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Subject: Comments on June 2006 Notice of Preparation and Initial Study for El Sur Ranch Water Rights Application No. 30166, Monterey County, California

Water Right Application No. 30166 seeks to extract ground water from underflow at the mouth of the Big Sur River. The point of diversion is two existing agricultural irrigation wells located in the flood plain northwest of the river within the Andrew Molera State Park. The El Sur Ranch (ESR) submittal included three technical documents dated May 2005 in support of their Water Rights Application. These documents provide the environmental data and technical analyses for the June 2006 Notice of Preparation (NOP) and Initial Study (IS) prepared by EIP Associates for the State Water Resources Control Board. The two ESR agriculture wells are called the Old Well and the New Well. A third smaller well, called the Navy well, is operated by State Parks and Recreation Department.

At the request of the Department of Fish and Game, Agreement No. P0530003, I have reviewed the three technical reports and the Initial Study. This letter presents my findings and opinions on the technical data and Initial Study and makes recommendations in section 9 for additional hydrologic, hydrogeologic and environmental assessment and filling of data gaps that would help quantify the potential impacts from the proposed water diversion. The recommendations for additional study are based on the data, analysis and conclusions provided in the ESR technical submittals. The amount and complexity of the recommendations are in part due to both the complexity of the project site and to the applicant's reliance on ground water upwelling as mitigation for potential pumping impacts.

Summary of Comments

1. Hydraulic constriction of the alluvial aquifer at the ocean does not appear to be present due to the high hydraulic conductivity zone below an elevation of –20 feet below mean sea level (msl) which makes up for the reduction in aquifer cross-sectional area.

2. The influence of saltwater intrusion on upwelling of ground water at the "cold pool" needs to be quantified.

3. Data are needed on the elevation of surface water and ground water in the river reach adjacent to the pumping wells to measure the hydraulic gradient between the river and aquifer in order to calculate the quantity of ground water inflow and outflow, and to establish the location of the transition from the losing to gaining reach.

4. Calibration is needed of the relationship between water quality parameters, temperature, dissolved oxygen and electrical conductivity, and ground water flow direction and quantity before they can be used as indicators of impact.

5. Additional data and analysis are needed to explain the variation in water temperature observed during the 2004 pumping season.

6. The water balance for the study area needs to be revised to reflect pumping levels requested in the water rights application and to provide more information on the known inflows and outflows to reduce the high percentage of unknowns.

In reviewing the documents provided, a key hypothesis of the hydrogeologic setting at the ESR well field is that "upwelling" ground water at the "cold pool" that lies between water quality transects #7 and #9 demonstrates that the river is not losing flow due to pumping, and that there is sufficient inflow of cooler ground water to the river to mitigate the impacts from pumping. Pumping may even benefit surface water quality by capturing ground water low in dissolved oxygen, thereby preventing it from reaching the river. This upwelling is the result of the constriction of the river valley at the ocean which reduces ground water outflow to a rate that is less than at the middle of the alluvial valley causing ground water to rise to the surface. Because this constriction is a physical barrier to groundwater flow, the upwelling occurs throughout the irrigation season regardless of the level of pumping. The applicant assumed for the salt water intrusion model that the upwelling may be as high as half the pumping rate, approximately 1,200 gpm (gallons per minute) or 2.67 cfs (cubic feet per second). The applicant reasons that the upwelling has to stop before the pumping can cause an impact to the river, i.e., deplete the river, apparently because as long as the river is gaining it can't be losing. This letter will discuss several issues related to the data supporting the upwelling hypothesis and make recommendations for additional study to quantify the effects of upwelling on river quality and flow rates.

1. The Initial Study appears to accept the upwelling ground water hypothesis and relies on it throughout the evaluation of environmental impacts. For example, on pages 5-14 and 5-15, the discussion of potential impacts to biological resources from groundwater pumping lists impacts on the riparian resources from a reduction of underflow and groundwater levels and potential changes in salinity caused by increased saltwater intrusion. The Initial Study does not however list as a potential impact to biological resources the possibility for a reduction in the flow of the Big Sur River as the result of pumping ground water. A potential for impacts to surface water from ground water pumping does exist for reasons discussed below and should be addressed as a potential environmental impact.

2. The May 2005 hydrogeologic report by The Source Group, Inc. (SGI) discusses the hydrogeologic setting and the constriction of the aquifer in sections 3.3 and

5.1. The report states on page 5-2 that the reduction in the aquifer width between the Franciscan bedrock from 1,600 to 700 feet results in a pinching of the aquifer. While the width of the alluvial valley in the project area does lessen at the ocean, the flow of ground water is the result of the aquifer's transmissivity, not just width at the top of the aquifer. The ability of an aquifer to transmit water can be calculated by the product of the hydraulic conductivity and the cross-sectional area, the k*A portion of Darcy's Law, Q = k*i*A.

The change in the aquifer cross-section between the wider part of the aquifer and the ocean can be measured using the geologic cross-sections B-B' on Figure 3-11 and D-D' on Figure 3-12. Measurement of the cross-sectional area needs to separate the aquifer area above minus 20 feet below msl from that below because of the difference in hydraulic conductivity (see discussion on SGI page 3-10). The hydraulic conductivity of the shallow aquifer (above minus 20 feet below msl) can be taken from the pump test data that resulted in an average value of 3,623 feet/day (SGI page 3-9), although a value of 1,500 feet/day was used for the saltwater intrusion modeling effort (see SGI page 3-33). The deeper aquifer (below minus 20 feet below msl) is thought to be much coarser grained to bouldery with a hydraulic conductivity ranging from 10,000 to 100,000 feet/day (see SGI page 3-10). A hydraulic conductivity of 15,000 feet/day was used for the saltwater intrusion modeling effort (see SGI page 3-33).

Based on these two geologic cross-sections and the stated hydraulic conductivities, I did not find that the alluvial aquifer is constricted at the ocean, rather it appears to be more transmissive at the ocean than at the mid-section of the alluvial valley by approximately 20 to 75%, depending on an assumption on the inland extent of the deeper, high conductivity layer. The SGI report also attributes the rise in ground water at the ocean to the presence of the saltwater wedge. While this may have an effect, the inland extent of the saltwater wedge is not fixed, but varies based the elevation of surface water, tidal influences and to a significant extent on the rate of pumping, particularly at the Old Well (see SGI section 3.5.2).

Thus, the Initial Study's findings under the Hydrology Section 8b, starting on page 5-30, include: (1) the magnitude of any pumping withdrawals are exceeded by the influx of ground water recharging or upwelling into the river; and (2) water quality changes in the river near Creamery Meadow are naturally occurring and unrelated to pumping. These two findings may not be valid because they rely on the aquifer constriction to drive the "natural" upwelling ground water. Without the constriction of the aquifer at the ocean, the cause(s) of any groundwater inflow or upwelling and the changes in surface water quality are an open question. The lack of a constriction may result in the pumping rates and timing, as well as location of the wells, becoming the most significant parameters in determining the movement of ground water, the amount and timing of saltwater intrusion, and the resulting impacts to river flows. Without the constriction of the aquifer at the ocean, the monitoring mitigation measures mentioned in the Initial Study may differ substantially from those now being considered.

3. The Initial Study appears to agree with the 2005 SGI report's conclusion that water quality parameters can be used to measure hydraulic conditions between the river and aquifer. Specifically, the direction of change in water quality parameters, namely, temperature, dissolved oxygen, and electrical conductivity indicates the direction and quantity of water flow. This assumption becomes critically important in the discussion of the "cold pool" and its significance. However, the reliance on this assumption requires calibration of the relationship(s) between water chemistry, and ground water and surface water hydraulics which has not yet been done. In fact, there are no hydraulic gradient or flow data in the area of the "cold pool" to document the direction(s) or volume of water flow, either across or along the river channel. Recommendations are provided below in section 9 for additional data needed to demonstrate that water quality parameters can be used as a measure of water flow direction and quantity.

4. It is known that the pumping of a well in an unconfined aquifer lowers the water table around the well, creating a cone of depression that decreases in depth radially outward. The water table depressions created around the ESR irrigation wells must eventually intercept the river. The river and ground water are said to be in good hydraulic connection (see SGI sections 3.4.8.1, 4.0, and 5.2). The aquifer and the stream bed are coarse-grained with high hydraulic conductivity (see SGI section 3.3.2). No continuous low permeability layer has developed in the riverbed (see SGI section 4.0). The river can be a recharge boundary and lose water to the aquifer during pumping (see SGI section 5.2). Evidence of the recharge boundary can be found in the pumping test of the New Well, where no pumping related effects, i.e., drawdown, were observed in monitoring well JSA-05 located on the opposite side of the river (see SGI section 5.2). However, the river as a recharge boundary conflicts with the inflow of ground water that's needed to create the "cold pool." Resolving the apparent conflict of the river acting as a source of recharge to the aquifer during pumping while at the same time receiving inflow from upwelling is important to understanding the potential impacts from pumping and for selection of the appropriate monitoring requirements. The SGI report does provide some data on the hydrogeologic and hydraulic setting of the river and wells that may provide insight as to the location and nature of the losing-to-gaining transition as discussed below.

    a. The 2005 SGI report (section 3.4.6.3) identifies the reach of the Big Sur River between velocity transect #1 (VT#1) and velocity transect #2 (VT#2) as being a recharging or losing reach where higher temperature surface water infiltrates and was eventually seen as warm ground water in the monitoring wells ESR-10A, B, and C as well as ESR-02 and ESR-03 (see SGI section 3.4.6.3). As noted above, the "cold pool" was identified as a gaining reach where cooler ground water is thought to flow into the river generally between water quality stations #7 and #8, and sometimeS as far upstream as station #9. The SGI report does not provide any information on where upstream of VT#2 the infiltration occurs, or what happens downstream of VT#2 before reaching the gaining "cold pool" reach. If the river changes from a losing to a gaining reach, there must be a point or section of channel where this transition occurs and an associated physical reason for this reversal in hydraulic gradient. The SGI report does not discuss the nature of this transition, what causes it, or whether it is stationary or moves as the result of changes in pumping rates, pumping times, river flow, tides, etc. Additional information is needed on the location and orientation of this transition zone in order to determine the appropriate monitoring locations and times.

b. The available information on the hydraulic gradient between the river and the aquifer comes from the river elevations measured at the stilling well installed near VT#2 (see SGI Figure 1-3), and water levels measured in the ESR-10 wells located in a southwesterly direction about 300 feet from the New Well (see SGI Figure 2-2). The direction of hydraulic gradient between the stilling well and ESR-10 wells was always away from river towards the pumping wells (see attached Figures 1 and 2). Similarly, the direction of hydraulic gradient between the stilling well and the more distant monitoring wells ESR-02 and ESR-03 located approximately 750 to 800 feet from the river was also always sloping from the river towards the pumping wells. This suggests that the losing reach of the Big Sur River extends at least into the area of the stilling well near VT#2. Additional information is needed to determine how far upstream and downstream the losing reach extends.

c. In order for the river to transition from a losing reach at VT#2 to a gaining reach by water quality station #9, the direction of the hydraulic gradient must reverse and a groundwater divide or boundary must develop where the direction of hydraulic gradient changes from flowing towards the river to flowing away towards the pumping wells. This groundwater divide must lie either between the river and the pumping wells or possibly beneath the river. The divide would also likely connect with the point of transition from losing to gaining river between water quality station #9 and VT#2, as discussed above. To create this groundwater divide, either the elevation of the water table between the river and the wells must rise above the river water surface, the surface water elevation drop below the water table, or a combination of both. Unfortunately, no data are available on the elevation of either surface water or ground water between VT#2 and water quality station #7, the downstream end of the "cold pool" to help determine where and by how much the hydraulic gradient between the river and ground water changes. In addition, there are no flow data for the river downstream of VT#2 to measure river flow gains or losses except the VT#3 gage at the ocean, which was not available during closure of the lagoon. Hydraulic gradient and flow data are needed from the area of groundwater upwelling to the losing reach at VT#2 to determine the nature of the transition. Additionally, a longitudinal profile of the river should be developed to help determine whether changes in the grade of the channel bottom are causing any changes in hydraulic gradient. Specific recommendations for additional data are given below in section 9.

d. In order for the river to be a continuously gaining reach at the "cold pool," the water table elevation for at least a portion of the Creamery Meadow area south of the river must be higher than the surface water between stations #7 to #9. Again, there are no data to document the elevation of the water table in Creamery Meadow relative to the adjacent river. Piezometers are needed in Creamery Meadow adjacent to the "cold pool" reach of the river and possibly further upstream to the area of VT#2 to document the direction and gradient of groundwater flow. Consideration should be given to making these piezometers so that water quality samples can be obtained to document upgradient groundwater quality.

e. Although there is no water elevation data in the vicinity of the "cold pool," one sampling event at water quality station #8 might provide some information on the complexity of ground water flow in the reach. On September 15, 2004, the water quality sampling event at station #8 consisted of two samples at different water depths for each of the three sampling sites, #8-L, #8-M and #8-R. The results of that sampling event are given in the following table.

September 15, 2004 Temperature, Dissolved Oxygen, and Electrical Conductivity at Water Quality Station #8

Station ID	Date	Time	Temp °C	Temp °F*	Conductivity µS/cm	DO mg/L	Sample Depth, ft
#8-L	15-Sept.	16:45	15.15	59.27	247	6.15	3.8
#8-L	15-Sept.	16:50	13.21	55.78	234	3.45	4.5
#8-M	15-Sept.	16:50	13.50	56.30	239	4.87	3.5
#8-M	15-Sept.	16:45	14.20	57.56	237	5.84	4.3
#8-R	15-Sept.	16:50	13.15	55.67	232	4.50	3.8
#8-R	15-Sept.	16:45	14.30	57.74	241	5.57	4.0

* Converted from °C

At the left sampling point, #8-L, located on the Creamery Meadow side of the river, there was an upward increase in temperature with a decrease in sampling depth which suggests upward movement of cooler waters, which agrees with the "upwelling" hypothesis. For the middle and right side sampling stations, #8-M and #8-R, the direction of water quality change reverses. There is a downward increase in temperature and dissolved oxygen. If the water quality change by itself is an indicator of water flow direction, the data from this sampling event suggest water flows into the river on the Creamery Meadow side and out on the middle and right, pumping well side. Although, this is the only sampling event and sampling station where two depths were sampled at the same time, it demonstrates the importance of the location and depth that a sample is taken, and reinforces the need for specific water elevation information during water quality sampling events to document the direction and amount of hydraulic gradient between the river and ground water.

5. The Initial Study's Hydrology and Water Quality section on page 5-30 states that, "the ability to measurably affect river stage remains inconclusive, yet there was no noticeable effect on surface water elevations when the pumps were turned off for the season in 2004." This statement appears to ignore the documented change

in surface water and groundwater levels as the result of increasing the pumping from one to two wells as discussed in SGI section 3.4.8.1 and as shown in SGI Figure 3-35. SGI Figure 3-35 shows the water levels dropping from mid-September to early October in 2004 at the stilling well in the river adjacent to VT #2 and in monitoring well ESR 10-B. The SGI report noted that the surface water level dropped approximately ½ inch and the ground water in the well dropped approximately 1 foot as a result of increased pumping. While this may not appear to be much of a physical change to the river, it is a significant change in hydraulic gradient between the river and well. The change in hydraulic gradient is a measure of the significance of increase, or decrease, in pumping because ground water flow is governed by Darcy's Law (Q = k*i*A). Assuming the hydraulic conductivity (k) and cross-sectional area (A) are not significantly changed, then the change in hydraulic gradient (i) quantifies the change and level of impact. As the Initial Study noted, ground water losses or gains to a river do not generally occur at a single point, but are spread along the river reach. Thus, the total change in flow can't be measured at a single point but must be measured between at least two points placed on either side of the impacted reach. By the statement of "no noticeable impact," the Initial Study appears to expect that the impacts from pumping the wells will be similar to a diversion into a pipe or canal, all occurring at one point on the river. The following discusses the significance of the hydraulic changes measured when the pumping rates varied.

a. The volume change from ½-inch rise or fall in surface water level at VT#2 where the average depth was less than 2 feet all pumping season is not insignificant. From the velocity profile calculation sheets in Appendix L, the average velocity at VT#2 is at least 0.10 feet per second (ft/sec), and the top width of the channel is approximately 20 to 24 feet (wetting perimeter – channel bank depths). Assuming that the surface velocity is equal to the average (generally it is considered slightly greater) and using the relationship Quantity = Velocity * Area, then ½-inch of flow is:

   Q = 0.1 ft/sec. * (½ / 12)ft * 20 ft = 0.083 cfs = 0.623 gal/sec ~ 37gpm
   Q = 0.1 ft/sec. * (½ / 12)ft * 24 ft = 0.1 cfs = 0.748 gal/sec ~ 45gpm

   A loss at this rate over a river length of 100 feet would cumulatively be 8 to 10 cfs, which clearly is not the case here. The point is, however, that ½-inch of change in surface water level while seemingly a minor change in elevation, is not an insignificant change in rate of flow, particularly when the change accumulates along a reach during a period low flow.

b. As noted above, the SGI report acknowledges that the river between VT#1 and VT#2 is a losing reach. The change in water levels at the stilling well and the increase in groundwater gradient that resulted from the increased pumping rate document that river losses from pumping can extend downstream to at least VT#2. Before September 19th, the Old Well was pumping at 2.55 cfs (see SGI Table 2-2). After the New Well began pumping, the combined rate of pumping was approximately 4.8 cfs, an increase of approximately 88%. Because the flow of ground water follows Darcy's Law, a change in groundwater flow is proportional to the change in hydraulic gradient. With an almost doubling of the pumping rate, the hydraulic gradient between VT#2 and ESR 10-B increased approximate 50 percent (SGI Figure 3-36). This increase in gradient agrees with the analysis by Miller and Durnford (2005) that when the rate of stream depletion approaches the rate of pumping, then approximately half of the seepage occurs within a reach of stream centered on the well, the length of which is twice the closest stream-to-well distance. For the study area, the river's closest point to the New Well is approximately 500 feet away (see SGI Figure 2-2) and VT#2 is approximately the same distance upstream. Therefore, with the 88% increase in pumping rate, the hydraulic gradient of ground water increased by approximately 50%, which suggests an increase in seepage losses from the river of approximately 50%.

c. A second opportunity to evaluate the impacts of pumping on river flow was made by using data from mid-October 2004 when both wells were turned off (see SGI Figure 3-36). Following cessation of pumping on October 16, 2004, there was no immediate rise in surface water elevation at the stilling well near VT#2. In fact, an analysis of the daily average elevation at the stilling well indicates that it dropped approximately ½ inch from October 15th to October 16th (see the ESR technical reports data). The surface water elevation began to rise the following day likely in response to the rain event on October 17th and 18th. If pumping ceased, why did the surface water level drop?

   Jenkins (1968) provides an explanation to this apparent inconsistency. River losses from pumping do not stop immediately when pumping stops; there is residual depletion. In fact, for certain hydrogeologic settings, the amount of water lost from a river after cessation of pumping can exceed the losses during pumping. Thus, the continued drop in surface water level is not inconsistent with known residual depletion and suggests that the river was still a losing reach. The rise in river stage due to the rain event eventually obscured the effects of stopping the pumping.

6. Periodic water quality sampling of the river was undertaken during the 2004 pumping season along the river at twenty-one sampling sites, while continuous sampling of river temperature was done at five temperature logger sites (see SGI Figure 2-2 for sampling locations). Two continuous recording temperature loggers, numbered 3 and 4, were placed in the section of river between water quality stations #12 and #6, temp-logger #3 at water quality station #7R, and temp-logger #4 at water quality station #11R. Temp-loggers #4 is in an apparent losing reach and temp-logger #3 is in an apparent gaining reach, the "cold pool." Figure 3 (attached) shows the continuous data from the upstream, bottom temp-logger #4 in red, with the downstream "cold pool," bottom temp-logger #3 values superimposed in grey. Point symbols indicate the measurements taken at adjacent water quality stations. Figure 4 shows the temperature logger data as a 24-point running average; most samples were taken hourly. These graphs show that temperatures at the two locations do not differ significantly from the beginning of the record on April 18th to approximately July 16th when a difference of 2 ^{o}F to 4 ^{o}F occurs for highest temperatures only. On August 26th , the lagoon closes and

the temperature differences increase for both high and low temperatures. Between September 2nd and the 20th, there is a gradual drop in the temperature at the upstream temp-logger #4. By mid-October, near the end of the record, the temperature range and variations are again similar at the two locations. Even though these temperature data were taken from the right side of the channel, the pumping well side, the data show that the differences between the hotter upstream reach and the "cold pool" were not uniform throughout the irrigation season. The questions then are why is there a variation, how consistent is the upwelling, and what impact might this have on the proposed mitigation monitoring program. The following is a discussion of the 2004 irrigation season temperature data taken by the two continuous temperature loggers, and at the adjacent water quality stations.

a. From the beginning of data collection on April 18th, through July 16th, the river bottom temperatures at the two temperature stations appear to be similar. This may be due in part to the higher flow rates during this period of time. Following the initial measurements on April 18th, no water quality transect sampling was reported from stations #7 through #10 until July 23rd, 96 days later. Thus, the available data do not appear to document the "cold pool" effect of ground water upwelling during the first half of the 178-day 2004 irrigation season.

b. The hypothesized upwelling is in part thought to be caused by the presence of a saltwater wedge, and high spring tides are thought to be a significant factor in the landward movement of the saltwater wedge (see SGI section 3.5.2). The saltwater modeling effort simulated the high spring tides from June 15 to July 10 (see SGI section 3.5.3). No water quality data were collected from the "cold pool" reach during the period of highest tides. The July 12th transect sampling skipped water quality stations #7 through #10, as well as several others. In the period when saltwater intrusion is thought to have had the greatest influence on upwelling, there are no data to document the effect in the "cold pool."

c. The period of measurable temperature difference between the temperature loggers begins on July 16th when the higher temperatures start to differ. This time corresponds with the beginning of the period of lowest flow in the river as measured at the USGS gage (see SGI Figures 3-26 and 3-27). The high temperature difference continues until August 26th when a sand bar closes the lagoon's surface water outlet to the sea.

d. On August 26, 2004, when a sand bar closes the river's outlet, the lagoon surface water level starts rising from approximately 5.2 feet above msl and reaches 8.5 feet above msl by mid-September (see SGI Figure 3-43 and section 3.4.8.3). By the end of September, the lagoon surface drops to approximately 6.75 feet above msl. Groundwater levels in monitoring wells also go up approximately 1.5 feet to 2.0 feet by the start of September (see SGI Figure 3-44 and section 3.4.8.3). By mid-September, groundwater levels drop back to below approximately 6.25 feet above msl. The attached Figure 5 shows the changes in groundwater levels at monitoring well ESR-02 which is representative of the effects of the lagoon closure over a longer period than shown in SGI Figure 3-44. The rise in river stage with the closure of the lagoon may have extended upstream into the reach of the "cold pool" (see SGI Figures 3-28 and 3-29 for a comparison of lagoon water levels). The evidence for this can be found in the sampling depths of the water quality stations.

e. The March 11, 2005 Hanson Environmental, Inc.'s Biology report states in Section 3.3 that water quality samples were taken mid-way in the water profile. Thus, the depth of each sample can be used as a general index of the total depth at each transect location during each sampling event. A review of the sampling depths finds similarities to the lagoon data, in that the sampling depths at water quality stations #6 to #9 increase after the lagoon closure. The average sampling depth across each transect increases typically from approximately 1.0 to 1.5 feet (see summary table below). This corresponds to an increase in total water depth of 2 to 3 feet, assuming the mid-column sampling criteria. The cause of this rise does not appear to be an increase in surface water flow from upstream, as discussed below. If the river rise is the result of an increase in ground water discharge at the 'cold pool," the discharge would have to be very significant to cause this amount of sustained change.

Range of Sampling Depth Before and After Lagoon Closure

Transect	Aug. 19 Depth, ft	Sept. 2 Depth, ft	Difference, Min-Max
#6	0.40 – 0.90	2.00 – 3.20	2.10 – 2.50
#7	2.25 – 3.50	3.70 – 4.50	0.05 – 1.95
#8	2.10 – 2.70	3.30 –3.90	0.65 – 1.70
#9	1.70 – 3.75	3.80 – 5.20	0.10 – 1.45
#10	1.60 –3.10	1.80 – 3.25	0.15 – 0.60
#11	2.50 – 3.00	2.50 – 3.50	-0.20 – 1.00
#12	0.40 – 0.85	0.70 – 1.15	0.15 – 0.60

f. The differences in sampling depth do not appear to correspond to an increase in surface water flow as measured upstream at VT#2 (see SGI Table 3-1). On August 19th, the flows at VT#2 ranged from 5.90 to 6.97 cfs with sampling depths at water quality station #8 ranging from 2.10 to 2.70 feet. On September 2nd, the stream flows measured at VT#2 were higher at 7.28 to 10.26 cfs with the sampling depths at water quality station #8 ranging from 3.3 to 3.9 feet, showing an increase sampling depth with increased flows. However, on September 15th and 16th, VT#2 surface flows are reduced, ranging from 6.18 to 5.96 cfs, respectively, with sampling depths at water quality station #8 at 3.5 to 4.5 feet, slightly higher than on September 2nd and much higher than on August 19th when surface flows were at a similar rate. On October 28, after the river mouth has opened to the ocean, the measured surface water flow at VT#2 is approximately 46 cfs and the sampling depths at water quality station #8 range from 2.7 to 3.2 feet the following day, October 29th, showing shallower conditions than on September 2nd and September 15th and 16th.

Clearly, the greater water quality sampling depths at station #8 after closure of the lagoon on August 26th do not have a linear correlation with the total rate of surface water flow as measured at VT#2 suggesting some change in channel hydraulics or inconsistencies at the sampling locations. A possible reason for this lack of correlation between flow rate and water depth at station #8 is that the rising lagoon waters extended upstream creating a backwater effect in the area of the "cold pool" area, which likely widened the channel surface, creating the non-linear relationship between stage and flow before and after lagoon closure.[1]

g. The temperature values plotted for station #6 to #12 on SGI Figure 3-31, River Temperature Profiles, are generally taken from the left sampling point at water quality station #8, except on April 18 and October 29. Those for the other water quality stations were taken from the middle sampling point. The range of temperatures across stations #7, #8 and occasionally #9 is generally greater than at the other transects. The attached Table 1 shows temperature differences of water quality stations #6 to #12 for each reported sampling event in 2004. Data plotted on SGI Figure 3-31 are shown with red highlights. The question arises as to why the sampling points for the "cold pool" were taken from the bank opposite the pumping wells, likely the greatest area of upwelling, while the upstream samples were taken from the middle of the reach?

7. The lower section of the Big Sur River is a dynamic environment. The rates of surface water flows, precipitation, natural vegetation and crop evapotranspiration, and to some extent groundwater underflow vary throughout the year. The water balance for the pumping area is discussed in SGI section 3.4.7 and its subsections starting on page 3-22, and in Tables 3-6A and B. The water balance assumes for outflow that the surface water and groundwater underflow are a single system, which is generally correct, except that the timing and locations of inflows and outflows for each can have a significant impact on the local availability of water, which is a critical condition for some plants and wildlife. Although the water right being applied for requires a 30-day running average, the SGI water balance for the study area, Table 3-6B, does not provide analysis on a short term basis, e.g., monthly, but instead gives an annual and a 2004 season water balance. The combining of surface flow and underflow for the outflow balance misses the issue that the availability of surface flow is at times critical to sustaining the resource. The following is a discussion of the water balance.

    a. In calculating the water balance for the study area, the surface water runoff and groundwater underflow were kept separate as inflow, but combined as outflow. In the outflow portion of the 2004 season water balance, the combined outflow to the ocean of runoff and underflow was considered an unknown. The value was "solved for" by calculating the difference between the inflow and outflow and setting the imbalance equal to the combined outflow of runoff and underflow to the ocean. This

[1] Compare SGI Figures 3-28 and 3-29 for effects on lagoon water surface width, from pre- to post-lagoon closure.

combined outflow of runoff and underflow to the ocean made up approximately 83% of the total outflow for the 2004 season study area water balance. Because such a large percentage of the outflow is unknown, it creates concerns about the accuracy of the estimate and introduces the issue of measurement error. That is, if 80% of the flow can't be measured, how accurate is the estimate? It would be a more useful water balance if what is known about the runoff and underflow draining to the ocean is included and what is not known is calculated. This would give a measure of not only the inflow and outflow, but also the accuracy of the measurement.

b. In the annual water balance calculations for the study area (Table 3-6B), the combined runoff and underflow to the ocean was given as a known value taken from the total watershed discharge water balance presented in Table 3-6A. In the calculation of the total watershed water balance, this discharge to the ocean was taken from the Lower Big Sur watershed water balance, where it was an unknown and "solved for." Thus, an unknown at the watershed scale become a known at the scale of the study area. This appears to create a fact out of a previously unknown. As noted above, establishing what is accurately known and identifying what is still unknown is probably a better use of the water balance exercise because it will point to where more data should be collected.

c. In the annual study area water balance (Table 3-6B), the unknown that was "solved for" was the surface water inflow at cross-section A-A', which represents approximately 94% of the inflow. However, this value was previously estimated in Table 3-4 using an assumption that it has a relationship to the upstream USGS gage. The "solved for" value of 82,271 ac.-ft. (116.64cfs) in the study area's annual water balance is higher than the value that would result from summing the monthly values in Table 3-4, 77,851 ac.-ft. (107.53cfs). It is unclear why the surface water inflow at section A-A' was considered an unknown for the annual study area water balance and why the calculated result exceeds that estimated elsewhere. Again, the inconsistency of the water balance reduces its accuracy and questions its utility.

d. In the annual study area water balance (Table 3-6B), the annual value for pumping was 977 ac.-ft. This value is much less than the quantity requested in the water right application, a maximum of 1,615 ac.-ft., with a 20-year rolling average not to exceed 1,200 ac.-ft. The note in the table states that it is the average pumping rate for 1975 to 2004 with the addition of the Navy well's pumping. While this would be of interest in establishing the baseline water usage, there is no analysis of future use which is the subject of the environmental review. An additional water balance using the permit requested pump rate is needed.

e. In the 2004 season study area water balance (Table 3-6B), rainfall of 7.59 inches is assumed over a one-square-mile area producing 405 ac.-ft of inflow. Based on the ratio of cfs to acre-feet for the terrace subsurface inflow line item, the 405 acre-feet of rainfall appears to represent approximately 1.15 cfs. This rate is approximately 20% of the peak pumping rate requested in the water right application, a maximum 30-day average of 5.34 cfs and a maximum instantaneous rate of 5.84 cfs. However, most of this precipitation fell after mid-October (see SGI Appendix G) and was essentially never available during the 2004 pumping season which ended before mid-October (see SGI Table 2-2). In addition, the period for the surface water inflow at section A-A' was stated as July to September. The inclusion of precipitation that fell outside of the pumping season adds more inflow than was actually available. The water balance should be revised.

Based on the above discussion, the SGI water balance for the study area does not appear to provide a sufficiently accurate estimate to allow for use in measuring potential impacts from pumping on surface water flows or to measure the available waters. The water balance analysis for the study area should be done on a shorter time interval, no longer than monthly, because when less water is available in summer, more water is needed, and the water right being sought is in part based on a 30-day running average. The water balance and availability analysis should demonstrate that the requested 30-day average can be sustained. The analysis should also keep separate the surface water and groundwater flows to demonstrate how much of each is available. Because much of the outflow to the ocean is difficult to measure and subsequently has a high standard of error, it would be a more useful if the water balance documents what is known and then calculates the level of the unknown or error in the measurement. A water balance analysis where 80% or more of the data are unknown is not reliable. The balance should present data and calculations using both rate and volume, because the water right seeks diversion using both measures. The balances should be estimated for not only the average water year, but also for low flow years to establish minimum by-pass flow requirements and associated triggers.

8. A source of groundwater inflow to the river that was not discussed in the applicant's technical documents is bank storage. The rise in surface water flow during winter and spring months will raise the river stage and, with a sufficiently long duration, surface water will infiltrate the adjacent alluvium, temporarily storing ground water as bank storage (Freeze and Cherry, 1979). The rate of infiltration is dependent on the hydraulic conductivity of the stream bed and surrounding aquifer. The high hydraulic conductivity values of the Creamery Meadow area should allow for rapid saturation of the aquifer. In fact, the annual water balance for the study area (Table 3-6B) assumed an increase in underflow at sections A-A' of 0.55 cfs in winter months. This increase requires an approximate 5-foot rise in the groundwater level during winter months at section A-A', which likely extends downstream throughout the study area. With a drop in river stage during the spring and summer, the stored ground water will discharge back into the river, delivering baseflow. The rate of groundwater discharge decays over time as the gradient between the river and the water table falls (Glover, 1964). The volume of available bank storage is limited in the project area because the alluvial valley is bounded by low permeability bedrock (see SGI section 3.4.4). If all of the approximately 200-acre alluvial plain of the valley

surrounding the ESR wells is saturated for an additional 5 feet, then approximately 250 acre-feet of bank storage would be produced annually. The potential for ground water inflows to the river being derived from bank storage has not been discussed or eliminated as a source in the technical documents submitted by ESR. Given that the aquifer constriction is questionable and the influence of saltwater intrusion on upwelling is not yet quantified, as discussed above, bank storage should be considered as a potential source of summer inflow to the river, although the quantity is likely to be much less than the 1,200 gpm assumed in the SGI report (see SGI section 3.5.3).

9. Based on the discussions given above, there are several data gaps in the hydrogeologic and hydrology data for the study site that should be collected and analyzed in order to determine the available waters, quantify the gains and losses to the river from various pumping rates, and to assist in selection of type, location, and timing for monitoring water quality, quantity, flow rate, and elevation data. The following are my recommendations for additional data needs.

   a. **Lack of ground water and surface water hydraulic head data along the river on both sides.** This is especially critical between stations #6 to #12 and within the areas not under pumping influence, e.g., Creamery Meadow, to document water level differences within and outside the area of upwelling, to obtain background groundwater quality parameters, and to delineate the transition from a losing to a gaining river. Upstream of VT#2 where surface water is said to be infiltrating, hydraulic head data are needed to document flow direction. Without data on the water levels, surface and ground water, the validity of the chemistry signature of the upwelling ground water hypothesis can't be validated.

      Piezometers are needed in Creamery Meadow adjacent to the "cold pool" reach of the river and possibly further upstream to the area of VT#2 to document the elevation and gradient of groundwater flow. Data from these piezometers should be tied to surface water elevations in the adjacent river. Consideration should be given to making these piezometers so that water quality samples can be obtained to document upgradient ground water quality.

   b. **Lack of hydraulic conductivity data on the stream bed.** There is no information on whether the channel bed develops a clogging layer of fine materials, as asserted in the applicant's response to my previous comments. The text of the hydrogeology report suggests otherwise. If there is a large percentage of the channel bed covered with a fine-grained layer, then the clogging will reduce the rate of groundwater movement **into or out of** the channel. Variation in this clogging will also result in a variation in the impacts on the river. If fine sediments are commonly found covering the stream bed, then documentation is needed because it might affect where and when monitoring is done. Hydraulic conductivity data are needed for the channel bed. The number and location of measurements should adequately document the channel variability.

c. **Estimate the quantity of ground water upwelling into the river.** The presence of upwelling ground water in the reach of the river adjacent to the pumping wells is said to be an indicator of no surface water losses and is apparently thought to supply sufficient water to mitigate impacts of ground water pumping. However, none of the technical documents submitted provide a measured estimate of the rate or volume of upwelling ground water. The saltwater intrusion modeling effort assumed an upwelling inflow of 50 percent of the pumping, approximately 1,200 gpm, but this value was not measured or validated. The hydraulic gradient data combined with stream bed permeability data can be used to estimate the quantity and volume of inflowing or outflowing ground water.

d. **Estimation of influence of saltwater influx on upwelling ground water.** The cause(s) of the upwelling ground water in the reach of the river adjacent to the pumping wells still needs to be determined. As discussed above, the aquifer constriction appears to be unlikely, and the influence of the saltwater intrusion on upwelling is not adequately quantified. In addition, if the cause of the upwelling ground water is largely due to saltwater intrusion, then the rate and timing of the pumping of ground water is linked. Control of the pumping schedule might determine the rate and timing of upwelling. Data are needed to demonstrate the influence of saltwater intrusion on upwelling and to quantify the effects of pumping on upwelling.

e. **Water level and water quality data are lacking for ground water outside of the pumping well field.** The upwelling hypothesis is based an assumption that water chemistry changes and differences along the channel are caused primarily by inflows of ground water to the stream, but the background quality of ground water is assumed. Data are needed on the quality of background ground water to determine the extent of aquifer and surface water mixing and to track the migration direction and rate of surface water and ground water movement.

f. **Data are needed on the changes in surface water flow rates from water quality stations #6 to #12**. Stream flow data are needed in this critical reach to document the rate and timing of ground water inflow or loss. The value of inflow assumed for the salt water intrusion model between June 15th and July 10th was approximately 2.67 cfs (1,200 gpm) or 50% of the pumping rate (see SGI pages 3-33 and 3-34). However, the hydrogeology report fails to provide data and calculations on how this inflow rate was measured, estimated, or validated. Flow measurements at VT#2, near water quality station #10, do not have a downstream counterpoint of measurement to document rates of groundwater inflow in this most critical section of the reach, before water quality station #6. The velocity transect VT#3 at the mouth of the river failed when the lagoon closed and was not available during the time of greatest temperature variability. In addition, VT#3 was not hydraulically a good measuring point because of the upstream lagoon's non-linear storage characteristics and the downstream variability in elevation of discharge at the ocean, which causes variations in surface water gradient.

g. **A longitudinal profile of the river channel.** Data are needed to document the relationship between ground water and surface water levels and the channel bottom. The hydrogeology report indicates that upstream of VT#2 the river is a losing reach and a gaining reach downstream of water quality station #9. Is this the result of a change in elevation of the river bottom? If so, is this caused by the change in direction of the channel from down the valley axis to across the valley, or is there a geologic barrier? It is important to know whether there is a natural change in channel gradient or a geologic barrier in the transition zone between the losing and gaining portions of the river.

h. **Review of historic aerial photos and topographic maps.** Figure 9-1 of the May 18, 2005 NRCE water use report shows the study area in 1929. A comparison of the 1929 river configuration to that of today (see attached Figure 6) clearly shows that today's sinuous channel next to the pumping wells was instead rather linear and a somewhat braided reach. This change in channel morphology may be an important feature in determining where to monitor, and may help explain the movement of ground water because the main channel of a river is often coarser grained than bank deposits and becomes a preferred flow path. Historic photos, aerial or ground based, would be a valuable source to document historic changes in channel morphology. Knowledge of any changes in the channel is critical in interpreting the existing data and in selecting monitoring points for the water rights permit. An effort should be make to collect and analyse these.

Cited References:

Freeze, R.A., and Cherry, J.A.,1979, Groundwater, Prentice-Hall, Englewood Cliffs, New Jersey, 604 pp.

Glover, R.R., 1964, Ground-Water Movement, Engineering Monograph No. 31, Water Resources Technical Publication, Bureau of Reclamation, U.S. Department of Interior, Denver, Colorado, 76 pp.

Jenkins, C.T., 1968, Techniques for Computing Rate and Volume of Stream Depletion by Wells, Groundwater, vol. 6, pgs. 37-46.

Miller, C.D., and Durnford, D.S., 2005, Modified Use of the "SDF" Semi-Analytical Stream Depletion Model in Bounded Alluvial Aquifers, Hydrology Days 2005, pgs, 146-159.

Table 1
El Sur Ranch
Station #6 to #12 Temperature Differences of Plotted Data

18-Apr-04

								Temp. Difference Going Upstream					
L	M	R	Average	Range	Plotted - Ave	Plotted oF		***6***	***7***	***8***	***9***	***10***	***11***
55.76	**55.58**	**55.58**	55.64	**0.18**	**-0.06**	55.58	***6***	-	-	-	-	-	-
55.40	**55.40**	55.76	55.52	**0.36**	**-0.12**	55.40	***7***	-0.18	-	-	-	-	-
54.50	**55.40**	55.22	55.04	**0.90**	**0.36**	55.40	***8***	-0.18	0.00	-	-	-	-
55.04	**55.04**	**55.04**	55.04	**0.00**	**0.00**	55.04	***9***	-0.54	-0.36	-0.36	-	-	-
55.04	**55.04**	**55.04**	55.04	**0.00**	**0.00**	55.04	***10***	-0.54	-0.36	-0.36	0.00	-	-
54.86	**54.86**	55.04	54.92	**0.18**	**-0.06**	54.86	***11***	-0.72	-0.54	-0.54	-0.18	-0.18	-
54.68	**54.68**	**54.68**	54.68	**0.00**	**0.00**	54.68	***12***	-0.90	-0.72	-0.72	-0.36	-0.36	-0.18

23-Jul-04

								Temp. Difference Going Upstream					
L	M	R	Average	Range	Plotted - Ave	Plotted oF		***6***	***7***	***8***	***9***	***10***	***11***
66.72	**66.97**	67.33	67.01	**0.61**	**-0.04**	66.97	***6***	-	-	-	-	-	-
-	**-**	-	-	**-**	**-**	-	***7***	-	-	-	-	-	-
58.10	66.63	67.23	63.99	**9.13**	**-5.89**	58.10	***8***	-8.87	-	-	-	-	-
66.24	**68.54**	68.79	67.86	**2.55**	**0.68**	68.54	***9***	1.57	-	10.44	-	-	-
68.97	**68.94**	68.63	68.85	**0.34**	**0.09**	68.94	***10***	1.97	-	10.84	0.40	-	-
68.29	**68.34**	68.31	68.31	**0.05**	**0.03**	68.34	***11***	1.37	-	10.24	-0.20	-0.60	-
68.34	**68.52**	68.41	68.42	**0.18**	**0.10**	68.52	***12***	1.55	-	10.42	-0.02	-	0.18

6-Aug-04

								Temp. Difference Going Upstream					
L	M	R	Average	Range	Plotted - Ave	Plotted oF		***6***	***7***	***8***	***9***	***10***	***11***
63.37	**62.04**	62.06	62.49	**1.33**	**-0.45**	62.04	***6***	-	-	-	-	-	-
59.65	**60.73**	61.11	60.50	**1.46**	**0.23**	60.73	***7***	-1.31	-	-	-	-	-
60.35	61.72	61.65	61.24	**1.37**	**-0.89**	60.35	***8***	-1.69	-0.38	-	-	-	-
62.08	**62.13**	62.35	62.19	**0.27**	**-0.06**	62.13	***9***	0.09	1.40	1.78	-	-	-
61.79	**61.70**	61.79	61.76	**0.09**	**-0.06**	61.70	***10***	-0.34	0.97	1.35	-0.43	-	-
61.09	**61.09**	61.14	61.11	**0.05**	**-0.02**	61.09	***11***	-0.95	0.36	0.74	-1.04	-0.61	-
62.20	**62.31**	62.19	62.23	**0.12**	**0.08**	62.31	***12***	0.27	1.58	1.96	0.18	0.61	1.22

Red highlight values plotted on Figure 3-31

Table 1, cont'd

19-Aug-04

L	M	R	Average	Range	Plotted - Ave	Plotted oF		Temp. Difference Going Upstream					
								6	7	8	9	10	11
62.42	61.86	61.95	62.08	0.56	-0.22	61.86	6	-	-	-	-	-	-
59.74	60.78	61.84	60.79	2.10	-0.01	60.78	7	-1.08	-	-	-	-	-
58.10	60.87	59.90	58.74	4.79	-2.66	-	8	-	-	-	-	-	-
56.08	-	-	-	-	-	56.08	8	-5.78	-4.70	-	-	-	-
63.25	63.28	63.30	63.28	0.05	0.00	63.28	9	1.42	2.50	7.20	-	-	-
63.19	63.03	62.92	63.05	0.27	-0.02	63.03	10	1.17	2.25	6.95	-0.25	-	-
62.58	62.60	62.60	62.59	0.02	0.01	62.60	11	0.74	1.82	6.52	-0.68	-0.43	-
63.50	63.66	63.46	63.54	0.20	0.12	63.66	12	1.80	2.88	7.58	0.38	0.63	1.06

2-Sep-04

L	M	R	Average	Range	Plotted - Ave	Plotted oF		Temp. Difference Going Upstream					
								6	7	8	9	10	11
64.00	64.04	64.11	64.05	0.11	-0.01	64.04	6	-	-	-	-	-	-
60.04	57.87	58.53	58.81	2.17	-0.94	57.87	7	-6.17	-	-	-	-	-
56.03	57.54	57.56	57.04	1.53	-1.01	56.03	8	-8.01	-1.84	-	-	-	-
64.40	59.45	57.96	60.60	6.44	-1.15	59.45	9	-4.59	1.58	3.42	-	-	-
67.03	66.94	66.92	66.96	0.11	-0.02	66.94	10	2.90	9.07	10.91	7.49	-	-
67.46	67.33	67.19	67.33	0.27	0.00	67.33	11	3.29	9.46	11.30	7.88	0.39	-
67.73	67.95	67.77	67.82	0.22	0.13	67.95	12	3.91	10.08	11.92	8.50	1.01	0.62

15-Sep-04

L	M	R	Average	Range	Plotted - Ave	Plotted oF		Temp. Difference Going Upstream					
								6	7	8	9	10	11
63.09	63.79	64.53	63.80	1.44	-0.01	63.79	6	-	-	-	-	-	-
-	57.74	60.26	59.00	2.52	-1.26	57.74	7	-6.05	-	-	-	-	-
59.27	57.56	57.74	58.19	1.71	-2.41	55.78	8	-	-	-	-	-	-
55.78	56.30	55.67	55.92	0.63	-0.14	55.78	8	-8.01	-1.96	-			
64.06	62.47	62.22	62.92	1.84	-0.45	62.47	9	-1.32	6.69	6.69	-	-	-
65.77	65.73	65.73	65.74	0.04	-0.01	65.73	10	1.94	9.95	9.95	0.00	-	-
65.62	65.61	65.62	65.62	0.01	-0.01	65.61	11	1.82	9.83	9.83	-0.12	0.00	-
65.28	65.28	65.26	65.27	0.02	0.01	65.28	12	1.49	9.50	9.50	-0.45	-0.33	-0.33

Table 1, cont'd

30-Sep-04

L	M	R	Average	Range	Plotted - Ave	Plotted oF		Temp. Difference Going Upstream					
								6	***7***	***8***	***9***	***10***	***11***
59.81	60.15	60.76	60.24	0.95	-0.09	60.15	***6***	-	-	-	-	-	-
57.31	59.22	58.89	58.47	1.91	0.75	59.22	***7***	-0.93	-	-	-	-	-
56.75	58.10	58.39	57.75	1.64	-1.00	56.75	***8***	-3.40	-2.47	-	-	-	-
60.48	60.42	60.24	60.38	0.24	0.04	60.42	***9***	0.27	1.20	3.67	-	-	-
60.40	60.40	60.39	60.40	0.01	0.00	60.40	***10***	0.25	1.18	3.65	-0.02	-	-
60.42	60.44	60.42	60.43	0.02	0.01	60.44	***11***	0.29	1.22	3.69	0.02	0.04	-
60.51	60.53	60.51	60.52	0.02	0.01	60.53	***12***	0.38	1.31	3.78	0.11	0.13	0.09

15-Oct-04

L	M	R	Average	Range	Plotted - Ave	Plotted oF		Temp. Difference Going Upstream					
								6	***7***	***8***	***9***	***10***	***11***
56.53	56.57	56.55	56.55	0.04	0.02	56.57	***6***	-	-	-	-	-	-
56.19	56.57	56.68	56.48	0.49	0.09	56.57	***7***	0.00	-	-	-	-	-
55.72	56.68	56.68	56.36	0.96	-0.64	55.72	***8***	-0.85	-0.85	-	-	-	-
56.97	56.82	56.77	56.85	0.20	-0.03	56.82	***9***	0.25	0.25	1.10	-	-	-
56.55	56.52	56.52	56.53	0.03	-0.01	56.52	***10***	-0.05	-0.05	0.80	-0.30	-	-
56.39	56.39	56.37	56.38	0.02	0.01	56.39	***11***	-0.18	-0.18	0.67	-0.43	-0.13	-
56.39	56.43	56.48	56.43	0.09	0.00	56.43	***12***	-0.14	-0.14	0.71	-0.39	-0.09	0.04

29-Oct-04

L	M	R	Average	Range	Plotted - Ave	Plotted oF		Temp. Difference Going Upstream					
								6	***7***	***8***	***9***	***10***	***11***
-	-	-	-	-	-	-	***6***	-	-	-	-	-	-
51.69	51.46	51.51	51.55	0.23	-0.09	51.46	***7***	-	-	-	-	-	-
51.69	51.55	51.49	51.58	0.20	-0.03	51.55	***8***	-	0.09	-	-	-	-
51.37	51.33	51.35	51.35	0.04	-0.02	51.33	***9***	-	-0.13	-0.22	-	-	-
51.26	51.28	51.33	51.29	0.07	-0.01	51.28	***10***	-	-0.18	-0.27	-0.05	-	-
51.21	51.21	51.21	51.21	0.00	0.00	51.21	***11***	-	-0.25	-0.34	-0.12	-0.07	-
-	-	-	-	-	-	-	***12***	-	-	-	-	-	-

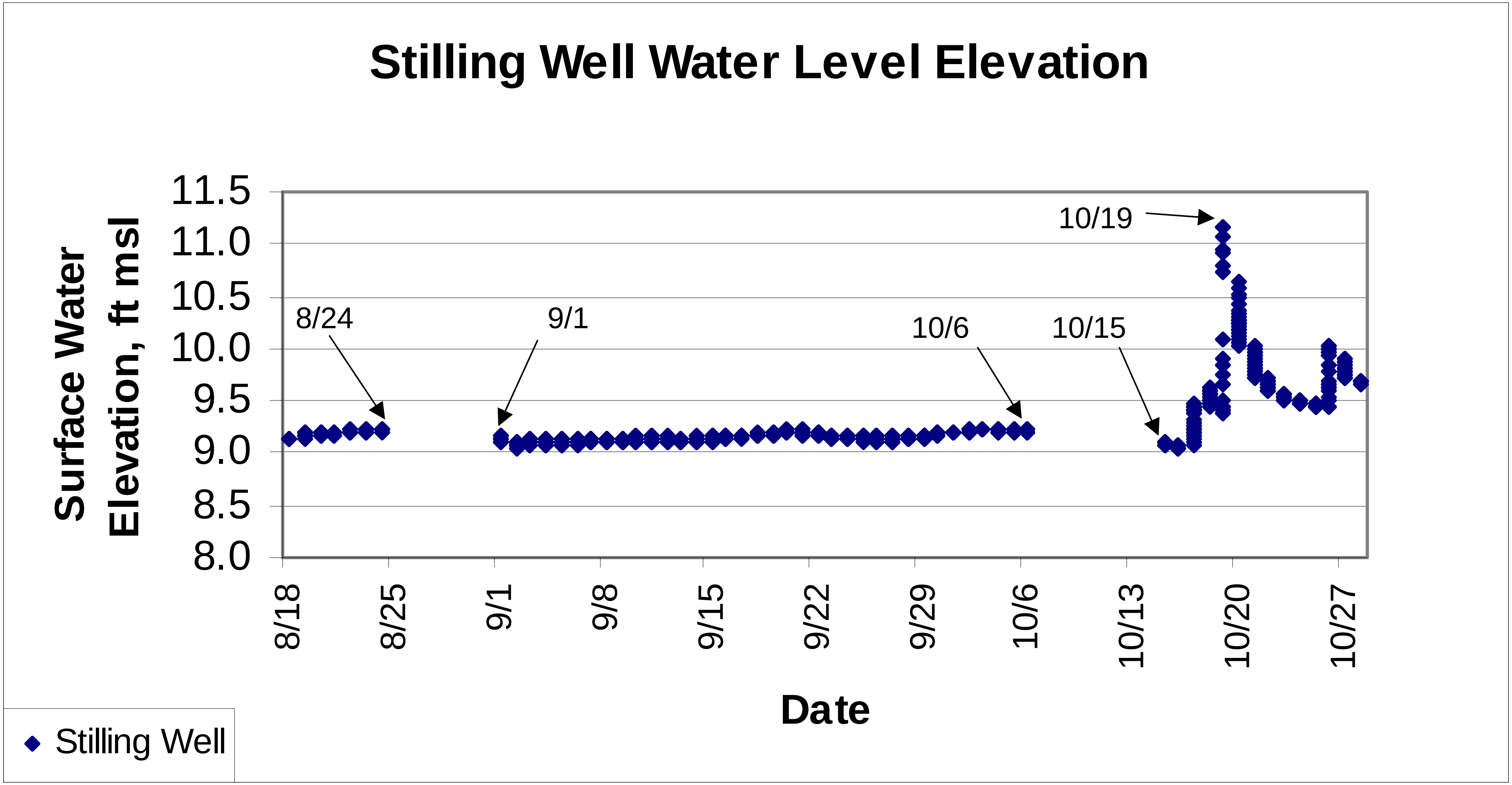

Stilling Well Water Level Elevation
Surface Water Elevation, ft msl
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
8/24
9/1
10/6
10/15
10/19
8/18
8/25
9/1
9/8
9/15
9/22
9/29
10/6
10/13
10/20
10/27
Date
Stilling Well

Figure 1

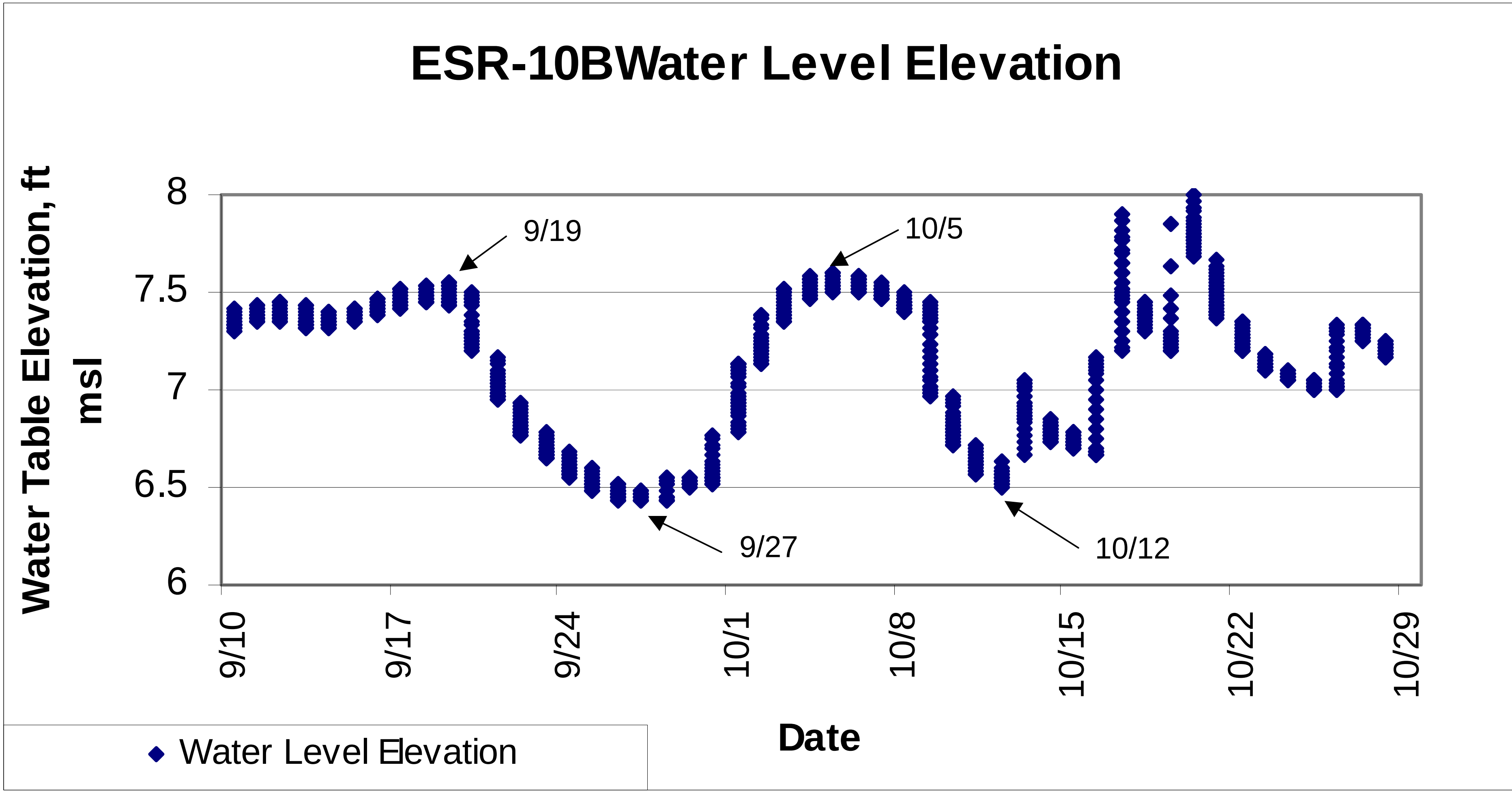

ESR-10BWater Level Elevation
Water Table Elevation, ft msl
8
7.5
7
6.5
6
9/19
10/5
9/27
10/12
9/10
9/17
9/24
10/1
10/8
10/15
10/22
10/29
Date
Water Level Elevation

Figure 2

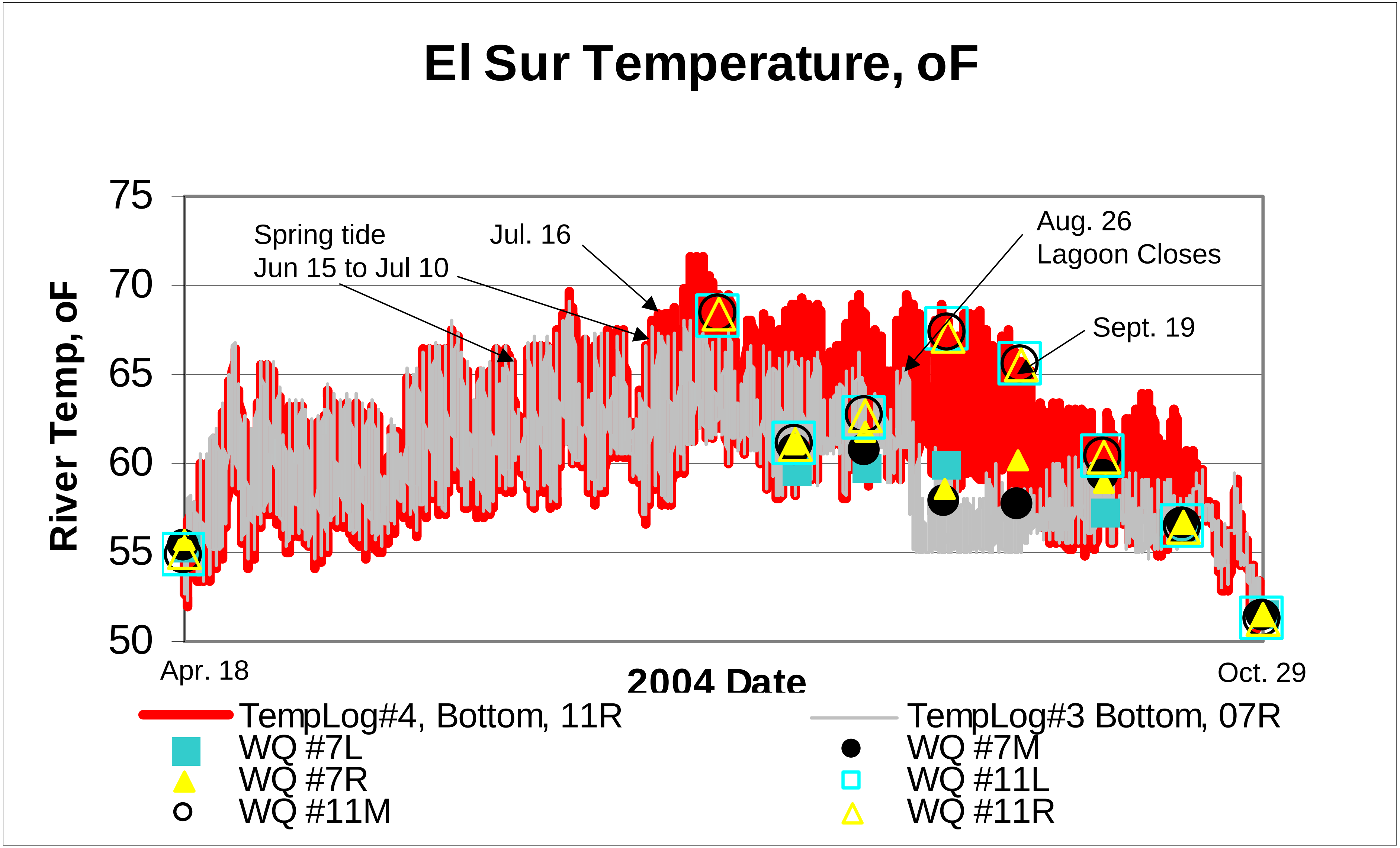

El Sur Temperature, oF
River Temp, oF
75
70
65
60
55
50
Spring tide
Jun 15 to Jul 10
Jul. 16
Aug. 26
Lagoon Closes
Sept. 19
Apr. 18
2004 Date
Oct. 29
TempLog#4, Bottom, 11R
TempLog#3 Bottom, 07R
WQ #7L
WQ #7M
WQ #7R
WQ #11L
WQ #11M
WQ #11R

Figure 3

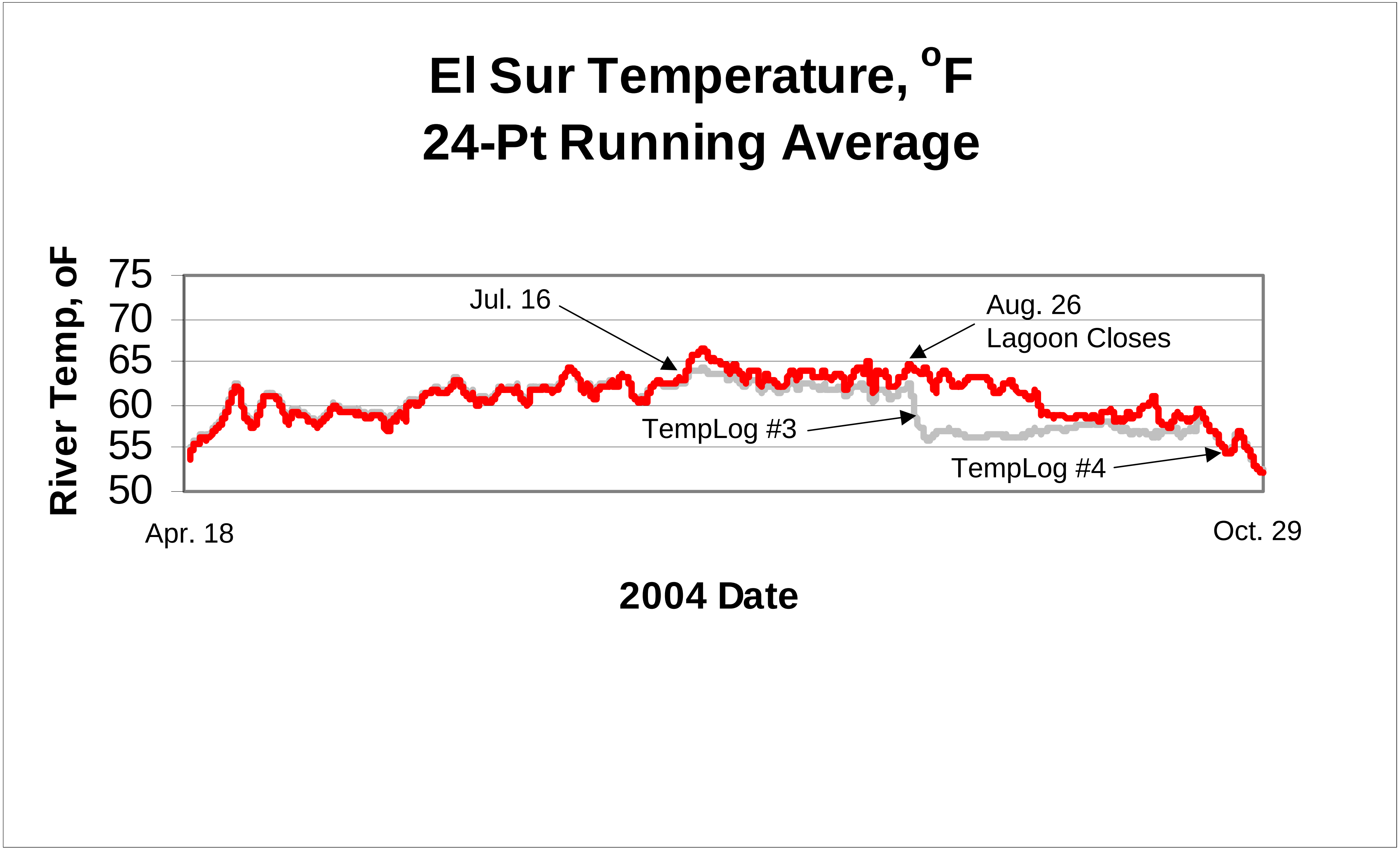
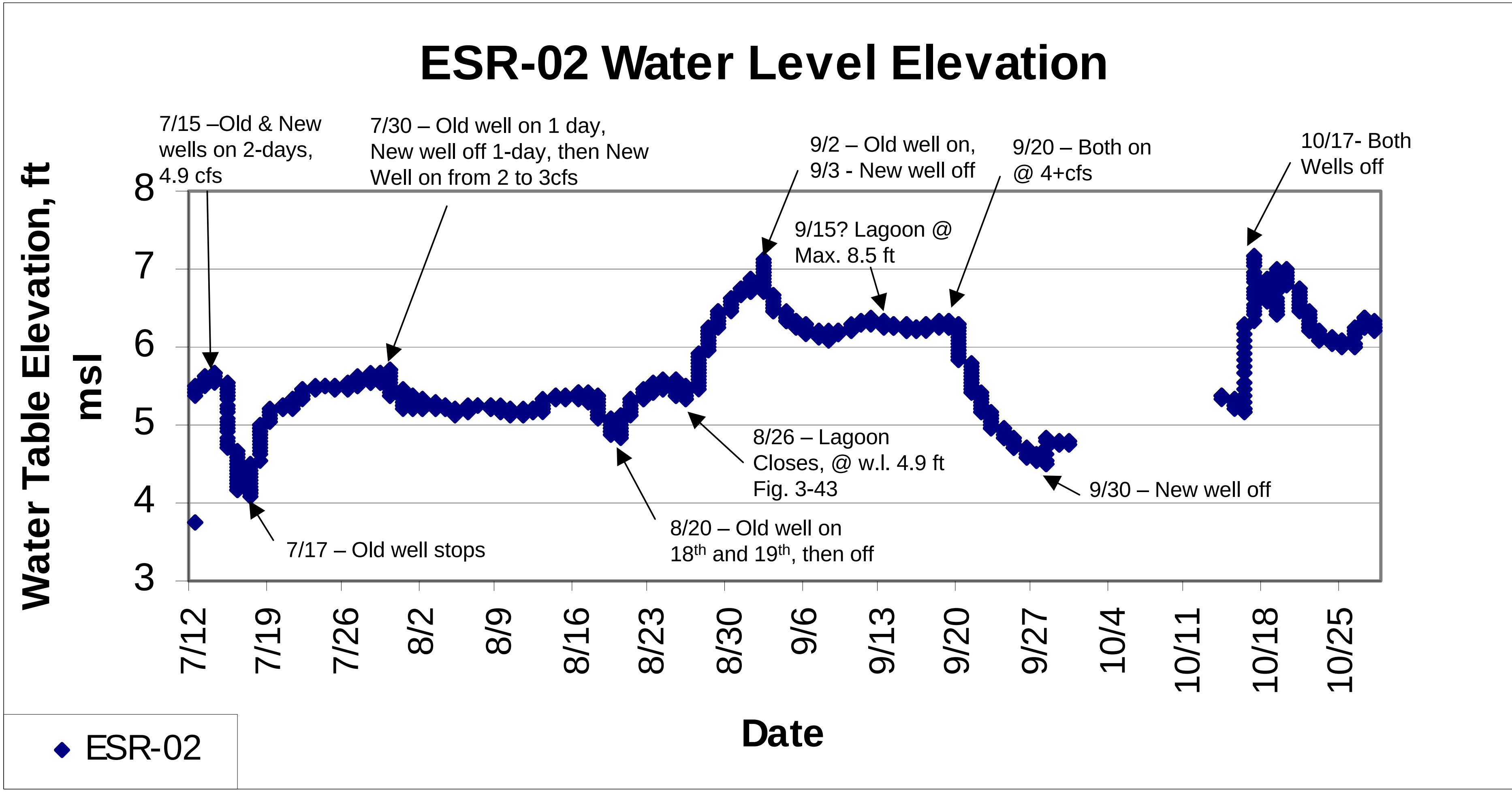
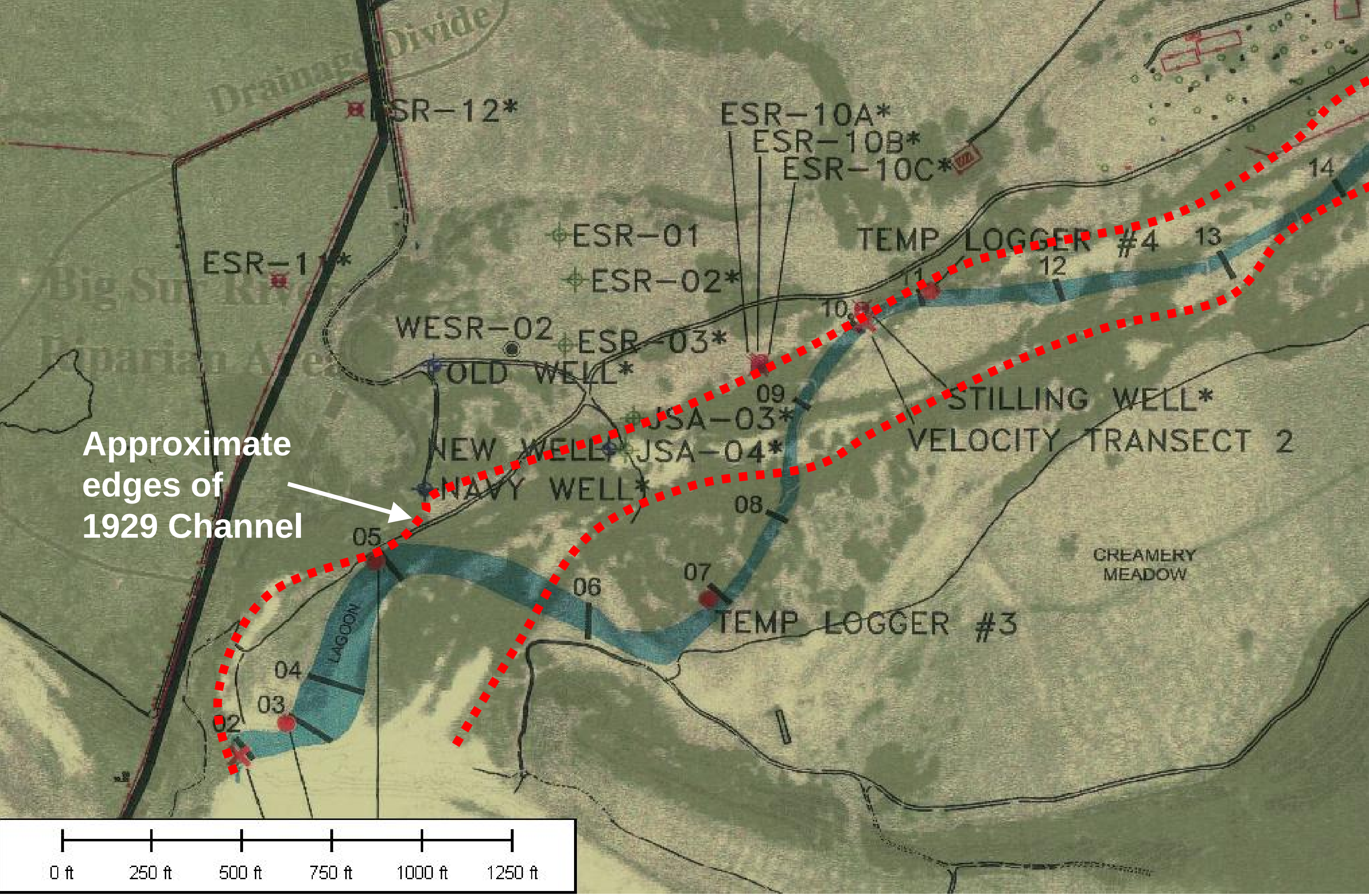

El Sur Temperature, °F
24-Pt Running Average
River Temp, oF
75
70
65
60
55
50
Jul. 16
Aug. 26
Lagoon Closes
TempLog #3
TempLog #4
Apr. 18
Oct. 29
2004 Date

Figure 4



ESR-02 Water Level Elevation
Water Table Elevation, ft msl
8
7
6
5
4
3
7/15 –Old & New wells on 2-days, 4.9 cfs
7/30 – Old well on 1 day, New well off 1-day, then New Well on from 2 to 3cfs
9/2 – Old well on, 9/3 - New well off
9/20 – Both on @ 4+cfs
10/17- Both Wells off
9/15? Lagoon @ Max. 8.5 ft
8/26 – Lagoon Closes, @ w.l. 4.9 ft Fig. 3-43
9/30 – New well off
7/17 – Old well stops
8/20 – Old well on 18th and 19th, then off
7/12
7/19
7/26
8/2
8/9
8/16
8/23
8/30
9/6
9/13
9/20
9/27
10/4
10/11
10/18
10/25
Date
ESR-02

Figure 5



El Sur Ranch wells, closeup of 2004 channel overlayed on to 1929 image

Figure 6