells where a pressure gage is used, h is equal to 2.31 ft/psi multiplied by the gage reading. The constant value for k is approximately equivalent to the length of the air line.

- Calibrate the air line by measuring an initial depth to water (d) below the RP with a graduated steel tape. Use a tire pump, air tank, or air compressor to pump compressed air into the air line until all the water is expelled from the line. When all the water is displaced from the line, record the stabilized gage reading (h). Add d to h to determine the constant value for k.
- To measure subsequent depths to water with the air line, expel all the water from the air line, subtract the gage reading (h) from the constant k, and record the result as depth to water (d) below the RP.

The air line method is not as accurate as a graduated steel tape or electric and is typically accurate to the nearest one foot at best. Errors can occur from leaky air lines, or when tubing becomes clogged with mineral deposits or bacterial growth. The air line method is not desirable for use in the Groundwater Monitoring Program.

Pressure Transducer

Electrical pressure transducers make it possible to collect frequent and long-term water level or pressure data from wells. These pressure-sensing devices, installed at a fixed depth in a well, sense the change in pressure against a membrane. The pressure changes occur in response to changes in the height of the water column in the well above the transducer membrane. To compensate for atmospheric changes, transducers may have vented cables or they can be used in conjunction with a barometric transducer that is installed in the same well or a nearby observation well above the water level.

Transducers are selected on the basis of expected water level fluctuation. The smallest range in water levels provides the greatest measurement resolution. Accuracy is generally 0.01 to 0.1 percent of the full scale range.

Retrieving data in the field is typically accomplished by downloading data through a USB connection to a portable computer or data logger. A site visit to retrieve data should involve several steps designed to safeguard the stored data and the continued useful operation of the transducer:

- Inspect the wellhead and check that the transducer cable has not moved or slipped (the cable can be marked with a reference point that can be used to identify movement);
- Ensure that the instrument is operating properly;
- Measure and record the depth to water with a graduated steel or electric tape;
- Document the site visit, including all measurements and any problems;
- Retrieve the data and document the process;
- Review the retrieved data by viewing the file or plotting the original data;
- Recheck the operation of the transducer prior to disconnecting from the computer.

A field notebook with a checklist of steps and measurements should be used to record all field observations and the current data from the transducer. It provides a historical record of field activities. In the office, maintain a binder with field information similar to that recorded in the field notebook so that a general historical record is available and can be referred to before and after a field trip.

Quality Control

The field technician should compare water level measurements collected at each well with the available historical information to identify and resolve anomalous and potentially erroneous measurements prior to moving to the next well location. Pertinent information, such as insufficient recovery of a pumping well, proximity to a pumping well, falling water in the casing, and changes in the measurement method, sounding equipment, reference point, or groundwater conditions should be noted. Office review of field notes and measurements should also be performed by a second staff member.

Groundwater Sampling Procedures for the
Los Osos Basin Plan Groundwater Monitoring Program

Introduction

This document establishes groundwater sampling procedures for the Los Osos Basin Plan (LOBP) Groundwater Monitoring Program. Groundwater sampling procedures facilitate obtaining a representative groundwater sample from an aquifer for water quality analysis. The water sampling procedures for general mineral and dissolved nitrogen sampling are presented below, along with special procedures for collecting samples for analyzing Constituents of Emerging Concern (CECs).

References

The procedures used for the LOBP Groundwater Monitoring Program have been developed through consideration of the constituents of analysis, well construction and type, and a review of the following references:

- U.S. Environmental Protection Agency, 1999, *Compendium of ERT Groundwater Sampling Procedures*, EPA/540/P-91/007, January 1999. https://www.epa.gov/sites/production/files/2015-06/documents/fieldsamp- ertsops.pdf
- Wilde, F. D., 2004, *Cleaning of Equipment for Water Sampling* (ver 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapter A3, revised April 2004. http://water.usgs.gov/owq/FieldManual/chapter3/Ch3_contents.html
- Wilde, F. D., 2008, *Guidelines for Field-Measured Water Quality Properties* (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapter A6, Section 6, October 2008. http://water.usgs.gov/owq/FieldManual/Chapter6/6.0_contents.html

Well Information

Table 1 below lists important well information to be maintained in a well file or in a field notebook. Additional information that should be available to the person collecting groundwater samples include a description of access to the property and the well, the presence and depth of cascading water, or downhole obstructions that could interfere with sampling equipment.

Table 1
Well File Information

Well Completion Report	Hydrologic Information	Additional Information to be Recorded
Well name	Map showing basin boundaries and wells	Township, Range, and ¼ ¼ Section
Well Owner	Name of groundwater basin	Latitude and Longitude (Decimal degrees)
Drilling Company	Description of aquifer	Assessor's Parcel Number
Location map or sketch	Confined, unconfined, or mixed aquifers	Description of well head and sounding access
Total depth	Pumping test data	Reference point elevations
Perforation interval	Hydrographs	Well use and pumping schedule if known
Casing diameter	Water quality data	Date monitoring began
Date of well completion	Property access instructions/codes	Land use

Groundwater Sampling Procedures

Non-equipped wells

1) Calibrate field monitoring instruments each day prior to sampling;
2) Inspect wellhead condition and note any maintenance required (perform at earliest convenience);
3) Measure depth to static water (record to 0.01 inches) from surveyed reference point;
4) Install temporary purge pump to at least three feet below the water surface (deeper setting may be needed if water level draw down is too great);
5) Begin well purge, record flow rate;
6) Measure discharge water EC (measured to 10 µmhos/cm), pH (measured to 0.01 units), and temperature (measured to 0.1 degrees C) at regular intervals during well purging. Record time and gallons purged. Note discharge water color, odor, and turbidity (visual);
7) A minimum of three casing volumes of water should be removed during purging, or one borehole volume opposite perforated interval, whichever is greater*. In addition, a set of at least three consecutive field monitoring measurements with stable values should be recorded. For EC, stability within 5 percent of the first value in the set is sufficient (typically within 20-50 µmhos/cm). For pH, stability within 0.3 units is sufficient. For temperature, stability within 0.2 degrees C is sufficient;
8) Collect sample directly from discharge tube, note sample color, odor, turbidity (visual). Use only laboratory-provided containers. Wear powder-free nitrile gloves when collecting groundwater samples;
9) Place samples on-ice for transport to the laboratory;
10) Remove temporary pump and rinse with clean water;
11) Close well and secure well box lid;

*note: If well is pumped dry at the minimum pumping rate, the well may be allowed to recover and then sampled by bailer within 24 hours.

Equipped wells

The sampling port for an equipped well must be upstream of any water filtration or chemical feeds. Sample from the discharge line as close to the wellhead as possible. Sampling procedures for equipped wells will vary. For active wells (i.e. wells used daily), the need for purging three casing volumes is unnecessary. Flush supply line from well or holding tank to sampling port, and record one set of EC, pH, and temperature readings prior to sampling. For inactive wells, a field monitoring procedure similar to that described for non-equipped wells above is appropriate. Static water level measurements should also be taken before sampling. Water samples should always be transported on-ice to the laboratory.

Chain-of-Custody

The chain-of-custody and associated sample bottle labels are used to document sample identification, specify the analyses to be performed, and trace possession and handling of a sample from the time of collection through delivery to the analytical laboratory. The sampler should fill out the sample identification labels and affix them to the sample bottles prior to, or upon, sample collection. A chain-of-custody form should be filled out by the sampler and a signature and date/time of sample transfers are required for each relinquishing and receiving party between sample collection and laboratory delivery.

Groundwater Sampling Equipment Decontamination

Field equipment should be cleaned prior to the sampling event and between sampling locations. Sampling pumps and hand bailers should be brushed with a nylon-bristle brush using a solution of 0.1 to 0.2-percent (volume/volume) non-phosphate soap in municipal-source tap water. The equipment should then be triple-rinsed with deionized water. Purge the pump hose of well water between sampling locations by pumping deionized through the hose. Groundwater sampling equipment should be protected from contact with the ground, or other potentially contaminating materials, at all times.

Special procedures for sampling for CEC compounds from unequipped well:

1) A new, teflon-lined polyethylene discharge hose or bailer will be used at each unequipped well sampling location;
2) The sampling pump will be decontaminated prior to each well sampled: Decontamination will consist of brushing pump body, inlet screen, and submerged portion of power cable in a phosphate-free cleaning solution, followed by rinsing, pumping distilled water, and final rinse;

3) Personnel collecting the sample will use powder-free nitrile gloves and observe special precautions for testing as directed by the laboratory (such as no caffeinated drink consumption on day of sampling, standing downwind of sampling port during sample collection, double-bag sample bottles, etc.);
4) Equipment blanks of distilled water pumped through the sampling pump are recommended;
5) A clean water/travel blank of distilled water (from the same source used for pump decontamination) is recommended.

APPENDIX E

Land Use and Water Use Areas
(from LOBP)

Figure 5. Land Uses in the Plan Area

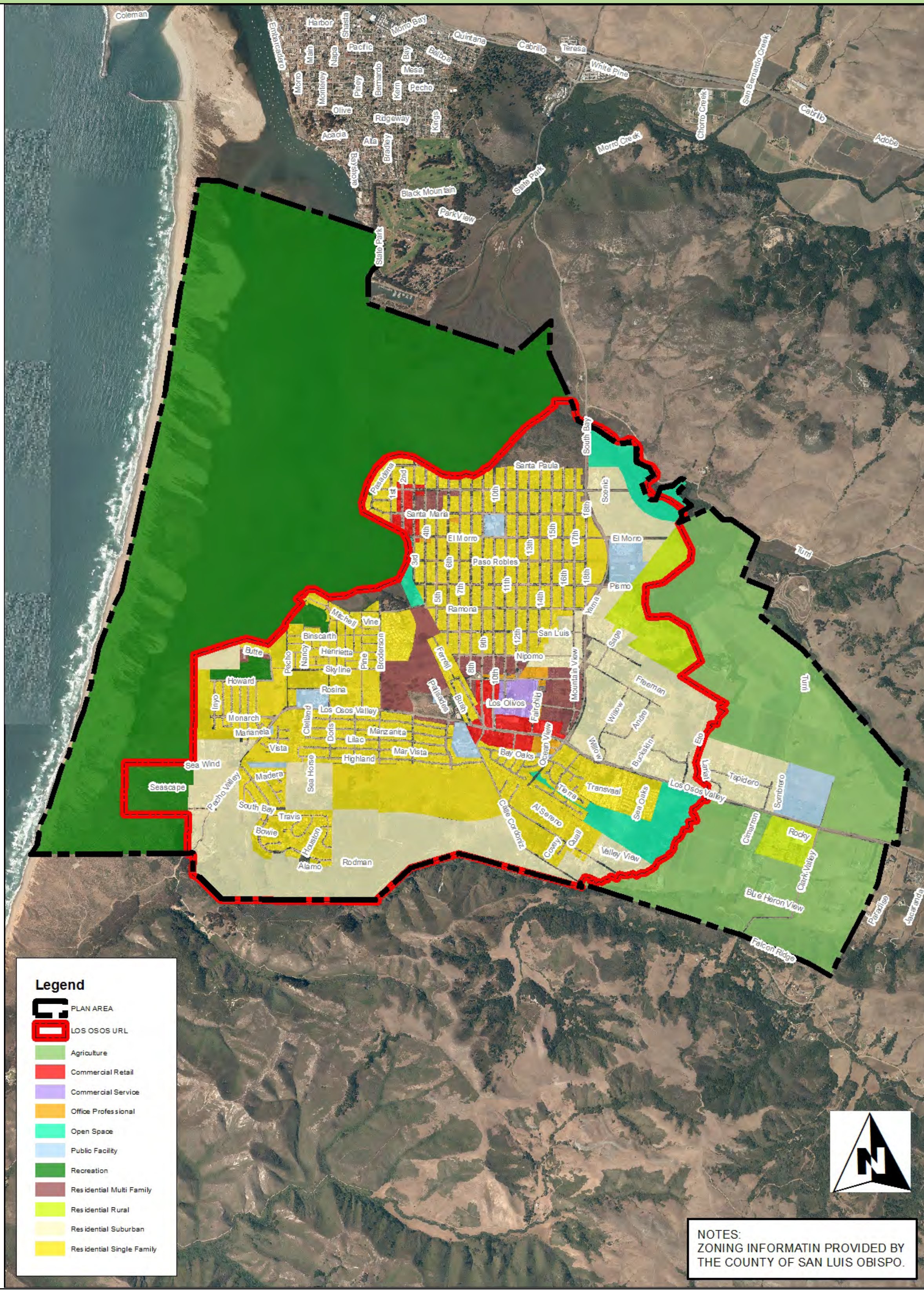
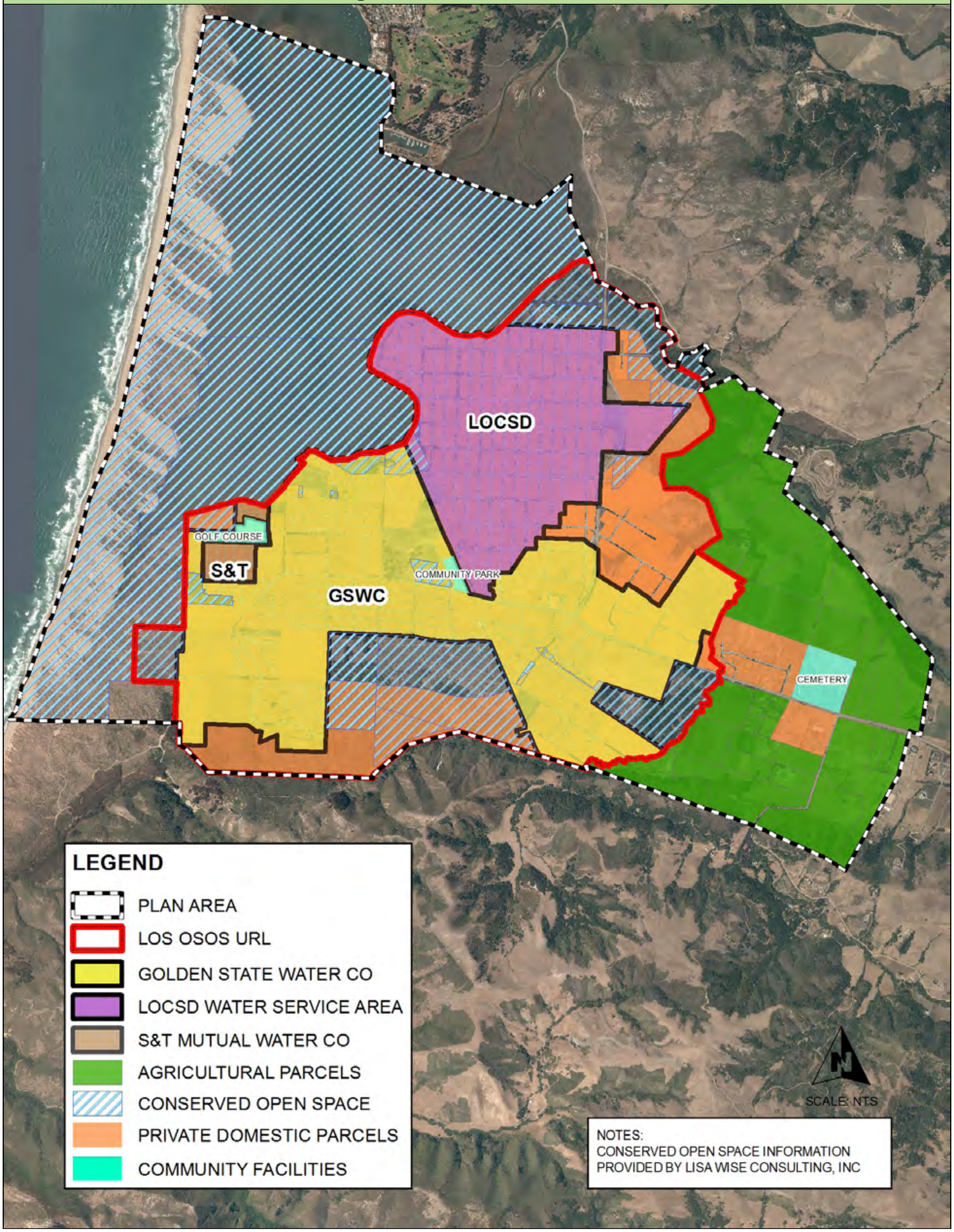


Figure 10. Water Use Areas



APPENDIX F

2017 Agricultural Water Use Estimates

Agriculture and Turf Applied Irrigation Water Estimate - 2017

Groundwater production estimates for agriculture and turf irrigation were developed using a daily soil-moisture budget with local data input. Sources of data included:

- The most recent land use survey by the County for estimating irrigated acreages (2016).
- Daily rainfall from County rain gage 727 (former Los Osos Landfill).
- Daily reference evapotranspiration from the California Irrigated Management Information System (CIMIS) Station 160 (San Luis Obispo West - Chorro Valley) located in DWR Climate Zone 6, which is the same climate zone as the Los Osos Valley.
- Water holding capacity and rooting depths from UC Davis Cooperative Extension at http://UCManageDrought.ucdavis.edu
- Crop Coefficients (Kc) from prior work in the Los Osos basin.

The soil-moisture budget methodology used accounts for soil holding capacity, crop rooting depth, leaching fraction, irrigation efficiency, local precipitation, and local reference evapotranspiration. The following equation, modified from a general formula for irrigation water requirements, was used for the soil-moisture budget (Carollo, 2012, modified from Burt et al., 2002):

Applied Irrigation Water = (ETc - ER) / (EF)

Where:

ETc [Crop evapotranspiration] = ETo [reference evapotranspiration] x Kc [crop coefficient]
ER [effective rainfall] = rainfall stored in soil and available to crop
EF [efficiency factor] = (1-LF[leaching fraction]) x IE [irrigation efficiency]
Assumes no frost protection for crops in the Los Osos Creek Valley.

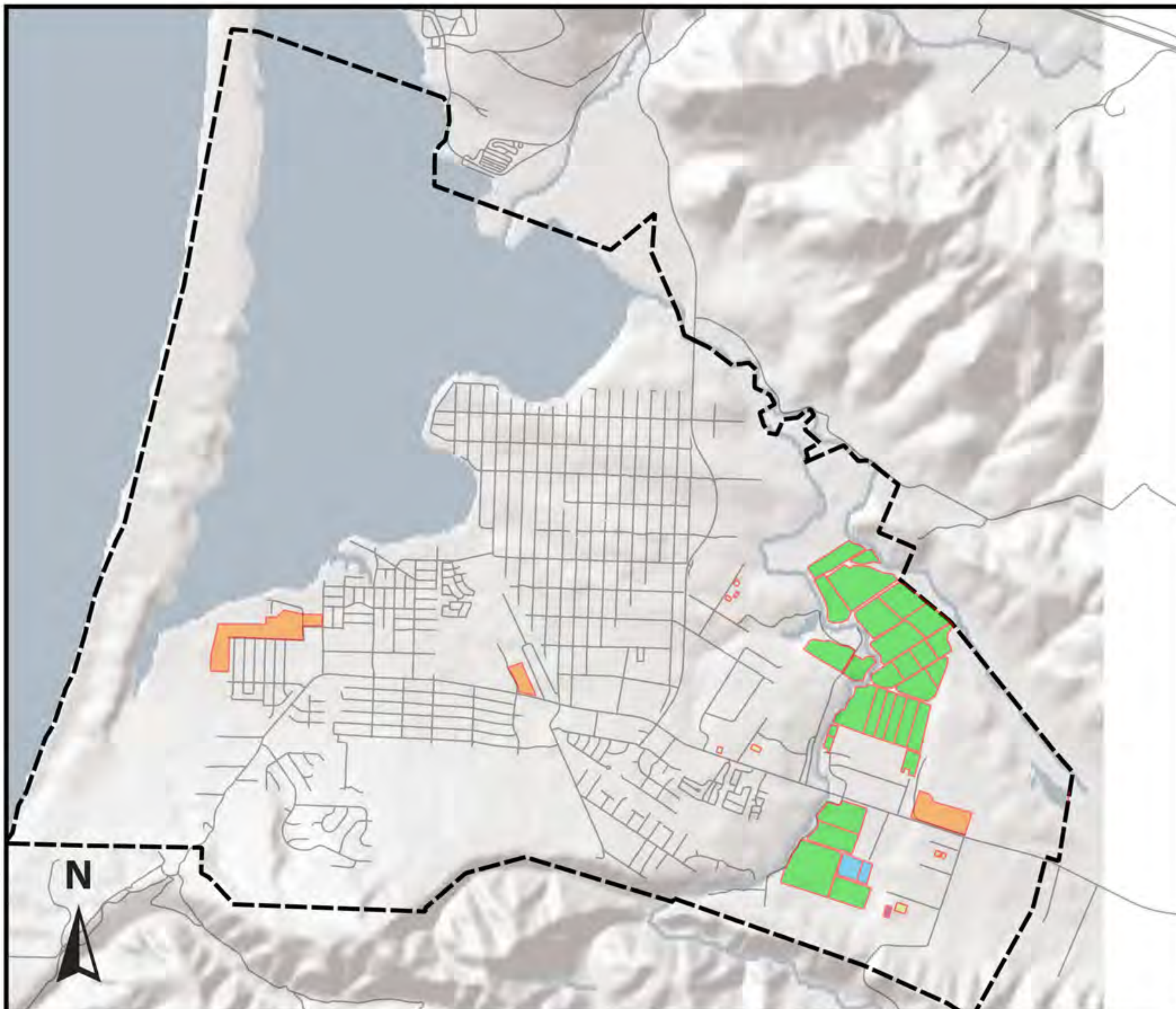
A land use survey map for 2016 is shown in Figure F-1. Irrigated acreages for 2017 will not be available until October 2018. Tabulation of the irrigated acreages is presented in Table F-1 below.

Table F-1
2016 County Crop Survey
Eastern Area

Crop Type	Acres
Nursery	1.8
Pasture[1]	8.7
Vegetables	279.6
Vineyard	0.8
Total	290.9

[1]Sod farm listed as nursery in survey

Crop acreages listed in Table F-1 are in the Eastern Area (Los Osos Creek Valley and Cemetery Mesa). In addition, the turf areas for community facilities were calculated from areal images. Table F-2 presents these areas below.



Base Image: ESRI Shaded Relief

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

Crop Type (2016 County of San Luis Obispo)

- Nursery
- Pasture
- Vegetables
- Vineyard

- Adjudicated Plan Area
- Community Facilities with Turf Areas

Figure F-1

Crop Types
County of San Luis Obispo
2016 Data
Los Osos Groundwater Basin

2017 Annual Report

Cleath-Harris Geologists

Table F-2
Community Irrigated Turf Areas

Location	Acres
Memorial Park	12.5
Community Park	1.2
Sea Pines	24

Turf areas for schools, parks, cemeteries, and golf courses are generally classified in land use surveys as urban landscape, rather than given an agricultural designation. Turf grown for sod farms falls under an agricultural classification (pasture). For the purposes of the soil-moisture budget, the turf for community facilities and sod farms are considered as pasture.

The soil-moisture budget was constructed as a spreadsheet. Irrigation was applied as needed to offset soil moisture deficits after accounting for crop evapotranspiration, rainfall, rooting depths, and soil holding capacities. An efficiency factor of 92 percent was estimated by calibrating the average annual irrigation requirement from a daily soil-moisture budget prepared for 2006-2008 to the irrigation estimate from prior work, which was also based on the 2006-2008 period (CHG, 2009b). Results of the soil-moisture budget method for estimating applied irrigation for agriculture and community facilities are included in tables below.

Table F-3
Soil-Moisture Budget Results (Vegetables)

Year	Irrigation demand	ETo	ETc	Precip*
	(inches)			
2006	17.34	46.45	30.06	21.23
2007	25.14	50.78	32.79	7.93
2008	25.12	49.64	31.51	14.55
2017	24.92	51.19	33.18	19.74

*calendar year

Table F-4
Soil-Moisture Budget Results (Pasture/Turf)

Year	Irrigation demand	ETo	ETc	Precip*
	(inches)			
2006	27.77	46.45	46.45	21.23
2007	43.45	50.78	50.78	7.93
2008	40.49	49.64	49.64	14.55
2017	41.27	51.19	51.19	19.74

*calendar year

Table F-5
Applied Irrigation for Agriculture

Description	Units	Average 2006-2008	2017
Irrigation demand vegetables	inches	22.53	24.92[1]
Irrigation demand pasture	inches	37.24	41.27[2]
Irrigation Efficiency Factor[3]	factor	0.92	0.92
Applied irrigation vegetables	feet	2.04	2.26
Applied irrigation pasture	feet	3.37	3.74
Vegetables acreage[4]	acres	339	282.2
Vegetables applied water	acre-feet	692	637.8
Pasture acreage[4]	acres	18.3	8.7
Pasture applied water	acre-feet	61.7	32.5
TOTAL applied agricultural irrigation	acre-feet	754	670
TOTAL from CHG (2009b)	acre-feet	750	--

[1]From Table F-3;
[2]From Table F-4;
[3]Efficiency factor used to calibrate 2006-2008 total
[4]2006-2008 acreage from CHG, 2009b (excludes memorial park);
"--" = no value for this cell
2017 acreage from County GIS 2016 (1 vineyard and 1.8 nursery acres counted as 2.2 acres in vegetables, based on equivalent water demand conversion using 2012 County Master Water Plan Table A1 [Carollo, 2012]).

Table F-6
2017 Applied Irrigation for Community Facilities

Description	Units	Memorial Park	Sea Pines Golf*	Community Park	Total
Turf Area (from Table F-2)	acres	12.5	24	1.2	37.7
Applied Irrigation (from Table F-5)	feet	3.74	3.74	3.74	3.74
TOTAL Applied Irrigation	acre-feet	46.8	89.8	4.5	140

*includes estimated 15 acre-feet of recycled water (75 acre-feet net production)

Results of the soil-moisture budget show that both the quantity and timing of rainfall during the year affects the applied irrigation estimates. Tables F-3 and F-4 present irrigation demand for two above-normal rainfall years (2006 and 2017) and two below-normal rainfall years (2007 and 2008). While the below-normal rainfall years (2007 and 2008) have the highest irrigation demand, as expected, 2017 also has an irrigation demand similar to the below-normal rainfall years, despite being an above-normal rainfall year. This is due to the timing of rainfall during the year.

In 2017, the majority of rainfall (16.7 inches) fell in January and February, when crop evapotranspiration (ETc) is at the lowest level of the year, leaving only 3 inches to offset irrigation demand in other high ETc months. By comparison, 8.2 inches of rain was measured in January and February 2006, leaving 13 inches to help meet irrigation demand in months with higher ETc values. The soil-moisture budget shows that effective rainfall was much greater in 2006 than 2017 (Tables F-3 and F-4).

Table F-5 summarizes the estimated applied irrigation for the various agricultural land uses. Due to the relatively minor acreage involved, vineyard and nursery were converted to equivalent acres in vegetables based on water demand estimates from the County Water master Plan table A1 (Carollo, 2012). The soil-moisture budget methodology resulted in an estimate of 754 acre-feet of applied irrigation for average 2006-2008 conditions, compared to the original estimate of 750 acre-feet per year (CHG, 2009b). The estimated applied irrigation for calendar year 2017 is 670 acre-feet.

Table F-6 summarizes the estimated applied irrigation for community facilities. The total estimated water demand for community facilities in the 2017 calendar year was 140 acre-feet.

A portion of the soil-moisture budget spreadsheet covering the month of November 2017 is attached, along with sample calculations. November 2017 included days with effective rainfall and with irrigation demand.

Sample Calculations:
Daily Soil-Moisture Budget

NOTE: Wilting point (maximum allowable deficit), irrigation efficiencies, leaching fraction, and specific growing season dates are collectively approximated with the Efficiency Factor (EF), which calibrates the soil-moisture budget results to the prior estimates for 2006-2008 (CHG, 2009b). The soil-moisture budget is a tool developed to assist basin management and is not an irrigation schedule.

[A], [B]: Date used for sample calculation: November 9, 2017 (highlighted on soil-moisture budget page)
[C]: ETo = 0.06 inches
[D]: Kc = 0.46
[E]: ETc = ETo*Kc = 0.028 inches
[F]: Precipitation + Irrigation = **[N]** + **[M]** = 0.12 inches + 0 inches = 0.12 inches
[G]: Water Available from Soil Profile = WHC of active root zone (4 inches) + soil moisture deficit on November 8 (-3.99 inches)= 0.01 inches
[H]: ETc Met by Precipitation + Irrigation = **[E]** *OR* **[F],** whichever is smaller. In this case both are equal, so **[H]** = 0.12 inches
[I]: ETc Met by Profile = **[G]** *OR* (**[E]** - **[H]**), whichever is smaller, in this case **[E]** - **[H]** = 0 inches
[J] Precip Available for Profile = **[F]** - **[H]** = 0.12 inches -0.03 inches = 0.09 inches
[K] Soil Moisture Deficit = whichever is greater between (a) -WHC (-4.0 inches) and (b) minimum of either (c) 0 inches or (d) November 8 Soil Moisture Deficit (-3.99 inches) - **[I]** **(**0 inches) + **[J]** (0.09 inches) = -3.90 inches. In this case (d) is less than (c) and greater than (a), therefore **[K]** = (d) = -3.90 inches
[L] Monthly Deep Percolation and Runoff = whichever is greater between (a) 0 inches and (b) Nov 8 Soil Moisture Deficit (-3.99 inches) + **[J]** (0.09 inches) = -3.90 inches, therefore **[L]** = 0 inches
[M] Irrigation Demand = **[E]** - **[N]** - **[G]** if greater than zero, otherwise 0 inches. In this case [M]= 0 inches
[N] Precipitation = 0.12 inches

[A], [B]: Date used for sample calculation: November 17, 2017 (highlighted on soil-moisture budget page)
[C]: ETo = 0.08 inches
[D]: Kc = 0.46
[E]: ETc = ETo*Kc = 0.037 inches
[F]: Precipitation + Irrigation = **[N]** + **[M]** = 0 inches + 0.015 inches = 0.015 inches
[G]: Water Available from Soil Profile = WHC of active root zone (4 inches) + soil moisture deficit on November 16 (-3.978 inches)= 0.022 inches
[H]: ETc Met by Precipitation + Irrigation = **[E]** *OR* **[F],** whichever is smaller. In this case **[E]** is greater, so **[H]** = 0.037 inches
[I]: ETc Met by Profile = **[G]** *OR* (**[E]** - **[H]**), whichever is smaller. In this case both are equal, so **[I]** = 0.022 inches
[J] Precip Available for Profile = **[F]** - **[H]** = 0.015 inches - 0.015 inches = 0 inches
[K] Soil Moisture Deficit = whichever is greater between (a) -WHC (-4.0 inches) and (b) minimum of either (c) 0 inches or (d) November 16 Soil Moisture Deficit (-3.978 inches) - **[I]** **(**0.022 inches) + **[J]** (0 inches) = -4.00 inches. In this case (d) is less than (c) and equal to (a), therefore **[K]** = (a,d) = -4.00 inches
[L] Monthly Deep Percolation and Runoff = whichever is greater between (a) 0 inches and (b) Nov 16 Soil Moisture Deficit (-3.978 inches) + **[J]** (0 inches) = -3.978 inches, therefore **[L]** = 0 inches
[M] Irrigation Demand = **[E]** (0.037 inches) - **[N]** (0 inches) - **[G]** (0.022 inches) if greater than zero, otherwise 0 inches. On this date **[M]** = 0.015 inches
[N] Precipitation = 0 inches

Water Holding Capacity (WHC) (in/ft)	**2**
Active Root Zone Depth (ft)	**2.0**
WHC of Active Root Zone (in)	**4.0**
Crop Coeficient (Kc)	**Variable**

Highlighted rows used for example calculations

[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]	[M]	[N]
Day	Month	Refernce ET (ETo) CIMIS Sta. 160	Crop Coefficient (Kc)	Crop ET (ETc)	Precipitation + Irrigation	Water Available from Soil Profile	ETc met by Precipitation + Irrigation	ETc met by Profile	Precip Available for Profile	Soil Moisture Deficit	Monthly Deep Percolation and Runoff	Irrigation Demand	Precip Sta. 727
2017		(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
1	November	0.100	0.460	0.046	0.040	0.006	0.040	0.006	0.000	-4.000	0.000	0.040	0.000
2		0.070	0.460	0.032	0.032	0.000	0.032	0.000	0.000	-4.000	0.000	0.032	0.000
3		0.040	0.460	0.018	0.030	0.000	0.018	0.000	0.012	-3.988	0.000	0.000	0.030
4		0.050	0.460	0.023	0.011	0.012	0.011	0.012	0.000	-4.000	0.000	0.011	0.000
5		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
6		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
7		0.110	0.460	0.051	0.051	0.000	0.051	0.000	0.000	-4.000	0.000	0.051	0.000
8		0.070	0.460	0.032	0.040	0.000	0.032	0.000	0.008	-3.992	0.000	0.000	0.040
9		0.060	0.460	0.028	0.120	0.008	0.028	0.000	0.092	-3.900	0.000	0.000	0.120
10		0.100	0.460	0.046	0.000	0.100	0.000	0.046	0.000	-3.946	0.000	0.000	0.000
11		0.100	0.460	0.046	0.000	0.054	0.000	0.046	0.000	-3.992	0.000	0.000	0.000
12		0.060	0.460	0.028	0.019	0.008	0.019	0.008	0.000	-4.000	0.000	0.019	0.000
13		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
14		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
15		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
16		0.040	0.460	0.018	0.040	0.000	0.018	0.000	0.022	-3.978	0.000	0.000	0.040
17		0.080	0.460	0.037	0.015	0.022	0.015	0.022	0.000	-4.000	0.000	0.015	0.000
18		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
19		0.080	0.460	0.037	0.037	0.000	0.037	0.000	0.000	-4.000	0.000	0.037	0.000
20		0.090	0.460	0.041	0.041	0.000	0.041	0.000	0.000	-4.000	0.000	0.041	0.000
21		0.120	0.460	0.055	0.055	0.000	0.055	0.000	0.000	-4.000	0.000	0.055	0.000
22		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
23		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
24		0.140	0.460	0.064	0.064	0.000	0.064	0.000	0.000	-4.000	0.000	0.064	0.000
25		0.100	0.460	0.046	0.046	0.000	0.046	0.000	0.000	-4.000	0.000	0.046	0.000
26		0.060	0.460	0.028	0.160	0.000	0.028	0.000	0.132	-3.868	0.000	0.000	0.160
27		0.090	0.460	0.041	0.080	0.132	0.041	0.000	0.039	-3.829	0.000	0.000	0.080
28		0.110	0.460	0.051	0.000	0.171	0.000	0.051	0.000	-3.880	0.000	0.000	0.000
29		0.150	0.460	0.069	0.000	0.120	0.000	0.069	0.000	-3.949	0.000	0.000	0.000
30		0.100	0.460	0.046	0.000	0.051	0.000	0.046	0.000	-3.995	0.000	0.000	0.000

APPENDIX G

Precipitation and Streamflow Data

San Luis Obispo County Public Works

Recording Rain Station

MONTHLY PRECIPITATION REPORT

Station Name - Los Osos Landfill # 727

Station Location -

Latitude - 35° 19' 19"

Longitude - 120° 48' 03"

Description - Northeast Los Osos South of Turri Road

Water Years -

Beginning - 2005-2006

Ending - 2017-2018

Station Statistics -

Month	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
Minimum	0.00	0.00	0.00	0.00	0.04	0.12	0.00	0.35	0.00	0.20	0.00	0.00	6.81
Average	0.15	0.02	0.08	1.00	0.93	2.77	3.92	3.02	2.14	0.95	0.33	0.12	15.79
Maximum	1.93	0.20	0.63	6.22	2.76	11.46	10.47	7.65	8.03	3.70	2.64	1.10	31.77

Notes -

Earlier data may be available. Contact Public Works for more information.

San Luis Obispo County Public Works

Recording Rain Station

MONTHLY PRECIPITATION REPORT

Station Name and no. Los Osos Landfill # 727

*** All units are in inches ***

Water Year	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Total
2017-2018	0.00	0.00	0.16	0.16	0.47	0.12	3.78						
2016-2017	0.00	0.00	0.00	1.65	2.76	3.39	9.02	7.65	1.34	0.55	0.27	0.00	26.63
2015-2016	1.93	0.00	0.08	0.08	1.26	1.85	5.04	0.86	4.85	0.20	0.00	0.00	16.15
2014-2015	0.00	0.00	0.00	0.00	0.28	5.20	0.08	0.91	0.43	0.67	0.12	0.00	7.68
2013-2014	0.00	0.00	0.00	0.24	0.28	0.12	0.00	4.06	1.42	0.71	0.00	0.00	6.81
2012-2013	0.00	0.00	0.00	1.18	1.69	2.64	1.02	0.67	0.43	0.31	0.12	0.04	8.11
2011-2012	0.00	0.08	0.04	1.06	2.17	0.16	2.28	0.35	2.68	2.24	0.00	0.00	11.06
2010-2011	0.00	0.00	0.12	1.54	1.85	11.46	3.03	3.78	8.03	0.28	0.59	1.10	31.77
2009-2010	0.00	0.00	0.04	6.22	0.04	2.87	9.76	4.13	1.14	1.93	0.04	0.00	26.18
2008-2009	0.00	0.00	0.00	0.04	0.04	0.75	0.71	4.61	1.06	0.20	0.20	0.35	7.95
2007-2008	0.00	0.00	0.00	0.43	0.12	2.68	10.47	2.99	0.00	0.24	0.00	0.00	16.93
2006-2007	0.00	0.00	0.00	0.12	0.43	2.28	1.26	2.56	0.43	0.35	0.04	0.00	7.48
2005-2006	0.04	0.20	0.63	0.24	0.75	2.52	4.45	3.70	3.90	3.70	2.64	0.00	22.76

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2017-2018**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1													1
2													2
3					0.03								3
4							0.19						4
5													5
6													6
7													7
8					0.04		1.42						8
9					0.12		1.77						9
10			0.08										10
11			0.08										11
12													12
13													13
14													14
15													15
16					0.04								16
17													17
18							0.08						18
19							0.08						19
20				0.12		0.12							20
21													21
22													22
23													23
24													24
25							0.24						25
26					0.16								26
27					0.08								27
28													28
29													29
30													30
31				0.04									31

Total	0.00	0.00	0.16	0.16	0.47	0.12	3.78						
Cum. Total	0.00	0.00	0.16	0.32	0.79	0.91	4.69	4.69	4.69	4.69	4.69	4.69	

Season Total **4.69**

San Luis Obispo County Public Works

DAILY PRECIPITATION

(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2016-2017**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1													1
2								0.24					2
3								0.16					3
4							2.25						4
5							0.23	0.55	0.35				5
6								0.51					6
7							0.52	0.63		0.15	0.27		7
8						1.18	1.10	0.04		0.04			8
9						0.08	0.12	0.28					9
10						0.12	0.23	0.43					10
11							0.04	0.04					11
12							0.59						12
13										0.08			13
14										0.04			14
15				0.08		1.07							15
16				0.08		0.55		0.31					16
17				0.08				3.27		0.08			17
18							0.56	0.32		0.16			18
19							0.27	0.08					19
20					1.90		1.22	0.51					20
21					0.04		0.16	0.24	0.20				21
22							1.26		0.47				22
23						0.35	0.43						23
24							0.04		0.12				24
25									0.20				25
26					0.67			0.04					26
27				0.67	0.15								27
28				0.71									28
29													29
30				0.03		0.04							30
31													31
Total	0.00	0.00	0.00	1.65	2.76	3.39	9.02	7.65	1.34	0.55	0.27	0.00	
Cum. Total	0.00	0.00	0.00	1.65	4.41	7.80	16.82	24.47	25.81	26.36	26.63	26.63	

Season Total **26.63**

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2015-2016**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1													1
2					0.59								2
3						0.04							3
4				0.04									4
5							1.02		1.54				5
6							0.75		0.35				6
7							0.23		1.06				7
8					0.23					0.08			8
9					0.04		0.04						9
10					0.04	0.04	0.08		0.04				10
11						0.39			1.22				11
12													12
13						0.08	0.04		0.36				13
14			0.08						0.20				14
15				0.04	0.28		0.04						15
16							0.08						16
17								0.67					17
18							0.28	0.19					18
19	1.69					0.51	0.86						19
20	0.24								0.04				20
21						0.28			0.04				21
22						0.47	0.16			0.12			22
23							0.08						23
24						0.04							24
25					0.08								25
26													26
27													27
28													28
29													29
30							0.27						30
31							1.11						31
Total	1.93	0.00	0.08	0.08	1.26	1.85	5.04	0.86	4.85	0.20	0.00	0.00	
Cum. Total	1.93	1.93	2.01	2.09	3.35	5.20	10.24	11.10	15.95	16.15	16.15	16.15	

Season Total **16.15**

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2014-2015**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1									0.43				1
2						0.51							2
3													3
4						0.67							4
5						0.04							5
6								0.12					6
7								0.51					7
8					0.04			0.20					8
9													9
10								0.08					10
11					0.04	1.22							11
12						1.22							12
13					0.04								13
14											0.12		14
15						0.71				0.47			15
16						0.71							16
17						0.08							17
18						0.04							18
19					0.08								19
20													20
21													21
22					0.04								22
23													23
24													24
25										0.20			25
26													26
27							0.08						27
28													28
29					0.04								29
30													30
31													31

Total	0.00	0.00	0.00	0.00	0.28	5.20	0.08	0.91	0.43	0.67	0.12	0.00	
Cum. Total	0.00	0.00	0.00	0.00	0.28	5.47	5.55	6.46	6.89	7.56	7.68	7.68	

Season Total **7.68**

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2013-2014**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1									0.59	0.24			1
2								0.87	0.20	0.28			2
3								0.04					3
4													4
5													5
6								0.31					6
7						0.12							7
8								0.04					8
9								0.04					9
10								0.08					10
11													11
12													12
13													13
14								0.04					14
15													15
16													16
17													17
18													18
19													19
20					0.20								20
21					0.08								21
22													22
23													23
24													24
25										0.16			25
26								0.87	0.04	0.04			26
27								0.28					27
28				0.24				1.50					28
29									0.16				29
30									0.04				30
31									0.39				31

Total	0.00	0.00	0.00	0.24	0.28	0.12	0.00	4.06	1.42	0.71	0.00	0.00	
Cum. Total	0.00	0.00	0.00	0.24	0.51	0.63	0.63	4.69	6.10	6.81	6.81	6.81	

Season Total **6.81**

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2012-2013**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1						0.12				0.28			1
2						0.55							2
3													3
4										0.04			4
5							0.39						5
6							0.31				0.12		6
7									0.24				7
8								0.47	0.08				8
9					0.04								9
10				0.24									10
11				0.87									11
12						0.04							12
13													13
14									0.04				14
15						0.04							15
16					0.08	0.08							16
17					0.47	0.16							17
18					0.24								18
19								0.20					19
20													20
21				0.04									21
22						0.75							22
23						0.24							23
24							0.28					0.04	24
25						0.28	0.04						25
26						0.04							26
27													27
28					0.55								28
29					0.08	0.35							29
30				0.04	0.24				0.04				30
31									0.04				31
Total	0.00	0.00	0.00	1.18	1.69	2.64	1.02	0.67	0.43	0.31	0.12	0.04	
Cum. Total	0.00	0.00	0.00	1.18	2.87	5.51	6.54	7.20	7.64	7.95	8.07	8.11	

Season Total **8.11**

San Luis Obispo County Public Works

DAILY PRECIPITATION

(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2011-2012**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1													1
2													2
3				0.08	0.04								3
4				0.04	0.28								4
5				0.91									5
6					0.28								6
7								0.04					7
8													8
9													9
10				0.04				0.04		0.55			10
11					0.31					0.16			11
12						0.16				0.28			12
13								0.08		1.02			13
14													14
15								0.08					15
16									0.12				16
17									1.46				17
18									0.12				18
19													19
20					1.26		0.20						20
21							0.87						21
22													22
23							1.22						23
24													24
25									0.63	0.20			25
26		0.04								0.04			26
27													27
28									0.16				28
29								0.12					29
30		0.04	0.04										30
31									0.20				31

Total	0.00	0.08	0.04	1.06	2.17	0.16	2.28	0.35	2.68	2.24	0.00	0.00	
Cum. Total	0.00	0.08	0.12	1.18	3.35	3.50	5.79	6.14	8.82	11.06	11.06	11.06	

Season Total **11.06**

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2010-2011**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1							0.39						1
2							2.52		0.08				2
3													3
4			0.04			0.04			0.04			0.59	4
5				0.31		0.75						0.35	5
6				0.24	0.04				0.12			0.12	6
7					0.47								7
8													8
9						0.04							9
10					0.04								10
11									0.04				11
12													12
13						0.04							13
14								0.04					14
15						0.04					0.16		15
16								0.59	0.08		0.16		16
17			0.04	0.04		0.43		0.47			0.16		17
18				0.08		2.95		1.54	0.47		0.08		18
19					0.24	2.24		0.55	2.28				19
20			0.04		0.71	1.06		0.04	2.91				20
21				0.04	0.24	0.35			0.24	0.28			21
22				0.04		1.57			0.04				22
23				0.08	0.12				0.87				23
24				0.28					0.63				24
25						0.79		0.51	0.04				25
26								0.04	0.16				26
27													27
28						0.31			0.04				28
29				0.35		0.83					0.04	0.04	29
30				0.08									30
31							0.12						31
Total	0.00	0.00	0.12	1.54	1.85	11.46	3.03	3.78	8.03	0.28	0.59	1.10	
Cum. Total	0.00	0.00	0.12	1.65	3.50	14.96	17.99	21.77	29.80	30.08	30.67	31.77	

Season Total **31.77**

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2009-2010**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1										0.04			1
2									0.08				2
3									0.43				3
4								0.08	0.04				4
5								0.51		0.31			5
6								0.39	0.20				6
7						0.47							7
8									0.04				8
9								0.63					9
10						0.75			0.04				10
11										0.98			11
12						1.22	0.51		0.08	0.08			12
13				5.43		0.04	0.31	0.04					13
14				0.79		0.04							14
15													15
16													16
17							0.55				0.04		17
18							1.14						18
19							0.91						19
20					0.04		2.36	0.04		0.51			20
21						0.16	2.01	0.12					21
22							1.22		0.04				22
23			0.04				0.04	0.04					23
24								0.39					24
25													25
26							0.59	1.42					26
27						0.08		0.47					27
28													28
29							0.08		0.04				29
30						0.12	0.04		0.04				30
31									0.12				31
Total	0.00	0.00	0.04	6.22	0.04	2.87	9.76	4.13	1.14	1.93	0.04	0.00	
Cum. Total	0.00	0.00	0.04	6.26	6.30	9.17	18.94	23.07	24.21	26.14	26.18	26.18	

Season Total **26.18**

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2008-2009**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1					0.04						0.04		1
2							0.08		0.16		0.12		2
3									0.59				3
4				0.04					0.08				4
5											0.04	0.35	5
6								0.87					6
7										0.20			7
8													8
9								1.10					9
10													10
11								0.04					11
12								0.04					12
13								0.63					13
14								0.04					14
15													15
16						0.12							16
17								1.10					17
18													18
19													19
20													20
21						0.08							21
22						0.43		0.47	0.24				22
23							0.51	0.31					23
24							0.12						24
25						0.12							25
26													26
27													27
28													28
29													29
30													30
31													31

Total	0.00	0.00	0.00	0.04	0.04	0.75	0.71	4.61	1.06	0.20	0.20	0.35	
Cum. Total	0.00	0.00	0.00	0.04	0.08	0.83	1.54	6.14	7.20	7.40	7.60	7.95	

Season Total **7.95**

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2007-2008**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1								0.08					1
2					0.04			0.24		0.20			2
3								1.02		0.04			3
4							3.66						4
5							0.20						5
6						0.24	0.39						6
7						0.08							7
8							0.08						8
9							0.04						9
10													10
11					0.08								11
12													12
13													13
14													14
15													15
16				0.28									16
17				0.08									17
18						2.24							18
19								0.20					19
20						0.12		0.16					20
21							0.08	0.08					21
22							2.32	0.12					22
23							1.06	0.87					23
24							0.87	0.24					24
25							0.31						25
26							0.63						26
27				0.08			0.67						27
28							0.08						28
29							0.04						29
30							0.04						30
31													31
Total	0.00	0.00	0.00	0.43	0.12	2.68	10.47	2.99	0.00	0.24	0.00	0.00	
Cum. Total	0.00	0.00	0.00	0.43	0.55	3.23	13.70	16.69	16.69	16.93	16.93	16.93	

Season Total **16.93**

San Luis Obispo County Public Works

DAILY PRECIPITATION

(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2006-2007**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1													1
2								0.04					2
3													3
4							0.12				0.04		4
5													5
6													6
7								0.20					7
8						0.39							8
9						0.94							9
10						0.31		0.71					10
11					0.08								11
12								0.04					12
13				0.08	0.20								13
14					0.08								14
15													15
16													16
17					0.04	0.04	0.04						17
18													18
19										0.04			19
20									0.28	0.24			20
21						0.04							21
22								0.87		0.08			22
23				0.04				0.12					23
24													24
25								0.08					25
26					0.04	0.43		0.16	0.08				26
27						0.12	0.83	0.20	0.08				27
28							0.20	0.16					28
29							0.08						29
30													30
31													31

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	
Total	0.00	0.00	0.00	0.12	0.43	2.28	1.26	2.56	0.43	0.35	0.04	0.00	
Cum. Total	0.00	0.00	0.00	0.12	0.55	2.83	4.09	6.65	7.09	7.44	7.48	7.48	

Season Total 7.48

San Luis Obispo County Public Works

DAILY PRECIPITATION
(inches)

Station Name and no. **Los Osos Landfill # 727** Season **2005-2006**

Day	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Day
1							1.61						1
2			0.63			0.55	2.32			0.24			2
3								0.04		1.18			3
4										0.59			4
5										0.39			5
6													6
7										0.08			7
8						0.47							8
9					0.59				0.04				9
10									0.28	0.43			10
11		0.16			0.04				0.12				11
12		0.04							0.28				12
13													13
14	0.04						0.24		0.04	0.04			14
15													15
16										0.08			16
17				0.12					0.24	0.04			17
18						0.16	0.16	3.66					18
19													19
20				0.04					0.35				20
21						0.04			0.04		2.60		21
22						0.04					0.04		22
23						0.04							23
24													24
25					0.08	0.12			0.12				25
26				0.08		0.04	0.08			0.63			26
27									0.43				27
28						0.12			1.38				28
29									0.16				29
30					0.04		0.04						30
31						0.94			0.43				31

Total	0.04	0.20	0.63	0.24	0.75	2.52	4.45	3.70	3.90	3.70	2.64	0.00	
Cum. Total	0.04	0.24	0.87	1.10	1.85	4.37	8.82	12.52	16.42	20.12	22.76	22.76	

Season Total **22.76**

Stream Flow

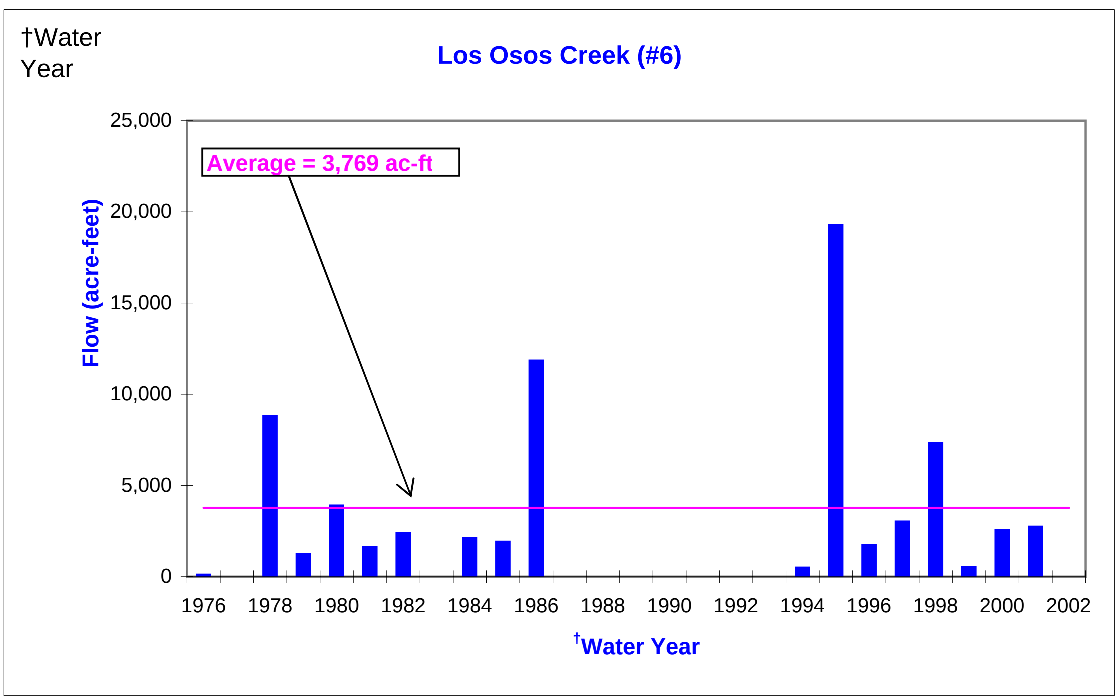
Stream Gage Name: **Los Osos Creek (#6)**
Water Planning Area: **3**

Water Year†	Annual Stream Flow (acre-feet)	Water Year†	Annual Stream Flow (acre-feet)
1976	110 [1]	1990	[9]
1977	0	1991	[10]
1978	8,810	1992	[11]
1979	1,240	1993	[12]
1980	3,890 [2]	1994	497
1981	1,630	1995	19,270
1982	2,390 [3]	1996	1,740
1983	[4]	1997	3,020
1984	2,110	1998	7,340
1985	1,920	1999	505
1986	11,850 [5]	2000	2,540
1987	[6]	2001	2,470
1988	[7]	2002	0
1989	[8]	2003	NA [13]

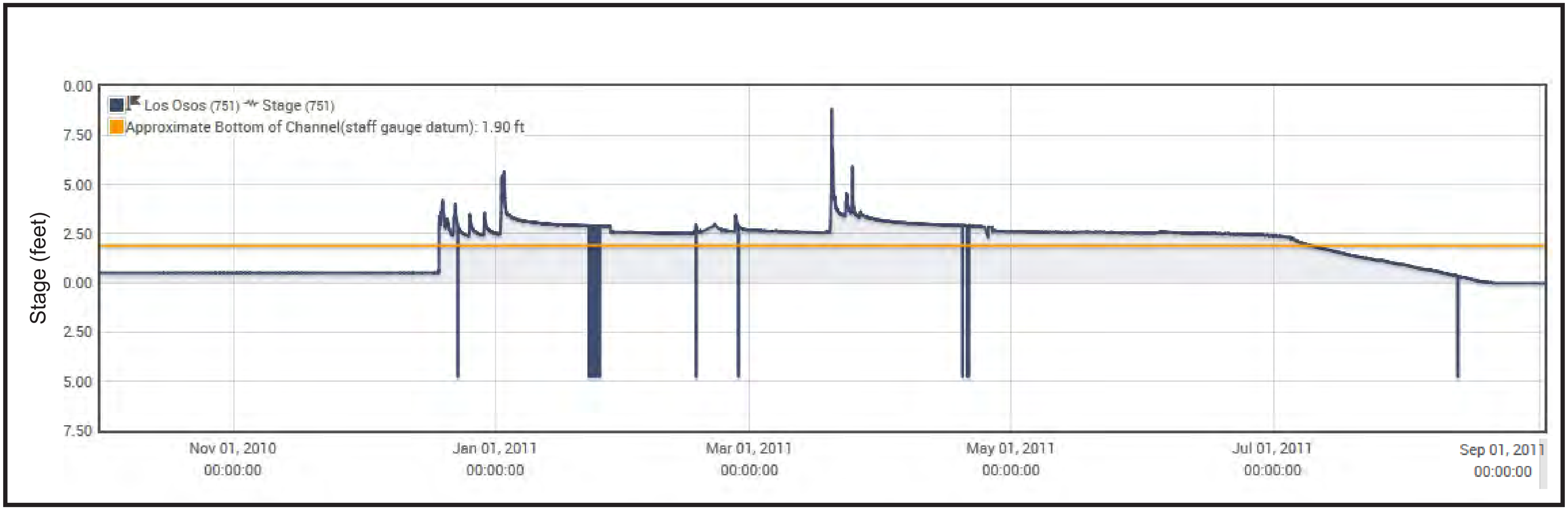
[1] gage put into operation in February
[2] missing data for one day in February
[3] missing data for various days in February, March, and April
[4] only visual observations were available for this year
[5] missing data for the end of February and beginning of March
[6-12] no data available for this time period
[13] Data not available at the time the report was published

(notations as recorded in San Luis Obispo County stream flow log books)

From Annual Stream Flow Records	
Average Flow:	3,769 AFY
Median Flow:	2,110 AFY
Minimum Flow (2002):	0 AFY
Maximum Flow (1995):	19,270 AFY

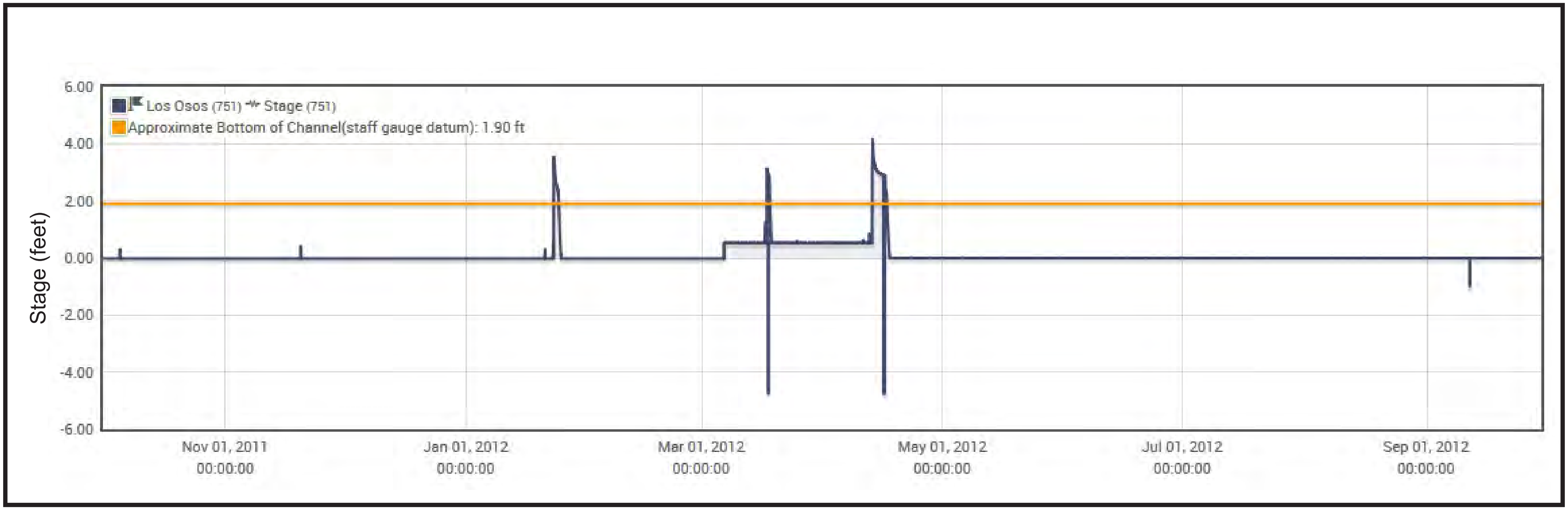


† October 1 - September 30



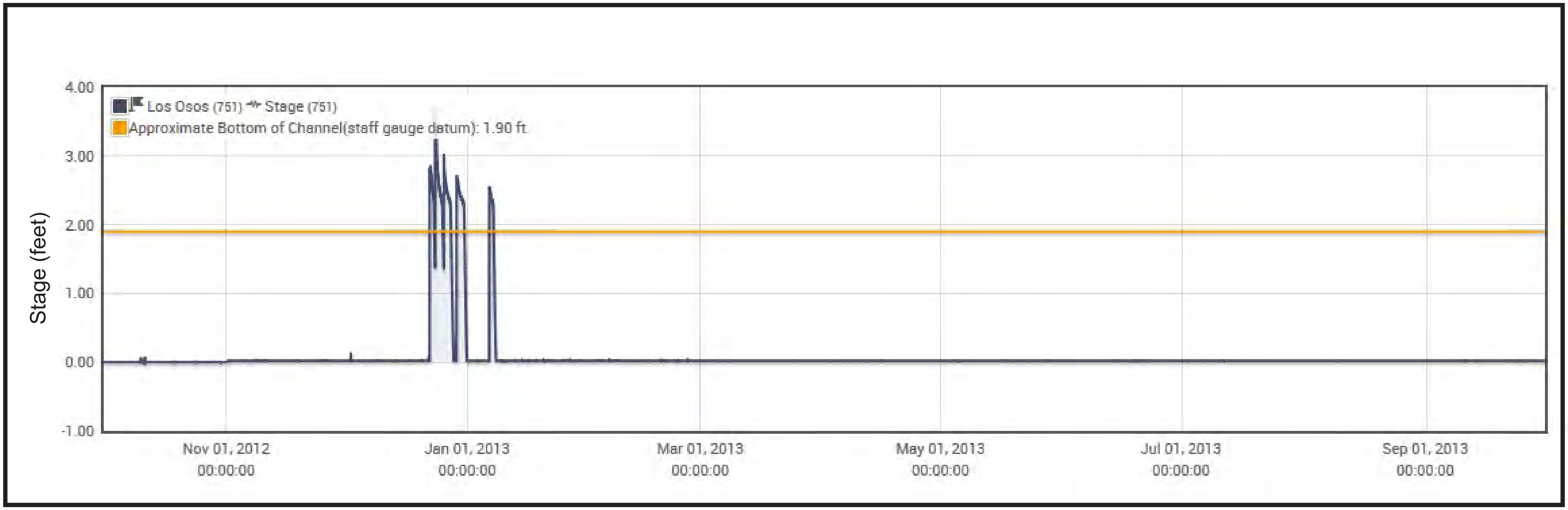
Source: County of San Luis Obispo Public Works Department, Stream Gage #751

Figure E1
Stream Stage for 2011 Water Year
Los Osos Creek, Gage #751



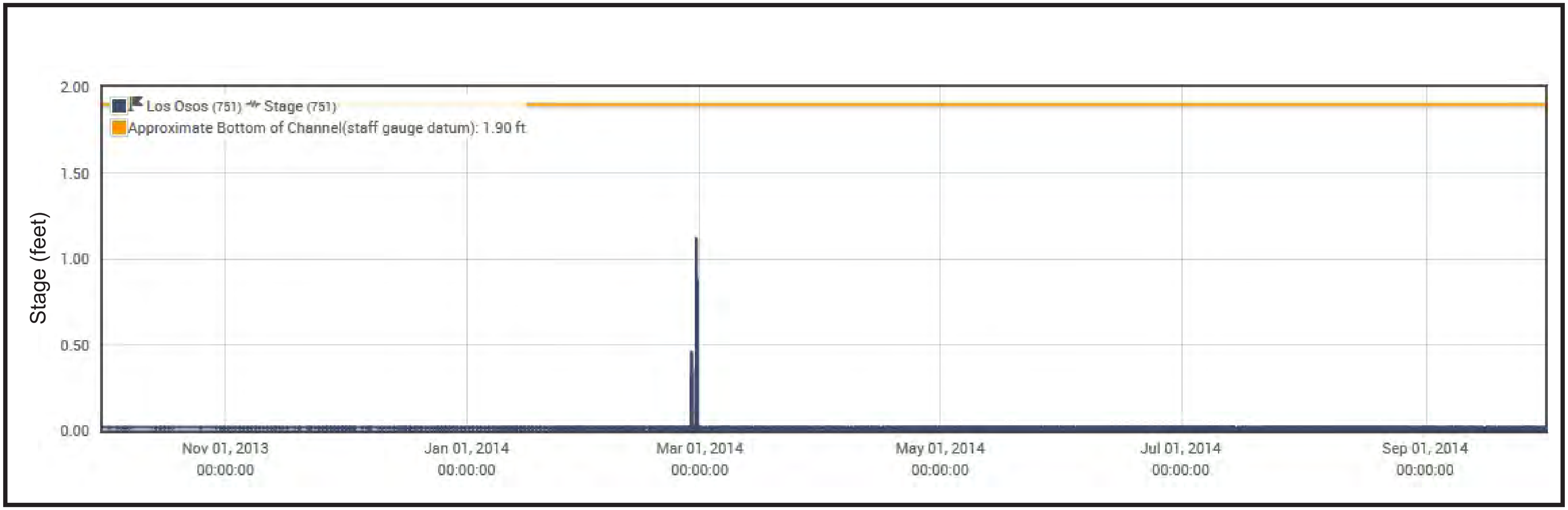
Source: County of San Luis Obispo Public Works Department, Stream Gage #751

Figure E2
Stream Stage for 2012 Water Year
Los Osos Creek, Gage #751



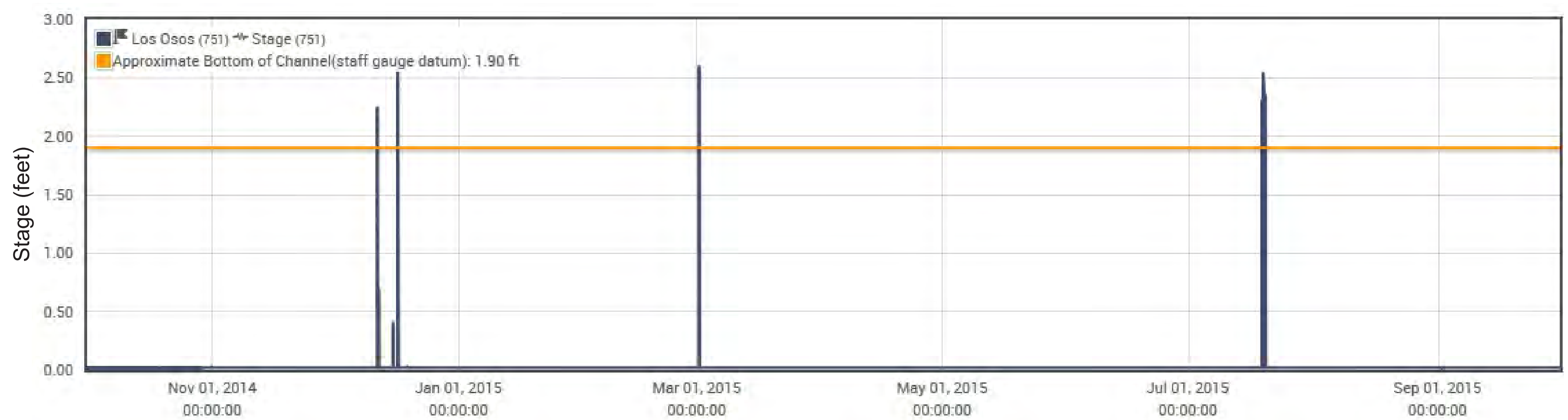
Source: County of San Luis Obispo Public Works Department, Stream Gage #751

Figure E3
Stream Stage for 2013 Water Year
Los Osos Creek, Gage #751



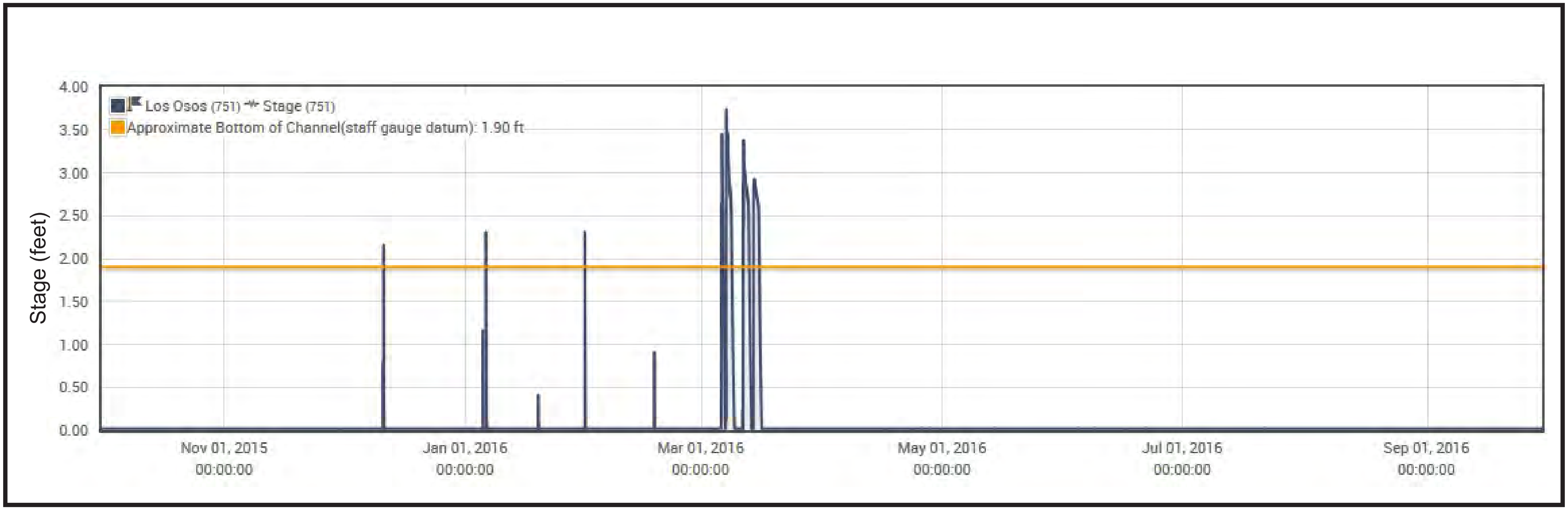
Source: County of San Luis Obispo Public Works Department, Stream Gage #751

Figure E4
Stream Stage for 2014 Water Year
Los Osos Creek, Gage #751



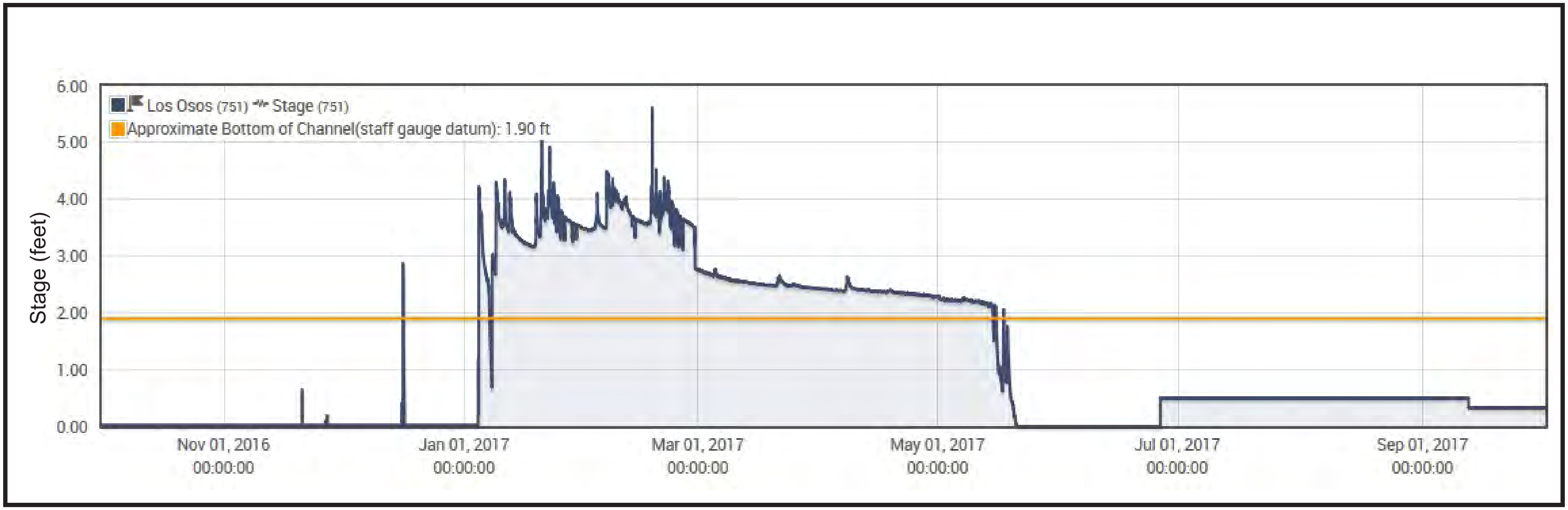
Source: County of San Luis Obispo Public Works Department, Stream Gage #751

Figure E5
Stream Stage for 2015 Water Year
Los Osos Creek, Gage #751



Source: County of San Luis Obispo Public Works Department, Stream Gage #751

Figure E6
Stream Stage for 2016 Water Year
Los Osos Creek, Gage #751



Source: County of San Luis Obispo Public Works Department, Stream Gage #751

Figure E7
Stream Stage for 2017 Water Year
Los Osos Creek, Gage #751

APPENDIX H

Transducer Hydrographs

Table H-1

Transducer Well Information

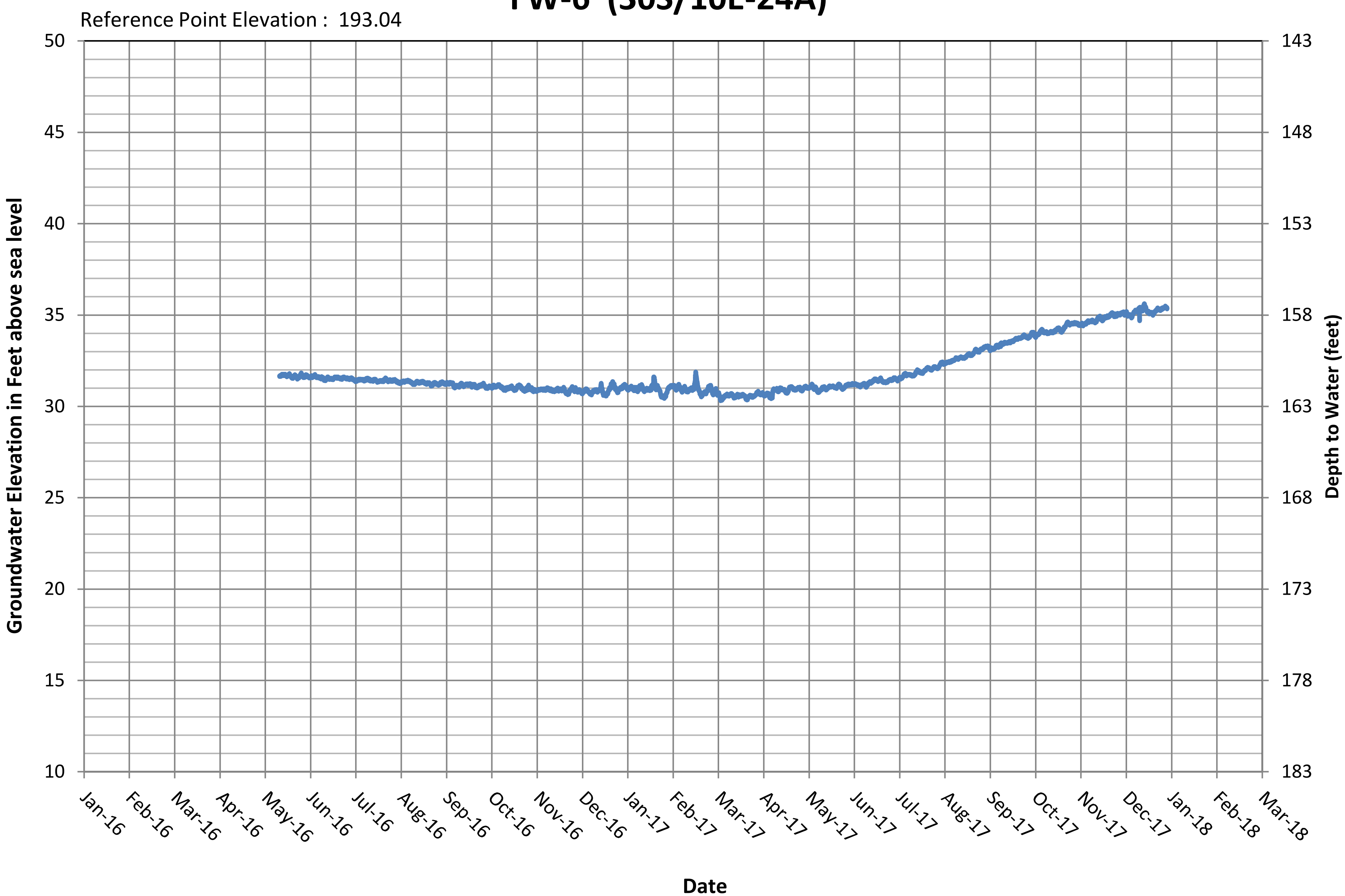
Well	GSE (ft)	TD (ft)	Casing	Screened interval (ft)
FW-6 (30S/10E-24A)	193.04	165	2-inch pvc	154-164
FW-10 (30S/11E-7Q1)	25.29	75	8-inch steel	29-53; 54-75
FW-27 (30S/10E-20L1)	134.07	119	8-inch steel	--
UA-4 (30S/10E-13L1)	39	140	8-inch steel	80-140
UA-10 (30S/11E-18H1)	107.1	233	10-inch steel	112-125; 145-159; 172-186; 216-231
LA-13 (30S/11E-18F2)	100	625	12-3/4-inch steel	425-620
LA-37 (30S/11E-21B1)	81	140	6-inch steel	--

GSE = Ground Surface Elevation (datum varies between NGVD 29 and NAVD 88 - see report Tables 4-8 for details)

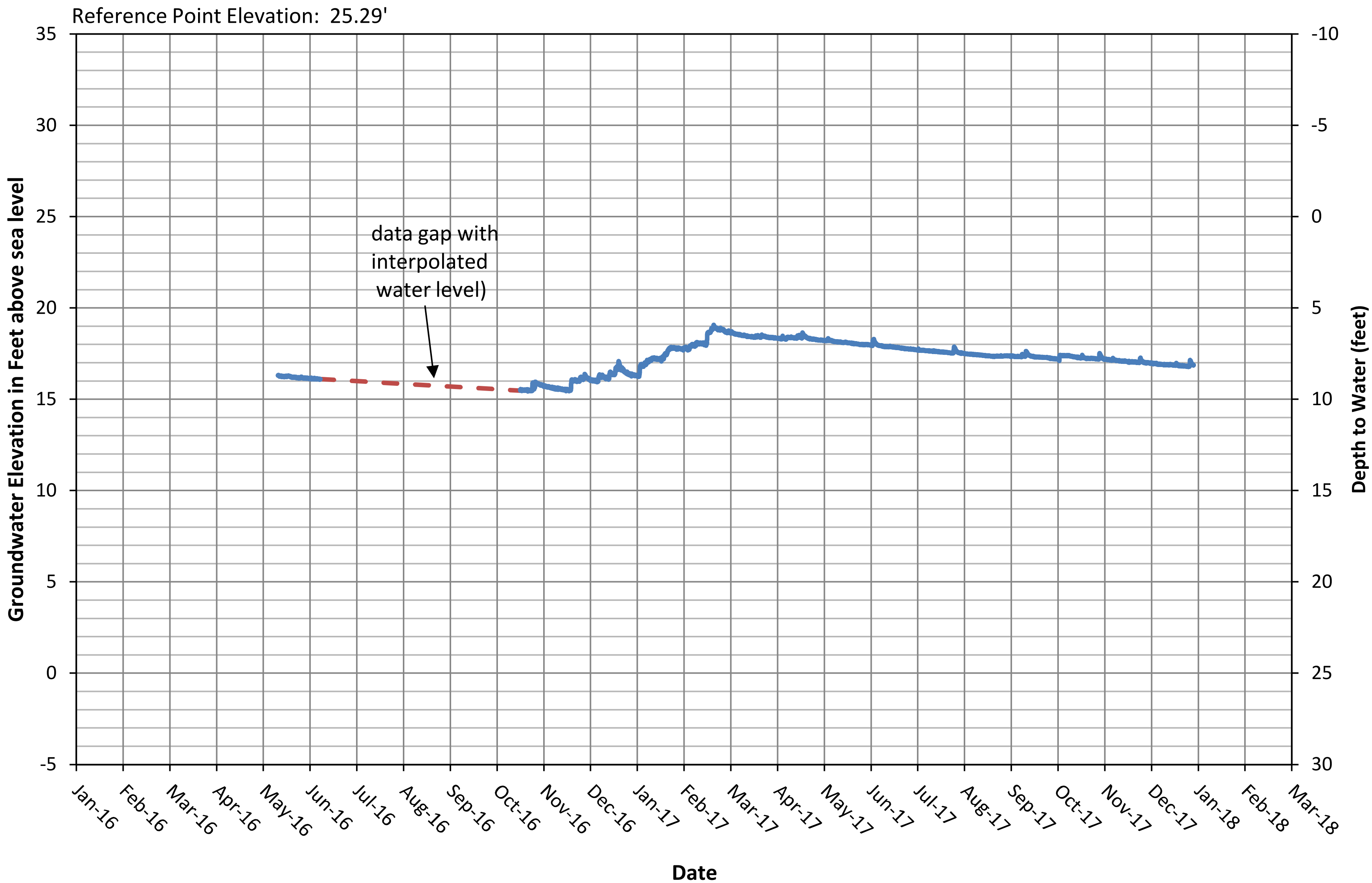
TD = Total Depth

"--" = screened interval not available

Hydrograph
FW-6 (30S/10E-24A)

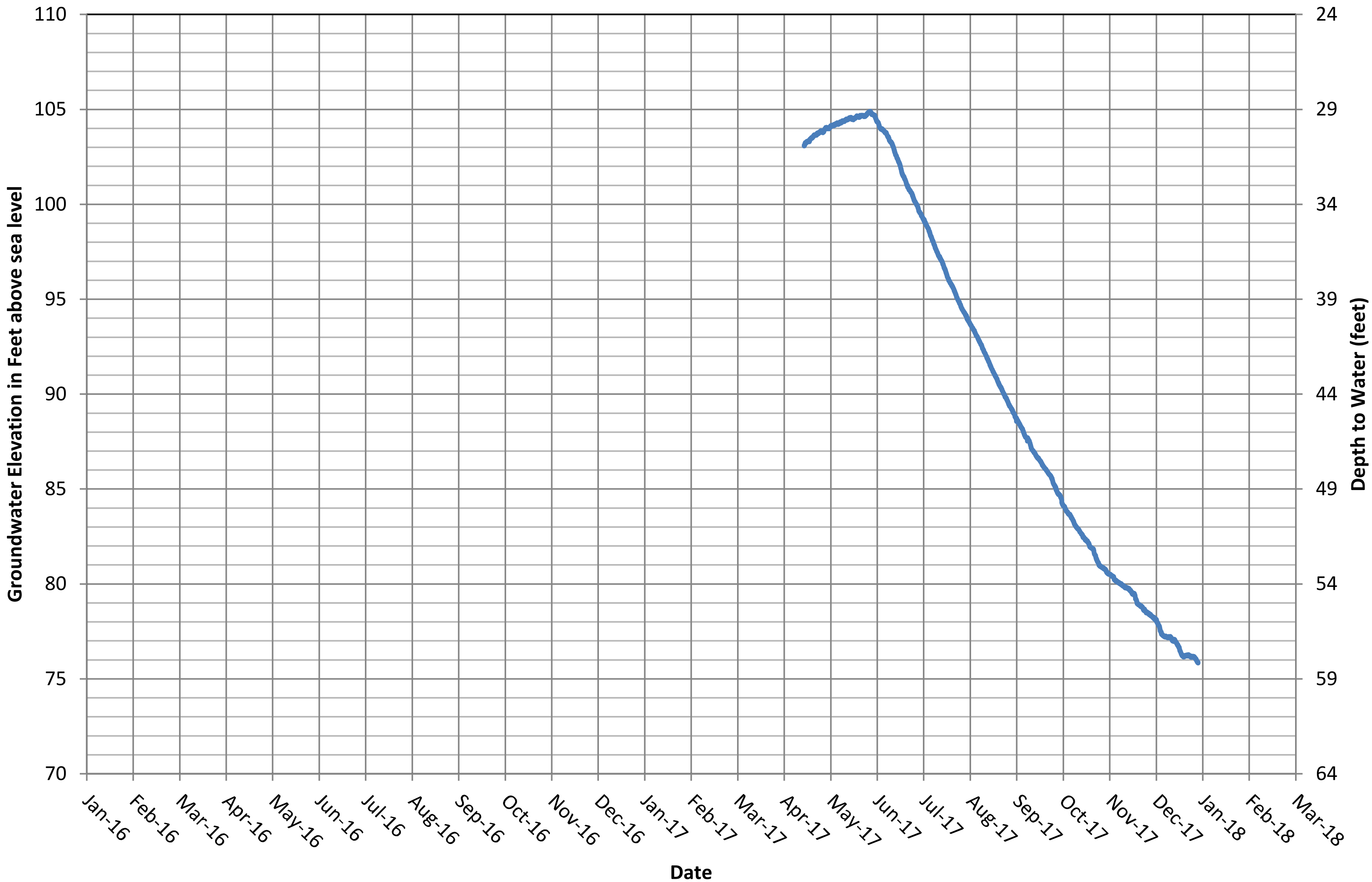


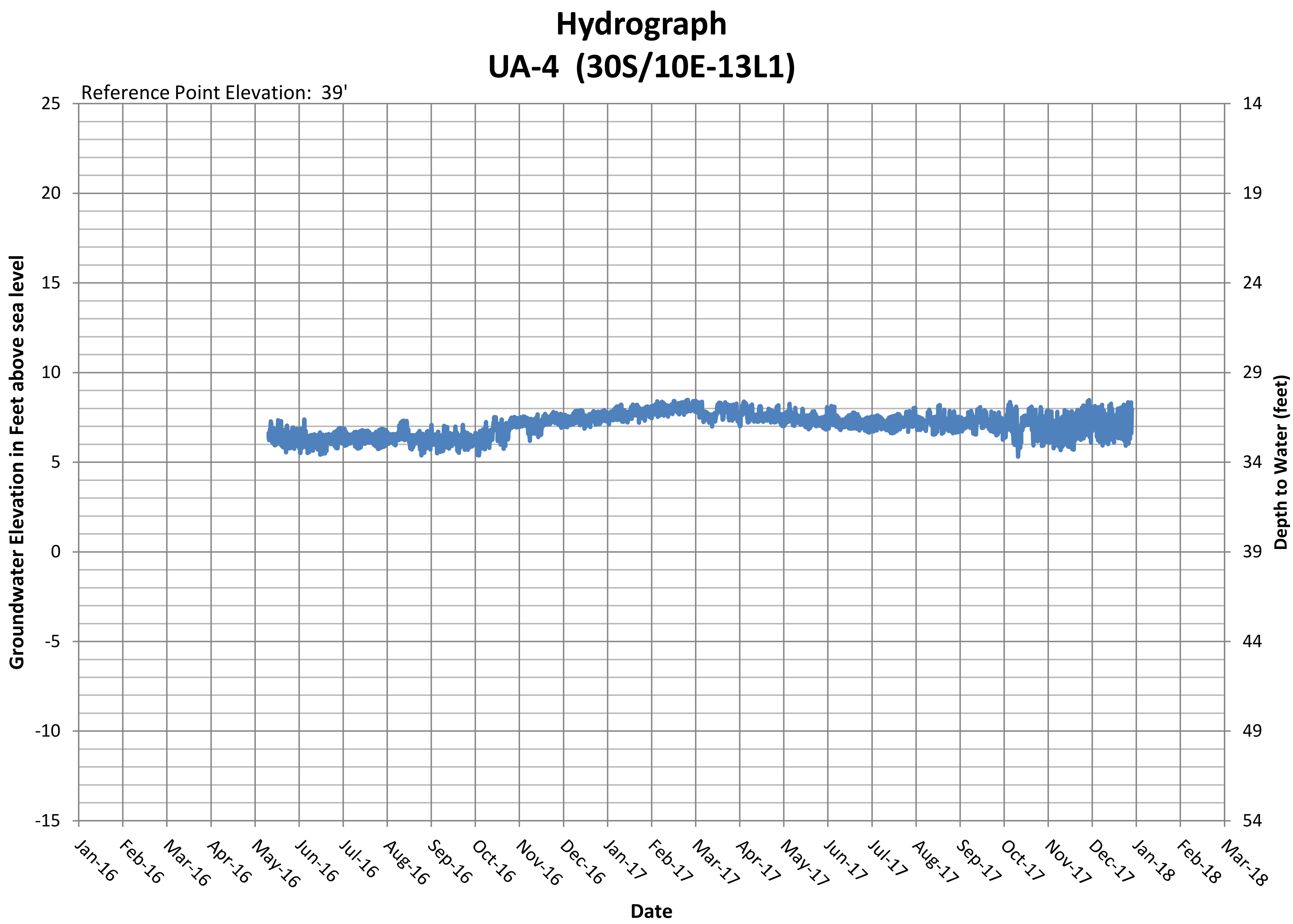
Hydrograph
FW-10 (30S/11E-7Q1)



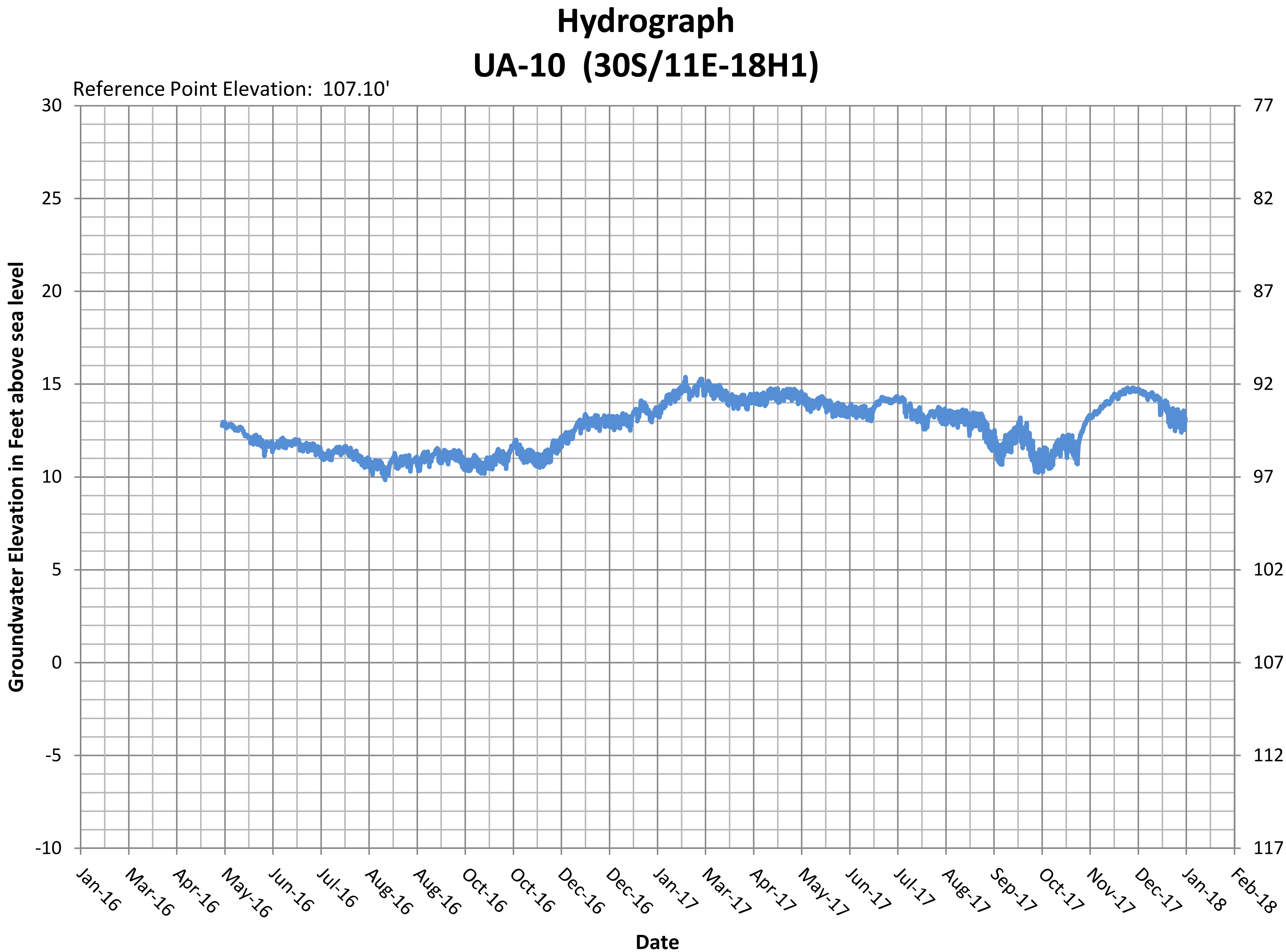
Hydrograph
FW-27 (30S/10E-20L1)

Reference Point Elevation: 134.07



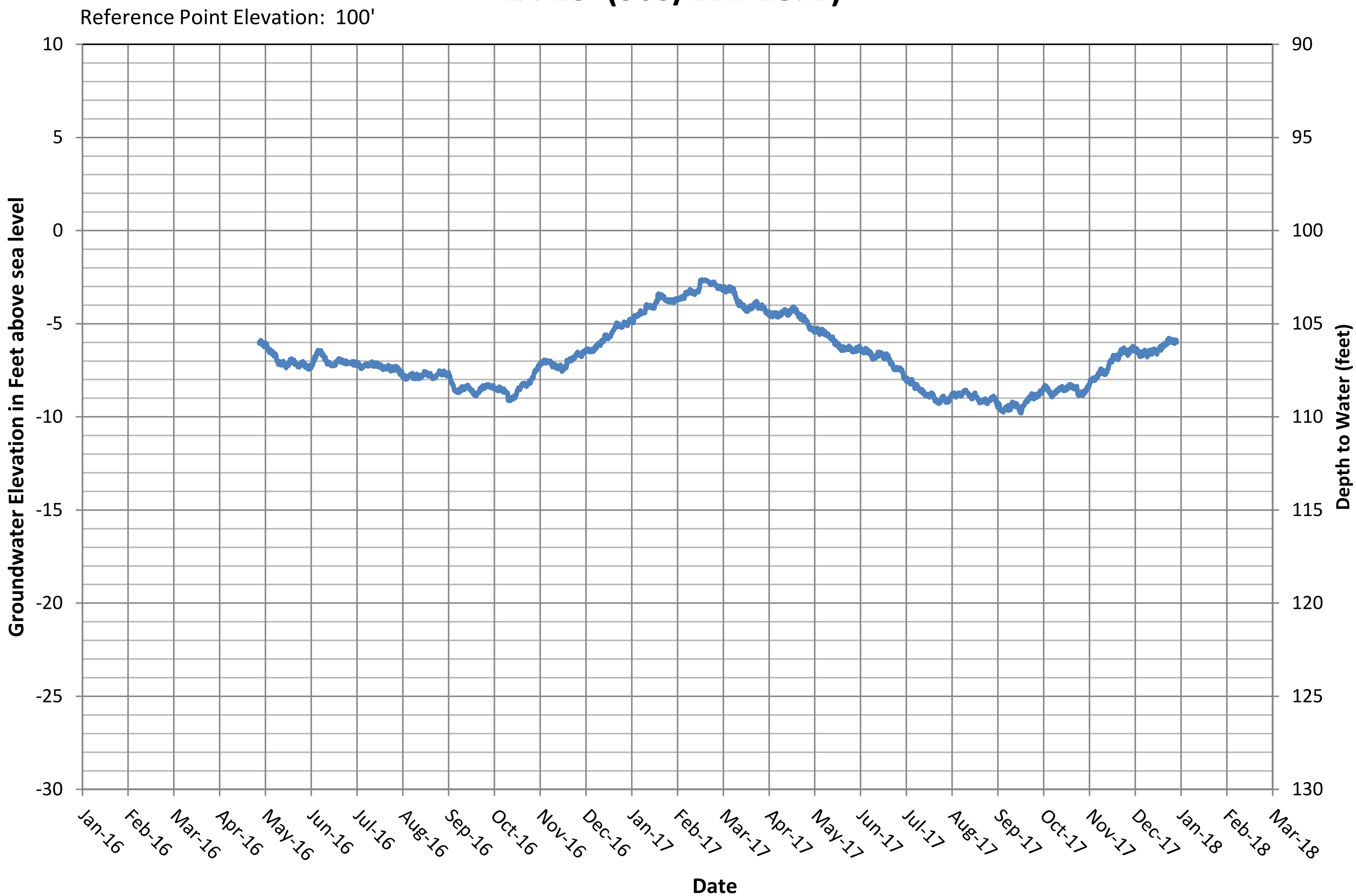


Hydrograph
UA-4 (30S/10E-13L1)
Reference Point Elevation: 39'
Groundwater Elevation in Feet above sea level
Depth to Water (feet)
25
20
15
10
5
0
-5
-10
-15
14
19
24
29
34
39
44
49
54
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Date

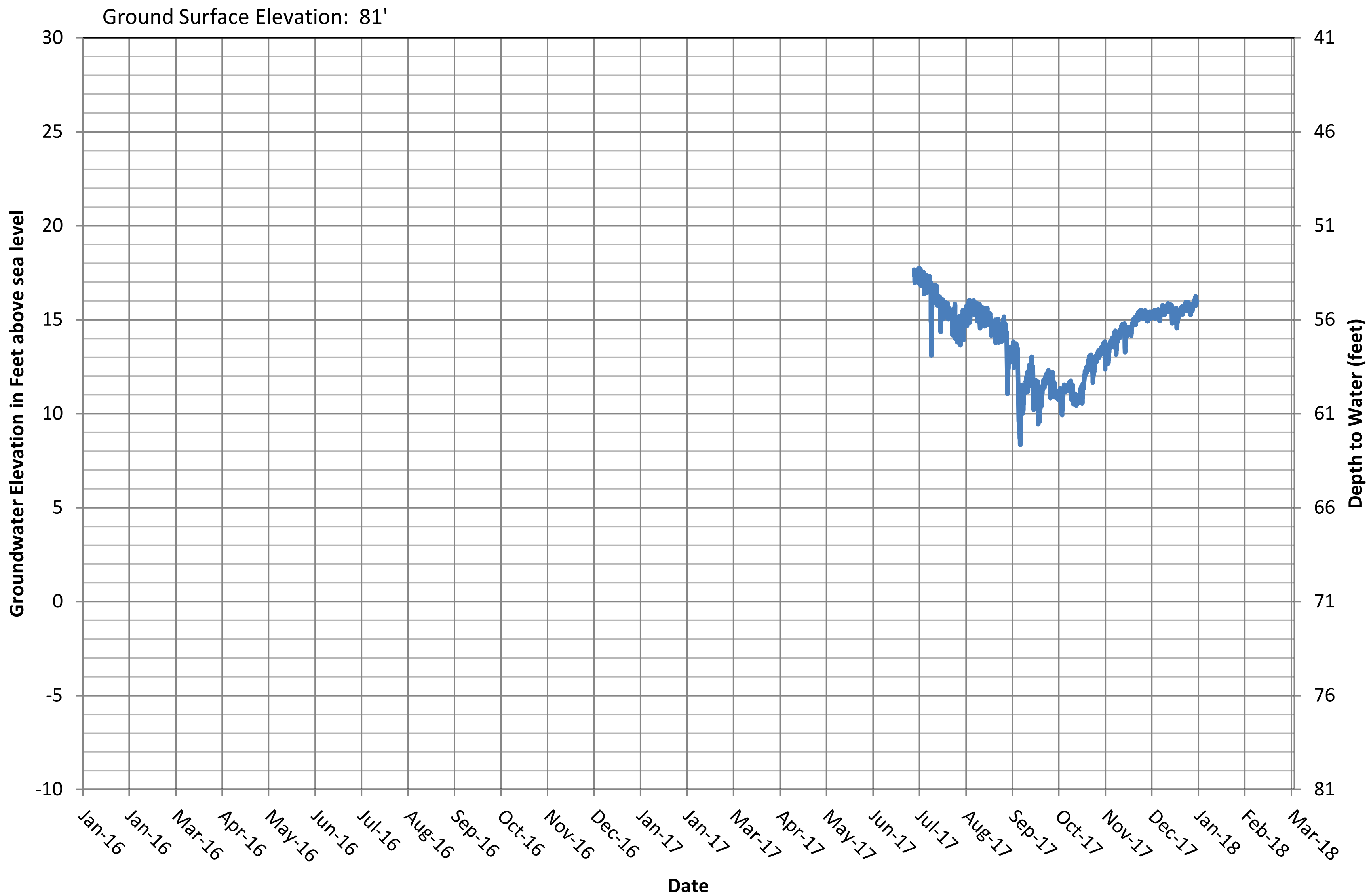


Hydrograph
UA-10 (30S/11E-18H1)
Reference Point Elevation: 107.10'
Groundwater Elevation in Feet above sea level
Depth to Water (feet)
Date
30
25
20
15
10
5
0
-5
-10
77
82
87
92
97
102
107
112
117
Jan-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Aug-16
Oct-16
Oct-16
Dec-16
Dec-16
Jan-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18

Hydrograph
LA-13 (30S/11E-18F2)



Hydrograph
LA-37 (30S/11E-21B1)



APPENDIX I

Groundwater Storage Calculation Example and Specific Yield Estimates

WELLS USED FOR GROUNDWATER ELEVATION CONTOURS
2017 GROUNDWATER STORAGE CALCULATIONS

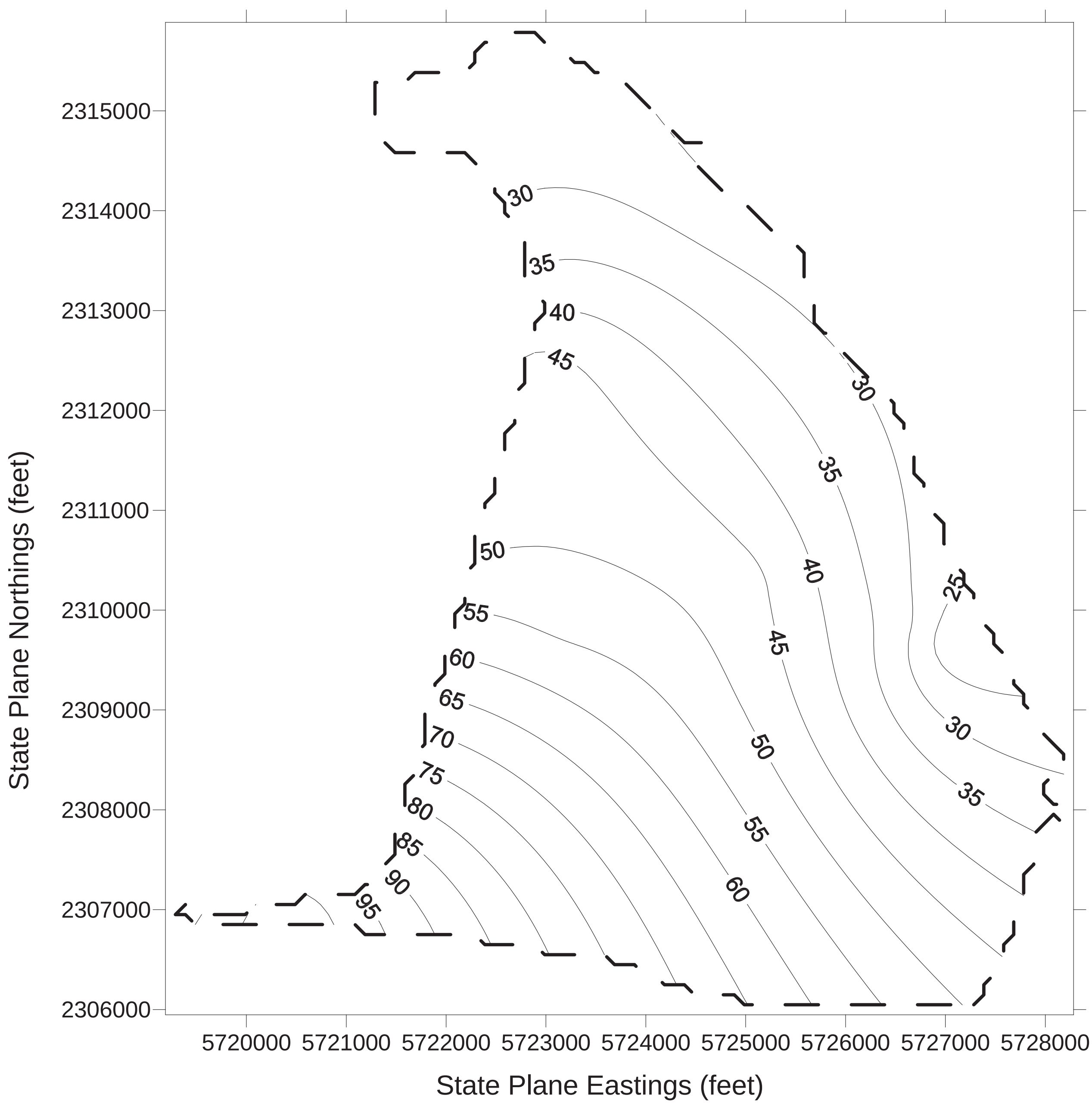
FIRST WATER		UPPER AQUIFER		LOWER AQUIFER	
SPRING	FALL	SPRING	FALL	SPRING	FALL
FW2	FW2	UA1	UA1	LA1	LA1
FW3	FW3	UA2	UA2	LA2	LA2
FW4	FW4	UA3	UA3	LA3	LA3
FW5	FW5	UA4	UA4	LA4	LA4
FW6	FW6	UA5	UA5	LA5	LA5
FW8	FW8	UA6	UA6	LA6	LA6
FW9	FW9	UA8	UA8	LA8	LA8
FW10	FW10	UA9	UA9	LA9	LA9
FW11	FW11	UA10	UA10	LA10	LA10
FW12	FW12	UA12	UA12	LA11	LA11
FW13	FW13	UA16	UA16	LA12	LA12
FW14	FW14	UA17	UA17	LA13	LA13
FW15	FW15	UA18	UA18	LA14	LA14
FW17	FW17	FW2	FW2	LA15	LA15
FW18	FW18	FW3	FW3	LA16	LA16
FW19	FW19	FW4	FW4	LA18	LA18
FW20	FW20	FW5	FW5	LA19	LA19
FW21	FW21	FW6	FW6	LA20	LA20
FW22	FW22*	FW8	FW8	LA21	LA21
FW23	FW23	FW9	FW9	LA24	LA24
FW24	FW24	FW10	FW10	LA26	LA25
FW27	FW26	FW11	FW11	LA27	LA26
FW28	FW27	FW12	FW12	LA29	LA27
FW29	FW28	FW14	FW14	LA33	LA29
FW30	FW29	FW15	FW15	LA34	LA30
FW31	FW30	FW24	FW24	LA35	LA33
LA34	FW31	FW27	FW26	LA37	LA34
LA35	LA34	FW29	FW27	FW27	LA35
LA37	LA35	FW32	FW29		LA37
	LA37	LA34	FW32		LA38
	LA38	LA35	LA34		FW27
		LA37	LA35		
			LA37		
			LA38		

*Spring measurement at FW22 repeated for Fall to mitigate data gap (additional details in Appendix I sensitivity analysis).

NOTE: Wells LA34, LA35, LA37, and LA38 represent the shallowest available water level data in the Eastern Area, and are included in the First Water and Upper Aquifer contour data sets for improved lateral control. Well FW27 is located where maximum recharge to lower aquifer from stream seepage likely occurs and provides control for all aquifers locally.

EXAMPLE STORAGE CALCULATION FOR EASTERN AREA:

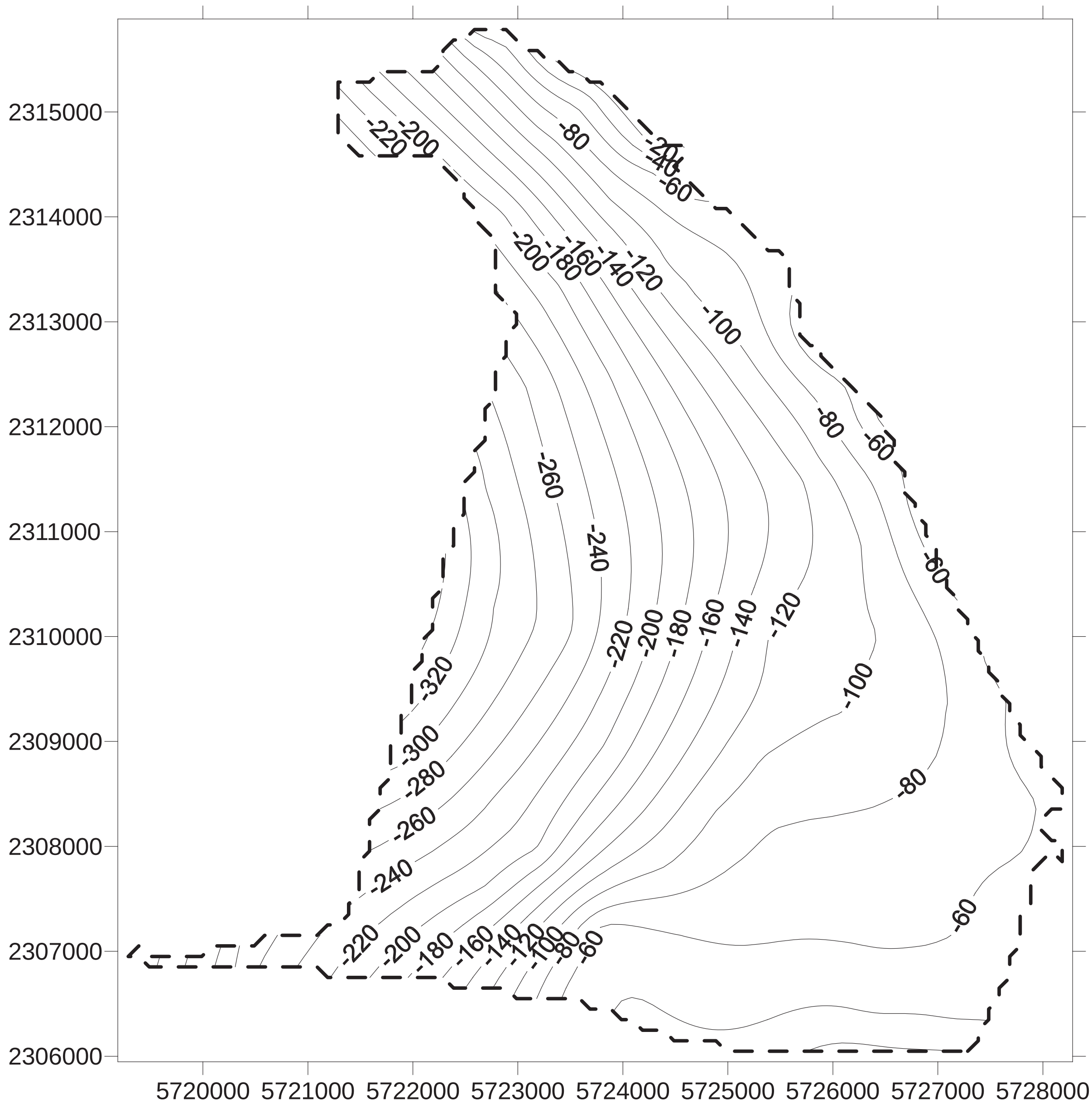
STEP 1: GRID AND TRIM WATER LEVEL CONTOURS



Spring 2017
Eastern Area Water Levels
Alluvial Aquifer and Lower Aquifer

EXAMPLE STORAGE CALCULATION FOR EASTERN AREA:

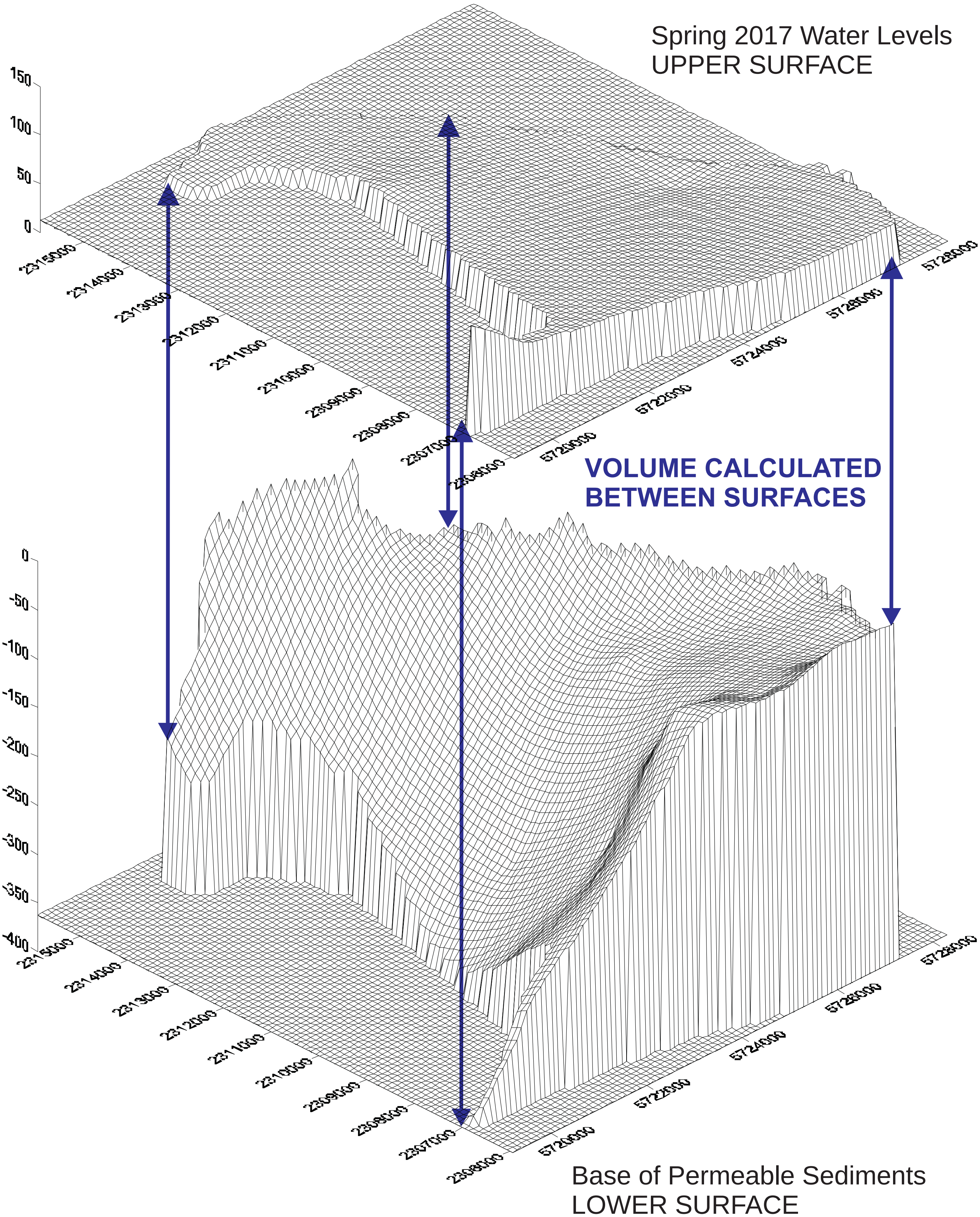
STEP 2: GRID AND TRIM BASE OF PERMEABLE SEDIMENTS



Eastern Area
Base of Permeable Sediments

EXAMPLE STORAGE CALCULATION FOR EASTERN AREA:

STEP 3: MATCH UPPER AND LOWER SURFACE GRIDS



EXAMPLE STORAGE CALCULATION FOR EASTERN AREA:

STEP 4: VOLUME COMPUTATION

Grid Volume Computations

Wed May 02 17:11:38 2018

Upper Surface

Grid File Name:	C:\CHG 2018\Projects\Los Osos BMC 2018\2017 Annual Report\Surfer 2017 QAQC\BLANKED FILES\EASTERN\upper eastern spring 2017 blanked qaqc.grd
Grid Size:	100 rows x 92 columns
X Minimum:	5719189
X Maximum:	5728284
X Spacing:	99.945054945055
Y Minimum:	2305947
Y Maximum:	2315886
Y Spacing:	100.39393939394
Z Minimum:	21.546183725484
Z Maximum:	104.24928798201

Lower Surface

Grid File Name:	C:\CHG 2018\Projects\Los Osos BMC 2018\2017 Annual Report\Surfer 2017 QAQC\BASE GEOMETRY\EASTERN\BOP Eastern blanked.grd
Grid Size:	100 rows x 92 columns
X Minimum:	5719189
X Maximum:	5728284
X Spacing:	99.945054945055
Y Minimum:	2305947
Y Maximum:	2315886
Y Spacing:	100.39393939394
Z Minimum:	-362.32467224801
Z Maximum:	2.39586300134

Volumes

Z Scale Factor: 1

Total Volumes by:

Trapezoidal Rule:	8260011367.3533
Simpson's Rule:	8255601348.679
Simpson's 3/8 Rule:	8251857104.0689

EXAMPLE STORAGE CALCULATION FOR EASTERN AREA:

STEP 5: CALCULATE GROUNDWATER IN STORAGE

Cut & Fill Volumes

Positive Volume [Cut]:	8260011367.3533
Negative Volume [Fill]:	0
Net Volume [Cut-Fill]:	8260011367.3533

Areas

Planar Areas

Positive Planar Area [Cut]:	41665677.518315
Negative Planar Area [Fill]:	0
Blanked Planar Area:	48729527.481685
Total Planar Area:	90395205

Surface Areas

Positive Surface Area [Cut]:	41782756.835343
Negative Surface Area [Fill]:	0

STORAGE CALCULATION

Positive Volume: 8,260,011,367 ft^3 * 0.1 specific yield ÷ 43,560 acre-feet per ft^3 = 18,962 acre-feet

WELL 30S/10E-12J01 (LA11)						
Lithology	***Start Depth***	***End Depth***	***Thickness***	***Specific Yield (percent)****	***Zone***	***Weighted Specific Yields (percent)***
sand	5	27	22	20	C	
clay	27	32	5	3		
sand (peat)	32	70	38	5		
clay	70	72	2	3		Weighted Specific Yield
gravel	72	82	10	18		10.8
clay	82	96	14	3	D	
sand	96	100	4	20		
silt	100	135	35	5		
clay	135	157	22	3		
gravel	157	158	1	18		
sand	158	169	11	20		
sand and clay	169	194	25	5		
gravel	194	205	11	18		Weighted Specific Yield
sand and clay	205	217	12	5		7.3
clay	217	222	5	3	E	
sand and clay	222	245	23	5		
sand and gravel	245	257	12	18		
sand	257	264	7	20		
sand and gravel	264	274	10	18		
sand	274	290	16	20		
sand and silt	290	304	14	5		
sand	304	323	19	20		
sand and clay	323	330	7	5		
clay	330	339	9	3		
sand	339	341	2	20		
clay	341	346	5	3		
sand	346	352	6	20		
sand and clay	352	356	4	5		
sand	356	370	14	20		Weighted Specific Yield
sand and gravel	370	386	16	18		13.4
clay	386	392	6	3	BEDROCK	Weighted Specific Yield
shale	392	402	10	13		8
Total Depth	402			**BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)**		**10.6**

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

WELL 30S/10E-13L04 (LA6)

Lithology	*Start Depth*	*End Depth*	*Thickness*	*Specific Yield (percent)**	*Zone*	*Weighted Specific Yields (percent)*
top soil	0	19	19	unsaturated	C	
clay, some gravel and sand	19	26	7			
gravel, clay and sand	26	41	15			
fine sand	41	61	20	20		
clay, sand, small rocks	61	71	10	7		
clay, few pebbles	71	75	4	7		
fine gravel and sand	75	81	6	18		
sandy clay	81	95	14	5		
hard clay	95	97	2	3		
fine sand	97	115	18	20		
clay	115	118	3	3		
sand and gravel	118	149	31	18		
reddish brown clay, pebbly	149	164	15	7		
gravel	164	170	6	18		Weighted Specific Yield
sand and clay	170	190	20	5		12.9
tan clay, some gravel	190	210	20	7	D	
hard green clay	210	240	30	3		
tan sand	240	248	8	20		
clay and sand	248	260	12	5		
fine sand	260	277	17	20		
gravel	277	283	6	18		
fine sand	283	293	10	20		
fine gravel	293	310	17	18		
sand and clay	310	340	30	5		
coarse gravel	340	356	16	18		Weighted Specific Yield
gravel and clay	356	370	14	7		10.8
fine sand	370	394	24	20	E	
coarse gravel boulders	394	426	32	18		
gravel	426	456	30	18		
clay sand and gravel	456	500	44	7		
sand clay and gravel	500	570	70	7		
gravel and clay	570	600	30	7		
silt and clay	600	619	19	5		
black mud	619	621	2	3		Weighted Specific Yield
gravel	621	670	49	18		12
hard clay, sandstone	670	675	5	3	BEDROCK	Weighted Specific Yield
						3
Total Depth	675			BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)		**11.8**

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

WELL 30S/11E-7Q03 (LA12)						
Lithology	***Start Depth***	***End Depth***	***Thickness***	***Specific Yield (percent)****	***Zone***	***Weighted Specific Yields (percent)***
sandy brown soil	0	6	6	unsaturated	A	Weighted Specific Yield
sand	6	17	11	20		20
clay some gravel	17	20	3	7	C	
sand	20	48	28	20		
clay	48	52	4	3		Weighted Specific Yield
cemented sand	52	**127**	75	15		15.6
clay	**127**	230	103	3	D	
sand some gravel	230	245	15	18		Weighted Specific Yield
gravel	245	276	31	18		7.6
clay	276	325	49	3	E	
sand	325	332	7	20		
clay	332	343	11	3		
sand	343	350	7	20		
sand and gravel	350	356	6	18		
rock	356	357	1	15		Weighted Specific Yield
sand and gravel	357	402	45	18		11.1
clay	402	411	9	3	BEDROCK	Weighted Specific Yield
						3
Total Depth	411			**BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)**		**11.3**

#	corrected depth using e-log

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

WELL 30S/11E-17C01 (LA23)						
Lithology	***Start Depth***	***End Depth***	***Thickness***	***Specific Yield (percent)****	***Zone***	***Weighted Specific Yields (percent)***
sandy soil	0	3	3	unsaturated	A	
sand	3	28	25			
sandy clay	28	34	6	5		Weighted Specific Yield
sand	34	48	14	20		15.5
clay	48	52	4	3	C	
sand and gravel	52	56	4	18		
clay	56	76	20	3		
clay and gravel	76	80	4	7		
sandy clay	80	91	11	5		
sand	91	104	13	20		
clay	104	108	4	3		Weighted Specific Yield
sand	108	114	6	20		9.4
silty clay	114	148	34	5	D	
sandy clay	148	165	17	5		
sand	165	183	18	20		Weighted Specific Yield
sand and gravel	183	230	47	18		12.6
clay	230	236	6	3	E	
sandy clay	236	246	10	5		
sand and gravel	246	254	8	18		Weighted Specific Yield
clay	254	270	16	3		6.5
Total Depth	270			**BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)**		**11**

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

WELL 30S/11E-17J01 (LA24)						
Lithology	***Start Depth***	***End Depth***	***Thickness***	***Specific Yield (percent)****	***Zone***	***Weighted Specific Yields (percent)***
all inferred from e-log						
no data	0	8	8	unsaturated	C	
clay	8	15	7			
sandy clay	15	37	22	5		
clay	37	40	3	3		
sandy clay	40	48	8	5		Weighted Specific Yield
sand	48	72	24	20		11.2
sandy clay	72	118	46	5	D	
sand	118	128	10	20		
sandy clay	128	150	22	5		
sand	150	163	13	20		
clay	163	168	5	3		Weighted Specific Yield
sand	168	189	21	20		10.6
sandy clay	189	214	25	5	E	
sand	214	220	6	20		
clay with sand beds	220	232	12	5		
sand, some clay	232	244	12	15		
clay	244	262	18	3		
sandy clay	262	271	9	5		
clay	271	278	7	3		
sandy clay	278	291	13	5		
clay	291	297	6	3		
sandy clay and clay	297	315	18	5		
clay	315	319	4	3		Weighted Specific Yield
sand	319	329	10	20		7.1
rock	329	333	4	13	BEDROCK	Weighted Specific Yield
						13
Total Depth	333			**BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)**		**9.1**

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

WELL 30S/11E-17N10 (LA20)						
Lithology	***Start Depth***	***End Depth***	***Thickness***	***Specific Yield (percent)****	***Zone***	***Weighted Specific Yields (percent)***
fill	0	3	3		A	Weighted Specific Yield
sand	3	37	34	20		20
clay	37	42	5	3	B	
gravelly clay	42	50	8	7		
clay	50	58	8	3		
sand and gravel	58	81	23	18		
sand	81	92	11	20		Weighted Specific Yield
sand and gravel	92	98	6	18		13.7
clayey sand	98	120	22	5	C	
sand and gravel	120	150	30	18		
clayey gravel	150	170	20	7		
gravelly sand	170	187	17	18		
gravelly clay	187	197	10	7		Weighted Specific Yield
sandy gravel	197	210	13	18		12.5
clay	210	225	15	3	D	
sand and gravel	225	250	25	18		
sandy clay	250	260	10	5		
sand and gravel	260	270	10	18		
gravelly clay	270	275	5	7		
gravelly sand	275	290	15	18		
sandy clay	290	320	30	5		Weighted Specific Yield
sand	320	400	80	20		14.6
sandy clay	400	480	80	5	E	
gravelly sand	480	530	50	18		
sand / silty sand	530	630	100	5		Weighted Specific Yield
sandy clay	630	750	120	5		6.9
Total Depth	750			**BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)**		**10.8**

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

WELL 30S/11E-18K08 (LA18)

Lithology	*Start Depth*	*End Depth*	*Thickness*	*Specific Yield (percent)**	*Zone*	*Weighted Specific Yields (percent)*
						Weighted Specific Yield
sand	50	110	60	20	A & B	20.00
sandy clay	110	132	22	5	C	
cemented sand	132	151	19	15		
sandy clay	151	158	7	5		
sand	158	195	37	20		
sandy clay	195	200	5	5		
sand	200	225	25	20		
sandy clay	225	235	10	5		
sand	235	254	19	20		
sandy clay	254	260	6	5		Weighted Specific Yield
sand with gravel	260	264	4	18		14.5
sandy clay	264	288	24	5	D	
clayey sand	288	305	17	5		
sandy clay	305	310	5	5		
clayey sand	310	324	14	5		
clay with sand	324	350	26	5		
silty sand	350	370	20	3		
sandy clay	370	380	10	5		
sand	380	386	6	20		
sandy clay	386	395	9	5		Weighted Specific Yield
silty sand	395	490	95	3		4.4
clay sandy clay	490	515	25	5	E	
silty sand	515	592	77	3		Weighted Specific Yield
sand with seashells	592	660	68	20		10.1
Total Depth	660			**BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)**		**10.1**

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

WELL 30S/11E-18M01 (LA16)						
Lithology	***Start Depth***	***End Depth***	***Thickness***	***Specific Yield (percent)****	***Zone***	***Weighted Specific Yields (percent)***
fine brown sand	40	70	30	20	C	
sand, sandy clay	70	160	90	5		Weighted Specific Yield
sand	160	165	5	20		9.2
sandy clay	165	245	80	5	D	
sandy clay with gravel	245	275	30	7		
sandy clay	275	350	75	5		Weighted Specific Yield
sand and gravel	350	372	22	18		6.7
sandy clay with gravel	372	392	20	5	E	
sandy clay	392	460	68	7		
sandy clay with gravel	460	490	30	5		
sandy clay	490	536	46	7		
sand and gravel	536	562	26	18		Weighted Specific Yield
sandy clay with gravel	562	630	68	7		7.7
Total Depth	630			**BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)**		**7.7**

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

WELL 30S/11E-20G02 (LA26)						
Lithology	***Start Depth***	***End Depth***	***Thickness***	***Specific Yield (percent)****	***Zone***	***Weighted Specific Yields (percent)***
silty-clay-soil	0	11	11	unsaturated	C	
gravel	11	15	4			
clayey sand	15	53	38	5		
gravel	53	55	2	18		Weighted Specific Yield
clayey sand	55	75	20	5		5.4
clay	75	117	42	3	D	
gravel	117	120	3	18		
sand	120	197	77	20		Weighted Specific Yield
coarse sand and gravel	197	213	16	18		14.6
clayey sand	213	290	77	5	E	
sand	290	315	25	20		Weighted Specific Yield
gravelly sand	315	335	20	18		10.2
bedrock, tight rock	335	380	45	15	BEDROCK	Weighted Specific Yield
						15
Total Depth	380			**BOREHOLE WEIGHTED SPECIFIC YIELD (PERCENT)**		**11.2**

** Johnson, A. I., 1967, Specific Yield - Compilation of Specific Yields for Various Materials, U.S. Geological Survey Water Supply Paper 1662-D*

APPENDIX J

Groundwater Storage Sensitivity Analysis

APPENDIX J

Groundwater Storage Sensitivity Analysis

Groundwater in storage for basin areas and aquifers has been estimated through water level contouring, boundary definition, volume calculations, and aquifer property estimation. The methodology was developed to facilitate change in storage calculations from year to year and is described in report Section 7.4 and Appendix I.

Description of Analysis

This Appendix J presents a sensitivity analysis to evaluate the potential range of error associated with groundwater storage estimates and change in groundwater storage estimates to support future data interpretation. Three sources of potential error were considered:

- Tape Bias/Survey Error
- Specific Yield Error
- Data Gaps

Sources of error associated with storage calculations include those that produce random (precision) error and those that introduce systematic (bias) error. Random error results in data scatter, while systematic error changes data uniformly.

The sensitivity analysis evaluates how storage calculations are affected by variables (groundwater elevation, specific yield, and spatial data) associated with the above sources of error. Storage volumes calculated after applying changes to the variables are compared to baseline volumes for each storage compartment, which are the volumes used in the annual report. Storage compartments are secribed in report Section 7.4 and shown in Figure 19.

<u>Tape Bias/Survey Error</u>

Error associated with a tape being too short or too long would be systematic. A tape that is short may be due to portions missing at splices, while a tape that is too long may be due to stretching over time. The sounder tapes used for groundwater monitoring are calibrated annually and are accurate to within a few hundredths of a foot when compared to a steel reference tape. Surveyed elevations for reference points are also generally accurate within a few hundredths of a foot when tied to a benchmark. Error associated with a particular survey could be systematic or random. Not all of the wells in the monitoring network have surveyed elevations, and some are estimated based on topographic maps, where the potential error in estimating wellhead reference elevations may be a few feet. For the sensitivity analysis, a systematic error of two feet was assumed, which would be expected to exceed the actual error for most elevations. All elevations were increased by two feet and decreased by two feet from the baseline for the Tape Bias/Survey Error analysis.

Specific Yield Error

Specific yield is used by convention to calculate the volume of water contained in a given volume of saturated aquifer. The average specific yield of basin sediments was estimated at 10 percent based on correlating the lithology of nine boreholes spanning 4,200 feet of aquifer materials. A 10 percent specific yield value has been used for every calculation, in every aquifer or compartment, associated with estimating the amount of groundwater in storage in the basin.

The usual range of the specific yield for aquifer materials is 1 to 30 percent (Freeze and Cherry, 1979). In San Luis Obispo County, the specific yield of Paso Robles formation sediments is estimated to range from 3 percent for clay to 20 percent for sand (Johnson, 1967), and was the range used to develop estimates for the Los Osos Basin. Average specific yield for the nine boreholes in Appendix I ranged from 7.7 percent to 11.9 percent, or roughly 20 percent above or below the basin average, or baseline, of 10 percent. The sensitivity analysis was performed using a specific yield greater or less than 20 percent of the baseline specific yield.

Using a single value for specific yield throughout the basin is a simplification of actual conditions. A sensitivity analysis was also performed using the specific yields calculated for each individual aquifer, rather than the basin average. This aquifer-specific analysis shows the range of potential error from assuming a uniform basin with respect to specific yield, rather than discrete zones. The calculations on pages 2-6 of Appendix I that include specific yields for individual aquifers were used for the sensitivity analysis.

A single value for aquifer storativity of 8×10^{-4}, based on pumping tests, was used for the confined (pressure) component of groundwater storage in Lower Aquifer Zone D and E (Cleath & Associates, 2005). The typical rages of values for storativities in confined aquifers is 5×10^{-3} to 5×10^{-5} (Freeze and Cherry, 1979). Confined storage is a small fraction of the total estimated groundwater in storage and is not part of this sensitivity analysis.

Data Gaps

The Data Gaps analysis evaluates mostly random error sources associated with the spatial coverage used for water level contouring. Two examples of data gaps from the 2017 data set were used, one from the spring and one from the fall. The spring data gap involved two wells where water levels were measured in the fall but which had no corresponding spring levels. These wells (private wells FW26 and UA38) were not previously accessible to the program, and normal procedure would be to add the new data points in the fall, when they were measured. For the sensitivity analysis, however, elevations from Spring 2018 for these two wells were added to the prior Spring 2017 data set to see how sensitive these point were to storage estimates.

There was also a fall data gap where a well (private well FW22) was measured in the spring but not in the fall. This well has a long history of water levels and normal procedure would be to evaluate the need for adding a substitute water level for fall storage calculations (effectively a point-specific sensitivity analysis). In the case of FW22, the missing fall water level does affect perched aquifer storage significantly, therefore, a substitute fall water level was added while preparing the annual report. For the sensitivity analysis, the substitute fall water level (which is used for the baseline) was removed in order to show the impact on storage.

Adding new boring logs to the specific yield dataset would improve the specific yield estimates. The sensitivity of adding new borehole data would be equivalent to the

Results of Analysis

Tables J-1 and J-2 below show the results of the sensitivity analysis for Spring 2017 storage calculations.

TABLE J-1

Storage Sensitivity Analysis - Spring 2017 Storage Comparison

Variables		Western and Central		Western	Central	Eastern	TOTAL
		Perched	Upper	Lower	Lower	Alluvial/Lower	
		Groundwater Storage in Acre-Feet					
Baseline (reported)[1]		4,680	27,890	15,730	56,220	18,960	123,480
Elevation	Elev +2 feet	4,910	28,420	15,730	56,230	19,160	124,450
	Elev -2 feet	4,450	27,370	15,730	56,220	18,760	122,530
Specific Yield (Sy)	Sy +20%	5,616	33,468	18,876	67,464	22,752	148,176
	Sy -20%	3,744	22,312	12,584	44,976	15,168	98,784
	Aquifer Sy	7,390	31,520	15,580	53,970	18,960	127,420
Data Gap	Spring Gap	4,680	27,960	15,730	56,220	18,880	123,470

[1] Baseline values have been rounded to the closest 100 acre-feet in report Table 17, but for the sensitivity analysis are rounded to the closest 10 acre-feet .

TABLE J-2

Storage Sensitivity Analysis - Spring 2017 Percent of Baseline

Variables		Western and Central		Western	Central	Eastern	TOTAL
		Perched	Upper	Lower	Lower	Alluvial/Lower	
		Percent of Baseline Storage					
Elevation	Elev +2 feet	105%	102%	100%	100%	101%	101%
	Elev -2 feet	95%	98%	100%	100%	99%	99%
Specific Yield (Sy)	Sy +20%	120%	120%	120%	120%	120%	120%
	Sy -20%	80%	80%	80%	80%	80%	80%
	Aquifer Sy	158%	113%	99%	96%	100%	103%
Data Gap	Spring Gap	100%	100%	100%	100%	100%	100%

The elevation (Tape Bias/Survey Error) sensitivity results for Spring 2017 show up to 5 percent change from the baseline storage due to raising or lowering water levels two feet. The greatest potential error would be for the perched aquifer, which is the smallest storage compartment. The relatively minor sensitivity to Tape Bias/Survey Error is to be expected, given the much greater thickness of the aquifers themselves.

Storage volume is directly correlated to changes in specific yield. A range of 20 percent potential error is considered appropriate, given the range of variability seen in the basin averages. For the aquifer-specific sensitivity, there is a much greater range in potential error for individual aquifer storage estimates, compared to the basin-wide estimate. The perched aquifer in particular, which is mainly dune sand, has an estimated specific yield of close to 16 percent, compared to the basin average of 10 percent. Data gap sensitivity shows that storage does not change significantly when adding substitute water levels for the two data points missing in the spring.

Tables J-3 and J-4 below show the results of the sensitivity analysis for Fall 2017 storage calculations.

TABLE J-3
Storage Sensitivity Analysis -Fall 2017 Storage Comparison

Variables		Western and Central Perched	Western and Central Upper	Western Lower	Central Lower	Eastern Alluvial/Lower	TOTAL
		Groundwater Storage in Acre-Feet					
Baseline (reported)[1]		4,460	27,140	16,350	56,210	18,150	122,310
Elevation	Elev +2 feet	4,690	27,680	16,350	56,220	18,340	123,280
	Elev -2 feet	4,230	26,630	16,350	56,210	17,950	121,370
Specific Yield (Sy)	Sy +20%	5,352	32,568	19,620	67,452	21,780	146,772
	Sy -20%	3,568	21,712	13,080	44,968	14,520	97,848
	Aquifer Sy	7,050	30,680	16,190	53,960	18,150	126,030
Data Gap	Fall Gap	5,160	26,140	16,350	56,210	18,150	123,010

[1] Baseline values have been rounded to the closest 100 acre-feet in report Table 17, but for the sensitivity analysis are rounded to the closest 10 acre-feet .

TABLE J-4
Storage Sensitivity Analysis - Fall 2017 Percent of Baseline

Variables		Western and Central Perched	Western and Central Upper	Western Lower	Central Lower	Eastern Alluvial/Lower	TOTAL
		Percent of Baseline Storage					
Elevation	Elev +2	105%	102%	100%	100%	101%	101%
	Elev -2	95%	98%	100%	100%	99%	99%
Specific Yield (Sy)	Sy +20%	120%	120%	120%	120%	120%	120%
	Sy -20%	80%	80%	80%	80%	80%	80%
	Aquifer Sy	158%	113%	99%	96%	100%	103%
Data Gap	Fall Gap	116%	100%	100%	100%	100%	101%

Storage volumes are generally lower in Fall 2017, except for the western area lower aquifer, where seawater is in retreat. The percent of baseline sensitivity is virtually the same as in Spring 2017 for elevation and specific yield variables. The only difference between spring and fall is the data gap sensitivity, which for the fall analysis removed a substitute data point from the baseline (i.e. re-inserted the data gap), resulting in a 16 percent change from the baseline.

Tables J-5 and J-6 below show the results of the sensitivity analysis for Spring to Fall 2017 change in groundwater storage calculations.

TABLE J-5
Storage Sensitivity Analysis -Spring to Fall 2017 Change in Storage Comparison

Variables		Western and Central Perched	Western and Central Upper	Western Lower	Central Lower	Eastern Alluvial/Lower	TOTAL
		Groundwater Storage Change in Acre-Feet					
Baseline (reported)		-220	-750	620	-10	-810	-1,170
Elevation	Elev +2	-220	-740	620	-10	-820	-1,170
	Elev -2	-220	-740	620	-10	-810	-1,160
Specific Yield (Sy)	Sy +20%	-264	-900	744	-12	-972	-1,404
	Sy -20%	-176	-600	496	-8	-648	-936
	Aquifer Sy	-340	-840	610	-10	-810	-1,390
Data Gap	Data Gaps	480	-820	620	-10	-730	-460

TABLE J-6
Storage Sensitivity Analysis - Spring to Fall 2017 Change in Storage Percent of Baseline

Variables		Western and Central Perched	Western and Central Upper	Western Lower	Central Lower	Eastern Alluvial/Lower	TOTAL
		Percent of Baseline Change in Storage					
Elevation	Elev +2	100%	99%	100%	100%	101%	100%
	Elev -2	100%	99%	100%	100%	100%	99%
Specific Yield (Sy)	Sy +20%	120%	120%	120%	120%	120%	120%
	Sy -20%	80%	80%	80%	80%	80%	80%
	Aquifer Sy	155%	112%	98%	100%	100%	119%
Data Gap	Data Gaps	-218%	109%	100%	100%	90%	39%

Potential error for storage estimates and change in storage estimates is within 20 percent of baseline for most variables and storage compartments. The data gap sensitivity shows the greatest range in potential error is due to the missing fall water level, which resulted in a gain in storage from spring to fall in the perched aquifer, rather than a decline. That type of error, however, is screened for during report preparation and was mitigated with a substitute value.

The estimated change in groundwater storage between Spring 2016 and Spring 2017 is 3,000 acre-feet, compared to basin storage estimates for Spring 2016 and Spring 2017 of 120,300 acre-feet and 123,300 acre-feet respectively (see report Tables 17 and 18). Based on the sensitivity analysis, the potential range of error for total basin storage would be 25,000 acre-feet, while the potential range of error for the change in storage would be 600 acre-feet. Change in storage estimates have the same potential error ratio (20 percent) as the storage estimates themselves, despite being much lower absolute values, which allows the correlation of relatively small changes in groundwater storage to basin conditions (such as drought) or basin activities (increased or reduced pumping).

One potential improvement to storage calculations would be to utilize an aquifer-specific methodology for assigning the specific yields. If this approach is pursued, however, correlating specific yields to a more robust sample set of logs for the individual aquifers would be recommended.

APPENDIX K

Nitrate-Nitrogen Monitoring Data 2002-2017

TABLE K-1

NITRATE-NITROGEN RESULTS 2002-2017

YEAR		2002	2002	2003	2003	2003	2003-04	2004	2004	2004	2005	2005	2006	2006	2012	2013	2014	2014	2014	2015	2015	2016	2016	2017	2017
SEASON CODE		**2**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**1**	**3**	**1**	**3**	**2**	**2**	**4**	**1**	**3**	**1**	**3**	**1**	**4**	**2**	**4**
WELL ID	**BMC ID**	**nitrate-nitrogen (mg/L)**																							
30S/10E-13A7	FW1	12	9.8	10	12	13	11	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
30S/10E-13G	FW3	9.3	8.6	9.1	9.4	11	9.7	9.4	7.1	11	8.9	9.6	11	10	11.7	9.7	13	15.3	12	13.1	10	13.3	8.7	16	18
30S/10E-13H	FW4	1	1	1.5	1.9	1.8	1.5	2	2.9	3.2	1.3	14	8.7	2.6	2.3	2.2	3.6	4	3.7	3.4	5.1	4.2	5.3	6.3	3.1
30S/10E-13L8	**FW2**	**19**	**28**	**23**	**36**	**40**	**46**	**35**	**24**	**26**	**28**	**22**	**23**	**11**	**17.5**	**16**	**10**	**17.2**	**22**	**26**	**27.8**	**30.3**	**28**	**20**	**44**
30S/10E-13Q2	FW5	20	19	20	20	21	20	20	19	21	21	20	22	18	30.4	25.7	19	29.9	29	28.8	28.8	30.8	25	28	29
30S/10E-24A	**FW6**	**11**	**10**	**12**	**11**	**12**	**11**	**12**	**11**	**11**	**11**	**12**	**12**	**11**	**17**	**15.9**	**15**	**17.4**	**--**	**13.4**	**18.6**	**15.5**	**15**	**--**	**10**
30S/11E-7K3	FW9	12	8.5	14	16	13	12	15	11	14	14	6.1	12	11	14.4	17.3	15	19.2	20	24	21.9	19.6	28	--	--
30S/11E-7L4	FW8	15	14	15	16	16	28	17	18	16	19	52	21	23	19	18.7	21	22	21	19.4	21.6	15	15	--	--
30S/11E-7N1		3	3.1	2.7	2.2	2.5	2.4	2.3	2.3	2.4	2.2	2.1	2.6	2.9	3.8	5.2	5.5	6.3	6	6.4	7.2	4.7	--	--	--
30S/11E-7Q1	**FW10**	**16**	**18**	**15**	**17**	**17**	**17**	**19**	**19**	**16**	**18**	**20**	**22**	**21**	**15.7**	**18.4**	**18**	**10.8**	**25**	**26.5**	**23.4**	**21.4**	**29**	**--**	**--**
30S/11E-7R2	FW11	12	14	9.6	13	14	14	14	12	15	12	14	17	13	13.1	16.3	18	21.9	18	17.6	19.5	11.6	21	--	--
30S/11E-8Ma		--	--	--	--	--	--	--	--	--	--	--	4.9	4.2	2.5	2.8	2.5	2.3	--	--	--	--	--	--	--
30S/11E-8Mb	FW20	--	--	--	--	--	--	--	--	--	--	--	19	18	32.5	77.6	57	--	--	--	--	--	--	--	--
30S/11E-8N4	FW21	2.4	2.7	2.9	1	0.7	0.7	0.8	0.6	0.8	0	0.8	2.4	1.2	2.1	2.8	2.8	3.5	4.5	8.3	9.2	4.8	2.5	--	--
30S/11E-17D		17	17	21	20	19	19	19	17	17	20	17	18	17	19.1	19.8	19	19.6	18	24.2	22.7	30	--	32	--
30S/11E-18E9		--	--	--	--	--	--	--	--	--	--	--	14	13	--	--	--	--		--	--	--	--	--	--
30S/11E-17F4	FW22	3	2.4	0	2	1.5	1.3	1.1	0.8	0.7	0.5	0.5	0.6	0.6	0.6	0.7	0.92	1	1.1	0.9	1	1.1	1.1	0.94	1.3
30S/11E-17N4	FW23	7.6	7.5	7.3	7.5	7.4	6.3	6.3	6.1	6.3	5.1	5.6	6.2	5.6	--	--	7.4	7.9	8.2	7.7	7.1	7.8	3.7	7.7	8.4
30S/11E-18A		--	--	--	--	--	14	15	14	15	14	14	13	11	10.9	13.1	16	--	--	--	--	--	--	--	--
30S/11E-18B2	FW13	6.9	8.6	10	7.9	10	11	11	9.8	7.4	2.4	12	8.6	7	7.1	11.7	20	18.3	22	14.5	22	11.4	14	--	--
30S/11E-18C2	FW12	15	15	15	15	15	15	15	14	15	10	17	16	14	16.1	17.3	18	18.7	17	16.8	17.5	18	12	--	--
30S/11E-18E1	FW14	11	11	11	11	11	9.1	9.7	7.9	7.9	7.9	6.9	6.2	7.9	8.7	9.9	8.9	10.9	8.3	10.6	11.1	11.9	10	11	11
30S/11E-18H3		11	10	9.8	11	--	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
30S/11E-18J7	FW19	6.9	4.6	5.4	5.4	3.5	3.7	2.8	3.5	4.9	4.4	6.2	4.4	1.9	3.5	3.6	12	10.8	9.3	10.4	11.3	8.7	12	16	15
30S/11E-18L11	FW16	9.2	9.8	8.8	11	11	11	9.3	8.6	9.4	13	10	9.1	5.9	4.2	5	9.4	5.6	8.4	10.8	7.9	13.5	21	16	16
30S/11E-18L12	**FW17**	**19**	**20**	**19**	**20**	**23**	**22**	**18**	**15**	**16**	**9.6**	**15**	**15**	**14**	**18.2**	**27.4**	**18**	**19.6**	**29**	**29.6**	**32.6**	**32.3**	**36**	**20**	**48**
30S/11E-18N2	**FW15**	**18**	**15**	**16**	**16**	**16**	**15**	**14**	**13**	**15**	**12**	**21**	**22**	**20**	**25.9**	**27.9**	**28**	**27.8**	**23**	**25.4**	**24.8**	**21.1**	**22**	**23**	**27**
30S/11E-18R1	FW30	14	14	15	16	17	15	15	15	17	15	17	18	18	21.1	20	18	18.3	18	17.2	--	18.8	15	8	13
30S/11E-20B		5.7	5.6	4.4	3.7	4.6	4.6	3.7	2.8	3.8	2.5	6.2	7	6	--	--	--	--	--	--	--	--	--	--	--
30S/11E-21D		--	--	--	--	--	--	11	4.9	3	9.2	6	7.3	4.8	--	--	--	--	--	--	--	--	--	--	--
METRIC WELL AVG.		**16.6**	**18.2**	**17**	**20**	**21.6**	**22.2**	**19.6**	**16.4**	**16.8**	**15.7**	**18**	**18.8**	**15.4**	**18.9**	**21.1**	**17.8**	**18.6**	**24.8**	**24.2**	**25.4**	**24.1**	**26**	**21**	**32.3**
AVERAGE ALL		11.1	11.1	11.1	12.1	12.5	12.7	11.9	10.4	11	10.4	13.1	12.3	10.5	13.2	16	15	14.3	15.4	16.1	16.7	15.7	16.2	15.8	18.8

SEASON CODES:

1 **SPRING (MAR-APR-MAY)**
2 **SUMMER (JUN-JUL-AUG)**
3 **FALL (SEP-OCT-NOV)**
4 **WINTER (DEC-JAN-FEB)**

DATA SOURCES: Quarterly and Semi-Annual Groundwater Monitoring Reports for the Los Osos Nitrate Monitoring Program (C&A, 2002-2006)
Semi-Annual Groundwater Monitoring Reports for Los Osos Water Recycling Facility (CHG, 2012-2013; 2015)
Semi-Annual Groundwater Monitoring Reports for Los Osos Water Recycling Facility (Rincon, 2014; 2017)
"--" = no measurement

TO: Los Osos Basin Management Committee

FROM: Rob Miller, Interim Executive Director

DATE: June 20, 2018

SUBJECT: Item 7b – Discussion of Program C Well Site Selection Process

Recommendation

Receive a presentation and provide input to staff for future action.

Discussion

Section 10.4 of the Basin Plan describes Infrastructure Program C as follows:

> *Program C includes a set of infrastructure improvements that would allow the Purveyors to shift some groundwater production within the Lower Aquifer from the Western Area to the Central Area. Since groundwater production from the Central Area induces less seawater intrusion than the same amount of production from the Western Area, this landward shift increases the Sustainable Yield X of the Basin. Program C consists of three wells located on the eastern side of the Central Area, an upgrade to GSWC's water main located along Los Osos Valley Road and pipelines to connect each of the expansion wells to that main.*
>
> *The three wells in Program C would be located to prevent or minimize impacts to private wells already producing groundwater from the Central Area. That is expected to be possible because the new wells would penetrate the Lower Aquifer, whereas existing domestic wells are concentrated in the Upper Aquifer.*

In general, the three wells (Expansion Wells 1, 2, and 3) were intended to be located to the west of Los Osos Creek, and in the central portion of the Basin. Golden State Water Company (GSWC) previously completed Expansion Well No. 1 at its Los Olivos tank site. CHG is currently reviewing the Basin model to determine if both Expansion Wells 2 and 3 are necessary to balance the Basin under current water demands. Staff believes that it is likely that only Expansion Well No. 2 will be required for current demands. Also, the upgrades to the existing GSWC mains are unlikely given the reduced production requirements. The Los Osos Community Services District (LOCSD) has adopted water rates sufficient to fully fund Expansion Well No. 2, though the well may ultimately become a shared asset among the parties. The anticipated general characteristic of the well are as follows:

- Depth – depending on the location, production would be focused in the lower aquifer, Zones D and E. In one potential location (Site D) where no adjacent Zone C wells are evident, the well may be screened in Zone C as well.
- Annual production volume – 100 acre feet per year (AFY) minimum, with 150 to 200 AFY preferred.

- Site requirements – 50’ protection zone around the well, with appropriate access for a drilling rig and for maintenance. The well will be enclosed in a structure for security and general protection.
- Casing – depends on test hole results, but it is expected to be 12” in diameter or smaller.
- Pump type – submersible motor for noise attenuation
- Electrical service – PG&E with no backup power anticipated

Given the above characteristics, LOCSD made contact with over 20 large parcel owners in an attempt to locate a suitable site with a potential willing seller. Four alternative sites have been identified, though until negotiations proceed, is should not be assumed that any given site involves a willing seller. The four sites are identified in Figure 1 on the following page and are described below. Geologic cross sections are also attached that have been assembled by CHG for a review of the various alternatives.

<u>Site A – Los Osos Middle School (LOMS):</u> This site would occur on developed property adjacent to or on the fringe of the LOMS play fields and associated parking area. This site is near the edge of the basin, and therefore the production may not meet minimum expectations. As with all wells, the actual production can only be determined by drilling and testing. The total depth of this well would be approximately 300 feet, and production would be focused on Zones D and E.

<u>Site B – Sage Avenue</u>: This site would be located in an undeveloped area on private property, and therefore the willingness of the seller should not be assumed early in the process. The LOCSD previously completed a biological assessment of the property. The total depth of a well at this site would be on the order of 350 feet, and production would be focused on Zones D and E.

<u>Site C – Andre Avenue</u>: This site would be located on a developed 1-acre residential property, which is the smallest parcel currently under consideration among the four alternatives. The site is developer-owned and if completed, the purveyors will be required to set aside 10% of the well production for future uses. The total depth of the well would be on the order of 600 feet, and production would be focused on Zones D and E.

<u>Site D – Sunny Oaks MHP</u>: This location is on the southern boundary of the existing Mobile Home Park, in a vacant area that may ultimately be available for other residential uses, and therefore no assumptions should be made about the willingness of the owner to sell. The total depth of the well would be on the order of 470 feet, and production would be focused on Zones D and E. Zone C may also be viable at this location, given the absence of private Zone C wells in the vicinity.

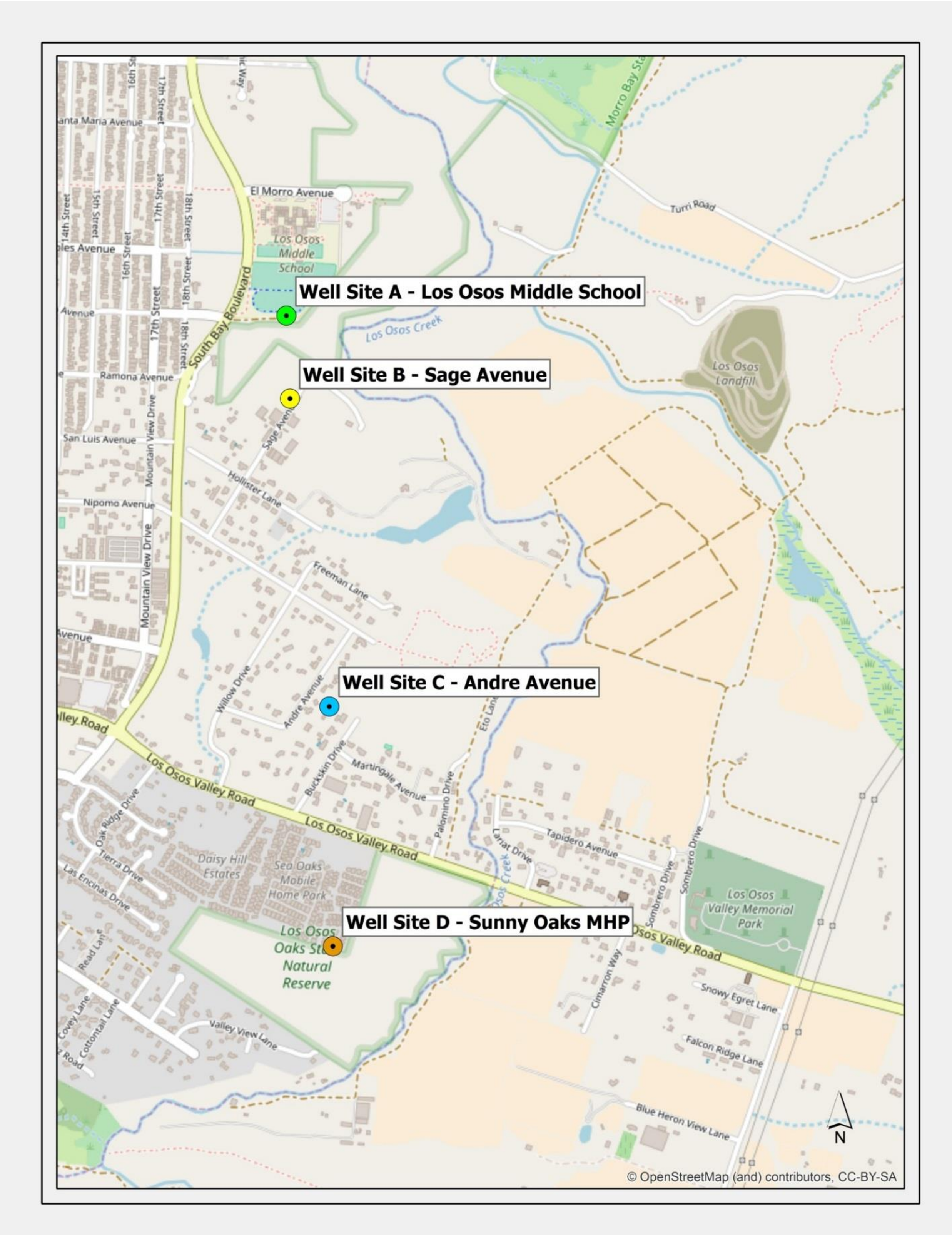

Well Site A - Los Osos Middle School
Well Site B - Sage Avenue
Well Site C - Andre Avenue
Well Site D - Sunny Oaks MHP
Los Osos Middle School
Los Osos Creek
Los Osos Landfill
Los Osos Valley Road
South Bay Boulevard
Los Osos Valley Memorial Park
Daisy Hill Estates
Sea Oaks Mobile Home Park
Natural Reserve
N
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Figure 1

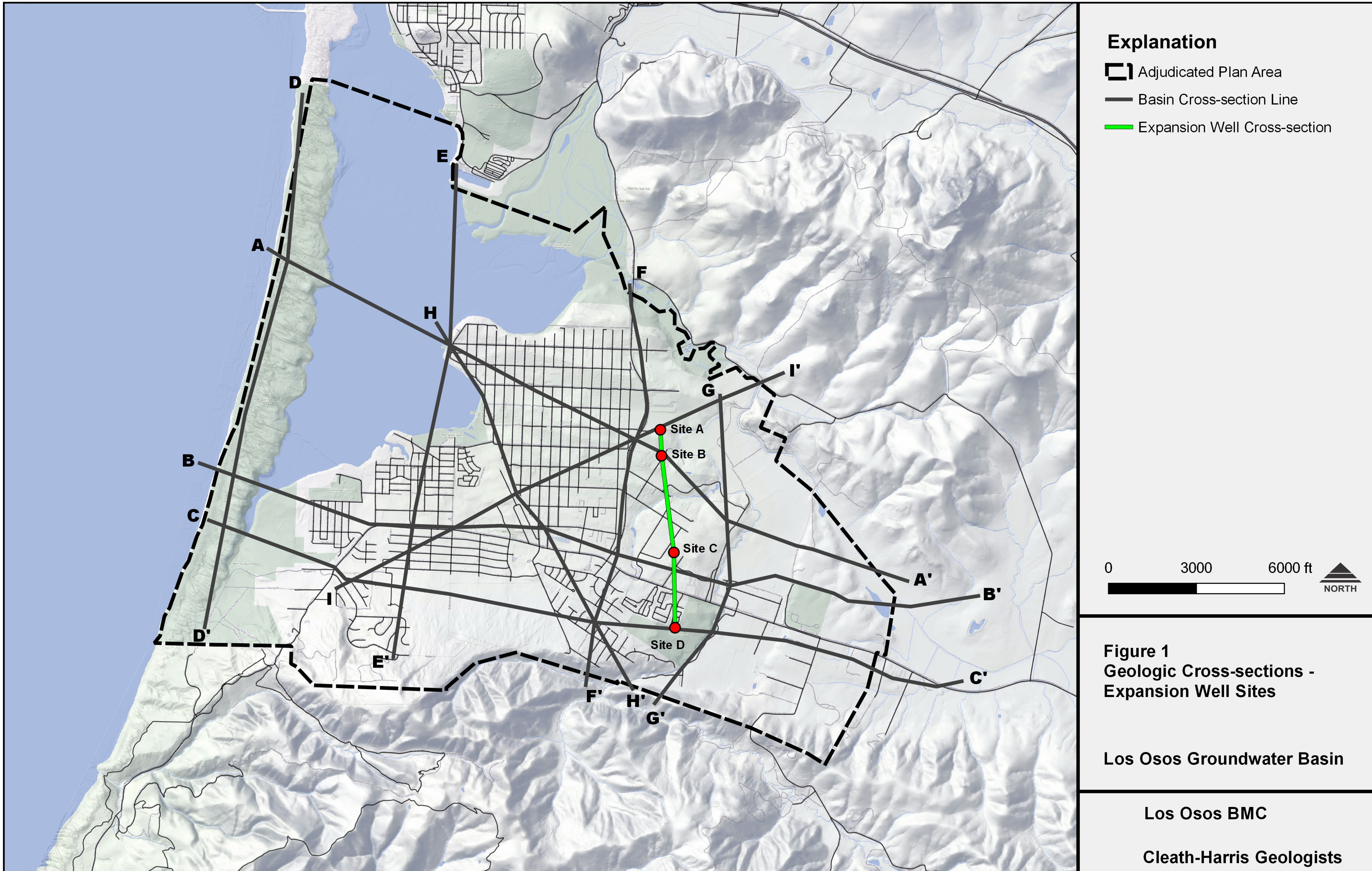
During the meeting, staff will provide a presentation on the many factors that should be considered prior to selecting a site. No site recommendation will be presented at this time, and all four of the sites, as well as additional locations, may ultimately be considered in an environmental document as potential alternatives. Key factors include, but are not limited to the following, which are not listed in order of priority:

- Anticipated annual production by aquifer zone
- Proximity to existing conveyance infrastructure
- Neighborhood and community acceptance
- Seller status and land acquisition cost
- Aesthetic concerns – visual, noise, operations, construction phase impacts
- Potential interference with adjacent private wells, though Zone D/E wells are expected to have minimal impacts on existing Zone C wells
- Environmental and endangered species impacts, which are expected to be higher on undeveloped property
- Site layout and access
- Likely timing for environmental permits and Coastal Development Permit
- Other factors to be identified by stakeholders

Staff has received a substantial amount of verbal and written feedback from the neighborhood adjacent to Site C – Andre Avenue. Neighboring property owners have expressed concerns about well interference with private domestic wells, neighbor aesthetics and compatibility, and other factors. This staff note and the presentation during the meeting are intended to be technical and informational in nature, and therefore no site recommendations are provided. Other well sites that have not been fully considered may also be raised prior to final site selection. The LOCSD will be taking the lead on the next steps in the process, which include the following:

1. Community workshop in July to discuss the selection process and provide a forum for community input in a less formal setting
2. Environmental review process to examine the impacts of each alternative
3. Identification of a recommended alternative for permitting
4. Completion of land purchase of selected site
5. Coastal Development Permit process through SLO County
6. Preparation of final design and construction documents

Financial Considerations
The final cost of Expansion Well No. 2 will be determined after the site is selected, but a budgetary value of $2.0M has been assigned. The LOCSD is currently advancing the effort, and water rates have been put in place to fully fund the project.



Explanation

Adjudicated Plan Area

Basin Cross-section Line

Expansion Well Cross-section

Figure 1
Geologic Cross-sections - Expansion Well Sites

Los Osos Groundwater Basin

Los Osos BMC

Cleath-Harris Geologists

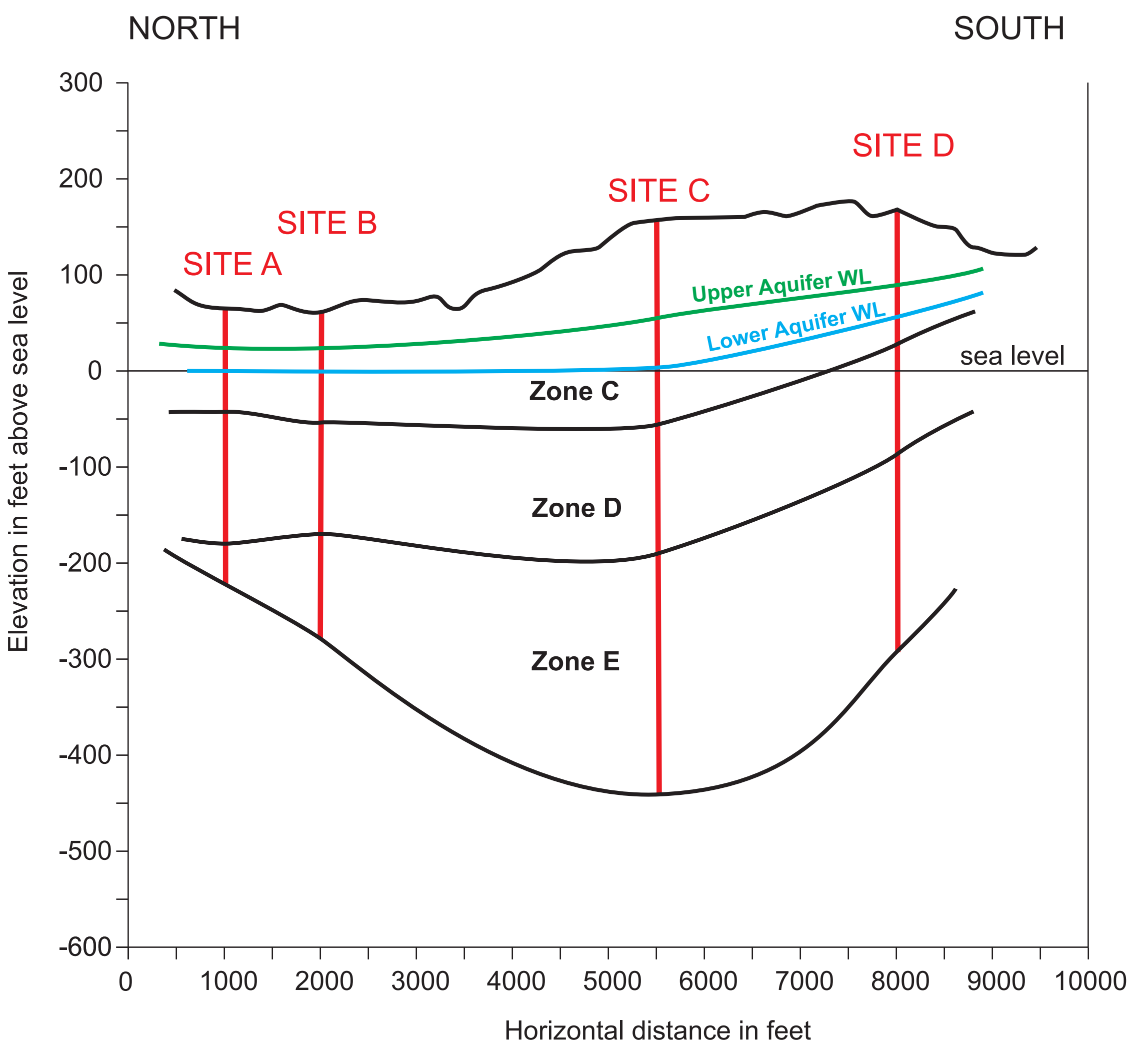
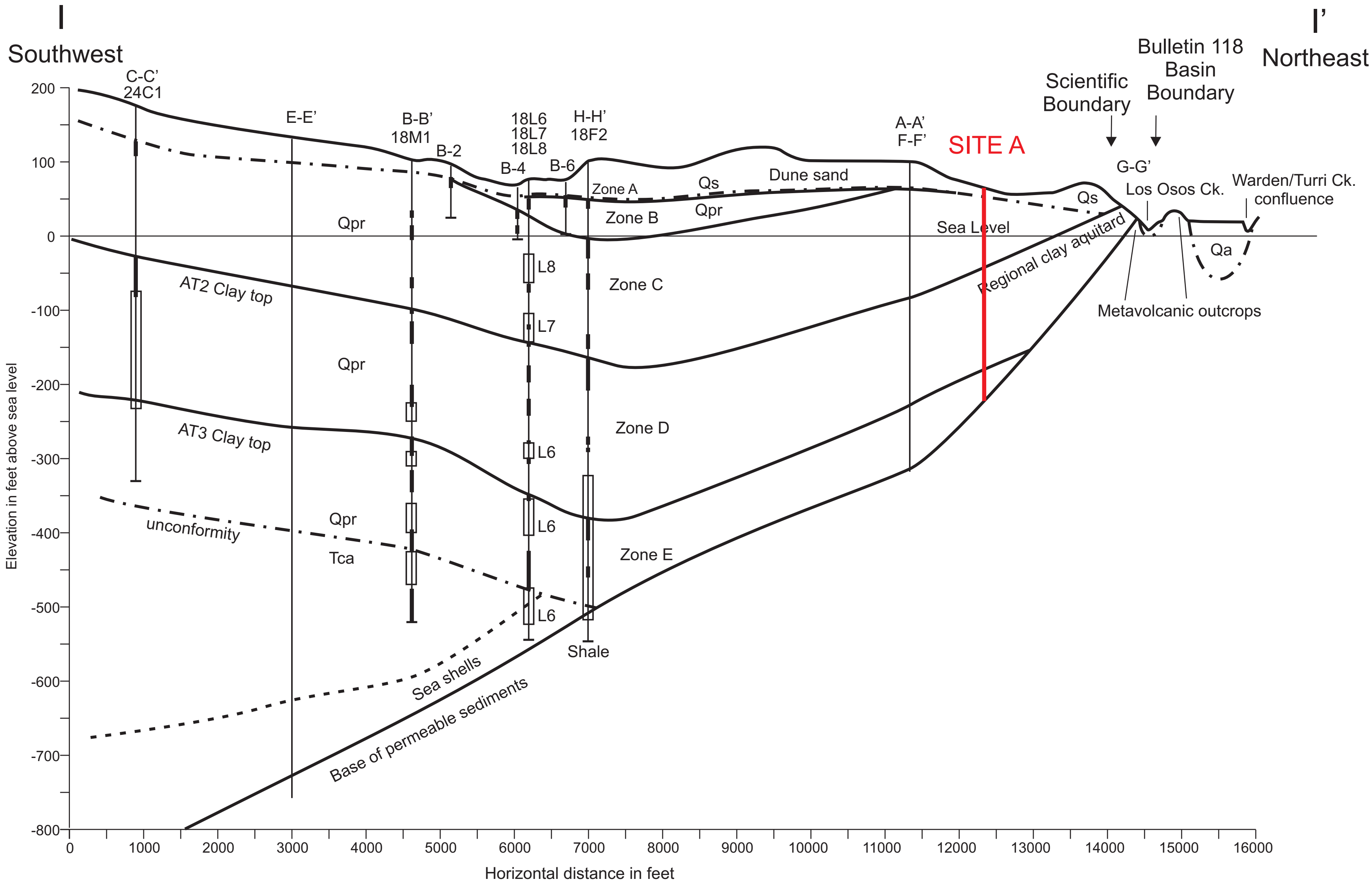


Figure 2

Expansion Well Site Cross-Section
Los Osos Groundwater Basin
Los Osos BMC

Cleath-Harris Geologists



Aquifer Zones:
Zone A - Perched Aquifer
Zone B - Transitional Aquifer
Zone C - Upper Aquifer
Zone D - Lower Aquifer (shallow)
Zone E - Lower Aquifer (deep)

Well data point
18M1 Well ID
Clay layer
Well screen

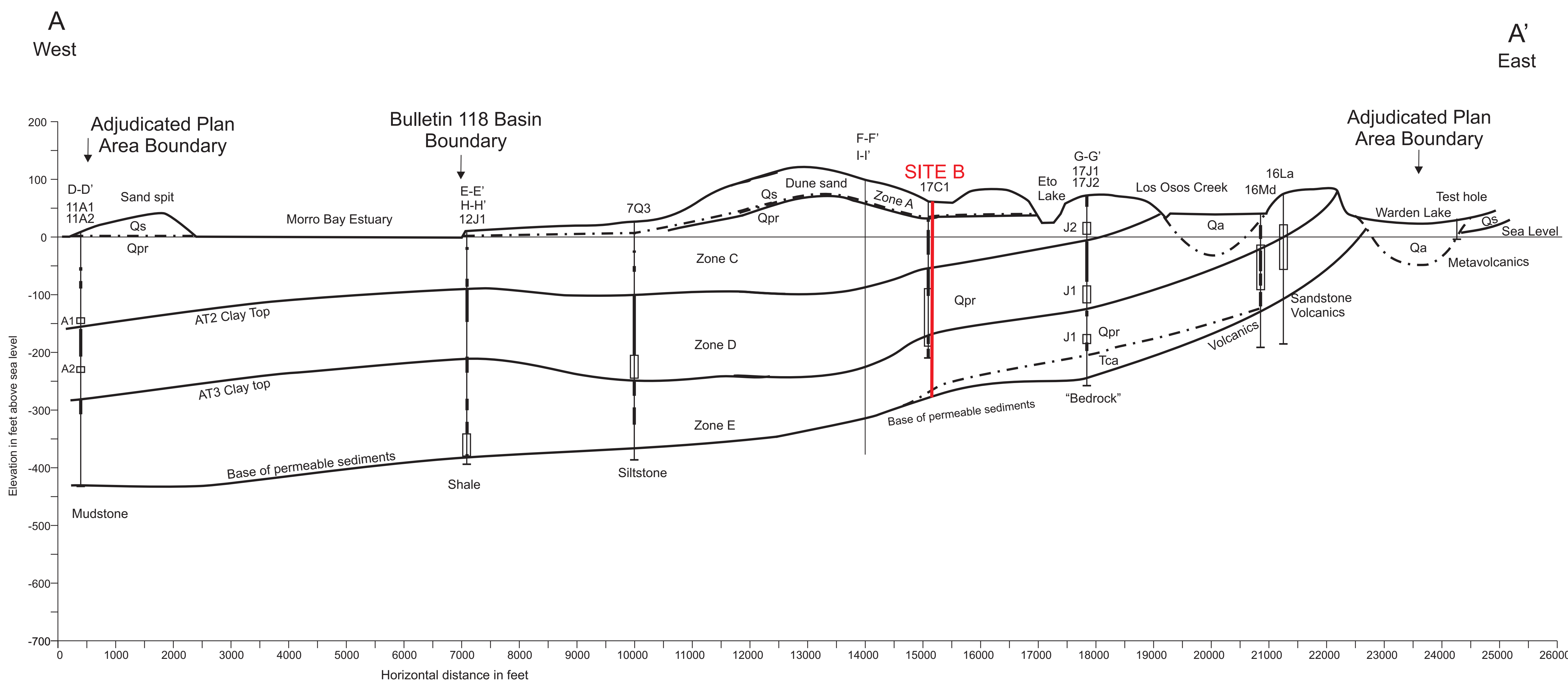
Formation:
Qa - alluvium
Qs - dune sand
Qpr - Paso Robles Formation
Tca - Careaga Formation

Figure 3

Cross-Section I-I'
Los Osos Groundwater Basin

Expansion Well SITE A
Los Osos BMC

Cleath-Harris Geologists



Aquifer Zones:
Zone A - Perched Aquifer
Zone B - Transitional Aquifer
Zone C - Upper Aquifer
Zone D - Lower Aquifer (shallow)
Zone E - Lower Aquifer (deep)

Well data point
12J1 Well ID
Clay layer
Well screen

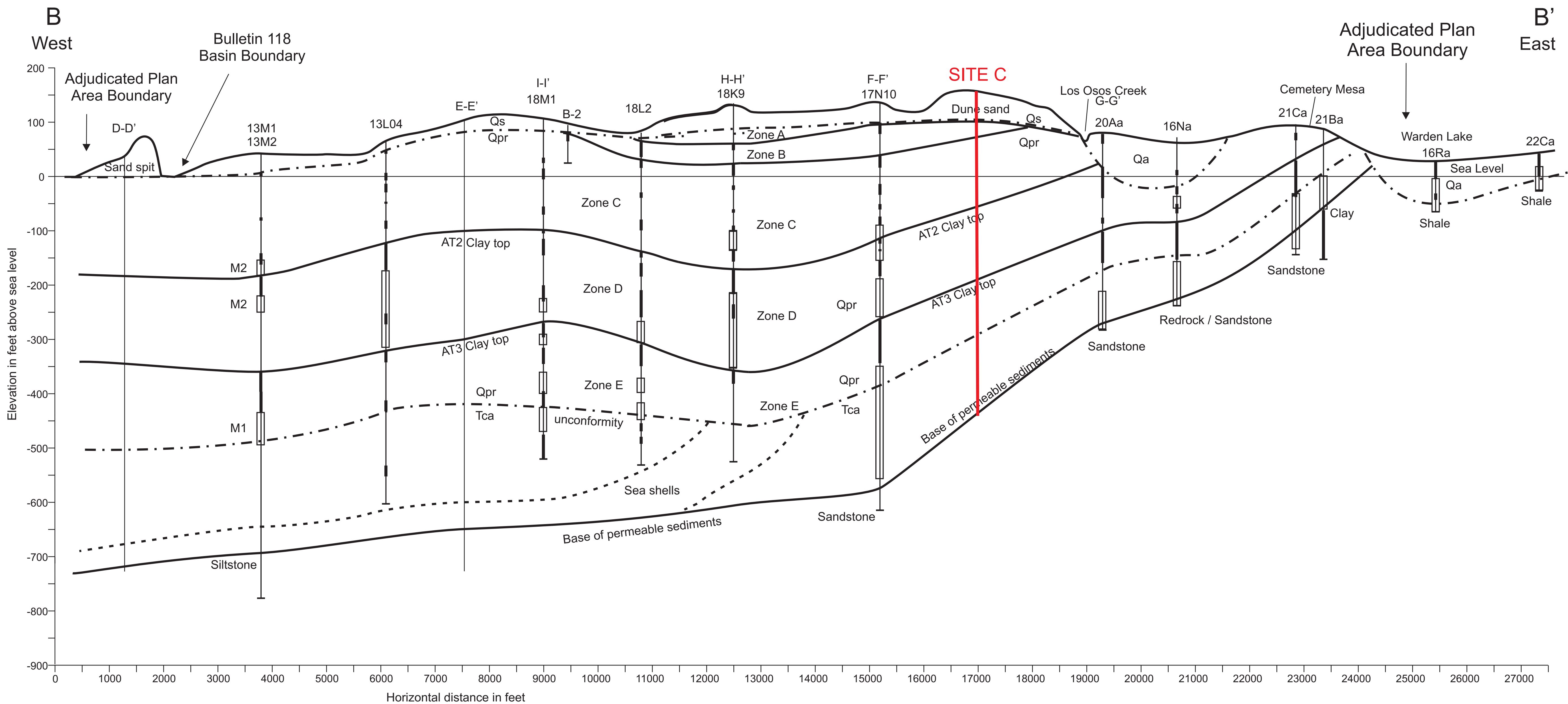
Formation:
Qa - alluvium
Qs - dune sand
Qpr - Paso Robles Formation
Tca - Careaga Formation

Figure 4

Cross-Section A-A'
Los Osos Groundwater Basin

Expansion Well SITE B
Los Osos BMC

Cleath-Harris Geologists



Aquifer Zones:
Zone A - Perched Aquifer
Zone B - Transitional Aquifer
Zone C - Upper Aquifer
Zone D - Lower Aquifer (shallow)
Zone E - Lower Aquifer (deep)

Well data point
18M1 Well ID
Clay layer
Well screen

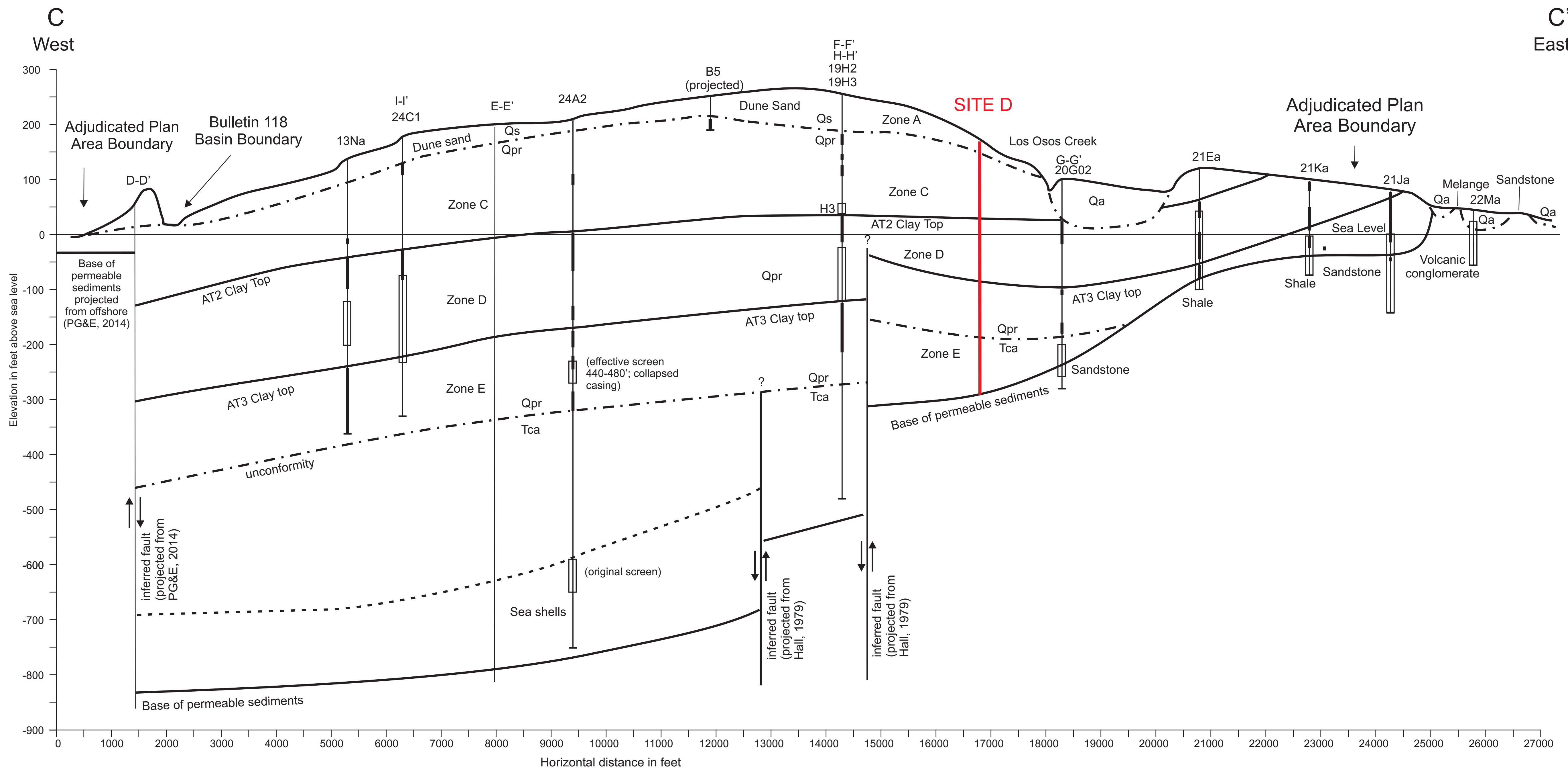
Formation:
Qa - alluvium
Qs - dune sand
Qpr - Paso Robles Formation
Tca - Careaga Formation

Figure 5

Cross-Section B-B'
Los Osos Groundwater Basin

Expansion Well SITE C
Los Osos BMC

Cleath-Harris Geologists



Aquifer Zones:
Zone A - Perched Aquifer
Zone B - Transitional Aquifer
Zone C - Upper Aquifer
Zone D - Lower Aquifer (shallow)
Zone E - Lower Aquifer (deep)

Well data point
24A2 Well ID
Clay layer
Well screen

Formation:
Qa - alluvium
Qs - dune sand
Qpr - Paso Robles Formation
Tca - Careaga Formation

Figure 6

Cross-Section C-C'
Los Osos Groundwater Basin

Expansion Well SITE D
Los Osos BMC

Cleath-Harris Geologists