Abstract

El Sur Ranch, established 1834, is located in Monterey County on the California Central Coast about 1 1/2 miles south of Point Sur Lighthouse as shown on Figure 1. El Sur Ranch seeks a permit for diversion of pumped well water from the lower reach of the Big Sur River for irrigation of an existing ranching operation. (Water Right Application #30166) The water has been used since 1950 to irrigate approximately 290 acres including riparian acres, providing forage for cattle. Diverted water is provided by two wells located at Andrew Molera State Park on land transferred to the California Department of Parks and Recreation (DPR) by El Sur Ranch in 1971. Figure 2, Site Plan, depicts the location of El Sur Ranch irrigated pastures, the subject wells, the "Navy Well", owned and operated by DPR, Andrew Molera State Park and Creamery Meadow.

In order to provide scientific evidence in support of its application for water right within the Lower Reach of the Big Sur River, El Sur Ranch retained consultants with expertise in hydrogeology, The Source Group, Inc.; biology, Hanson Environmental, Inc.; and agricultural water use, NRCE, Natural Resources Consulting Engineers, Inc. The completed technical reports are provided herein and include the following:

Hydrogeologic Investigation and Conceptual Site Model Within the Lower Big Sur River. May 20, 2005. The Source Group, Inc. (SGI)

Assessment of Habitat Quality & Availability Within the Lower Big Sur River: April-October 2004. March 11, 2005. Hanson Environmental, Inc. (Hanson Environmental)

Reasonable Beneficial Use - Land Use Study for El Sur Ranch Irrigated Pastures, Water Rights Applicant #30166. May 18, 2005. Natural Resources Consulting Engineers, Inc. (NRCE)

Attached hereto and entitled "Figure 3 Summary of 2004 Study Data in Support of ESR Water Right Request (SWRCB Water Right Application #30166)" is a visual/textual graphic of conclusions contained within the three technical reports.

Study Area

The Study Area is located within the lower Big Sur River Basin, on the western slope of the Santa Lucia Mountain Range and includes the last mile of the river before it flows into a lagoon, then into the Pacific Ocean. It includes El Sur Ranch irrigated pastures and Andrew Molera State Park as shown in Figure 2.

Prior Site Work and Studies

- Engineering and geologic investigation conducted at the mouth of the Big Sur River evaluating the feasibility of constructing a harbor (Dames & Moore, 1964);

Analysis of historic data supports the conclusion that 1991 was a representative year upon which to base long-term irrigation management planning as it was a year preceded by four years of low rainfall and low total summer flows. In September 1991 river flows were measured at 5.3 cfs (USGS gauge) simultaneous with pumping for irrigation and no discontinuity of river flow was observed. **(SGI Report Sections 5.3, 5.4)**

Since pumping for pasture irrigation began in 1950, data for five of the years, reflected flows below 5.3 cfs (review of USGS gauge flow data) and no discontinuity of river flow was recorded during those years. SGI concludes that a flow of 5.3 cfs at the USGS river gauge could serve as a supportable measure when considering future monitoring and management requirements to maintain river flows. **(SGI Report Sections 5.3, 5.4)**

SGI monitored temperature, electrical conductivity and dissolved oxygen within the river and lagoon and monitored for temperature within wells diverting from the subsurface flow. SGI concludes based upon review of prior studies, data collected, and analysis of the same that so long as surface flows exist in the Big Sur River, pumping from El Sur wells will not impact surface water quality in the river or lagoon. Further, so long as surface flows are observed in the river, El Sur irrigation pumping will not adversely impact subsurface flows beneath Creamery Meadow. **(SGI Report Sections 3.4.6, 3.4.8, and 5.0)**

Saline intrusion from the ocean, beneath fresh water subsurface flows occurs primarily due to spring tides that are more pronounced in the summer months and recede thereafter. By practice, El Sur irrigation pumping ceases whenever salinity reaches 1mml. **(SGI Report Sections 3.5 and 5.1)**

SGI performed a screening level water balance evaluation and estimates that pumping from subsurface flows during 2004 represents approximately 15% of total flows within the Study Area during the irrigation season, with an estimated 83% of total river system flows discharging to the ocean. **(SGI Report Section 4.0)**

The 2004 study year resulted in pumping conditions that were ranked within the 90 percentile for all years 1975 through 2004 with more water being pumped in only three other years. Within the studied 29 years only 9 years had less precipitation than that measured in 2004. Average September 2004 surface river flows were 12.17 cfs as compared with an average September surface river flow of 15.34 cfs (derived from 1950 - 2004 data). Therefore SGI concludes that the 2004 study year represents higher than average diversions/pumping during a drier than average year type. It is reasonable to expect that such conditions might reflect more stresses than average upon the flows of the Big Sur River, but none were observed. **(SGI Section 3.4)**

SGI analysis of DPR records concludes that the Big Sur River evidenced discontinuity of flow once during the period of 1950 through 2004. The cause of the discontinuity in surface river flows upstream of the El Sur well field in 1990 was the manual disruption of considered suitable for juvenile steelhead/rainbow trout summer rearing. **(Hanson Environmental Report Sections 4.3, 5.4)**

Continuous water temperature data collected to evaluate seasonal changes in habitat conditions for juvenile steelhead rearing supports the following conclusions: temperatures increase during the spring and decline in the fall and habitat conditions remained within a suitable range for juvenile steelhead rearing throughout the study period. **(Hanson Environmental Report Section 4.4)**

Snorkel surveys corroborate the existence of good habitat conditions including good stream flow and water quality. Juvenile steelhead/rainbow trout rearing stage coincides with El Sur Ranch irrigation season. No limiting factors to juvenile steelhead/rainbow trout survival were observed. Observed juvenile steelhead/rainbow trout were healthy, in good condition, exhibited good growth and high summer survival and showed characteristics of smolting in preparation for emigration to the ocean. **(Hanson Environmental Report Sections 4.5, 5.5)**

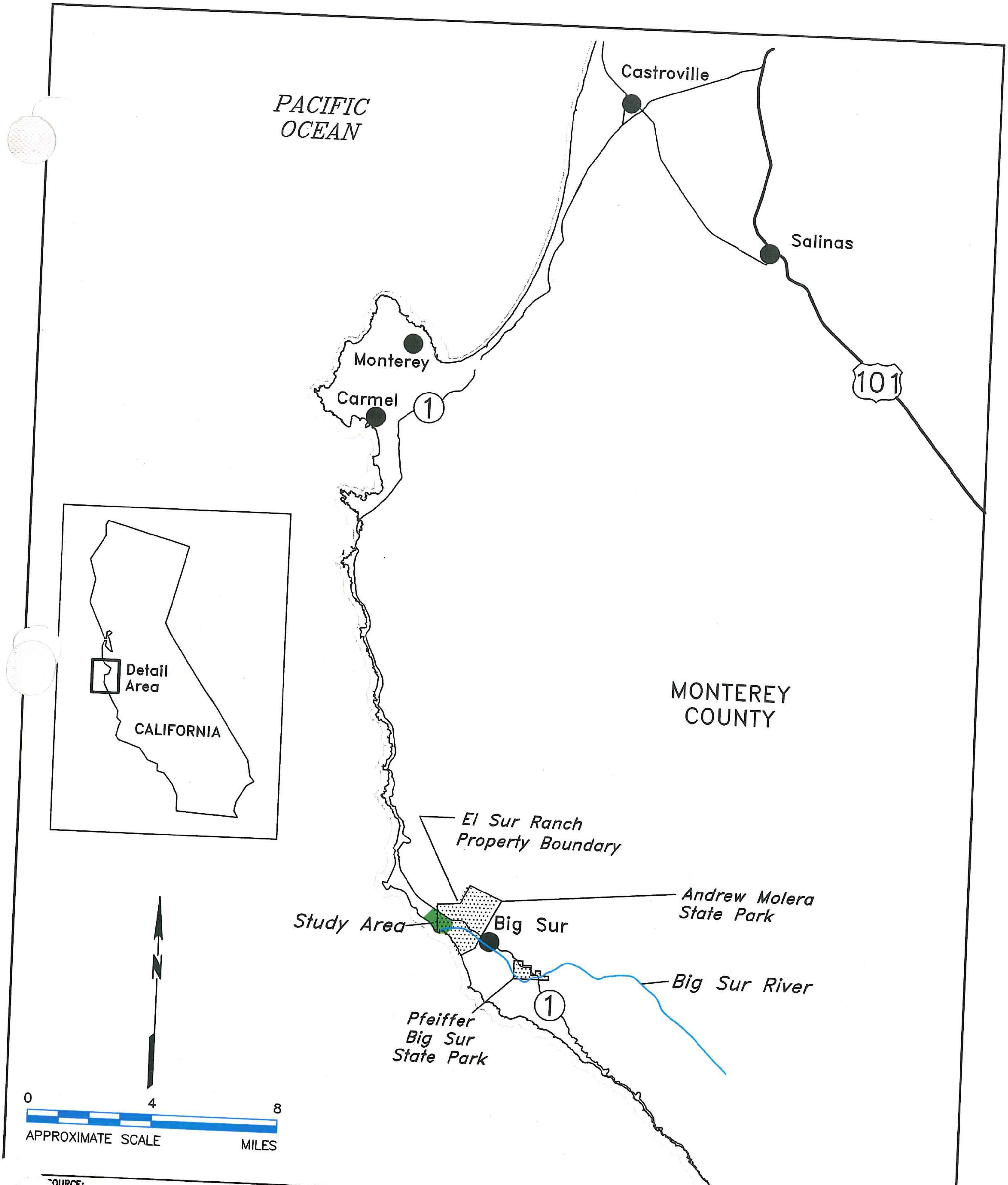
The overall health and condition of juvenile steelhead/rainbow trout reflect an overall healthy habitat and conditions for all other sensitive and endangered species and habitat within the lower reach of the Big Sur River during the El Sur irrigation season. **(Hanson Environmental Report Sections 4.5, 5.5, 5.6)**

Land and Water Use

Irrigated cattle ranching by El Sur Ranch is consistent with and protected by both the California Coastal Act (CCA) and the Monterey County Local Coastal Program, including the Big Sur Area Land Use Plan (LUP) which recognize agriculture as a priority use of coastal lands. The El Sur Ranch use is similarly identified as one of the beneficial uses for the Big Sur River in the Water Quality Control Plan for the Central Coast Region (the Basin Plan). **(NRCE Report Section 2.1)**

Irrigated pasture on El Sur Ranch is an essential component of the cattle operation providing high quality forage during the dry summer period. Irrigation practices and system at El Sur Ranch result in an increase in forage and cattle production beyond that possible with non-irrigated acreage. **(NRCE Report Section 5)**

El Sur Ranch use of pumped water from subsurface of lower reach of Big Sur River is beneficial and reasonable. **(NRCE Report Section 8.2)**



SOURCE:
THE SOURCE GROUP, MAY 2005

EL SUR RANCH
BIG SUR, CALIFORNIA

DATE	DR. BY	APP. BY
3/11/05	SB	PH

FIGURE 1
EL SUR RANCH AND
STUDY AREA LOCATION
ESR--4

REPORT SOURCE:	EL SUR RANCH BIG SUR, CALIFORNIA				FIGURE 2
THE SOURCE GROUP, MAY 2005	PROJECT NO. NA	DATE 3/11/05	DR. BY SB	APP. BY PH	SITE PLAN

Water Right Application #30166
El Sur Ranch, Monterey County, California

HYDROGEOLOGY

Hydrogeology

ESR--4

HYDROGEOLOGIC INVESTIGATION AND CONCEPTUAL SITE MODEL WITHIN THE LOWER REACH OF THE BIG SUR RIVER`

El Sur Ranch
Big Sur, California

01-ESR-001

Prepared For:

Applicant
El Sur Ranch
Monterey County, California

Prepared By:

SGI environmental THE SOURCE GROUP, INC.

3451-C Vincent Road
Pleasant Hill, California 94523

May 20, 2005

Prepared By:

Steven M. McCabe, P.G.
Senior Hydrogeologist

Jon Philipp
Project Geologist

Paul D. Horton, P.G., C.HG.
Principal Hydrogeologist

CERTIFIED HYDROGEOLOGIST PAUL D. HORTON HG 581 STATE OF CALIFORNIA

ESR--4

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

A comprehensive hydrologic and hydrogeologic investigation was conducted at a portion of the Lower Big Sur River Basin, defined as approximately the last mile of the Big Sur River as it empties into the Pacific Ocean (the Study Area). The investigation was conducted in accordance with the work steps outlined in the May 13, 2004 Interim Monitoring Plan, Water Right Application #30166 prepared on behalf of El Sur Ranch (ESR) for the State Water Resources Control Board Division of Water Rights (SWRCB-DWR).

We understand that the State has questioned the effects of ESR pumping on river level, lagoon temperature, lagoon salinity, and the health of vegetation in Creamery Meadow. These questions motivated the need for this evaluation of how the lower portion of the Big Sur River basin responds to groundwater pumping.

Previous investigations have been conducted in the Study Area in an attempt to clarify the effects of pumping by ESR on river flow and underflow, and to understand the mechanism(s) of saltwater intrusion into the Study Area. The early investigations did not conclusively determine the degree of impact of pumping on the Study Area nor did they demonstrate the mechanism for saltwater intrusion. These investigations have concluded that the transmissivity of the alluvial aquifer is high and that as a result, there is significant connectivity between the river, lagoon and the aquifer. They did not reveal impacts to the river from pumping.

The hydrogeologic investigation included the following: research and review; field reconnaissance; installation of additional monitoring wells to further evaluate river, aquifer and pumping interactions; continuous water level monitoring in multiple wells including pumping wells; continuous river stage monitoring at one location; bi-weekly river stage and flow monitoring at three locations; hourly river temperature monitoring; bi-weekly river water quality evaluations; monitoring of irrigation well pumping durations; and daily monitoring of water quality in water pumped from the irrigation wells. In addition, publicly available river flow and weather data at Big Sur was collected from the United States Geological Survey (USGS) station. Tidal and weather data were also collected from stations in the Study Area and from a National Oceanic and Atmospheric Administration (NOAA) station in Monterey. Two geophysical surveys and groundwater modeling were also conducted.

Three principal geologic units occur in the Study Area including Franciscan formation bedrock, terrace alluvial deposits, and younger stream alluvium filling the Big Sur River valley. The rocks of the Franciscan formation underlie both the younger Quaternary alluvial deposits and the terrace alluvium throughout the Study Area. The Holocene aged (less than 11,000 years old) Quaternary alluvial deposits of unconsolidated boulders, cobbles, gravel, and sand lain down by the Big Sur River in a

deeper cut ancestral canyon make up the primary groundwater aquifer in the lower watershed. This alluvial aquifer is the source for water pumped in the Study Area.

The average estimated hydraulic conductivity value for the aquifer in the vicinity of the well field is 3,623 feet per day (ft/day) based on aquifer testing conducted in 1998. Additional information collected in 1964 indicates that the lower zones of alluvium in the area of the mouth of the river where the ancestral canyon cut deepest could have a local hydraulic conductivity significantly higher due to the presence of large boulders and cobbles.

The alluvial deposits are bounded to the north by semi-consolidated terrace deposits that also overlie Franciscan bedrock. These terrace deposits consist of significantly older alluvial and colluvial material with estimated hydraulic conductivities of less than 100 ft/day. Groundwater is present in these deposits and some discharge of groundwater (less than 0.64 cubic feet per second) from the terrace deposits to the south/southeast into the younger alluvium is estimated to occur along the northern boundary of the alluvial aquifer.

The southern boundary of alluvium in the ancestral canyon consists of Franciscan formation bedrock that has extremely limited hydraulic conductivity. Due to the fact that the Franciscan deposits are highly sheared and generally mixed up, they are interpreted to be unable to transmit any significant amounts of groundwater into the overlying and adjacent alluvium.

Near the mouth of the river at a point of valley constriction by Franciscan metavolcanic rocks, groundwater moving within the alluvium is forced into the river channel emerging as surface flow. This condition was maintained throughout the summer irrigation season regardless of pumping conducted.

Data collected during this investigation combined with analysis supports the conclusion that wave over wash is not the significant mechanism for measured saline impacts in the Old Well as stated by previous investigators. Data analysis combined with geophysical studies and modeling indicate that the ocean does act as a groundwater recharge source under the combination of ESR well pumping activities and the summer occurrence of spring tides (an exceptionally strong high tide). Intrusion of a saltwater wedge and its accompanying diffusion front under these conditions follows the bottom surface of the aquifer and then preferentially flows towards Old Well. The movement of the saltwater wedge responds to changing tide and pumping conditions at the Old Well. Co-incident with the cessation of larger than normal spring tides in September, no further evidence of this saltwater wedge is seen in Old Well water quality, even in the event of continued maximum pumping of both the Old and New irrigation wells. This late season condition has been documented in 2004 and in earlier pumping years for which data was available. These facts support the conclusion that the dominant cause of the intrusion and impacts to the Old well are directly linked to normal spring tides during the five months of summer.

The defined mechanism and behavior of saltwater intrusion indicates that saline impacts to groundwater quality in the vicinity of the mouth of the Big Sur River are induced by the summertime spring tides, and as such are seasonal and temporary having no lasting effect on groundwater quality. Monitoring data also indicates that due to density effects and the hydraulic field at the river mouth, the seasonal advancement of the saltwater wedge has no measurable impact to surface water quality in the lagoon and the river regardless of the irrigation pumping conducted. Finally, advancement of a saltwater wedge in connection with ESR pumping cannot have any impact to changes in groundwater quality beneath the Creamery Meadow.

River water quality measurements consisting of temperature, electrical conductivity and dissolved oxygen data have shown no correlation between irrigation pumping and changes in surface water quality. Surface water quality changed during the 2004 irrigation season in response to normal seasonal trends of warming and cooling. During the warm summer months, an area of groundwater inflow to the river was observed near western edge of Creamery Meadow where the Big Sur Valley narrows. The infiltration of groundwater into the river at this location was documented by temperature, electrical conductivity and dissolved oxygen measurements consistent with groundwater and which were significantly lower than those values measured in the river further upstream. Pumping did not induce any measurable surface water quality changes during this investigation.

The cause of a reported discontinuous river flow in 1990, which is the only such period we are aware of, is an issue of concern with respect to the current water rights permitting process for ESR as the discontinuous flow is alleged by the California Department of Parks and Recreation (DPR) to be caused or exacerbated by pumping of the ESR irrigation wells. It is now clear that the discontinuation of river flow occurred because the DPR used heavy equipment to move the river into a channel cut into a coarse cobble bar, as part of "stream restoration" work conducted near the Andrew Molera State Park parking lot during the low flow summer months of 1990 (one of the lowest flow years on record). DPR documents pertaining to this work stated that once re-routed, the river immediately disappeared into its gravels. In addition, the area of flow discontinuity occurred well upstream from the ESR wells, so it is not at all plausible that ESR pumping could dewater the river approximately 0.7 miles upstream without dewatering the section of river immediately adjacent to the wells (which did not occur).

During the following summer of 1991 (after the river was allowed to flow in its original channel), USGS gauge river flow conditions reached a low of 5.3 cfs in October while irrigation pumping continued. A USGS gauge flow of 5.3 cfs is well below the historic low flow average of 11.65 cfs. No discontinuity of river flow was noted during the 1991-pumping year as a result of this low river flow rate. This fact is especially significant for long-term management planning given that the 1991 pumping year was preceded by four years of low rainfall and low total summer river flows.

The 2004 irrigation season was a fortuitous time to conduct this investigation because river flows and winter precipitation were well below normal and the average extraction rate for ESR wells exceeded historical averages by more than 20%. Observations and data collected during the 2004 investigation supports the conclusion that the surface flow of the Big Sur River combined with the accompanying subterranean flow is adequate to support above average irrigation season pumping without any measurable impacts to surface water flow continuity or water quality for USGS river gauge flows equal or exceeding 10 cfs (expected approximately 75% of the time). In addition, considering the available 54 years of river flow data, observations and analyses presented above and throughout the report, and specifically considering the 1991 low flow data discussed above, at a minimum it can conservatively be concluded that pumping of the ESR wells consistent with current practices during the irrigation season will not result in surface flow disruption in the Study Area when USGS gauge flows equal or exceed 5.3 cfs. This knowledge can be used to create a trigger point for making management decisions regarding future irrigation season pumping when USGS gauged river flows are expected to reach historically low flow rates. This conclusion is predicated on the assumption that no net increase in water use or diversion occurs in the area between the ESR pumping wells and the USGS gauge.

Use of a methodology to estimate river flow based on winter precipitation totals developed by NRCE provides the ability to forecast, in advance, the possible need for special irrigation pumping management when the forecasted summer flow condition falls below 5.3 cfs. This condition has occurred only six years during the last 54 indicating that the need for such evaluation will be minimal. The NRCE methodology uses simple tables that allow correlation of recorded winter rainfalls to a predicted September USGS flow rate and its associated probability of occurrence. During such forecasted low stream flow years (less than 5.3 cfs), monitoring of stream flow conditions in combination with development of an irrigation management plan can be implemented to ensure that ESR pumping does not contribute to any surface flow disruption in the Study Area portion of the Big Sur River.

An alternative option for monitoring Streamflow rates during years when low flow conditions are reached may be the monitoring of river temperatures at the base of the water column in the area of the river directly up and cross-gradient from the New Well. Temperature, EC and DO monitoring data combined with Streamflow measurements have shown conclusively that this section of river was a gaining stream experiencing significant upwelling of groundwater in the bed of the river during the entire irrigation season. Prior to any ability of pumping to de-water this closest portion of river, aquifer hydraulics dictate that the river must experience a reversal from a gaining to a losing stream. The occurrence of this reversal would result in river temperature changes prior to any discontinuation of stream flow. Based on monitoring conducted during the 2004 season, the effect of a reversal of the river condition would be directly measurable via comparison of river temperature along this stretch of river during the warmer months of August and September to the river temperature up gradient near the State Park Parking lot, and as such, could serve as a trigger point to modify or reduce irrigation pumping

1.0 INTRODUCTION

A comprehensive hydrologic and hydrogeologic investigation was conducted at a portion of the Lower Big Sur River Basin, defined as approximately the last mile of the Big Sur River (the river) as it empties into the Pacific Ocean (the Study Area-Figure 1-1). The investigation was conducted in accordance with the work steps outlined in the May 13, 2004 Interim Monitoring Plan, Water Right Application #30166 (the Plan) prepared on behalf of El Sur Ranch (ESR) for the State Water Resources Control Board Division of Water Rights (SWRCB-DWR). This report specifically addresses work conducted as proposed in Sections 4.0, 6.0 and 7.0 of the Plan pertaining to the assessment of hydrologic and hydrogeologic conditions, associated data management, and reporting.

ESR has irrigated its pastures by pumping groundwater from wells located near the mouth of the Big Sur River since approximately 1950. The wells are located within Andrew Molera State Park, and the State of California (Department of Fish and Game and Department of Parks and Recreation) has expressed concern over potential negative ecological effects that might result from the groundwater pumping. We understand that, not withstanding the acknowledged detrimental effects of a temporary river re-routing by the State, the State has pointed to a period in 1990 when a reach of the river went dry as an example of the potential negative impacts from pumping. In addition, we understand that the State has questioned the effects of ESR pumping on river level, lagoon temperature, lagoon salinity, and the health of vegetation in Creamery Meadow. These questions motivate the need for a detailed evaluation of how the lower portion of the Big Sur River basin responds to groundwater pumping.

Previous investigations have been conducted in the Study Area in an attempt to clarify the effects of pumping by ESR on river flow and underflow, and to understand the mechanism(s) of saltwater intrusion into the Study Area. These investigations have demonstrated that the transmissivity of the alluvial aquifer is very high and that as a result, there is significant and rapid connectivity between the river, lagoon and the aquifer in the area of the pumping wells. Data has also indicated that lagoon stage and water levels in area wells respond rapidly to tidal fluctuations. The previous investigation results were based on data collected over a short period of time during the later part of a typical irrigation season. The early investigations did not conclusively determine the degree of impact of pumping on the Study Area nor did they demonstrate the mechanism for saltwater intrusion. Therefore, data collection steps to fill the remaining data gaps were identified and proposed to support a technically and legally defensible permitting process.

It has been recognized that the most critical time of data collection would be the dry period of the year (i.e., typically August and September) during a year (or consecutive years) of drought when subsurface and surface flow volumes would be most diminished naturally. However, it has also been recognized that drought conditions cannot be "created" and that the permitting process cannot be placed on hold until such conditions arise. Therefore, the following phased data collection approach was developed:

Phase 1: Reconnaissance Data Collection

Phase 2: Interim Monitoring

Phase 3: Monitoring and Permit Terms

The reconnaissance data was collected in early 2004 and presented in The Source Group, Inc (SGI) April 30, 2004 Phase 1 (Reconnaissance) Data Transmittal. This reconnaissance data was not purported to be statistically significant and was not provided as a statistical baseline. Rather, the reconnaissance data was to reflect general conditions in the Study Area during the wet part of the year before El Sur Ranch pumps began operating and to assist in scoping the Phase 2 data collection effort.

The Phase 2 data collection effort was proposed in the Plan and provided for data collection throughout the 2004 irrigation season.

1.1 Purpose and Goals

The purpose of the expanded hydrogeologic investigation reported herein was to: (1) provide a significant base of hydrogeologic data, and (2) allow refinement of the conceptual hydrogeologic site model for a better technical understanding of natural conditions and the potential effects from the two ESR pumping wells and one pumping well used by Andrew Molera State Park (the Navy Well) on those conditions.

The primary goal of this investigation was to resolve three key technical issues that are necessary for the development of guidelines for future water use by ESR. These technical issues are:

- Determination of the dominant mechanism for saltwater underflow resulting in the water quality conditions recorded in ESR pumping wells during the pumping season.
- Determination of the typical lagoon and river water quality conditions throughout the pumping season as it is influenced by saline water underflow, river flow conditions, pumping dynamics, and tidal fluctuations.
- Determination of the correlation between surface water flow and stream underflow in the area of the ESR and State Park pumping well (the Navy Well) throughout a typical pumping season and how these conditions relate to any noted changes in river water quality.

This study is focused on the Study Area hydrogeologic conditions that occur during the Study Period. The Study Period is defined as the period of time between April 15th and October 31st, 2004, which brackets the data collection period.

1.2 Study Area

The Study Area is within the Lower Big Sur River Basin located on the western slope of the Santa Lucia Mountain Range in southern Monterey County (Figure 1-1). The Study Area boundary is defined by an approximately one-mile stretch of the Big Sur River terminating at the Pacific Ocean and includes the land area that contributes groundwater and surface water flow into and out of this stretch of river (Figure 1-2). Within the Study Area, the river flows within a gently sloping alluvial plain (the Big Sur Valley) surrounded by marine terrace deposits and Franciscan complex outcrops. Several hundred yards before it enters the ocean, the river forms a lagoon contained by a transient sandbar (Figure 1-3). During the winter months, several seasonal tributaries enter the river within the Study Area. Three groundwater extraction wells, Old Well, New Well and the Navy Well, were operating within the Study Area during this investigation. These wells are located within the alluvial floor of the Big Sur Valley less than a quarter mile inland from the Pacific Ocean (Figure 1-3).

The Study Area has a Mediterranean climate with cool, wet winters and dry summers. Fog and high wind are typical during the summer months. The average annual precipitation for the Study Area is estimated at 27.58 (1975-2004) inches based on a regression analysis of limited ESR precipitation data and data from the National Climate Data Center weather station in Monterey, California (station 5759) (NRCE, 2005).

1.3 Previous Studies / Sources of Information

A significant amount of information regarding the hydrogeology of the lower portion of the Big Sur River basin has been collected. Investigations specifically evaluating the hydrology and subsurface geology of the Study Area include an engineering and geologic investigation conducted at the mouth of the Big Sur River to evaluate the feasibility of constructing a harbor (Dames & Moore, 1964). This harbor evaluation study consisted of driving several test piles onshore, excavation of test pits, numerous jet probings offshore, geologic mapping and a seismic refraction survey.

Additional hydrogeologic investigation work was conducted in the late '90s as documented in two reports by Jones and Stokes (1997 and 1999). A hydrogeologic conceptual model for the Study Area was presented by Jones and Stokes in these reports based on work that included:

- Installation of three additional wells during 1997 and 1998 (JSA-03, JSA-04 and JSA-05) (Jones & Stokes, 1999)

- Two aquifer tests: one using New Well and the other using both New Well and Old Well (Jones & Stokes, 1999)
- Two geophysical surveys: one in July 1997 (Geoconsultants, 1997), and one in October 1998 (Geoconsultants, 1998)
- A reconnaissance-level geomorphology evaluation in October 1998 (Mussetter Engineering, 1998)
- Continuous water level monitoring for two ESR wells conducted between August 1997 and June 1998, and one monitoring well from July through September 1998 (Jones & Stokes, 1999).

Jones and Stokes concluded that (1) the groundwater system is highly transmissive and hydraulically connected to the river, (2) the irrigation pumping draws water both from aquifer storage and the river but does not significantly decrease the stage or flow of the river, (3) the irrigation pumping does not impact groundwater levels in Creamery Meadow, (4) wave over wash is the cause of salinity in the surface water and groundwater, and (5) the pumping was not the primary cause of a dry river reach in 1990.

In addition to these site-specific studies, the hydrology, hydrogeology, and geology of the general surrounding area has been studied by many investigators over the last 78 years as presented in several published documents obtained and reviewed as part of this evaluation. Specific research attention was also paid to nearby studies of similar coastal river settings that have experienced the effects of saline intrusion. Published information exists related to the origins of sea-water intrusion in the Pajaro Valley and the Salinas River valley. A complete listing of these reference materials is included as Section 6.0.

1.4 Methods of Investigation

This section summarizes activities that were conducted as part of this investigation. Further information regarding details and methodologies to complete the activities summarized below are provided in Section 2.

The methods of investigation included a combination of direct field measurements from within the Study Area and routine downloading of public domain data via the Internet. Investigation activities included the following:

1) Public domain data were routinely collected from the Internet including tide data, climatological data and flow data for the Big Sur River. These data were used to evaluate interrelationships among the groundwater, surface water and ocean water within the Study Area.

2) Two geophysical surveys were conducted, one prior to the irrigation season, and one near the end of the irrigation season. The objectives of these surveys were to obtain data regarding the subsurface stratigraphy and to identify differences in the amount of saltwater intrusion between the two events. These data were combined with earlier geophysical survey data to refine the site conceptual hydrogeologic model.

3) Data from previous aquifer tests were used to estimate aquifer properties including hydraulic conductivity, transmissivity, and groundwater flow rates. Data from published and unpublished sources provided additional information on regional hydraulic properties of the aquifer.

4) A monitoring well cluster was installed adjacent to the Big Sur River in order to collect data regarding vertical variation in hydraulic head and water quality parameters in the groundwater adjacent to the river. In addition, two deeper borings (one continuously cored to 100 feet below ground surface (bgs), the other installed to 70 feet bgs) were installed within the terrace deposits flanking the Big Sur Valley and converted into monitoring wells in order to obtain data regarding the interconnectedness of groundwater within the terrace deposits and the aquifer beneath Big Sur Valley. Lithologic data from these boreholes and from other test wells were used to evaluate both the local and regional hydrogeology.

5) Long-term continuous water level and water temperature measurements were collected from selected wells and surface water within the Study Area. The continuous water levels and temperatures in both groundwater and surface water were used to assess water-level fluctuations, diurnal events, and the degree of interconnectedness.

6) Synoptic water level measurements were routinely collected from all known wells within the Study Area. The synoptic water level measurements were used to construct potentiometric surface maps showing the effects of different pumping configurations on the local water table.

7) Water quality parameter data were collected using handheld field instruments from both groundwater and surface water periodically during this investigation. These data were used to describe the general water quality and to characterize significant conductivity and temperature differences between groundwater, surface water and ocean water.

8) All of the monitoring wells and river transects used for data collection were surveyed by a licensed surveyor. The survey data were used in the construction of the potentiometric surface maps and for accurately placing the measurement locations on a base map.

2.0 WORK PERFORMED

The hydrogeologic investigation included the following: research and review; field reconnaissance; installation of additional monitoring wells to further evaluate river, aquifer and pumping interactions; continuous water level monitoring in multiple wells including pumping wells; continuous river stage monitoring at one location; bi-weekly river stage and flow monitoring at three locations; hourly river temperature monitoring; bi-weekly river water quality evaluations; monitoring of irrigation well pumping durations; and daily monitoring of water quality in water pumped from the irrigation wells. In addition, publicly available river flow and weather data at Big Sur were collected from the United States Geological Survey (USGS) station. Tidal and weather data were also collected from stations in the Study Area, and from a National Oceanic and Atmospheric Administration (NOAA) station in Monterey. Two geophysical surveys were also conducted.

Due to issues associated with acquiring access and other applicable permits, the investigation schedule was modified from that presented in the Plan and proceeded on a phased schedule as access and permits were granted. The result of permitting delays is the concentration of data collection activities during the late summer. Figure 2-1 presents a detailed schedule of the implementation of this investigation as it occurred.

2.1 Research and Review

Initial work included the review of documents and reports provided by ESR pertaining to site hydrologic and hydrogeologic conditions. Based on information provided in these documents, additional research was conducted to find and acquire all relevant publications relating to the geologic, hydrologic, hydrogeologic conditions in the Big Sur River Watershed and the Study Area. Reports and reference information were obtained from various sources including data and documents provided by ESR, documents acquired through the University of California Library system, and documents acquired from Internet sources including the USGS, Cal-Trans, and the California Geological Survey and other websites. A search of all relevant scientific document databases was conducted as part of the search for information related to this study. Relevant information obtained was reviewed and considered as part of the hydrogeologic investigation.

2.2 Permitting

An extensive permitting process was required to conduct this investigation. During this process, the following permits, exemptions and waivers were obtained from the following Federal, State and Local agencies:

- Army Corps of Engineers (ACOE), Nationwide Permit No. 5 (NWP No. 5). Verbal correspondence with the ACOE confirmed that the planned investigation activity was beneath the NWP reporting thresholds and was therefore covered by the General Permit.
- California State Water Resources Control Board (SWRCB) concurred (in writing) that the work was subject to NWM No. 5 and that this class of permit had a statewide water quality certification by the SWRCB.
- California Regional Water Quality Control Board (RWQCB) concurred (in writing) with the SWRCB.
- California Department of Fish and Game (DFG) approved a Notification of Lake or Streambed Alteration package allowing for the installation and removal of the two stilling wells.
- National Marine Fisheries Service was notified of this investigation by the SWRCB, however, consultation was not required due to ACOE determination that the investigation was covered by NWP No. 5.
- Monterey County Planning and Building Inspection Department (local proxy for the California Coastal Commission) issued a Coastal Development Permit exemption upon satisfactory completion of conditions such as submittal of a Site Restoration Plan. (SGI, 2004).
- Monterey County Department of Health issued well construction permits.
- California Department of Parks and Recreation issued a Permit to Conduct Biological, Geological or Soil Investigations granting State Park approval for implementation of the work plan.

Copies of the permits and related correspondence are included in Appendix A.

2.3 Field Reconnaissance

The entire reach of the river from the State Park parking lot to the lagoon mouth was surveyed on April 16th, 2004 for the purpose of selecting possible stream stage and flow gauging locations for monitoring to be conducted throughout the 2004 pumping season. The survey was conducted in a kayak allowing complete access and inspection of the entire riverbed along this length. Three areas were chosen for potential stream gauging based on the observed river flow characteristics and considering the channel shape and its effect on flow characteristics during the low flow season of late summer and fall. In addition to the riverbed survey, the potential location for a monitoring well cluster was evaluated via an inspection of the areas east and up-gradient of the pumping wells adjacent to the river. Results of the survey were presented in the May 13, 2004 Plan and was used to develop the scope of this investigation.

Two California State Registered Geologists surveyed the geology of the Study Area on September 27, 2004. The geologic survey was conducted to confirm interpretations made by earlier investigators of the area and to gather information used in refining the geologic conceptual model. One of the main objectives of the geologic survey was to determine if the "clay" reported in several well logs for Study Area borings could actually be weathered Franciscan material. Confirmation of this hypothesis was observed by the geologists at a Franciscan Formation outcrop along Highway 1 that contained a weathered zone that was similar in color and texture to a gray clay. Several sections of the Big Sur Valley were surveyed, as was the interface between the marine terrace deposits and the beach north of the river. Further results of the geological survey are discussed in Section 3. The flow conditions for the major tributaries to the river between the USGS gauge and the ocean were also observed during this visit. In addition, the entire reach of the river within the Study Area was walked over a dozen times during the data collection phase of this investigation.

2.4 Monitoring Station Installations

Installation of monitoring equipment at various locations was conducted as permits and equipment availability allowed based on the detailed work scope in the Plan. The locations of all monitoring stations are depicted on Figure 2-2 and a table summarizing the equipment installed at each monitoring well is included as Table 2-1. The following sections present the details of station installations.

2.4.1 Temperature Transducers

In April 2004, data logging temperature transducers were installed at five locations along the Big Sur River. Five self-contained computerized water temperature monitoring units (Onset Optic StowAway WTA08) programmed to record water temperature at one-hour intervals were deployed along the longitudinal gradient of the lower river and lagoon. The temperature logger stations were numbered sequentially from one to five starting at the mouth of the Big Sur River and working inland. The water temperature monitoring units were housed in a perforated PVC pipe with an attached 12-16 ounce lead weight secured by either 100-200 pound test monofilament or steel leader material attached to an anchor point (e.g., tree limb) at each monitoring station. As a result of the relatively shallow water depths, the temperature loggers were placed on the river bottom at each monitoring site. All temperature loggers have been calibrated to National Bureau of Standards (NBS) traceable standards and provide water temperature measurements within an accuracy of plus or minus 0.5 °C. See Figure 2-2 for the locations of the five transducers.

In July, a second set of transducers were installed at temperature logger stations 1 through 5 to additionally record near surface river temperatures. In August, a set of transducers was placed in the ocean surf zone fronting the ESR property. Later, a single transducer was installed in an alternate surf zone location, as the transducers at the first location were lost due to heavy wave action. The surf zone temperature loggers were collectively labeled temperature logger station 6.

2.4.2 Monitoring Wells

At the start of data collection activities, five monitoring wells (ESR-01, ESR-02, ESR-03, JSA-03, and JSA-04) and three groundwater extraction wells (Old Well, New Well, and Navy Well) existed in the Study Area. Upon final approval of all well installation permits (see Section 2.2), five new monitoring wells were installed in the Study Area. A cluster of three monitoring wells (ESR-10A, ESR-10B, and ESR-10C) were installed to explore both the vertical and horizontal flow of groundwater near the Big Sur River. Two additional monitoring wells (ESR-11 and ESR-12) were installed on the bluff overlooking the river to explore lateral groundwater movement between the river and the terrace deposits. The installation of ESR-12 was not part of the Plan, though was added later when it was determined additional groundwater monitoring data from the terrace formation would be required. See Figure 2-2 for the locations of the existing monitoring wells and the newly installed monitoring wells.

The ESR-10 monitoring well cluster consists of 3 monitoring wells installed adjacent to each other, but screened at different depths. The cluster was intended to supplement the existing wells to provide better definition of lateral and vertical gradient changes in response to seasonality and pumping conditions. A location up-gradient of the pumping center near the location of a river stage monitoring transect was selected to correlate river and groundwater interactions and their responses to pumping. The final location was chosen based on considerations of accessibility, and the likelihood that seasonal bank erosion and high flow conditions would not damage or destroy the well cluster.

Permit applications for the installation of all five monitoring wells were submitted to the Monterey County Health Department (MCHD). A copy of Water Well Construction Permit No. 04-07840 issued by the MCHD on July 30, 2004 for the installation of the wells is provided in Appendix A.

On September 1, 2004, monitoring wells ESR-10A, ESR-10B and ESR-10C were installed adjacent to the Big Sur River, approximately 500 feet northeast of monitoring well JSA-03. The wells were installed in a cluster approximately 5 feet apart to a maximum depth of 12 feet, 21 feet and 30 feet for well ESR-10A, ESR-10B, and ESR-10C, respectively. Test America® from Sacramento, California supplied a CME-75 hollow stem auger drill rig for the installation of the monitoring wells. Initially, a soil boring was advanced to a maximum depth of 31.5 feet with the aim of establishing a detailed soil profile and depth to bedrock using an unlined California Split Spoon sampler. The detail soil profile can be found in Appendix B.

After the soil profile was established, 8-inch outside diameter hollow stem augers were used to advance a boring to the proposed depth for each monitoring well. Each well was constructed using 2-inch inside diameter Schedule 40 PVC well casing attached to 5 feet of 0.020 inch machine slotted flush threaded Schedule 40 PVC well screen. A filter pack consisting of #2/12 dried silica sand was placed in the annular space between the casing and the borehole extending from the bottom of the boring to approximately 2-feet above the screened interval. A well seal consisting of approximately 2 feet of hydrated bentonite chips was placed above the sand filter pack. The remainder of the annular space was backfilled to within one-foot of ground surface with cement grout. Each well was finished with a 3 foot steel monument set in concrete and a locking well cap. Well construction details are found in Appendix B.

On September 8-10, 2004, monitoring wells ESR-11 and ESR-12 were installed on the ESR terrace overlooking the Big Sur River alluvial plain, approximately 1,000 feet west (ESR-11) and 1,000 feet northwest (ESR-12) of the Old Well groundwater extraction well. Each well was installed to a maximum depth of 70 feet below ground surface. ResonantSonic® from Sacramento, California supplied a Sonic drill rig for the installation of the monitoring wells. Initially, a soil boring was advanced at the location of the proposed ESR-11 monitoring well to a maximum depth of 100 feet with the aim of establishing a detailed soil profile and depth to bedrock using a plastic lined 5 foot core barrel. The detail soil profile can be found in Appendix B.

After the soil profile was established, 6-inch outside diameter drill rods were used to advance a boring to the proposed depth for each monitoring well. Each well was constructed using 2 inch inside diameter Schedule 40 PVC well casing attached to 20 feet of 0.020 inch machine slotted flush threaded Schedule 40 PVC well screen. A filter pack consisting of #2/12 dried silica sand was placed in the annular space between the casing and the borehole extending from the bottom of the boring to approximately 2 feet above the screened interval. A well seal consisting of approximately 2 feet of hydrated bentonite chips was placed above the sand filter pack. The remainder of the annular space was backfilled to within one-foot of ground surface with cement grout. The well was finished with a flush mounted, traffic-rated well monument set in concrete and a locking well cap. Well construction details are found in Appendix B.

2.4.3 Water Level Transducers

In June and July, 2004, data logging transducers capable of recording temperature and pressure were installed in monitoring wells ESR-02, ESR-03, JSA-03, and JSA-04 and the Old Well pumping well. In mid August, transducers were installed in the Navy Well pumping well and the Transect 2 stilling well. In early September, transducers were installed in the newly completed monitoring wells ESR-10A, ESR-10B, ESR-10C, ESR-11 and ESR-12. Each transducer was set to record water temperature and water pressure (as water column height) every five minutes. See Figure 2-2 to see the locations of the wells containing transducers.

2.4.4 River Gauge Transects/Stilling Wells

Three river gauge transects were constructed along the Big Sur River to allow periodic measurement of river stage height and flow volume from fixed locations. The river transect locations were numbered sequentially from one to three starting near the Andrew Molera State Park parking lot and working downstream. Up-gradient river Transect 1 is located just downstream of the 90 degree river bend in an area near a very large boulder resting on the south bank of the river. Based on river channel and flow conditions as determined during field reconnaissance, this location was considered the best for monitoring stream flow as it enters the Study Area. Transect 2 is located near the closest up gradient reach of the pumping center. The Transect 2 location is important because the nature of groundwater flow is such that if the ESR wells were to dewater the river, it would affect the closet adjacent stretch river first. Therefore flow and velocity measurements upstream of any possible river impacts would be important to help quantify such impacts. Transect 3 is located at the lagoon mouth located adjacent to the bounding rock outcrop. See Figure 2-2 for the location of the three river gauge transects. Each transect consisted of two stakes emplaced vertically on opposite banks of the river. When a measurement was to be taken, a level line was stretched across the river and attached to the stakes. River stage height was measured from the level line and river flow volume was measured along the level line using a portable flow meter.

In August, following final permit approval (see Section 2.2), stilling wells were constructed at river gauge Transects 1 and 2 to enhance the accuracy of the river stage elevation readings. Each stilling well was constructed using 5 feet of 2 inch inside diameter Schedule 40 PVC well casing connected to 5 feet of 0.020 inch machine slotted flush threaded Schedule 40 PVC well screen. At the joint between the casing and the screen is a 90-degree bend (Transect 1) or a 45-degree bend (Transect 2). Each well was buried in the bank of the river with the slotted section of the well resting parallel to the river surface approximately 1 foot underwater. See Appendix C for a diagram of the stilling well installations. In mid August, a pressure and temperature transducer was installed in the Transect 2 stilling well.

2.4.5 Weather Stations

In July, two weather stations were installed in the Study Area with the main purpose of monitoring rainfall and other weather conditions on an hourly basis. Station WESR-01 was placed in one of the ESR pastures while station WESR-02 was placed in the open field near the Old Well pumping well. Each weather station recorded the following data hourly: temperature, relative humidity, wind speed, wind direction, rainfall, incoming solar radiation and barometric pressure. See Figure 2-2 for the location of the two weather stations.

2.4.6 Elevation/Location Surveying

On April 16, 2003, Rasmussen Surveyors developed a benchmark at the location of ESR Old Well and surveyed wellhead and ground surface elevations at five accessible wells (Old Well, New Well, ESR-02, ESR-03, JSA-03 and JSA-04). Subsequent to the installation of wells ESR-10A, ESR-10B, ESR-10C, ESR-11 and ESR-12, an additional round of surveying was conducted on September 27, 2004. The second surveying event consisted of resurveying the original set of five wells, and surveying ESR-01 (which was located after the original survey event based on a review of historic aerial photographs), the five newly installed wells, and the three river transects. A copy of the survey data is provided in Appendix D.

A discrepancy in the wellhead elevation reported for well ESR-02 between the April and September survey events was noted. The reported difference of approximately 0.73 feet in the elevation for ESR-02 had a significant effect on the interpreted groundwater flow direction in the Study Area that was presented in the SGI April 30 Phase I (Reconnaissance) Data Transmittal (SGI, 2004). All data evaluations and interpretations presented in this report have been conducted using the September survey results.

2.4.7 Site Restoration Activities

On July 15, 2004, a Site Restoration Plan (SGI, 2004) was submitted to the Monterey County Planning and Building Inspection regarding the possible impact the installation of the proposed ESR-10 well cluster, wells ESR-11 and ESR-12, and the two river stilling wells might have on local soil and vegetation. Restoration objectives were detailed for disturbances of soil and vegetation caused by drilling implements, including vehicles and tools, and the generation of drill cuttings. The Site Restoration Plan was approved by the Monterey County Planning and Building Inspection Department prior to their issuance of the Coastal Development Permit exemption on August 3, 2004.

The drill cuttings generated during the installation of the ESR-10 well cluster, installed adjacent to the Big Sur River (Figure 2-2), were much less than anticipated. All the cuttings were used to restore the ruts created by the drilling rig. The remaining ruts were partially restored using hand tools. Full restoration of the site will occur after the removal of the monitoring well cluster. Additional restoration activities may be required pending the outcome of natural re-vegetation.

ESR-11 and ESR-12 were installed on ESR property. Drill cuttings from these wells were removed by ESR personnel pursuant to County approval and used to fill a hole next to the mailbox at the ranch driveway intersection with California Highway 1. No visible field impacts remain from these well installations other than the concrete well housings. It is likely that these two wells will be removed concurrent with the removal of the ESR-10 well cluster. Additional site restoration activities will be conducted at that time.

The stilling wells were installed in the bank of the Big Sur River using hand tools. Disturbance of local soil and vegetation was minimal. At this time, the well casings remain in the riverbank as their use will be instrumental pending another season of data collection.

2.5 Geophysical Surveys

Two geophysical surveys were conducted during this investigation: one in April during high-flow and non-pumping conditions (i.e., before the ESR pumping wells were activated); and the other in August during low-flow and pumping conditions (i.e., near the end of the irrigation season). NorCal Geophysical Consultants conducted both surveys. Both surveys employed time-domain electromagnetic (TEM) soundings and were designed for mapping potential saltwater intrusion effects beneath the lagoon towards the direction of the ESR pumping wells.

Both surveys consisted of a series of TEM soundings across three transects as shown on Figure 2-3. Both surveys were conducted identically, using the following three survey lines:

- Line 1 traversed across the entire mouth of the lagoon at the beach.
- Line 2 began at the beach and proceeded through the middle of the lagoon.
- Line 3 was completed on the trail located on the southeast side of the lagoon extending from the beach inland as conditions allowed.
- Line 4. The lagoon line was continued along the lagoon trail to the general location of the New Well.

NorCal Geophysical provided a preliminary report presenting the April TEM survey results (NorCal, 2004). However, subsequent updates to the geologic conceptual model required that the TEM data be re-interpreted. The new interpretation of the April TEM survey was provided by NorCal along with the August TEM data interpretation (NorCal 2005). The results of both TEM surveys are discussed in Section 3.5.2. A complete copy of the TEM survey report is included in Appendix E.

2.6 Monitoring Program

Thirteen groundwater wells were actively monitored during this investigation (Figure 2-2), including:

- Three active extraction/irrigation wells (Old Well, New Well, Navy Well).
- Three inactive extraction/irrigation wells (ESR-01, ESR-02, ESR-03).
- Two wells installed during the 1998 hydrogeologic investigation (JSA-03, JSA-04).
- Five wells installed during this investigation (ESR-10A, ESR-10B, ESR-10C, ESR-11, ESR-12).

In addition to the groundwater wells, two river stilling wells were monitored at Transect 1 and Transect 2 for the purpose of measuring river stage elevation and flow. A third river transect (Transect 3) was located at the river's mouth (the V-notch), however a stilling well was not installed at this location due to its exposed nature. A brief summary of the groundwater well construction data is provided in Table 2-1.

2.6.1 Pumping Well Status

Two agricultural supply wells located in the alluvial floodplain of the Big Sur River are used to irrigate the cattle pastures at ESR during the pumping season (See Figure 2-2). The Old Well was installed in 1949 and records reflect a pump was installed in the Old Well in 1950. The Old Well has a 60 horsepower centrifugal suction pump and reportedly began operation sometime in 1950. A second well (New Well) was installed in 1975. The New Well contains a vertical turbine pump with a 50 horsepower motor. Pumping well status for these two pumping wells was recorded on a daily basis during the Study Period. This data included groundwater temperature (discussed in Section 2.6.4), groundwater quality parameters (discussed in Section 2.6.5), start-up and shutdown events, and extraction rates. Groundwater extraction rates were estimated based on pumping tests conducted on each well when pumping with the normal irrigation valve configurations used by ESR personnel. Table 2-2 summarizes the pumping well operational status and estimated extraction flow rates for the 2004 irrigation season.

2.6.2 Groundwater Levels

Global Water model WL15 data logging transducers were used to collect and record temperature and groundwater head (amount of water above the sensor) measurements from groundwater monitoring wells, pumping wells and stilling wells within the Study Area. See Figure 2-2 for the location of each transducer equipped well. The data recorded by the transducers were downloaded to a handheld computer (PDA) on a bi-weekly basis. Each transducer arrived factory calibrated with a manufacturers recommendation of yearly recalibration. According to the manufacturer, the accuracy of the pressure transducers is ± 0.2% of the full pressure range between 35 °F to 70 °F. This equates to an accuracy of ± 0.006-ft (± 0.07 inches) for the pressure transducers with a 3-ft pressure range and an accuracy of ± 0.03-ft (± 0.36 inches) for the pressure transducers with a 15-ft pressure range. The pressure transducers used are known as "differential water level monitors", meaning that they automatically compensate for changes in atmospheric pressure and that no post data retrieval corrections need be made.

Concurrent with the download, depth to groundwater was measured manually in each well. A Heron "Little Dipper" water level meter was used to assess depth to water. According to the manufacturer, the instrument conforms to the upcoming American Society for Mechanical Engineers (ASME) performance standard for steel measuring tapes (reference B89.1.7). This standard calculates maximum permissible error (MPE) based on the following formula:

$$MPE = \pm (0.0118in + (0.00096in/ft * L\ ft))$$

where 'L' is the length of the tape being checked. Using 45-ft (the maximum use of the depth to water meter) for the value of 'L', the resulting MPE is ± 0.055-ft. The instrument also conforms to 'European Class II' standards, which require the tape to be accurate to 1/100th ft per 100-ft under an eleven pound load. Based on those two criteria and the small size of the tape and probe (i.e., results in minimal stress on the tape when played out), the accuracy of the instrument is ± 0.01-ft. The manufacturer does not recommend periodic calibration.

See Table 2-3 for a complete listing of all manually collected depth to water data. The list of monitoring wells, the types of data obtained from each well, and the data set date range can be found in Table 2-4.

2.6.3 River Stage and Flow

River stage and flow at each of the three transects was recorded once during the day and once at night approximately every two weeks. Data from the Transect 2 stilling well pressure and temperature transducer was downloaded to a handheld computer (PDA) concurrent with the stage and flow readings (see section 2.6.2 for specification for the Global Water model WL15 data logging pressure/temperature transducer used in the stilling well).

A Marsh-McBirney model 201D electromagnetic velocity meter was used collect river flow volume from the three transects located along the Big Sur River. River velocity was measured and recorded at 0.5-foot intervals along transects oriented perpendicular to the direction of river flow, with depth to river bottom being measured concurrently, from which river flow volume could be calculated. For each set of velocity measurements taken during the day, a corresponding set of measurements was taken at night to quantify diurnal effects on river flow. According to the manufacturers specifications, the meter can record velocities in the range of -0.5 feet per second (ft/sec) to +10 ft/sec, with an accuracy of ± 2% of the reading. This allows for a maximum error of ± 0.2 ft/sec at maximum velocity. The sensor is calibrated by placing it in a pan of standing water and 'zeroing' the unit. Periodic maintenance is confined to simply cleaning the sensor and checking the strength of the batteries.

2.6.4 River and Groundwater Temperatures

Optic Stowaway data logging temperature transducers were installed within the Study Area. Pairs of these loggers were located at five points along the Big Sur River and in the ocean surf zone recording temperature hourly. Each transducer arrived factory calibrated with an available National Institute of

Standards and Technology NIST-traceable temperature accuracy certification. According to the manufacturer, the accuracy of each unit is ± 0.4 °F at 70 °F with a resolution of 0.29 °F at 70 °F. There is no provision or requirement for user calibration or maintenance. Periodic calibration to NIST standards and battery replacement require factory servicing. Data was downloaded from the loggers twice prior to their removal.

Groundwater temperatures were monitored via Global Water model WL15 data logging temperature transducers installed in the Study Area groundwater wells, with an accuracy of ± 1.0 °F. The data recorded by the transducers were downloaded to a handheld computer (PDA) on a bi-weekly basis. When practical, temperature was measured manually in monitoring wells with suitable accessibility using a YSI 556 water quality meter (see section 2.6.5 for YSI 556 meter specifications). The list of monitoring wells, the types of data obtained from each well, and the data set date range can be found in Table 2-4.

2.6.5 River and Groundwater Quality Parameters

Twice a month, water quality parameters were collected from 21 different locations along the Big Sur River and in the ocean surf zone. A YSI 556 multiprobe system was used to measure temperature, electrical conductivity and dissolved oxygen content of both groundwater and river water at each location. The temperature sensor has an accuracy of ± 0.15 °C (± 0.27 °F) and does not require periodic calibration. The electrical conductivity sensor has an accuracy of ± 0.5% of reading + 1.0 µS/cm (example: a reading of 250 µS/cm would result in an accuracy of ± 2.25 µS/cm) and requires periodic calibration. The dissolved oxygen sensor has an accuracy of ± 2% of reading or 0.2 mg/L, whichever is greater (example: a reading of 12 mg/L would result in an accuracy of ± 0.24 mg/L) and requires periodic calibration and sensor maintenance. The YSI multiprobe was calibrated upon initial receipt of the instrument from the manufacturer, then on a frequency of every six weeks during the study period. At each calibration, the conductivity meter was calibrated to a 1,000 µS/cm standard solution and the dissolved oxygen sensor was calibrated using tap water, all following YSI published procedures. In addition, the dissolved oxygen sensor permeable membrane was replaced at each calibration as recommended by the manufacturer. Based on the calibration results, the average drift (change in calibration values) for the dissolved oxygen sensor is 1.5% while the average drift for the electrical conductivity sensor is 0.3%.

In general, three readings were collected from each station corresponding to the left edge, the right edge, and the center of the river. Due to safety considerations, it was sometimes not possible to obtain all three readings at a station. In addition, one reading per monitoring event was collected from the ocean surf zone.

When practical, water quality parameters were collected from select monitoring wells using the YSI 556 water quality meter. This data was recorded manually and entered into the database by hand.

With the seasonal start of groundwater extraction in April, the conductivity of water extracted from the New Well and Old Well were recorded daily. Groundwater was collected from each well individually from sample ports located at the respective well heads and analyzed using a handheld conductivity meter. Starting in June, conductivity, along with temperature and dissolved oxygen, were measured using the YSI 556 water quality meter in place of the handheld conductivity meter previously used.

2.6.6 Weather Station Data

Of the two weather stations erected onsite, only the fixed weather station (WESR-02) needed to be visited periodically to download hourly weather data from its data logger via direct hookup to a laptop computer. The mobile weather station (WESR-01) was equipped with a wireless modem allowing remote data downloading via the Globalstar™ satellite network. In general, data from the two weather stations was collected on a bi-weekly basis.

2.6.7 Public Domain Data Acquisition

Much of the data needed for the study was being collected by other entities and was available via Internet download. The following data was collected from the Internet:

2.6.7.1 Big Sur River Gauge Flows

United States Geological Survey (USGS) stream gauge #11143000 is located on the Big Sur River above the Study Area (see Figure 2-4). This gauge records stage height and stream flow of the Big Sur River every fifteen minutes. The data was obtained from the following Internet web page: http://waterdata.usgs.gov/ca/nwis/uv?dd_cd=02%2C03&format=html&period=31&site_no=11143000.

2.6.7.2 Precipitation Data

Weather station PPSC1 (former TR361) is located near the USGS Big Sur River stream gauge (see Figure 2-4). This station records accumulated rainfall on an hourly basis. The data from this station is collected and maintained by MESOWest, an online weather station data repository associated with the University of Utah. The data was obtained from the following Internet web page: http://www.met.utah.edu/cgi-bin/roman/meso_base.cgi?stn=TR361

2.6.7.3 Tidal Conditions

NOAA tidal station #9413450 is located in Monterey Harbor within Monterey Bay (see Figure 2-4). This station records tidal changes every six minutes. Data from this station is collected and maintained by the Center for Operational and Oceanographic Products and Services (CO-OPS). The data was obtained from the following Internet web page: http://co-ops.nos.noaa.gov/data_options.shtml?stn=9413450+Monterey,+CA.

2.7 Data Management

2.7.1 Database Development

A relational database was used to efficiently store and retrieve the large volume of data collected during this investigation. A custom data model (Figure 2-5) designed to accommodate the various types of data collected during this investigation was implemented using Microsoft Access. Individual database tables were created for each data type collected during this investigation including both the field measurement data and the Internet downloads of public domain data. The resulting database contained 14 tables and more than 140,000 records. An electronic copy of the database is included in Appendix F.

2.7.2 Data Importation/Input

A significant benefit to designing a custom data model was the ability to match the database structure to that of the raw data collected and/or downloaded during this investigation. This direct mapping of data columns between the raw data and the database made it possible to use "cut and paste" techniques to import the majority of the data into the Microsoft Access database.

2.7.3 Data QA/QC

Each table within the database was individually checked for completeness and accuracy when compared to the raw data, though the method varied dependant on the method of data collection. Manually collected data was physically checked line by line to determine accurate translation. The electronically collected datasets and the larger manually collected datasets were checked graphically. Specifically, the large datasets are expected to follow certain trends dependant on the data collected. Anomalous data points can be spotted graphically and analyzed for accuracy. See Table 2-5 for the data collection summary and anomalous data explanations. The following sections summarize the Quality Assurance/Quality Control (QA/QC) method for each type of data collected.

2.7.3.1 Manual DTW Data

Manual depth to water data collected in the field was recorded onto field data sheets. Information on the field data sheets was manually entered into the database. The data in the database was then checked against the field data sheets for accuracy. See Table 2-3 for a listing of all manual depth to water data collected.

2.7.3.2 Precipitation Data

All data was downloaded from the University of Utah MesoWest website. Data could only be downloaded one day at a time, and then compiled for upload into the database. No other data alterations were carried out. No independent data checking could be completed as we did not have access to the source data.

2.7.3.3 Pumping Status

Data was collected daily by ESR staff and manually recorded onto field data sheets. Information from the field data sheets was manually entered into the database. Data in the database from the 2004 field season was checked against the field data sheets for accuracy and was determined to by highly reliable.

2.7.3.4 Temperature Data

Temperature dataloggers were installed at five stations in the river and one station in the ocean, recording temperatures hourly. Data was downloaded from the loggers then uploaded into the database. All the data in this table was graphed and checked for anomalous data points. Several technical issues arose during the course of the study, which resulted in both anomalous data and data loss. In most cases, anomalous data could be corrected to accurately reflect environmental conditions at the time of data collection. Explanations of all of the anomalous data are found in Table 2-5. See Appendix H for graphs of all temperature logger data.

2.7.3.5 Tide Data

All data was downloaded from the NOAA Center for Operational Oceanographic Products and Services website. Data was downloaded from the website, then uploaded into the database. No independent data checking could be completed, as we did not have access to the source data. The downloaded data is noted on the website as being verified. The data was also graphed and checked for anomalous data points. See Appendix I for a graph of tidal data.

2.7.3.6 Transducer Data

Transducers were installed in most of the monitoring wells at the site, recording both temperature and head of water. Data from the loggers was downloaded in the field using a handheld computer and transferred to an Excel™ spread sheet. All the data in this table was graphed and checked for anomalous data points. Several technical equipment issues arose during the course of the study that resulted in some anomalous data and data loss. In most cases, the anomalous data could be corrected to accurately reflect environmental conditions at the time of data collection. Explanations of all anomalous data were found in the data validation table (Table 2-5). See Appendix H for graphs of all temperature data and Appendix J for graphs of recorded water level elevation in wells.

2.7.3.7 USGS River Gauge Data

All data was downloaded from the USGS Water Resources website. Data could only be downloaded in one-month increments. Needed data was extracted from the data download files, then uploaded into the database. No independent data checking could be completed as we do not have access to the source data. They note that "Recent data provided by the USGS in California -- including stream discharge, water levels, precipitation, and components from water-quality monitors--are preliminary and have not received final approval". See Appendix K for graphs of the USGS river gauge data.

2.7.3.8 Velocity Data

Data was collected in the field and recorded manually onto field datasheets. The data from the field data sheets was transcribed into electronic format and uploaded into the database. All the data in this table was graphed and checked for anomalous data points. The data in the table was also checked against the field data sheets for accuracy of translation. Explanations of all anomalous data were found in the data validation table (Table 2-5). See Appendix L for manually recorded river stage and flow data.

2.7.3.9 Weather Station Data

Two onsite data logging weather stations recorded and stored data every hour on the hour. Data was downloaded on a periodic basis using a laptop computer. Each downloaded data set was then uploaded into the database. All data was graphically checked for completeness and for data anomalies. Explanations of all anomalous data were found in the data validation table (Table 2-5). See Appendix G for graphs of all weather related data.

2.7.3.10 Water Quality Data

Water quality data was collected and manually recorded on field datasheets. The data was transcribed into electronic format and uploaded into the database. All the data in this table was graphed and checked for anomalous data points. The data in the table was also checked against the field data sheets. Explanations of all anomalous data were found in the data validation table (Table 2-5). See Appendix M for graphs of all water quality data.

2.8 Saltwater Intrusion Modeling

Numerical modeling was conducted to further evaluate the conceptual hydrogeologic model presented herein with respect to the mechanism for seawater encroachment resulting in measured saline impacts in both the Navy Well and the Old Well. Specifically, information for the lower reach of the Big Sur River Valley gathered during this study was processed using the equations that describe groundwater flow physics in a coastal environment in an attempt to reproduce the observed groundwater quality distributions. The U.S. Geological Survey (USGS) SEAWAT-2000 model (Langevin et al., 2003) was used to simulate density-dependent groundwater flow and transport at the site during the irrigation season at the mouth of the Big Sur River. SEAWAT-2000 was chosen because it couples the variable-density fluid flow (using a modified version of MODFLOW-2000) and the transport of solutes that contribute to the density variation (using MT3DMS) into a single program for variable-density flow. MODFLOW-2000 and MT3DMS are industry standard USGS numerical models with wide acceptance within the scientific community. The area evaluated by the model (the model domain) is depicted in Figure 2-6.

3.0 DISCUSSION OF FINDINGS AND HYDROGEOLOGIC CONDITIONS

The surface and subsurface conditions described in this report have been interpreted from information obtained from the geologic literature, geologic field mapping, air photo interpretation, interviews, reports of previous studies of the mouth of the Big Sur River and the large data collection effort documented herein.

3.1 Regional Geologic Setting

The dominant geologic structural trend of the area is west of north, consistent with the general structural trend of the Coast Ranges and the Santa Lucia Mountains. The main structural features of the region are the thrust faults – the Sur Hill fault and the Sur fault (Sur Thrust) – along which the rock formations were thrust several thousand feet upward and over both younger and older formations, with the movements in a general southwesterly direction (State of California, Department of Natural Resources, Division of Mines). The Big Sur River crosses the northwest-trending Sur Thrust, the major structural boundary of the Santa Lucia Mountain Range that separates dissimilar rock types. East of the Sur Thrust are Cretaceous aged granitic intrusive rocks and pre-cretaceous aged metamorphic rock (primarily gneiss, quartzite, and schists) of the Sur Series (Sur Complex) as described by Trask (Trask, 1926) and others. These hard crystalline rocks compose the core of the Santa Lucia Mountain Range from which the Big Sur River drains. Relief is rugged east of the Sur Thrust fault with slopes commonly 45 degrees or greater.

The Sur Thrust splits into two parallel faults in the Big Sur Area, the Sur Hill fault on the east and the Sur fault on the west. Sandwiched between these two faults is a narrow wedge of Tertiary aged sandstone called by variable names in the literature including the Santa Margarita Sandstone (Oakeshott, 1951; Cleveland, 1973). These rocks in the core of the fault zone form a weak foundation along the base of the hillslopes northeast of the Big Sur River and are more easily weathered and eroded than those of the Sur Series that are stacked above them to the east.

West of the Sur Thrust faults lie rocks of the Franciscan Formation. The rocks of the Franciscan Formation are mainly sandstone and shale. Slopes are generally less steep on the Franciscan rocks. Alluvial deposits discontinuously mask the bedrock geology along the Big Sur River as it flows between and across the Sur Thrust faults. The whole group of formations have been tilted at angles of 30 to more than 60 degrees toward the northeast in conformity with the general movement along the thrust faults (State of California, Department of Natural Resources, Division of Mines).

A map depicting the generalized bedrock geology as described above is presented as Figure 3-1. The map includes the outline of the Big Sur Watershed and the canyons of the Big Sur River. The character and orientation of these major geologic units plays a significant role in the determination of the hydrogeologic and hydrologic conditions that are the subject of this investigation.

3.1.1 Sur Complex

The Sur Complex consists of hard metamorphosed marine sedimentary rocks locally called the Sur Series that include quartzite, gneiss, schists, granofels and marble. Some of the amphibole and augite-plagioclase gneisses may be of igneous origin, and a part of the gneisses apparently are of primary origin. Many of the gneisses are of the injection gneiss type, the formation of which is associated with the intrusion of the Santa Lucia quartz diorite (Trask, 1926).

Approximately 80% of the Big Sur River Watershed overlies the metamorphosed crystalline rocks of the Sur Complex (Figure 3-1). Big Sur River summer base flow is primarily derived from groundwater stored within the fractured rocks of the Sur Complex.

3.1.2 Santa Margarita Formation

The Santa Margarita Formation crops out in the Big Sur area only in the narrow zone between the Sur fault and the Sur Hill fault (Figure 3-1 and 3-2). It represents a remnant of once more extensive sandstone, which was over-ridden on the east by the Sur gneiss along the Sur Hill fault and was itself pushed upward and westward over the Franciscan rocks along the Sur fault. For the most part, the Santa Margarita sandstone varies from a fine-grained, brown sandstone to a coarse-grained, white, pebbly sandstone with a little conglomerate. It is essentially massive, that is, it is difficult to distinguish any sign of bedding or stratification, although the formation was probably tilted to the northeast, as was the Franciscan Formation, when the major faulting occurred (State of California, Department of Natural Resources, Division of Mines).

3.1.3 Franciscan Formation

A northwest trending band of Franciscan rocks, partly covered by the Pacific Ocean, is located on the southwest side of the Sur fault zone. The strike of the beds is roughly parallel to the coast line and the dip is fairly uniformly 40 to 60 degrees northeast (Gilbert, 1971). Structural disorder and pervasive shear dislocation is characteristic of this belt of Franciscan Formation rocks forming a mixed up mélange. It consists of a mixture of sheared and faulted medium-grained, lithofeldspathic wacke or graywacke, micrograywacke, siltstone, or shale and conglomerate containing clasts of graywacke, siltstone, chert, and metavolcanic rocks in exposures along the coast between Point Sur and the Big Sur River (Figure 3-2). Most of the graywacke has been tectonically blended into mixed-up mélange, erasing stratigraphy and reorganizing the metamorphic rocks. Metavolcanic rocks - including greenstone and pillow basalt; red, white, green ribbon chert, greenschist; and blueschist - are also present in the mélange (Hall, 1991).

3.2 Surficial Geologic Units in Study Area

The Study Area boundary is defined by an approximately one-mile stretch of the Big Sur River terminating at the Pacific Ocean and includes the land area that contributes groundwater and surface water flow into and out of this stretch of the river. The generalized map of geologic units in the Study Area is depicted on Figure 3-3. Three principal geologic units occur in the Study Area including Franciscan Formation bedrock, terrace alluvial deposits, and Quaternary aged stream alluvium filling the Big Sur River valley. The Franciscan and Santa Margarita Formation bedrock slopes that border the Study Area to the east and south are mantled with a relatively thin layer of loose rock and debris called colluvium and with landslide/mudflow deposits. These materials thicken as the mountain slope lessens and onlaps onto the marine terrace deposits that border the Franciscan Complex rocks that outcrop to the east (Figure 3-2). The following sections describe the principal geologic units as they are encountered in the Study Area.

3.2.1 Franciscan Formation Bedrock

The bedrock in the Study Area has geologically been designated as the Franciscan Formation. The rocks of the Franciscan Formation underlie both the Quaternary alluvial deposits and the terrace alluvium throughout the Study Area. This is a varied formation with several different rock types occurring in the Study Area.

Forming the weathering resistant narrow ridge at the ocean's edge, the Franciscan Formation consists of massive sandstone, fractured shale, and altered volcanic rock (metavolcanic) known as greenstone. The sandstone and shale dip approximately 40 degrees to the north-northeast. Twelve to eighteen feet of soil and colluvium overlie the bedrock along the narrow ridge (Dames & Moore, 1963). Trask described the greenstone that makes up the resistant Franciscan rocks at the Mouth of the Big Sur River as a dark green rock in which small lath-shaped feldspar phenocrysts are occasionally seen (Trask, 1926). These greenstones occur in small isolated patches in various parts of the Franciscan. Figure 3-4 presents a photograph of these metavolcanic rocks as they occur at the mouth of the Big Sur River.

The Franciscan Formation bedrock that underlies the alluvium in the portion of the Study Area where all the wells are located (Figure 3-3) consists of dark gray clay that grades into a weathered micro-graywacke at depth as confirmed in core samples collected during this investigation for the drilling of wells ESR-10A,B,C (See Drill Log in Appendix B). An example of this same material is seen in an outcrop near the Andrew Molera State Park parking lot as shown in the photograph presented on Figure 3-5.

Immediately north of the Andrew Molera State Park parking lot, the river makes a right angle turn and exposes competent tan sandstone of the Franciscan Formation. This rock meets the description by Trask of Franciscan Formation rocks in the Point Sur Area described as a well indurated massive, medium-grained, feldspathic sandstones which, when fresh, are gray in color, but weather to a yellowish brown (Trask, 1926)

3.2.2 Terrace Alluvium

A series of terraces extending upward to a height of 500 feet occupies the indentations between the promontories along the Big Sur Coast. The best developed terrace is the 40-foot terrace, a part of which extends south of Pt. Sur to south of the Big Sur River and is 3,000 feet in width forming the ocean-side cattle grazing lands of ESR. This terrace separates the mouth of the Big Sur River from the abrupt rise of the Santa Lucia Mountains to the east (Figures 3-2 and 3-3).

These relatively flat and nearly level surfaces exposed along the coast are not wave-cut terraces, but represent the surfaces of alluvial deposits resting upon terraces cut by wave action into the underlying Francsican formation rocks. As a result of the highly variable make-up and resulting hardness of the underlying Franciscan formation rocks, the terrace surface upon which these deposits rest is interpreted to have an irregular topography in contrast to the nearly level surfaces of the alluvial deposits that overlie them. The alluvial deposits (called terrace alluvium) consist primarily of alluvial wash from the mountains to the east. The alluvium is thickest on the face of the sea cliff. From this point its upper surface slopes gently upward, covering younger and older terraces alike, until truncated by the sides of the mountains. The terrace alluvium is rudely stratified, poorly sorted, the constituents are very angular, and the kind of rock found depends upon the nature of rock present in the mountains at the rear of the terrace (Trask, 1926). A cliff along the coastline terminates the terrace abruptly. The character of these terrace deposits is documented in a photograph of their outcrop as they form a cliff on ESR (Figure 3-6).

Due to continuing mountain uplift, the Big Sur River has cut a valley 2,000 feet in width through the terrace alluvium in the Study Area. The terrace deposits documented in drilling cores (Appendix B) and inspection of outcrops indicates that in the Study Area the terrace alluvium consists of semi to weakly consolidated material made up of cobbles, gravel, sand, silt and some clay. These deposits are overlain in spots north of the mouth of the Big Sur River by sand dune deposits. To the east, landslide deposits consisting of rock and mudflow debris overlie the terrace deposits (Figure 3-2). These landslide deposits likely inter-finger with the alluvial deposits of the terrace along their eastern margin.

3.2.3 Quaternary Alluvium

Holocene aged (less than 11,000 years old) Quaternary deposits of unconsolidated boulders, cobbles, gravel, and sand derived from the bedrock of the Santa Lucia Mountains and lain down by the Big Sur River in a deeper cut ancestral canyon makes up the primary groundwater aquifer in the lower watershed and is the source for water pumped in the Study Area (Figures 3-2 and 3-3). The geologic term for this deposit is "alluvium".

3.3 Alluvial Aquifer

3.3.1 Description and Extent of Quaternary Alluvial Aquifer

In the eastern part of its watershed, the present Big Sur River rushes at a steep grade through the hard, resistant crystalline rocks of the Sur series to form the narrow, rock-bound valley called the Gorge. As water emerges from the lower end of the Gorge, its velocity is slowed and it has built up a series of boulders, gravel, and sand deposits along a channel several hundred feet to 2,000 feet wide. These stream-deposited sands, gravels and boulders make up the alluvium outlined on the geologic map along the course of the Big Sur River (Figures 3-2 and 3-3).

As the river meets the ocean, these deposits of sand, gravel, cobbles and boulders have filled the mouth of the Big Sur, both onshore and for some distance offshore. Due to scouring and erosion of the finer-grained materials, the top several feet consists almost entirely of gravel and cobbles, with some large boulders. This is characteristic throughout the onshore area, and offshore to a water depth of 20 feet below Mean Lower Water Datum. Below this upper zone of very coarse material, evidence from the one test pit and from pile driving records indicate that the deposits consist of silt and sand layers, with lenses of gravel, cobbles and boulders (Dames & Moore, 1964).

A petrographic examination of test pit samples collected from the alluvium at the mouth of the Big Sur River was conducted in 1964 by the American Cement Corporation (Dames & Moore, 1964). The results indicated three primary rock types make up 91.1% of the alluvial material as follows; Gneiss = 62.2%, graywacke/sandstone = 18.7%, and Quartzite = 10.2%. This finding is consistent with the geologic conditions in the majority of the watershed consisting of meta-sedimentary rocks of the Sur Series (gneiss and quartzite) and with the character of Franciscan rocks (graywacke, sandstone and shales) as mapped in the lower watershed. Figure 3-7 shows the character of the alluvial deposits in a photograph taken near the channel edge in the vicinity of the Navy Well.

The coarse and highly permeable Quaternary alluvium material fills an ancestral river canyon that was cut by the Big Sur River at lower sea levels. Figure 3-8 depicts this ancestral canyon as contour lines on the base of gravels (alluvium). Figure 3-9 presents a three-dimensional representation of the ancestral canyon bottom that is now filled with alluvium. This canyon was cut by the river through older terrace alluvium that now forms the north border, and into Franciscan Formation micro-graywacke/graywacke that underlies both the Quaternary alluvium in the Study Area and the terrace alluvial deposits to the north. Figure 3-8 could alternatively be called contours on the top of Franciscan bedrock. Franciscan Formation rocks form the south border of the Quaternary alluvial channel as depicted on the Study Area geologic map, Figure 3-3.

The contour map (Figure 3-8) depicting the base of alluvium is based on the compilation and re-interpretation of site-specific data collected beginning in 1963 and extending through this investigation. This information comes from several different investigations that included variable methods for exploring the subsurface as follows: excavation pits, pile driving, jetting, seismic refraction profiling, drilling with coring, drilling without coring, and electromagnetic geophysical surveys. Data collected from all of these investigations including the geophysical study conducted as part of this investigation (Appendix E) was evaluated and plotted for use in developing the presented basal surface.

Figure 3-10 provides the locations of five cross sections constructed to further demonstrate the nature of the alluvial filled channel that makes up the zone for groundwater movement through the Study Area. Figures 3-11 and 3-12 present these cross-sections demonstrating the interpreted alluvial-bedrock surface. Cross section D-D' on Figure 3-12 depicts the view of the ancestral river canyon across the area of the river mouth as it passes through the more resistant rocks consisting of metavolcanic greenstone. These metavolcanic rocks have reduced the width of the canyon and a buried knob of resistant bedrock identified by seismic refraction methods, is located west of mid-channel beneath the current location of the lagoon. A photograph of the metavolcanic cliff that makes up the east wall of this portion of the canyon is shown on Figure 3-13.

The nature of the Franciscan Formation bedrock that underlies the alluvium in the area of cross section C-C' on Figure 3-11 was confirmed in core samples collected during this investigation for the drilling of wells ESR-10A,B,C and field mapping of Franciscan outcrops in the area. The bedrock consists of dark gray clay that grades into a micro-graywacke at depth. An example of this same material is seen in an outcrop near the Andrew Molera State Park parking lot as shown on Figure 3-5. An interpretation by early investigators (Jones and Stokes, 1999) had suggested that this dark gray clay layer was possibly underlain by additional alluvial deposits throughout the Study Area and implied that the depth of the ancestral canyon might be much deeper than is presented herein. This conclusion appears to be based on a misinterpretation of a single drill log from a non-cored rotary drilled hole for well JSA-4 (Drill logs are contained in Appendix B). Prior to site evaluation using the misinterpreted drilling log, Jones and Stokes in an earlier document presented an interpretation consistent with that presented above as demonstrated in the following quote:

"The depth to clay is important because, as illustrated by the 1957 NAVY Well log, bedrock underlies the clay at a depth of 49 feet. It is assumed that there is only clay and rock below the other wells, not additional gravel and sand deposits; therefore, unless drilling of monitoring wells indicates otherwise, the thickness of the aquifer can be considered the thickness of aquifer material above the clay layer (Jones and Stokes, 1997)."

Careful consideration was given by the authors to reinterpreting the "clay layer" as a weathered bedrock surface rather than a laterally extensive aquaclude separating two alluvial water bearing zones. The following key points were considered:

1) In the borehole cored by SGI during the installation of ESR-10C, a gray clay was encountered that graded into a gray weathered graywacke/stiltstone coincident with the depth of a gray clay layer described by previous investigators (approximately 30 feet below grade). This clay and weathered bedrock sampled from the borehole was identical in color and texture to an an outcrop of weathered bedrock capped with gray clay observed at elevation within the Study Area (Figure 3-5).

2) In this coastal setting, the depositional environment required to create a laterally extensive clay layer across an uneven river channel surface would involve some form of marine environment created by an embayment. A clay layer created by such a process would likely have a significant blue or green color component, which was not observed by the authors in drilling cores taken from the site.

3) Seismic data collected during the 1963 harbor site evaluation study (Dames & Moore, 1964) indicated the presence of a competent bedrock pinnacle at an elevation consistent with the elevation of bedrock identified by drilling core.

4) Previous geologic mapping of the vicinity by others has indicated that the Big Sur Valley is underlain by Franciscan Formation bedrock consisting in large part of "graywacke, microgračke, siltstone and shale (Section 3.1.3), and

5) Review of the rotary-drilled log for JSA-4 in Appendix B (apparently used by Jones and Stokes to develop the theory of two alluvial zones separated by clay) shows that the "dominant lithology" in the lower alluvial zone is "angular, medium-gray, siltstone, followed by white quartz and minor rounded granite". The following two facts contradict the deeper alluvial zone interpretation:

   i) Alluvial material would be well rounded and not angular due to the fluvial nature of the depositional environment, and

ii) The nature of rotary drilling is such that if competent bedrock were encountered, the rotary drill bit would break it apart into "angular" pieces of graywacke (which could be interpreted as siltstone), and would likely pick up pieces of the overlying alluvial sediments (such as "rounded granite") as it was pushed back up to the surface in the uncased borehole.

In conclusion, the preponderance of evidence strongly supports the interpretation presented herein defining the base of the alluvial aquifer as weathered bedrock surface that is at least partially capped with a weathered zone that can consist of a well developed gray clay.

3.3.2 Alluvial Aquifer Characteristics

The character of the alluvial aquifer is best described through knowledge of the normal depositional process for fluvial deposits as aptly described by Fetter, 1980.

> *Flowing rivers deposit sediment, generally termed alluvium. During periods of flooding, alluvium is deposited in the channel as well as the floodplain. As the flood peak passes, flow velocities start to drop, the energy available to transport sediment decreases, and deposition begins. Coarse gravel is deposited in the stream channel, sand and fine gravel forms natural levees along the banks and silt and clay come to rest on the floodplain. Point bars are formed by deposition of coarse material on the inside of a bend in the river. Deposition of these coarse point bars is not limited to floods. The alluvium is reworked by a meandering stream, even during quiescent periods for the river. As the channel swings back and forth across the floodplain, point bar and channel deposits of sand, coarse gravel (and cobbles) are left behind. If the stream is aggrading, the general land level subsiding, or both, the alluvial deposits will thicken with time (Fetter, 1980).*

The alluvial aquifer in the study area is comprised of alluvium that is fairly coarse in nature due to the high energy of the regular winter floods that result in the deposition of large amounts of alluvium. Point bar deposits observed in the study area consist of large cobbles in the 6 to 10 inch size range with coarse gravels and sand. Inspection of the streambed indicates the presence of very large cobbles and boulders up to 2 feet in diameter indicative of the high velocity nature of the uncontrolled winter floods that dominate the depositional cycle of the river valley.

Dames and Moore studied the make-up of the study area alluvium in detail in the area of the river mouth in 1964 for the purpose of evaluating the feasibility of the construction of a harbor. Based on a combination of information collected via seismic survey, pile driving, and test pits, Dames and Moore (1964) concluded that in the bottleneck area of the river as it empties into the ocean, the character of the alluvium below negative 20 feet in elevation indicates a zone of boulders up to three-feet in diameter within the submerged historic river channel (Dames & Moore, 1964). The presence of large boulders in the historic channel of the alluvium is consistent with the nature of the defined ancestral canyon, the observed large cobbles to small boulders in the existing channel bed, and the regularly documented large flood events that dominate the depositional cycle for this river system.

In September 1998, a pumping test was conducted (Jones and Stokes, 1999) to determine the characteristics of the alluvial aquifer via the constant rate pumping of the ESR New Well groundwater extraction well. The pumping test was run for 27 hours with New Well extracting groundwater at an average rate of 1,150 gallons per minute (gpm). Four groundwater monitoring wells, JSA-03, JSA-04, JSA-05 and ESR-03, were equipped with data logging pressure transducers and used to observe and record the effects of the pumping.

Groundwater well JSA-05 was located in Creamery Meadow on the opposite side of the river from the pumping well. No pumping related effects were observed in this well. Measured water levels in the remaining three observation wells were corrected for all non-pumping related effects recorded in JSA-05. Data from observation wells JSA-03, JSA-04 and ESR-03 were analyzed by Jones and Stokes (1998) using type curves derived for confined, unconfined and leaky aquifers. The results from each calculation type on each set of well data were combined to define Transmissivity and specific yield for the aquifer. Transmissivity was reported to be over 600,000 gallons per day per foot (gpd/ft). Hydraulic conductivity based on the Jones and Stokes Analysis is calculated to range from 3,389 to 3,918 feet per day (ft/day) with an average of 3,679 ft/day. SGI reevaluated the data for observation well JSA-03 and JSA-04 using the Neuman type curves for a fully penetrating unconfined aquifer consistent with our evaluation of site hydrogeologic conditions. The resulting average hydraulic conductivity (K) for the alluvium was calculated to be 3,567 ft/day based on this analysis. The average estimated conductivity value for all of these analysis methods is 3,623 ft/day. Aquifer data analysis graphs and data are included in Appendix N.

SGI installed a cluster of three monitoring wells next to the Big Sur River approximately 500-ft northeast of the New Well pumping well. Alluvium soil samples recovered during the groundwater well installation process found the local lithology to consist primarily of medium to coarse sand, with minor amounts of gravel. The drilling logs can be found in Appendix B. The reported values for alluvial hydraulic conductivity measured during aquifer testing fall in the middle of the range reported for clean sands and gravels by the U.S. Department of the Interior (Groundwater Manual, 1985).

Additional information collected in 1964 (Dames & Moore, 1964) indicates that the lower zones of alluvium in the area of the mouth of the river where the ancestral canyon cut deepest could have a local hydraulic conductivity significantly higher than 3,623 ft/day due to the presence of large boulders and cobbles. The results of a seismic investigation combined with test pit and pile driving results in the alluvium of the bottleneck area of the river as it empties into the ocean indicated that the character of alluvium below negative 20 feet in elevation indicates a zone of boulders up to three-feet in diameter within the submerged historic river channel (Dames & Moore, 1964). Typical hydraulic conductivities for this type of cobble and boulder zone range from 10,000 to 100,000 ft/day.

Based on the measured values of aquifer hydraulic conductivity and the interpreted area of saturated alluvium at cross section A-A' (Figure 3-11), the estimated groundwater flux moving into the Study Area through the alluvial deposits was calculated to be an average of 3.45 cubic feet per second (cfs) during this study period as detailed in Table 3-2. Considering the range of hydraulic conductivity values estimated by aquifer testing analysis, estimated underflow is calculated to range from 3.16 to 3.81 cfs.

3.3.3 Potentiometric Surface

The potentiometric surface of the alluvial aquifer was measured by manually recording depth to water in the available groundwater monitoring wells located within the Study Area. A set of water levels was obtained in April 2004, prior to the start of groundwater extraction. Figure 3-14 shows the groundwater gradient generally following the flow direction of the Big Sur River to the southwest. The overall magnitude of the gradient was approximately 0.002 foot by foot (ft/ft). As monitoring wells ESR-11 and ESR-12 were still pending installation, no information on groundwater flow within the terrace deposits was available.

In early July, a set of groundwater elevation measurements was obtained at a time in which the New Well pumping well had been operating exclusively for the previous twelve days. Figure 3-15 shows the New Well capturing a significant quantity of groundwater flow north of the Big Sur River. The groundwater flow not captured by New Well continued to follow the flow of the Big Sur River to the southwest. The magnitude of the groundwater gradient ranged from 0.002 ft/ft to 0.006 ft/ft. As monitoring wells ESR-11 and ESR-12 were still pending installation, no information on groundwater flow within the terrace deposits was available.

In mid September, a set of groundwater elevation measurements was obtained at a time in which the Old Well pumping well had been operating exclusively for the previous eleven days. Figure 3-16 shows the Old Well capturing a greater amount of groundwater flow north of the Big Sur River than New Well did when operating alone. Otherwise, the groundwater flow not captured by the pumping well continued to follow the flow of the Big Sur River (southwest). At this time, groundwater elevation measurements were obtained from terrace wells ESR-11 and ESR-12 that indicate groundwater flow from the terrace deposit moving south and southeast to the alluvial aquifer. The magnitude of the flow gradient in the alluvium ranged from approximately 0.002 ft/ft to 0.014 ft/ft while the magnitude of the flow gradient in the terrace was approximately 0.012 ft/ft.

In late September, groundwater measurements were obtained at a time in which both Old Well and New Well had been operating together for the previous nine days. Figure 3-17 shows both wells capturing almost all of the groundwater flow north of the Big Sur River. The terrace wells continue to show groundwater flow to the south/southeast toward the alluvial aquifer. The magnitude of the flow gradient in the alluvium ranged from approximately 0.005 ft/ft to 0.011 ft/ft while the magnitude of the flow gradient in the terrace was approximately 0.019 ft/ft.

In late October, a set of groundwater measurements was obtained after the cessation of all groundwater pumping in the Study Area. Figure 3-18 shows the groundwater gradient generally following the flow direction of the Big Sur River to the southwest, mimicking the pre-pumping pattern seen in Figure 3-14. The terrace wells continue to show groundwater flow to the south/southeast toward the alluvial aquifer, with the magnitude of the gradient seemingly unaffected by the cessation of groundwater pumping. The magnitude of the flow gradient in the alluvium was approximately 0.002 ft/ft while the gradient in the terrace was approximately 0.019.

3.3.4 Groundwater Velocities

Groundwater seepage velocities are calculated by multiplying the conductivity by the hydraulic gradient and dividing the result by the effective porosity (% of porosity that is interconnected). Values for gradient and conductivity have been measured as discussed above. Values of effective porosity for unconsolidated coarse sand and gravels range from 22% to 27% (Johnson, 1967). These numbers are equivalent to specific yield for an unconfined aquifer.

The baseline groundwater velocity in the alluvial aquifer is calculated at approximately 29 ft/day, based on the measured pre-pumping groundwater gradient near the wells of 0.002 ft/ft, the calculated alluvial aquifer K of 3,623 ft/day and the estimated alluvial formation effective porosity of 25%. This result indicates it would take approximately 172 days for groundwater to travel from the parking lot area of Andrew Molera State Park to the lagoon area, a distance of approximately 5,000 ft, assuming that groundwater pumping is not occurring.

With both extraction wells pumping, the maximum groundwater gradient in the vicinity of the pumping wells has been measured at 0.014 ft/ft. This translates into a maximum groundwater velocity of 203 ft/day, nearly an order of magnitude increase in the baseline groundwater velocity.

Groundwater gradients in the terrace deposits range from 0.012 ft/ft to 0.019 ft/ft, while the terrace deposit K has been approximated at a maximum of 100 ft/day and the semi-consolidated terrace deposit porosity estimated at 20%. Therefore, groundwater velocities in the terrace deposits are estimated to range from 6 ft/day to 9.5 ft/day.

3.4 Hydrology

3.4.1 Watershed Boundaries

The Sur fault intercepts the Big Sur River as it flows westward out of the higher reaches of the Santa Lucia Range. The river then trends northwest and follows the Sur Thrust fault zone, cutting a wide valley in the more easily eroded rocks of the Santa Margarita Formation before it turns abruptly west as it contacts the rocks of the Franciscan Formation and empties into the sea.

The Big Sur watershed boundary is depicted on Figure 3-19. The watershed is divided into upper and lower zones. The upper zone comprises 46.5 square miles and is the zone that provides the predominant volume of both runoff and baseflow to the river. The lower watershed comprises 11.9 square miles. The cutoff between these two zones near the base of the Gorge is where the river crosses the Sur Hill Fault marking a significant change in subsurface geologic conditions from crystalline meta-sedimentary rocks to sandstone. The USGS Gauge in Pfeiffer-Big Sur State Park is located very near the Sur Hill Fault and flows measured at this gauge are considered to represent the Upper Big Sur Watershed. The Lower watershed extends from the Sur Hill Fault to the ocean and includes the Study Area. The Study Area includes the last mile of the river as it empties into the Pacific Ocean.

3.4.2 Precipitation and Evapotranspiration

The estimation of precipitation and evaporation within the Big Sur River basin is important in calculating a water balance within the Study Area. The following section provides calculations for precipitation and evapotranspiration for the 2004 El Sur Ranch irrigation season. A water balance calculation for the Study Area can be found in section 3.4.7.4.

Precipitation at the El Sur Ranch has been estimated by NRCE (March 2005) by correlating long term historical precipitation data from regional weather stations to recent data collected in the vicinity of the Ranch. For the year 2004, the estimated precipitation at the El Sur Ranch was 21.32 inches, which was lower than the average 27.58 inches of precipitation estimated for the years 1975 through 2004. The NRCE estimated precipitation for the period of April through October 2004 was 5.68 inches, while the measured precipitation at the Big Sur Weather Gauge located in Pfeiffer State Park was 7.59 inches for the same time period (Appendix G). The average rainfall in the Upper Big Sur Watershed is 55 inches per year (USGS 1996) while the average rainfall in the Lower Big Sur Watershed is 39.15 inches per year (Appendix Q).

Evapotranspiration (ET) requirements for local vegetation can be estimated if local reference evapotranspiration (ETo) values are known. ETo values on an hourly basis can be derived from any weather station that records the following data: air temperature, relative humidity, incoming solar radiation, and windspeed. Water requirements can then be calculated based on the following formula found in the "The Landscape Coefficient Method" published by the California Department of Water Resources (CDWR) and as used by NRCE in their ET calculations (NRCE, May 2005):

$$ETc = Kc \times ETo$$

where Kc is known as the "crop" coefficient and ETc is the actual water requirement of the "crop", or vegetation type. This formula simply states that water loss from any vegetation type can be estimated by multiplying ETo by a laboratory derived coefficient for the specific vegetation type (CDWR, 2000). The ET contribution for each vegetation type within an area of study can be calculated by multiplying the calculated ETc value by the area covered by that vegetation type. The total ET for an area of study is the sum of ET from all the individual vegetation types.

Note that the calculations for ET assume that there is an unlimited supply of water available to each crop type. In dry summer months when soil moisture is low, vegetation might not have enough water available to fully evapotranspire as calculated. The result is that calculations for ET in a dry area like in the Big Sur River alluvial basin (summer conditions) will lead to an overestimation of ET during dry summer months, i.e., actual vegetation ET will likely be less than what is calculated.

Hourly weather data in the Big Sur River alluvial valley was available starting in July from weather station WESR-02 erected in the Study Area near the Old Well extraction well (Figure 2-2). Additionally, hourly weather data was available for the entire pumping season from the weather station located in Pfeiffer State Park, identified in this study as PPSC1. The Penman-Monteith equations were used to calculate hourly ETo during the 2004 irrigation season as adopted by the American Society of Civil Engineers (Walter et. al., 2000). In contrast, NRCE used the Food and Agricultural Organization of the United Nations Penman-Monteith (FAO P-M) method to calculate ETo on a monthly basis for estimating crop ETo at the adjacent El Sur Ranch.

The result of ETo calculations from both weather stations show that the average ETo for the Study Area (WESR-02) is 0.006 inches per hour (in/hr) while the average ETo for the Big Sur Valley above the Study Area (PPSC1) is nearly a third greater at 0.008 in/hr. This indicates that ET demand for identical vegetation types will be greater in the Big Sur River alluvial basin above the Study Area than in the Study Area itself. This is largely due to summer coastal fog, which reduces ET demand in the foggy areas, including the Study Area.

ET demand was then calculated for the alluvial portion of the Study Area and the Big Sur Valley above the Study Area to the USGS Big Sur River gauging station. For each area, types of vegetation and amount of coverage were estimated based on direct observation, available literature and aerial photographs. The hills throughout the Big Sur area are covered largely with grasses and chaparral. According to Cleveland:

> *Chaparral is a collective term for a group of similar shrubs and small trees which make up the dull, grayish green, velvet-like cover on much of the coastal ranges of California. The composition if the chaparral community is not everywhere the same, but changes in concert with local soil and climatic conditions. At Big Sur it is composed of coast live oak, laurel, tan oak, chamise, ceanothus, toyon, and manzanita among other plants (Cleveland, 1973).*

Trees in the Big Sur area are found mainly in the canyon bottoms, along the banks of rivers and streams. Cleveland describes the primary tree types to be:

> *Trees in the canyon bottoms are the coast redwood, sycamore, madrone, cottonwood, maple, alder, and willow (Cleveland, 1973).*

Figure 3-20 shows the approximate surface coverage of different vegetation types (tree, chaparral, grass, none) within the Study Area. Cleveland's vegetation coverage estimates were used to approximate coverage of the different vegetation types in the Big Sur River valley above the Study Area:

> *Chaparral comprises about 65 percent of the plant cover with trees and grass comprising the remainder in about equal amounts (Cleveland, 1973).*

The predominant grass and chaparral local to the Big Sur region have very low crop coefficient values (~0.1), reflecting a very low ET demand. Alternatively, most of the trees represented have relatively high crop coefficients (>0.5), reflecting higher ET demands and demonstrating that overall ET demand is going to be governed by the amount of tree cover.

Because the relative abundance of tree types (i.e., Redwoods, Cottonwoods, etc.) varies between the Study Area and the Big Sur Valley above the Study Area to the USGS gauge, different crop coefficients for tree cover were used based on the "The Landscape Coefficient Method" (CDWR, 2000) and with input from Niel Allen of the NRCE. The crop coefficient used for trees in the Study Area was 0.85 while the crop coefficient used for trees above the Study Area was 1.0.

The results of these ET calculations are presented on Figures 3-21 and 3-22. Figure 3-21 indicates that the ET demand for the area of the Big Sur River alluvial valley depicted on Figure 3-20 ranges from 0.02 cfs to 0.46 cfs with an average summer ET of 0.29 cfs. The ET demand for the Big Sur Valley above the Study Area to the USGS gauge is calculated to range from 0.01 cfs to 2.25 cfs on a daily basis with an average summer ET of 1.07 cfs as seen in Figure 3-22. The calculated values of ET are conservatively estimated because as previously discussed, these calculations assume unlimited water availability which is not likely to be the case during the dry summer months. See Appendix O for all ET related source calculations.

The impacts of ET and open water evaporation on river flow are exhibited by diurnal changes in river water level elevations measured at Transect 2. Figure 3-23 is a graph of selected stream elevations at Transect 2 plotted along with USGS Gauge flow in cfs. The daily cycle of river elevations change demonstrates the effect of ET on river flow throughout the watershed and comparisons with USGS gauge flow indicate the correlation of flows between the two measurement locations.

3.4.3 Stream Flow

Big Sur River stage height and stream flow measurements are recorded every 15 minutes by the USGS from their gauge located in Pfeiffer-Big Sur State Park. Three stream flow measurement transects were established as part of this investigation as shown on Figure 2-2. Bi-weekly stream flow measurements were collected from these transects during the Study Period as conditions allowed. A summary of the velocity data for the USGS gauge and the three river transects within the Study Area is provided in Table 3-1.

3.4.3.1 USGS Gauge

There is one USGS flow gauging station on the Big Sur River: station #11143000 near Big Sur California, which is located at latitude 36° 14' 45", longitude 121° 46' 20", at an elevation of 240 feet above sea level, and 2.6 miles southeast of the town of Big Sur. The drainage area above the gauge is 46.5 square miles. There are no diversions or regulation upstream from this station. The average monthly flows for water years 1951 through 2004 are shown on Figure 3-24. The annual mean flow at the USGS gauge was 101 cfs (73,120 acre feet per year). The total drainage area of the Big Sur River watershed to the river mouth is 58.4 square miles (NRCE, 1999).

The USGS gauging station records the height of the river stage using a measuring device contained within a stilling well to an accuracy of 0.02 feet and a margin of error of +/- 5%. Stage height data is then translated into stream flow based on a history of points of correlation between stage height and manually collected stream flow data. On an approximately monthly basis, technicians come to the gauging station site and manually measure stream flow across a transect located just upstream from the station. The errors in the manual stream flow are considered insignificant and are ultimately not quantifiable, including such factors as changes in river bottom configuration, instrumentation errors and the influence of nearby swimmers. The manual stream flow measurement is then fixed to the concurrent reading of river stage height. All stage height based stream flow data collected previous to this point is adjusted to conform to the new reading and all previously correlated points.

Data from the USGS gauge, including both stage height and stream flow, are posted on the internet in real time. However, this data is provisional and is subject to change based on the results of the periodic correlation between stage height and manually collected stream flow data. At the end of a year, all the stage height and stream flow data for the year is checked and corrected based on the correlated points collected monthly. Once all the checks and corrections are made, a process that could take up to six months, the data is made available to the public.

Big Sur River flow consists of two components, runoff and baseflow. The runoff component occurs during and after periods of precipitation. The thin soil cover in the majority of the watershed developed on the metamorphic rocks of the Sur Complex leads to rapid runoff in response to precipitation. The baseflow component occurs because of the hydraulic head difference between groundwater and the water surface in the stream. During the dry season from May to October, when there is little or no precipitation, the stream flow is entirely baseflow. Figure 3-25 shows an approximate baseflow separation for the average annual hydrograph of the Big Sur River. The average annual hydrograph was developed using the average daily flows for the period between April 1950 and March 2003 (NRCE, 2004).

A review of Table 3-1 indicates that flow at the USGS gauge decreased from approximately 50 cfs in April 2004 at the start of the irrigation season to 10 cfs in mid October, the lowest flows of the season. The Big Sur River daily mean discharge for the period extending back to 1950 presented as percentile of total flow events is plotted alongside the daily mean flows recorded during the 2004 season (Figure 3-26). Comparison of 2004 flows to the long term daily mean discharge curves indicates that 2004 summer base flow reached a level very near the 25th percentile minimum of 9 cfs. This comparison indicates that conditions recorded during the 2004 summer season are generally reflective of 75% of normal summer river flow conditions.

3.4.3.2 Study Area Transects

Collection of river stage and flow data from Transects 1, 2 and 3 began in late July 2004 and included pairs of measurements representing stabilized afternoon versus stabilized night-time conditions. Collected flow data is plotted on Figure 3-27 alongside the corresponding flows recorded at the USGS gauge as well as contained in Table 3-1. A review of these flow data indicate that the flow rate of the river at Transect 1 is typically around 3 to 4 cfs less than it is at the USGS gauge. Flow data on Table 3-1 also shows that the flows at Transects 1 and 2 typically are within 1 cfs of each other with a variation between loss and gain in flows across this reach of the river.

River flow rates at Transect 3 are greater than the corresponding flows measured at Transects 1 and 2 for four of the five times of available measurements. These flow measurements indicate that a portion of groundwater flow moving in the alluvial aquifer discharges into the river and exits the basin as surface flow due to the constriction of the alluvial aquifer at the mouth. Constriction of the alluvial aquifer is caused by a reduction in total width and an effective reduction in depth due to the mixing interface with higher density seawater as the alluvial aquifer meets the ocean.

Transect 3, which was installed near the river mouth, was submerged on August 26, 2004 due to the lagoon closure, and remained out of service for the remainder of the irrigation season. The lagoon closure was caused by a reconfiguration of the sandbar at the river mouth due to a storm event coinciding with a high tide. The sandbar effectively blocked the outlet of the river to the ocean causing it to backup behind the lagoon thereby increasing the elevation of the lagoon and submerging Transect 3.

Photos of the river mouth before and after the lagoon closure event are presented as Figures 3-28 and 3-29, respectively. A copy of the daily field measurements from which river flow was calculated for Transects 1, 2 and 3 are provided in Appendix L.

3.4.4 Sources of Stream Base Flow

Baseflow in the Big Sur River is sourced by groundwater stored within the fractured crystalline meta-sedimentary rocks of the Sur Complex that make up more than 80% of the total watershed and comprise 100% of the Upper Big Sur watershed. Minor contributions to baseflow may be provided by the thin section of sandstone of the Santa Margarita Formation that exists as an isolated band between the meta-sedimentary rocks and the Franciscan rocks to the west (Figure 3-1). Contribution of groundwater from Franciscan rocks to baseflow is interpreted to be insignificant based on the lack of laterally continuous permeability pathways within the normally intensely sheared and faulted deposits of the Franciscan Formation. A small amount of baseflow contribution may be provided by deep groundwater (depth of approx 50 feet on the ranch) moving through the terrace alluvium in the Study Area. This groundwater is not interpreted to be sourced by irrigation of the ESR ranch, but by rainfall recharge along the flanks of these deposits as they on lap onto the adjacent mountains. Calculations based on simple cross sectional flow estimates indicate that these terrace alluvium in-flows are likely less than 0.64 cfs (463 acre feet per year) (Table 3-3).

3.4.5 Pumping

Three wells were actively pumping in the Study Area during this investigation, including two irrigation wells operated by ESR (Old Well, New Well) and one water supply well operated by the Department of Parks and Recreation (DPR) (Navy Well) as shown on Figure 2-2. The two ESR irrigation wells typically operate during the dry months and were in service during this investigation between April 21, 2004 and October 16, 2004 (Figure 3-30). According to a State Park employee, the Navy Well operated approximately four hours each morning during this investigation at an average extraction rate of approximately 0.07 cfs (30 gpm). Based on this information, the Navy Well removed approximately 23 acre-feet during the Study Period corresponding with a projected annual withdrawal of 40 acre/feet.

Because Old Well and New Well are not fitted with flow totalizers, their respective extraction rates were estimated based on the following information:

- Daily operational status of each irrigation well
- Daily total power consumption for both wells
- Daily irrigation practices (i.e., which pastures were being irrigated)
- Documented well yields for each well/pasture combination (SGI, 2004).

Because the pastures lie at varying elevations and distances from the well field, the extraction rate for each well is dependant upon irrigation practices. Pump test results (SGI, 2004) were used to determine flow rates vs. power usage under different irrigation scenarios, allowing daily flow rate estimates to be calculated based on operational status, power consumption and irrigation scenario. The New Well is normally pumped at the total capacity of the pump. As a result, the pumping rates for the New Well generally represent the maximum attainable pumping rate for the well and pump system for a given irrigation field valve setting. The Old Well is also pumped at a maximum sustainable rate as controlled by drawdown in the well. The pump at the Old Well is run in a valved down setting to prevent cavitations as a result of excessive drawdown. As a result of these system constraints, the pumping rates achieved by the ESR irrigation wells represent the maximum rates attainable for the given system components and configuration.

A summary of the estimated daily extraction rates for the two ESR wells is provided in Table 2-2. A review of Table 2-2 indicates that a total of approximately 1,136 acre-ft were extracted during the 2004 pumping season (a total of 178 days) at an average total extraction rate of 3.3 cfs. This represents an approximate 21% increase in pumping when compared with the average annual extraction rate of 937 acre-ft for the years of 1975 to 2004 (NRCE, January 2005). During 2004, Old Well and New Well were operating at a period average rate of approximately 1.36 cfs and 1.86 cfs respectively. The average rate calculations are based on pumping status for the full 178 day pumping season (i.e., non-pumping days are included in the average).

3.4.6 Water Quality

Water quality measurements for the river were initially collected in April and continued with bi-weekly surveys starting in July. Temperature, electrical conductivity (EC) and dissolved oxygen (DO) parameters were manually collected throughout the ESR irrigation season from the left edge, center and right edge (where practical) of the river at 21 different locations between the ocean surf zone at the river mouth to the Start Park parking lot (Figure 2-2) (Appendix M). In addition, data logging temperature transducers, which record hourly water temperature, were installed at five locations along the river starting in April. In mid July, a second set of temperature data loggers were installed to allow the recording of both surface water and river bottom temperatures (Appendix H). In addition, the stilling well at Transect 2 was fitted with a pressure transducer (Appendix J) and a temperature data logger (Appendix H).

Groundwater quality data were also collected via data logging equipment and manual measurements. Each well fitted with a pressure transducer (Table 2-4) was also fitted with a temperature logger, which recorded groundwater temperatures on an hourly basis (Appendix H). Manual temperature, EC and DO measurements were also collected from the monitoring wells approximately twice a month beginning in August 2004 (Appendix M).

3.4.6.1 River Water Quality

River temperature profiles for ten separate monitoring events conducted between April and October 2004 are presented on Figure 3-31. A review of Figure 3-31 indicates that, in April, at the start of the ESR irrigation season, and in October at the end of the irrigation season, the temperature of the river water was nearly uniform along the entire reach of the river. However, between July and September, as the overall river temperature increased due to warmer weather, an anomalous area of distinctly colder water became evident at water quality stations 7 and 8 and occasionally at station 9. The river temperatures at this cool zone remained fairly consistent throughout the warm summer months (July through September) even though the river temperatures in the upper reach increased by more than 10°F (6°C) between April and August.

EC and DO data collected from the 21 river water quality stations also exhibited measurable changes in water quality during the warm summer months near station 8 when compared to the upstream stations as indicated by lower than average values for both parameters (Appendix M). A review of the EC and DO charts in Appendix M indicates that, during the summer months, EC values in the cool zone were approximately 230 micro-Siemens per centimeter (µS/cm) and ranged to approximately 290 µS/cm in the upper reaches and DO values were around 5 mg/L in the cool zone and were typically around 10 mg/L in the upper reaches. The EC and DO values near station 8 are consistent with groundwater as discussed in Section 3.4.6.3.

The documented change in water quality at monitoring stations 7, 8 and 9 correspond with the bend in the river as it approaches the mouth where the alluvial aquifer width is diminished due to harder Franciscan bedrock conditions. The water quality measurements taken at the bottom of the river (along the southern bank) at stations 7, 8 and 9 are indicative of groundwater conditions showing lower temperatures, lower conductivities, and lower dissolved oxygen levels than measured in upriver stations. These data indicate that the river is receiving groundwater inflow in this area. This condition was consistently seen during July, August and September.

3.4.6.2 Lagoon Water Quality

Water quality measurements obtained from water quality stations 2, 3, and 4 correspond to the lagoon region of the Big Sur River, directly adjacent to the ocean. Measurement of temperature, EC and DO recorded throughout the pumping season reveal water quality nearly identical to that of the Big Sur River. Wave over wash into the lagoon during the spring tides of summer can result in temporary impacts to water quality in the lagoon as documented by Jones and Stokes during their 1998 investigation. Lagoon stage and EC data collected by Jones and Stokes for the period of July 23 to September 14, 1998 indicate that the lagoon experienced two distinct periods of elevated EC concentrations during that period (one in early August and the other in early September) (Jones and Stokes, 1999). Both of these events were reported to coincide with the maximum high tides for those months. Jones and Stokes concluded that these elevated EC concentrations were likely the result of wave over wash, and that the saltwater could be quickly flushed from the lagoon via stream flow in a single tidal cycle.

The occurrence of detectable wave over wash into the lagoon was observed only during late October following cessation of pumping during this Study Period. During the irrigation-pumping season, no impacts to lagoon water quality were evident based on visual observations and field data readings. Additionally, the constantly recording temperature loggers #1 and #2 located in the lagoon that included both surface and bottom temperature loggers at each location did not display any discernable impacts from the mixing of colder seawater during any high spring tide events. Graphs of the temperature logs for all temperature loggers are included in Appendix H. Lagoon temperatures as exhibited on the graph for temperature logger #1 in Appendix H show changes that correspond to seasonal river temperature changes, but do not exhibit any significant change as a result of the introduction of a large quantity of colder sea water due to wave over wash through the lagoon mouth. A review of Figure 3-31 shows that during the warm summer months, the lagoon temperatures are warmer than those recorded upstream near the groundwater inflow zone (station 8), but are lower than the upper reaches (stations 10 to 21). This warming below station 8 can be explained, in part, by exposure to the Sun as the lagoon water moves slowly toward the ocean.

On 26 August, heavy wave action, combined with unusually high tides, created a sand bar that closed the mouth of the Big Sur River, cutting off the lagoon from the ocean. While the lagoon was closed, groundwater and surface water elevations increased by several feet as discussed in Section 3.4.8.3. In general water quality in the lagoon remained consistent with the rest of the river. After heavy rains in mid October, the river pushed through the sand bar and the lagoon was reconnected with the ocean. During the final water quality collection event conducted on 28 October, sea water was observed over washing into the lagoon, as evidenced by an EC value of 2400 µS/cm for water quality station 3. However, the majority of this sea water was quickly pushed out of the lagoon by the force of the river water flowing to the ocean leaving localized areas of brackish water. During this same event EC values for station 4 were not elevated indicating that the brackish water did not migrate upstream any significant distance. Overall, there was no observation of significant infiltration of saline water into the fresh water of the lagoon area based on data collected during this investigation.

3.4.6.3 Groundwater Quality

Groundwater quality measurements consisting of temperature, EC and DO were routinely collected during this investigation. Dissolved oxygen and EC concentrations in groundwater remained fairly consistent throughout the irrigation season, with values typically below 5 mg/l and 300 µS/cm, respectively. The most notable exception to this is the EC data for the terrace wells (ESR-11 and ESR-12), which consistently had EC concentrations in excess of 400 µS/cm, indicating that the groundwater within the terrace deposits has a separate source than that beneath the valley below (Appendix M).

The groundwater temperature data exhibited significant changes, both seasonally, and spatially during this investigation. For example, groundwater temperatures for the ESR-10 wells were all in excess of 64°F (18°C) as measured on 2 September. On this same day, the groundwater temperature in the other wells was near or below 60°F (16°C), and the river temperature (as measured at water quality station 10) was approximately 67°F (19°C). The relationship between the river temperatures, the groundwater temperatures in the ESR-10 wells (located near the river) and the groundwater temperatures in the other wells for 2 September is depicted graphically on Figure 3-32. A review of Figure 3-32 indicates that:

1) The groundwater temperatures for the ESR-10 well cluster are similar to that of the river and likely the result of groundwater and surface water mixing. A review of the surface water flow data for Transects 1 and 2 (Table 3-1) indicates that, in general, the river reach above Transect 2 is a losing reach (i.e., the river is losing water to the ground), which is consistent with the apparent mixing indicated by the ESR-10 groundwater temperature data.

2) The river temperatures between stations 7, 8 and 9 are dramatically lower than the rest of the river (also see Figure 3-31). This zone of cooler water is the result of groundwater inflow as discussed in Section 3.4.6.1.

3) The groundwater temperatures for wells ESR-2, ESR-3 and JSA-4 are all similar to that of the cool zone in the river, which further supports the conclusion that the cool zone is sourced by groundwater entering the river between stations 7 and 9.

As Fall approached, the groundwater temperatures declined for the ESR 10 wells (and JSA-03), and increased or held steady for the other wells. By 28 October, the groundwater temperatures for all wells were within a few degrees of each other and are several degrees warmer than the river. The groundwater temperature decline for ESR-10 mimicked that of the river, which, at station 10, steadily declined for the remainder of the season (Appendix M). The slight rise in temperatures noted in wells ESR-02 and ESR-03 may be explained by the arrival of warmer groundwater, which entered the ground upstream at higher temperatures during the warm summer months, finally making its way down to these wells in the Fall.

3.4.7 Water Balance / Water Availability

Understanding the general water balance in the basin and how it relates to the Study Area is key to evaluating water availability. In the interest of evaluating water availability concerns, a screening level water balance was conducted. This water balance is based on a compilation of various data and information collected by various parties at different times. The core data supporting the water balance calculations consists of a lengthy record of Streamflow and rainfall data collected by the USGS and the NOAA.

The surface water and groundwater in the basin are hydraulically connected acting as a single system and, therefore, all components of the surface water and groundwater are treated within a single water balance. The alluvium in the Big Sur watershed is recharged through several processes including: 1) percolation of water through the soil and colluvium covering the bedrock slopes, 2) percolation through the shallow zone of weathered bedrock beneath the colluvium, 3) percolation through the fractures in the bedrock, 4) infiltration of surface water from the Big Sur River and tributaries, and 5) percolation of rainfall directly through the alluvium. Water flows recorded at the USGS gauge capture the net of these sources of water less ET losses for the upper watershed (Figure 3-19).

Considering published data presented herein, the work of the USGS (1996), the work of Jones and Stokes (1999) and the work of NRCE (January 7, 2005 and March 2005) a simplified average annual water balance was developed for the Big Sur Watershed delineated on Figure 3-19 as detailed on Tables 3-6A and 3-6B. Table 3-6A presents a three-section annual water balance for the Upper Watershed, the Lower Watershed and the combined total watershed. Table 3-6B presents a simplified annual water balance and a simplified 2004 irrigation season water balance for the Study Area.

3.4.7.1 Upper Watershed

The calculated water balance for the upper watershed depicted on Figure 3-19 is summarized in Table 3-6A. The water balance indicates that total runoff is estimated at 53.61% of rainfall input to the basin. As shown in Table 3-6A, it is assumed that there are no significant sources of underflow or return flow into the Upper Watershed and that all precipitation ends up as surface flow exiting the Big Sur Gorge at the USGS gauge, or is lost to ET. Therefore, the simplified water balance for the Upper Watershed has a single input (rainfall) and two outputs (surface flow and ET) as follows:

<u>Upper Watershed Inputs</u>

- The average annual rainfall for the Upper Watershed was estimated at 55 inches and the watershed area was estimated at 46.5 square miles (USGS, 1996), totaling 136,398 ac-ft/yr.

<u>Upper Watershed Outputs</u>

- Surface flow exiting Big Sur Gorge was estimated at 101 cfs based on USGS Gauge data for flow years 1951 to 2004, totaling 73,121 ac-ft/yr, and
- ET was calculated by subtracting the surface flow exiting the Gorge from the rainfall falling within the basin yielding an estimated ET rate of 46.39% of rainfall, totaling 63,277 ac-ft/yr.

3.4.7.2 Lower Watershed

A separate water balance was calculated for the lower watershed depicted on Figure 3-19 as also detailed in Table 3-6A. This water balance indicates that the total of diversion, exports and pumping represent approximately 1% of total inputs to the lower watershed. The inputs for the Lower Watershed include the surface flow exiting the Gorge, rainfall, and return flow; and the outputs include ET, diversions and basin exports above Transect 1, pumping diversions below Transect 1 and runoff/underflow to the ocean as follows:

<u>Lower Watershed Inputs</u>

- Surface flow exiting the Gorge (101 cfs as discussed above) is 73,121 ac-ft/yf. It was assumed that no significant underflow was entering the Lower Watershed due to the fault that separates the fractured rocks of the Sur Series from the non-transmissive Franciscan mélange marking the boundary of the Upper and Lower Watersheds,
- Rainfall (39.15 inches/year, NRCE, March 2005 (Appendix Q) with a surface area of 11.9 square miles, USGS 1996) accounts for 24,847 ac-ft/yr, and

- Return flow (0.1 cfs, Jones and Stokes, 1998 and Table 3-4) is only 72 ac-ft/yr (note: it was assumed that no significant return flow exists below Transect 1).

Lower Watershed Outputs

- Runoff/underflow to the ocean of 85,442 ac-ft/yr (118.02 cfs) was solved for in the water balance,
- ET (the rate of 46.39% of rainfall calculated for the Upper Watershed was assumed) totals 11,527 ac-ft/yr,
- Pumping diversions below Transect 1 total 977 ac-ft/yr (includes average ESR diversion for the years 1975-2004, NRCE January 7, 2005 plus an estimated 40 ac-ft/yr for the Navy Well), and
- Pumping diversions and basin exports above Transect 1 (0.13 cfs, Jones and Stokes, 1998 and Table 3-4) total 94 ac-ft/yr. A detailed average annual water balance for the lower watershed area from the USGS Gauge to Andrew Molera State Park, the beginning of the Study Area, was developed by Jones and Stokes (1999). This water balance included information collected by the USGS (1996) that included stream flows from tributary streams and estimates of basin exports diversions and return flow. The Jones and Stokes water balance as excerpted from their report is included as Table 3-4.

Analysis of the Jones and Stokes water balance in Table 3-4 indicates that on an annual basis, the estimated surface flow rate at the beginning of our Study Area near to the Transect 1 location should show an approximate 10% increase in total flow as compared to the USGS gauged flow. Review of the Jones and Stokes water balance for the low flow months of July, August and September, however, shows an average net increase of 1 cfs above average annual USGS gauged flow for those months (Table 3-4). Contrary to the conceptual annual water balance calculation presented by Jones and Stokes as excerpted in Table 3-4, actual measurements of steam flow at the area of Transect 1 by Jones and Stokes in August and September of 1998 consistently showed a loss of stream flow (Table 3-5). Additional measurements of stream flow at Transect 1 during this investigation for the months of July, August and September 2004 indicated a consistent level of flow loss between the USGS Gauge and Transect 1 ranging from 3.64 to 3.85 cfs with an average loss of 3.73 cfs (Table 3-5).

The field flow data (Table 3-5) indicate that for the low flow summer months of July through September, the Jones and Stokes conceptual annual water balance is slightly off, likely due to less inflow from tributaries or higher levels of diversion than estimated by Jones and Stokes. Further water balance analysis in this report will conservatively consider that during the irrigation season, a surface flow loss occurs between the USGS gauge and Transect 1 of the Study Area on the order of 3.73 cfs.

3.4.7.3 Total Watershed

The values for the Upper and Lower Watersheds were combined to estimate the water balance for the total watershed as detailed in the bottom of Table 3-6A. The results of the water balance for the entire watershed indicate that total runoff and underflow is estimated at 52.97% of inputs to the system. This compares favorably with SWRCB estimates for 36 coastal California rivers indicating an average runoff of 53.61 percent of total rainfall (SWRCB, 2001). Total exports, diversions and pumping are estimated to total approximately 0.61 % of total inputs to the basin.

3.4.7.4 Study Area Water Balance

Additional water balance calculations were conducted for the Study Area sub watershed as depicted on Figure 3-19. Table 3-6B contains a simplified water balance for the Study Area on an annualized basis and for the 2004 irrigation season (178 days in duration). The annualized Study Area water balance indicates that the net of pumping totals approximately 1.12% of inputs. A second water balance calculation estimates pumping approximated at 15.36% of inputs for the 2004 irrigation season.

The inputs for the Study Area include surface flow at Transect 1, underflow at Transect 1, subsurface flow from the terrace deposits and rainfall. These inputs are derived from simple analysis and are based on a small data set. The Study Area outputs include surface flow and underflow to the ocean, ET, and pumping diversions as follows:

<u>Study Area Annual Inputs</u>

- Surface flow at Transect 1, 82,271 ac-ft/yr, was estimated to be 113.64 cfs by solving the water balance,
- Underflow at Transect 1, 2,896 ac-ft/yr, was estimated to be 4 cfs, which is slightly higher than the summer rate presented in Table 3-2 consistent with an assumed increase in annualized saturated thickness and gradient,
- Subsurface flow from the terrace deposits was estimated at 0.64 cfs as discussed in Section 3.4.4 of this report (Table 3-3), totaling 463 ac-ft/yr, and
- Rainfall (27.58 inches/year, NRCE, March 2005, Appendix Q) and the surface area of 1 square mile estimated from Figure 3-19 equated to 1,471 ac-ft/yr.

Study Area Annual Outputs

- Surface flow and underflow to the ocean of 118.02 cfs, totaling 85,442 ac-ft/yr, was solved for in the Lower Watershed analysis presented in Table 3-6A,
- ET was conservatively assumed to be the same 46.39% of rainfall, totaling 682 ac-ft/yr, as discussed for the Upper and Lower Watershed balances above, and
- Pumping diversions total 977 ac-ft/yr (includes average ESR diversion for the years 1975-2004, NRCE January 7, 2005 plus an estimated 40 ac-ft/yr for the Navy Well).

Study Area 2004 Irrigation Season Inputs

- Surface flow at Transect 1 was estimated to be 16.1 cfs, totaling 5,698 ac-ft/yr, based on the average of flow measurement decrease of 3.73 cfs between the USGS gauge and Transect 1 for July through September 2004 presented on Table 3-5,
- Underflow at Transect 1 was estimated at 3.45 cfs, totaling 1,218 ac-ft/yr, based on the data presented in Table 3.2,
- Subsurface flow from the terrace deposits was estimated at 0.64 cfs, totaling 226 ac-ft/yr, as discussed in Section 3.4.4 and Table 3-3 of this report, and
- Rainfall (7.59 inches/year, Appendix G) and the surface area of 1 square mile estimated from topographic maps, totaling 405 ac-ft/yr.

Study Area 2004 Irrigation Season Outputs

- Surface flow and underflow to the ocean was estimated to be 16.7 cfs, totaling 6,286 ac-ft/yr, by solving the water balance,
- ET was estimated at 0.29 cfs, totaling 102 c-ft/yr, as discussed in Section 3.4.2, and
- Pumping diversions of 3.28 cfs were based on 2004 ESR diversions plus 23 Ac-ft estimated for the Navy Well, totaling 1,159 ac-ft/yr.

3.4.7.5 Sensitivity of Water Balance Calculations

The annualized water balance calculated for the entire watershed as presented in Table 3-6A is based on data collected over more than fifty years in the basin. Due to this long record of supporting data, the total watershed water balance is considered fairly robust. The calculation indicates that approximately 52.97% of total rainfall leaves the basin as runoff and underflow with only 0.66% of rainfall input leaving due to diversions and pumping. The least certain parameters in this water balance are the total rate of diversions, basin exports and return flow in the basin between the USGS gauge and the location of Transect #1 in the Study Area. The estimate of these rates is based on work conducted by the USGS as reported by Jones and Stokes (1999). These diversion and export rates as estimated total only 0.06% of the water input to the basin. Due to the small magnitude of these diversions and exports, the sensitivity of the water balance analysis to changes in these parameters is minimal. Considering a ten-fold increase in the exports and total elimination of the estimated return flow, the water balance net exports for pumping and diversion would convert to 1.25% of total basin inputs. As a result of the large data record for inputs, streamflow, and irrigation pumping, and a lack of sensitivity to the least uncertain parameters, the basin wide annualized water balance presented in Table 3-6A is considered by the authors to be robust and largely applicable for planning level decisions regarding water availability.

A second annualized water balance calculated specifically for the Study Area as presented in Table 3-6B is supported by all of the data in the water balance for the total watershed including the value of total runoff and underflow to the ocean which has been carried forward from Table 3-6A. The Study Area water balance calculation includes specification of two inputs that include some uncertainty. These inputs include the underflow contribution from Terrace deposits and the underflow contribution in the alluvial aquifer as the river enters the Study Area. The water balance calculations indicate that pumping in the Study Area accounts for approximately 1.12% of total annual inputs. Considering a sensitivity range of 0 to 1 cfs for terrace deposit underflow and from 2 to 10 cfs for alluvial aquifer underflow, the impacts to the Study Area water balance remain minimal with total pumping accounting for 1.07% to 1.15% of annual inputs. This low range indicates low sensitivity of the water balance to the potential range of uncertainty of these input parameters. Due to this low sensitivity, the annualized Study Area water balance is also considered robust and largely applicable for planning level decisions regarding water availability.

A third water balance calculation was created to evaluate the possible Study Area water balance during the irrigation season as presented on Table 3-6B. This water balance indicates that pumping is approximated at 15.42% of inputs for the 2004 irrigation season. This water balance is based on all of the supporting data from the two previous water balance analyses, and includes the specification of additional inputs that include some uncertainty. The irrigation season water balance assumes a 3.73 cfs loss of surface flow between the USGS gauge and transect #1. In addition, it includes additional uncertainty associated with the season specific estimates of evapotranspiration losses. Considering a sensitivity range of flow losses of 1 to 8 cfs, the sensitivity range of 0 to 1 cfs for terrace deposit underflow and from 2 to 10 cfs for alluvial aquifer underflow, the impacts to total pumping percentage range from 11 % to 22 % of total irrigation season inputs. This range indicates a higher degree of sensitivity to these estimated parameters when considering the abbreviated time period associated with the irrigation-pumping season.

3.4.8 Alluvial Aquifer Responsiveness

3.4.8.1 Stream Flow and Aquifer Connectivity

The Big Sur River and associated underflow travel above and within the gravelly alluvial deposits that comprise the floor of Big Sur Valley. The transmissive nature of these materials implies that the surface water traveling above the riverbed is in close communication with the groundwater traveling below the riverbed. Evidence of this connection is the fact that following precipitation events, the river elevations and the groundwater elevations have nearly instantaneous upward responses as shown in Figure 3-33. A review of this figure also shows that once the precipitation event is over, both the surface water and the groundwater levels decline together, without any time lag (as if they were in fact the same body of water).

3.4.8.2 Pumping Influence

Because the aquifer material within the Study Area is highly transmissive, water elevations in site wells show a nearly instantaneous response to pumping as shown on Figure 3-34. A review of the hydrographs shown in this figure indicates that the water table quickly responds to pumping conditions at distances of at least 500 feet away from the pumping wells.

As previously discussed, the surface water and groundwater are hydraulically well connected. The affects of pumping may be observed by minor changes in the surface water elevations as shown on Figure 3-35. This figure shows that both the groundwater elevation in well ESR-10B and the surface water elevation in the stilling well at Transect 2 appear to exhibit similar response curves to changes in pumping conditions (i.e., when both Old Well and New Well are pumping simultaneously). However, the magnitude of the responses are significantly different as evidenced by the fact that ESR-10B (which lies between New Well and Transect 2) exhibited a change in water elevation of approximately one foot while the change in the surface water elevation at Transect 2 was approximately 0.5 inches. The ability of the irrigation pumps to measurably effect the surface water elevation is inconclusive however because no noticeable effect on the surface water elevation was noted on October 16, 2004 when both irrigation wells were turned off for the season (Figure 3-36).

River temperature measurements collected during late September at Transect 2 indicate that surface water temperatures were not affected by the additional pumping associated with turning on the New Well late in the season (i.e., by pumping both Old Well and New Well simultaneously) (Figure 3-37).

A graph showing the relationship between elevation and temperature for Old Well groundwater is presented as Figure 3-38. A review of Figure 3-38 shows that, like surface water, the groundwater exhibited diurnal fluctuations in both elevation and temperature.

The Old Well salinity concentration plotted against pumping rate for the entire 2004 irrigation season is presented as Figure 3-39. This figure indicates that saline concentrations recorded for Old Well during this season are not solely related to pumping. This is evidenced by the fact that saline concentrations remained low during periods of sustained pumping in both the early and late portions of the pumping season.

3.4.8.3 Tidal Influences

Monitoring data from site wells indicate that the alluvial groundwater system is hydraulically connected to the ocean. Water levels in monitoring and pumping wells demonstrate a classic tidal pattern with 12.42 hour stage cycles. Figure 3-40 presents a water level hydrograph for select wells that demonstrates the time-lagged tidal response in the groundwater system. Tidal fluctuations resulted in groundwater elevation changes of up to 0.6 feet on a daily basis in the well closest to the ocean, the Navy Well. A tidal response is also seen in water levels in the terrace wells as shown in the hydrograph for terrace well ESR-12 (Figure 3-41). Groundwater moving within the terrace deposits is also hydraulically connected to the alluvial aquifer and the ocean. Hydrographs for all wells are presented in Appendix J.

The gravitational influence of the Moon and the Sun on the Earth's oceans is primarily responsible for governing the semi-diurnal (twice daily) tidal cycles generally seen world wide. Variations in the gravitational forces caused by the orbit of the Moon around the Earth and the orbit of the Earth around the Sun can greatly affect the amplitude of the tides. Spring tides are especially strong tides that occur when the Earth, the Moon and the Sun are in alignment. Twice each month, at the time of the new moon and the full moon, the gravitational influences of the Moon and Sun reinforce one another and cause the tides to rise to greater heights and fall to lower lows than average tides. The term 'spring tide' derives its name not from the spring season, but from the Old English word "springan" which means to well up.

Locally, tides vary greatly from location to location. The primary influences on local tides include the shape and depth of the regional ocean basin, the geography of the local ocean-land interface, and the Coriolis force. These influences can have a significant effect on both the period and magnitude of local tides, though are not easily quantified. For this reason, local tide predictions are dependant on access to historical tidal records.

Based on historic tidal records, the magnitudes of the spring tides within the Study Area are generally greater during the summer and winter months and lower in the spring and fall. Within the context of the pumping season, the tides are more pronounced during the months of May through August. Spring tides that occur during the month of September are generally reduced in magnitude relative to the proceeding months. A graph depicting the spring tides through the Study Period is presented as

Figure 3-42. Spring tide elevations during the months of May through August were more than one foot greater than the bracketing months of April and September. Based on the historical record, the effect of increased spring tides during the summer months recurs annually.

The spring tides in the summer combined with a storm surge can result in the temporary closure of the river outlet through the deposition of beach sands across the entire mouth of the river. The former ESR ranch manager, Tom Asmus, has indicated that closure of the mouth of the Big Sur River during the summer months was a regular occurrence during his fifty years of life at the ranch. A low-pressure weather system combined with a spring tide resulted in closure of the river mouth on the evening of August 26th, 2004. River mouth closure caused backup of the river level in the lagoon and resulting increases in groundwater levels within the lagoon and monitoring wells. Lagoon levels were monitored manually during the Study Period and indicate an increase in lagoon elevation of up to 3.5 feet as depicted on Figure 3-43. Closure of the lagoon mouth resulted in groundwater elevation increases of close to 2-feet in some monitoring wells as shown on a multi-well hydrograph presented as Figure 3-44.

Following the closure of the river outlet, water began building up within the lagoon. In order to relieve the increasing hydraulic pressure within the lagoon, water began to seep through the porous sand bar that blocked the former outlet. Eventually, water levels in the lagoon stabilized, forming equilibrium with incoming river water and water flowing from the lagoon to the ocean through the sand bar. Evidence of this mechanism could be detected during low tide conditions when significant quantities of water were seen emanating from an isolated patch of exposed beach opposite the sand bar from the lagoon.

3.5 Saltwater Intrusion

3.5.1 Geophysical Survey Results

Absent the ability to install monitoring wells along a transect from the beach to the Old Well to directly evaluate the mechanism and effect of saltwater intrusion, a geophysical survey that measures electrical conductivity of the subsurface was conducted at the mouth of the Big Sur River using time domain electromagnetic (TEM) technology by NorCal Geophysical Consultants. Others have successfully used this methodology for the mapping of saltwater intrusion fronts in the Salinas valley (Mills, 1988). Two TEM surveys were conducted to allow comparative analysis of results. The first survey was conducted in April prior to initiation of pumping during a time when river flow was still in recession from its winter high (USGS gauge flow of 50 cfs). The second survey was conducted August 5th when the summer base flow condition of the river was established at 12 cfs and the effects of saltwater intrusion had been observed in the Old Well. The complete geophysical report is included as Appendix E which includes a detailed analysis and discussion of the survey data and its interpretation by NorCal Geophysical.

To summarize this interpretation provided by NorCal Geophysical, comparison of the before and after survey results indicate a significant change in the distribution of electrical conductivity zones in August correlating with the alluvial aquifer showing a significant increase in conductivity both laterally along the beach area and extending across the beach upriver along both sides of the canyon. The interpreted data indicate conductivity increases to depths of 95 to 100 feet beneath the beach in the ancestral alluvial filled canyon extending up canyon a minimum of approximately 900 feet to the area of the Navy Well and the Franciscan rock cliffs that constrict the alluvial valley. These results are consistent with conductivity data collected from the Old Well indicating that saline encroachment was occurring prior to the time of the survey and further demonstrate that the movement of a saltwater wedge up-canyon in the deepest portion of the alluvial filled channel is the likely mechanism for measured salinity impacts to the Navy and Old Wells.

3.5.2 Salinity Impacts to Wells

Measurements of EC, an important indicator of salinity, were routinely collected from all accessible wells within the Study Area during this investigation. With the exception of Old Well and New Well, which were sampled nearly everyday, the wells were generally sampled every other week between August and October 2004. The two irrigation wells were sampled at a higher frequency so ESR personnel could turn the pumps off if EC exceeded the operational cutoff of 1,000 µS/cm. A summary of the EC data is presented in Appendix M.

The EC concentrations reported for all wells except Old Well were below 500 µS/cm during the entire pumping season and were typically in the range of values reported for the river (i.e., between 200 and 300 µS/cm). Concentrations of EC reported for Old Well during the 2004 pumping season, however, regularly exceeded the operational cutoff requiring that it be removed from service until salinity levels decreased. Historically, the salinity levels in Old Well have often exceeded the operational cutoff one or more times during the irrigation season (Jones and Stokes, 1999).

As previously discussed in Section 3.4.8.2, Old Well pumping and the timing of elevated EC concentrations are not strongly correlated as evidenced by the fact that during the late summer/early fall (i.e., beginning in September), when river flows are at their lowest, Old Well can continuously pump while maintaining EC concentrations below 500 µS/cm. Additionally, New Well, which is located slightly closer to the ocean, and approximately the same distance away from the lagoon as Old Well, was able to pump for extended periods throughout the 2004 pumping season while maintaining EC levels below 350 µS/cm the entire time.

There is however, a strong correlation between elevated EC concentrations in Old Well and the presence of the spring tides (see Section 3.4.8.3). To demonstrate this point, Figure 3-45 shows the EC concentration for Old Well plotted against the spring tide elevations for the 2004 pumping season. A review of this figure shows that when the spring tide approaches four feet above mean sea level (msl), elevated EC concentrations are consistently reported for Old Well. A similar plot for the 1991 irrigation season presented on Figure 3-46 also shows elevated EC concentrations following each of the summer spring tides.

The correlation of salinity increases in the Old Well with the high summer spring tides was consistent during the 2004 irrigation season. As discussed in section 3.4.6.3, monitoring of lagoon water quality during this investigation as well as the Jones and Stokes (1999) investigation did not indicate regular occurrence of sea water over wash with the summer spring tides that could explain this regular correlated occurrence of impacts to the Old Well.

The most likely explanation for the salinity increases in Old Well is the mechanism of intrusion of a saltwater wedge and movement of its accompanying diffusion front. The saltwater, being denser than fresh water, forms a saltwater wedge that pushes landward under the fresh water (Figure 3-47). The saltwater wedge moves landward or seaward in response to changes in the pressure balance at the interface between the two bodies of water. Changes that would serve to move the saltwater wedge landward include increases in the tide height and pumping near the river mouth. The opposite changes would move the saltwater wedge seaward. Therefore, the spring tides, in combination with pumping, appear to create conditions that allow salinity impacts to move inland at least 1,200 feet (the distance to Old Well). As discussed in Section 3.3.1, the base of the alluvial aquifer is defined by a scoured bedrock surface that is depicted on figures 3-8 and 3-9. Based on geophysical survey results, this bedrock surface appears to have a deep channel cut into it below the river mouth and lagoon. The Geophysical survey results indicate that this channel reaches depths of up to 100 feet below msl at its interface with the ocean and trends along the western side of the constricted alluvial aquifer near the confluence with the ocean. This deeper subsurface channel provides a preferential pathway for the saltwater wedge to approach Old Well as graphically depicted on Figure 3-48.

3.5.3 Saltwater Intrusion Modeling Results

In order to further evaluate the physical possibility of saline intrusion as the mechanism for observed water quality impacts to the Old well, a density dependent flow and transport modeling exercise was conducted. Information for the lower reach of the Big Sur River gathered during this study was processed using equations that describe groundwater flow physics in a coastal environment in an attempt to reproduce the observed groundwater quality distributions and evaluate the physical viability of the interpreted mechanism for saltwater intrusion derived from analysis of site data. Such reproduction of water quality distributions is generally viewed as support for the validity of a conceptual model. The U.S. Geological Survey SEAWAT-2000 model (Langevin et al., 2003) was used to simulate density-dependent groundwater flow and transport at the site during the irrigation season at the mouth of the Big Sur River. The area evaluated by the model (the model domain) is depicted in Figure 2-6.

A multi-layered model was used for the simulation with 12-layers extending from 20 to minus-100 ft msl, with 10-foot grid spacing in all three coordinate directions. A total of 480,000 finite difference grid cells were used with 116,600 cells active. Because only flow through the alluvium was modeled, the surrounding rock was considered impermeable consistent with known site conditions. The inflow (east) and outflow (south) boundaries were represented as constant-head boundaries. The inflow boundary remained constant with time at 7 ft msl, while the outflow boundary varied in order to simulate tidal fluctuations. The outflow boundary heads were based on tide data during the period from June 15 to July 10, 2004 when a spring tide occurred (Figure 3-49). A hydraulic conductivity value of 1,500 ft/d was applied throughout the shallow model area with a channel of higher conductivity gravels included in the deeper layers of the model along the north valley wall to simulate the boulder-filled channel (15,000 ft/d). Hydraulic Conductivity values were assumed to be the same in all three coordinate directions. The bottom surface of the model followed the interpreted bedrock surface as depicted on Figures 3-8 and 3-9. The aquifer thickness varied with location according to the bedrock elevation and the model calculated water table elevation. The following table summarizes other significant parameters used in the model.

Summary of Modeling Parameters El Sur Ranch	
Well Pumping Rates	
Old	1,800 gpm
New	1,800 gpm
Navy	0 gpm
Specific Storage	0.001
Specific Yield	0.15
Dispersivity	
Longitudinal	3 ft
Transverse (horizontal)	1 ft
Transverse (vertical)	0.3 ft
Sea Water Concentration	2.2 lb/ft^3

Evapotranspiration was not included in the model nor was recharge from or discharge to the river. The known condition of groundwater discharging into the river in the area adjacent to the pumping wells was approximated in the model by increasing well pumping rates in this preliminary model. Well pumping rates were simulated as 150% of the average operating rates in order to account for the water loss from the groundwater system due to upwelling into the river.

The results of this preliminary and simplified modeling exercise are presented as a plan view map of the movement of a saline wedge and accompanying saline diffusion front towards the Old well (Figure 3-50), and as a oblique view of the 3-D saline wedge and diffusion front as it moves preferentially towards pumping being conducted in the Old Well (Figure 3-51). Figure 3-51 presents the modeled three-dimensional image of the salinity plume depicting impacts reaching the Old Well following the time of peak spring tide following 26 days of the simulation.

Evaluation of the modeling results presented on these figures demonstrates how the salinity wedge and accompanying diffusion front migrates into the well area in response to the high spring tides, culminating with flow to the Old Well as the peak high spring tides are occurring. The shape of the ancestral canyon controls the movement of the salinity plume with salinity movement splitting around the subsurface knob located beneath the lagoon and preferentially takes the deeper path. The primary pathway for greater movement of the salinity plume towards the pumping wells is the deeper ancestral canyon on the northern boundary of the alluvial aquifer (Figure 3-48). Prior to the occurrence of the tide exceeding the 3-foot level, modeling results depicted oscillation of the front of the salinity plume near the area of the Navy Well. As the tides exceeded 3 feet and approached the high of just over 4 feet, the salinity plume turned the corner and rapidly migrated to the Old Well in response to its pumping. The modeling results also indicate that the flow physics within the mouth of the river do not lend to any significant movement of the salinity plume to the New Well consistent with historical salinity data collected from the New Well.

In summary, the results of this preliminary modeling exercise confirms that the groundwater flow physics at the mouth of the Big Sur River as a result of the shape and depth of the aquifer bottom, the high hydraulic conductivities associated with a boulder zone at depth in the alluvium, the high summer spring tides combined with pumping stresses and the density driven flow of a saltwater wedge are completely consistent with the interpretation that salinity impacts to the Navy and Old Wells are the result of subsurface saltwater intrusion and the movement of its accompanying diffusion front.

3.5.4 Saltwater Intrusion Analysis Conclusions

Previous investigations have been conducted in an attempt to clarify the interactions of pumping on river flow, underflow and the mechanism(s) of saline water impacts to the pumping wells. Three possible mechanisms were considered as possible causes of salinity impacts as follows:

1) Direct over wash of sea water into the lagoon during storm surges and high tide events that then travels through the bottom of the aquifer and preferentially flows towards the Old Well.

   The mechanism of wave over wash does not appear to occur on a regular basis and does not directly correlate with all of the high summer spring tides as the Old Well impacts do. This is because the occurrence of wave over wash is related to both tidal and wind conditions. The occurrence of wave over wash cannot adequately explain the regular correlation of saline impacts in Old Well to each and every high summer spring tide event. Development of the original hypothesis for the over wash mechanism did not have the benefit of the further definition of the 95 to 100 foot depth to the base of the alluvial aquifer as it approaches the ocean interface, nor the direct evidence of saline intrusion based on geophysical survey results.

2) Maintenance of a seawater level above lagoon level within the beach sands as a result of tide and wave action (this mechanism has been documented to be a significant source of saline water to fresh water forebay in Salinas).

   Monitoring of lagoon water quality throughout the irrigation season did not detect the presence of saline water that would be indicative of continual draining of seawater from the beach sands that border the lagoon.

3) A salt water wedge underlying the stream underflow that experiences seasonal fluctuation beneath the lagoon area in response to pumping, river flow and tidal dynamics.

   The results of information collected during this investigation combined with all previous information supports the conclusion that the movement of saline wedge and its accompanying diffusion front is the only mechanism that explains all of the physical observations and data collected.

4.0 REFINED HYDROGEOLOGIC CONCEPTUAL MODEL

Alluvial deposits less than 11,000 years old consisting primarily of sand, gravel, cobbles and boulders fill the Big Sur River Valley from the USGS flow gauge in Pfeiffer-Big Sur State Park to the confluence with the Pacific Ocean. These alluvial deposits make up an alluvial aquifer and are highly permeable with hydraulic conductivities measured at 3,000 to 4,000 ft/day allowing for significant transmission of groundwater. The deposits fill an ancestral canyon carved by the Big Sur River when sea levels were lower during previous ice ages. This ancestral canyon has since been partially filled to the present ground surface of the Big Sur Valley. Surface water and groundwater drainage from the Big Sur River watershed ultimately ends up traversing on and through these young alluvial deposits on its way to final discharge into the ocean.

In the Study Area, the base of this ancestral canyon is carved into Franciscan Formation bedrock of varying characteristics. These characteristics have determined the morphology of the canyon and the current course of the Big Sur River. Immediately North of the Andrew Molera State Park parking lot, the river makes a right angle turn and exposes a competent tan sandstone of the Franciscan Formation. Near the mouth of the river, drilling core results indicate that the character of the underlying Franciscan Formation consists of a more easily eroded micro-graywacke that is weathered to gray clay at its surface. In the final 500 feet of river channel, the Franciscan bedrock changes into meta-volcanic rocks that are hard and are more resistant to weathering and erosion. These meta-volcanics have constricted the canyon width as the river makes its escape to the ocean.

The surface of the ancestral canyon carved into the Franciscan Formation bedrock that makes up the bottom extent of the alluvial deposits has been fairly well defined throughout the Study Area based on the compilation of data collected through multiple investigations. The interpreted bedrock surface indicates that a fairly deep and narrow canyon was cut through the area at the mouth of the river hitting depths of 100 feet below sea level at the interface with the ocean. Inset 500 feet from the current ocean interface, the ancestral canyon is split into two channels by a subsurface knob of hard Franciscan rock that rises to an elevation of approximately minus-15 feet msl. A deeper narrow channel was carved on the northwest side of this knob and a shallower and wider channel was cut on the southeast side of the knob. Investigation results indicate that the alluvium deposited in the channels carved around this bedrock knob below an elevation of minus-20 feet msl is partially made up with very coarse material including boulders up to three feet in diameter. These deposits were mapped by Dames and Moore (1964) to continue beyond the current mouth of the Big Sur River within what is now the sub-marine portion of the ancestral canyon.

The alluvial deposits are bounded to the north by semi-consolidated terrace deposits that also overlie Franciscan bedrock. These terrace deposits consist of significantly older alluvial and colluvial material with estimated hydraulic conductivities of less than 100 ft/day. Groundwater is present in these deposits and some discharge of groundwater into the younger alluvium is occurring along the northern boundary of the alluvial aquifer as it abuts the semi-consolidated terrace alluvium. Estimates for total discharge from the terrace deposits into the alluvial aquifer indicate likely discharge of less than 0.64 cfs. The southern boundary of alluvium in the ancestral canyon consists of Franciscan Formation bedrock that has extremely limited hydraulic conductivity. Due to the fact that the Franciscan deposits are highly sheared and generally mixed up, they are interpreted to be unable to transmit any significant amounts of groundwater into the overlying and adjacent alluvium.

The predominant source of groundwater moving within the alluvium in the Study Area is Big Sur River flow as it exits the Gorge in Pfeiffer-Big Sur State Park. Additional sources include tributary stream inflows and precipitation that falls on the alluvium below Pfeiffer-Big Sur State Park as well as the minor contribution from the terrace deposits to the north. No significant contribution of groundwater from adjacent bedrock (Franciscan Formation) in the reach of the river from the Andrew Molera State Park parking lot to the USGS flow gauge in Pfeiffer-Big Sur State Park is indicated by both geologic conditions and water balance evaluations.

Big Sur River flows are uncontrolled and, as a result, respond immediately to rainfall events. Storm flow and typical winter runoffs maintain an active river channel that moves laterally and routinely scours and re-adjusts the channel configuration. This condition allows for a river bottom that is not isolated from communication with the underlying alluvium through development of a continuous low permeability riverbed. As a result of this condition, groundwater moving within the alluvial aquifer is hydraulically well connected to surface flow in the river. Due to this direct connection, during the summer months when the river is at baseflow condition, the presence of surface flow in the riverbed indicates that the alluvial groundwater aquifer is in equilibrium with surface flow and flowing at a relatively constant rate. Near the mouth of the river at the point of valley constriction by the Franciscan metavolcanic rocks, groundwater moving within the alluvium is forced into the river channel emerging as surface flow. This condition was maintained throughout the summer irrigation season regardless of pumping conducted.

Groundwater in the lagoon area is also directly hydraulically connected to the ocean through the interface of the submarine alluvial canyon. As a result of this connection, groundwater levels in site monitoring wells respond to tidal fluctuations as does lagoon surface water levels. Wave overwash does not appear to be a significant contributor to saltwater intrusion that results in the measured saline impacts at the Old Well. A combination of factors allow for the occurrence of density driven saltwater intrusion into the alluvial aquifer groundwater below the lagoon resulting in saline impacts reaching a minimum distance of 1,200 feet inland from the current beach (distance to Old Well). The factors that dictate these impacts include the depth and shape of the ancestral canyon bottom and the hydraulic conductivity of deposits in this canyon combined with the coincident effects of pumping the irrigation wells during periods of spring tides. The natural fluctuating tidal condition results in a constantly moving zone of saltwater intrusion during the summer season with rapid shifts occurring due to changing tidal and pumping conditions.

5.0 TECHNICAL ISSUES OF CONCERN

5.1 Mechanism and Significance of Saline Impacts to Water Quality

Long-term operation of the ESR pumping wells has documented regular occurrences of elevated electrical conductivity readings in the Old Well resulting in shutdown of the well due to water quality considerations. Previous investigators (Jones and Stokes, 1999) have concluded that these measured saline impacts were due to wave over wash into the lagoon during periods of high summer tides. Data and analysis conducted during this investigation indicates that wave over wash is not the significant mechanism for measured saline impacts in the Old Well.

Further data collection and analysis indicates that the ocean does act as a groundwater recharge source under the combination of ESR well pumping activities, that when combined with the occurrence of high summer spring tides results in a hydraulic condition that allows the further encroachment of a saline wedge and an accompanying diffusion front into the zone of capture of the Navy and Old Wells. Intrusion of a saltwater wedge and accompanying diffusion zone under these conditions is possible due to the depth and geometry of the bottom surface of the aquifer that causes preferential flow towards Old Well, with the saline wedge moving back and forth within the bottom of the ancestral canyon in the immediate area of the mouth of the river in response to the ever changing tides (Figure 3-47, 3-48). The movement of the saltwater wedge and associated diffusion zone responds rapidly to changing tidal and pumping conditions. Co-incident with the cessation of larger than normal spring tides in September, no further evidence of this saltwater wedge and its accompanying diffusion zone is seen in Old Well water quality, even in the event of continued maximum pumping of both the Old and New irrigation wells (Figure 3-42). This late season condition has been documented in earlier pumping years for which data was available (Figure 3-43). These facts point with certainty that the dominant cause of the intrusion and impacts to the Old Well are directly linked to the higher than normal spring tides during the five months of summer combined with the effects of groundwater pumping and the geometry of the aquifer.

The question of the ability of saline water to travel beneath the area of Creamery Meadow and ultimately result in the uptake of saline water by plants was also considered. Based on the site-specific geologic, hydrologic, and hydrogeologic conditions documented in this report, there is very little potential, if any, for the migration of a saline wedge, or of a saline diffusion zone into the groundwater beneath Creamery Meadow. The rationale for this conclusion is based on the following three key points:

a) In the absence of a reversal of natural groundwater gradients towards the ocean, the naturally induced movement of a saline interface and its accompanying saline diffusion zone of brackish water is dominated by relative density differences of ocean and fresh water and the geometry and hydraulic properties of the adjoining aquifer. The Badon Ghijben-Herzberg principle defines this relationship in very simple terms for the movement of a saltwater interface into a fresh groundwater body for a static system. This principle simply states that the depth to the saltwater interface below sea level at any point will equal 40 times the fresh water elevation above sea level. Based on data collected from monitoring wells during the 2004 study, the projected groundwater elevation in Creamery Meadow nearest the outlet to the ocean is somewhere between 5 and 7 feet (Figure 3-18). Solving for the Badon Ghijben-Herzberg equation indicates that the depth to the top of a saline wedge at this location based purely on density difference would be on the order of 200 to 280 feet below mean sea level. Considering high tides with elevations of 4 feet, the depth to a saltwater interface in a static system would be from 80 to 120 feet below mean sea level. The lowest elevation of the bottom of the aquifer in Creamery Meadow is 37 feet below sea level (Figure 3-8). Thus, due to the elevation of the base of the aquifer and the groundwater surface, the natural movement of a saline wedge could not penetrate beneath Creamery Meadow without other factors resulting in reversal of gradients and effectual lowering of head conditions.

b) There are no pumping or groundwater extraction activities conducted in Creamery meadow. No information indicating that there has ever been groundwater pumping from Creamery Meadow was discovered or provided by others during this investigation. Thus, there is no known mechanism for a reversal of gradients needed to overcome natural density effects and coax saline water or a saline diffusion zone into the groundwater beneath Creamery Meadow. The closest pumping well to Creamery Meadow is the New Well located 500 feet away at its closest point. The results of saline intrusion and the resultant movement of a saline diffusion zone towards the Old Well are the measured increases in electrical conductivity measured in the Old Well. Field data during the 2004 season did not show any indication that the movement of this saline diffusion zone was able to impact water pumped by the New Well regardless of whether or not the Old Well was also pumping. If the pumping effects of New and Old Well did not result in salinity impacts in the New Well, then it could not result in pumping induced impacts to the Creamery Meadow located 500 feet cross and up gradient on the other side of the river.

c) Temperature monitoring data collected in the river between the New Well and the Creamery Meadow further support basis (b) above. River temperature data as depicted on Figure 3-31 clearly depict a groundwater influx into the river along the bend in the river that separates Creamery Meadow from the New Well. The condition of groundwater influx into the river was consistent throughout the irrigation-pumping season regardless of the pumping being conducted. The flow of groundwater into the river at this location is interpreted to be primarily the result of the "pinching" of the extent of the aquifer by hard Franciscan rocks (Figure 3-3) cutting the areal extent of the aquifer width from 1,600 to 700 feet. The effect of this reduction of aquifer extent is further magnified by the presence of the naturally occurring saline wedge at the interface of the aquifer with the ocean that also has the effect of forcing groundwater to leave the basin via movement up into the surface water system. Before pumping at the New Well could have any appreciable effect on the groundwater surface elevation and flow-field in the Creamery Meadow, it would have to reverse the condition of groundwater in-flow into the river in the area between the New Well and Creamery Meadow. This did not happen during the 2004 irrigation season.

In summary, the defined mechanism and behavior of saltwater intrusion indicates that saline impacts to groundwater quality in the vicinity of the mouth of the Big Sur River are very localized and controlled by the geometry of the aquifer bottom. The migration of the saline wedge and accompanying diffusion front is induced by the high summertime spring tides in combination with pumping, and as such are seasonal and temporary having no lasting effect on groundwater quality. Monitoring data also indicates that due to density effects and the hydraulic field at the river mouth, the seasonal advancement of the saltwater wedge has no measurable impact to surface water quality in the lagoon and the river regardless of the irrigation pumping conducted. Finally, advancement of a saltwater wedge such that it could cause significant changes in groundwater quality beneath the Creamery Meadow is not a plausible conclusion based on the conditions observed and the hydraulic conditions evaluated.

5.2 Surface Water Quality Relationship to Pumping and Tides

River water quality measurements consisting of temperature, electrical conductivity and dissolved oxygen data have indicated no correlation between irrigation pumping and changes in surface water quality. Surface water quality changed during the 2004 irrigation season in response to normal seasonal trends of warming and cooling. Although pumping did not induce any surface water quality changes, natural groundwater discharge into the river did significantly affect river water quality by lowering temperatures and lowering electrical conductivity during the warm summer months. Monitoring data documented a zone of natural groundwater inflow into the river around the bend prior to its reaching the lagoon area.

No relationship between river or lagoon water quality and tidal cycles was noted in the collected data. The closure of the lagoon mouth in late August due to a spring tide combined with a low pressure weather system created a larger lagoon area resulting in a slight increase in surface water temperatures in the lagoon during late August. Due to the mediating effects of colder groundwater inflows, these temperatures were still below the background seasonal water temperatures in surface water flowing into the Study Area above the zone of groundwater discharge.

These water quality data, when considered with all other site data and the refined conceptual hydrogeologic model, indicate that as long as surface water is flowing in the Big Sur River, pumping of the ESR irrigation wells is not likely to impact surface water quality, nor will it impact the groundwater quality beneath the adjacent Creamery Meadow. The key rationale that form the basis of this conclusion are as follows:

1) The river and alluvial aquifer are highly connected in the Study Area.

2) Due to the high degree of connectivity, if the river is flowing, the aquifer water levels are in equilibrium with the river and due to the unconfined nature of the aquifer, the river is in part, an extension of the phreatic surface of the water moving through the alluvial aquifer. This condition was in evidence throughout the irrigation season as demonstrated by the direct measurement of water quality parameters indicative of groundwater moving into the river between temperature stations 7 and 9, and by the nearly instantaneous responses in both surface and groundwater to precipitation events as discussed in Section 3.4.8.1.

3) Pumping throughout the irrigation season did not reverse the condition of upwelling in the course of the river adjacent to the area of the pumping wells between stations 7 and 9.

4) The infinite recharge source of the ocean is hydraulically connected to the system and serves to mediate impacts to groundwater and river levels due to a "propping up" effect caused by movement of the saline wedge beneath the out flowing fresh water in the river and alluvial aquifer.

5) Due to the geometry of the constriction of the groundwater flow exit path to the ocean caused by aquifer pinching and the saline interface, the groundwater flow is forced to the surface and leaves the basin primarily as surface flow or near-surface flow through beach sand deposits. This phenomenon serves to additionally mediate water depletion effects in the last 1200 feet of the river's course adjacent to the pumping wells.

6) And finally, because Creamery Meadow is located on the opposite side of the river from the pumping center, the river will serve as an aquifer recharge boundary, providing an effective barrier to the southeasterly expansion of the cone of depression associated with ESR pumping. Therefore groundwater beneath Creamery Meadow cannot be affected as long as surface water is available.

5.3 Reflections on Surface Flow Disruption in 1990

As previously described, the only known disruption in the surface flow of the river occurred in 1990. Because of claims made by DPR personnel that the disruption of the flow was caused by ESR pumping 3700 feet downstream, it is necessary to review the factual circumstances surrounding this event and provide an evaluation of the true cause or causes of the disruption.

In the summer of 1990, the California Department of Parks and Recreation utilized heavy equipment to conduct work in the bed of the Big Sur River near the Andrew-Molera State Park parking lot (figure 5-1). According to a Natural Heritage Stewardship Program completion Report written by Steve Zembsch, the associate resource ecologist with the DPR who was responsible for implementation of the project (Appendix P), "the first phase of this project was to restore the proper hydraulic geometry relationships to a section of the river adjacent to the parking lot."(Appendix P). In the Program Completion Report, Mr. Zembsch discussed the phase of the project relevant to the disruption of surface flow:

> "Construction began in the middle of July, 1990. A condition of the DFG 1601 (reference to the permit) was the diversion of the river around the project site. This involved the construction of a 250-foot channel where the floodplain meets the terrace known as Creamery Meadow. Once in the diversion channel, the river immediately disappeared into its gravels... The downstream reach, a long, straight riffle-run, remained dry for the rest of the project. There were diurnal fluctuations in the length of the dry reach, but it averaged about 600 feet."[1]

During the second half of July of 1990, Big Sur River flows at the USGS gauge dropped to an average of 5.95 cfs. The total river flow continued to fall in early August hitting a low of 3.4 cfs on August 13th, ranking among the lowest flows recorded at the gauge during the last half-century. These were also the lowest flows recorded during the period of low rainfall in the watershed from 1987 through 1994. The area of River relocation is near the location of Transect 1 developed during this investigation and near the area of stream flow measurements made by Jones & Stokes in August of 1998 and by SGI in 2004. These flow measurements indicated a significant loss in summer time flow between the USGS gauge and the reported area of river relocation. The average flow loss for this section of the river measured by SGI during this investigation averaged 3.73 cfs (Table 3-4). These site data suggest that during the lowest flow months of the year (July, August and September) upstream diversions combined with ET losses that occur between the USGS gauge and the area of river rerouting near Transect 1 account for a loss of surface flow on the order of 3 to 4 cfs (possibly more).

Subtracting the estimated surface flow loss of 3.73 cfs (average recorded in 2004) from the recorded USGS flow rate in mid and late July of 1990 of 5.95 cfs indicates that the natural surface flow at the point of the re-routing was likely on the order of less than 2.22 cfs during the time of flow diversion. USGS Stream gauge flow continued to drop in early August.

All surface flow was reportedly rerouted to the inside of the right angle turn in the River immediately west of the Andrew-Molera State Park parking lot. The inside turn of a river is typically an area where coarse material is deposited causing localized increases in porosity and permeability. This particular

[1] A subsequent document in the DPR file variously cite the length of dry streambed as 3,000 feet. (Appendix P). El Sur wells are located 3700 feet downstream of the river re-routing, and the streambed did not go dry in the reach adjacent to the wells.

inside turn consists of a large cobble bar as noted by previous investigators and as was observed during this investigation. Considering the measured hydraulic conductivity of the alluvial deposits of 3,000 to 4,000 ft/day, the estimated thickness of the gravel bar of at least 20 feet, the 1,000 foot width of the alluvial plain, and the obvious coarseness of the cobble bar on the inside of the turn, it is not at all surprising that the rerouting of a flow of 2 cfs or less resulted in an immediate drying up of the River from that point to some point down stream. Continuation of surface flow downstream would be the technical anomaly in this case.

Additionally, the nature of groundwater flow is such that if well pumping had been responsible for discontinuous surface flow, the point of discontinuity would have occurred first in the stretch of the river channel closest to the wells, not in a section of river significantly upstream. This is because the cone of depression caused by pumping would have initially expanded in a fairly uniform radial manner away from the pumping wells until it reached a barrier or recharge area. Once the cone reached the river, a recharge area, the shape would have become elongated as water was drawn into the aquifer. The cone would then have continued to expand upstream and, due to the down gradient flow within the alluvium, expand an even greater distance downstream in a non-radial manner. If the cone were to continue expanding until it reached the Pacific Ocean it would cease to expand in any direction due to the virtually unlimited supply of water available at that point. The Pacific Ocean is approximately 1200-feet away from the pumping wells. Thus, because water is drawn in from the nearest River reach first, it is not plausible that pumping would have dried up a distant up-gradient stretch while maintaining surface flow in the closest adjacent stretch of the River. The cone of depression from El Sur wells could not have extended much beyond Transect 2 in the up-gradient direction and certainly could not have extended up to the area where the river rerouting and flow interruption occurred.

The information reviewed and the analyses conducted support the conclusion that the cause of the discontinuity in surface flow (drying up of the river) and its effects on the connected groundwater/surface water flow system was initiated and likely sustained by the implementation of stream rerouting by DPR during the critically dry months of a critically dry year. This conclusion is consistent with the opinions of other investigators including a subsequent hydrogeologic investigation by Jones & Stokes, concluding that the "flow discontinuity in 1990 was not primarily caused by the El Sur Ranch Wells" (Jones & Stokes, 1999) and in a letter from NOAA to DWR dated November 5, 2002, stating, "The wells are located near the mouth of the river, so flow reduction will have limited effect upstream"(Appendix P). Data from DPR files is also consistent with the foregoing conclusion. [2]

---

[2] Because the river had been flowing and was noted to have immediately disappeared upon rerouting by DPR, one would logically suspect that the flow disruption was caused by DPR construction work and rerouting of the River. Without a discussion of the full extent of impacts from DPR activities within the river bed Mr. Zembsch provided other explanations for flow disruption:
"Four years of drought and an aggressive groundwater pumping operation (3000 gallons an hour during a protracted drought) a half mile downstream converted this stretch of the Big Sur River into a net losing reach. It took the better part of a day for the river to reach the end of the diversion channel. By the time, the

In what appears to be reliance upon Mr. Zembsch's report, Mr. Ken Gray of the Monterey District of DPR, (Appendix P) stated the following in his Second Natural Heritage Stewardship Program Completion Report dated August 15, 1994:

> "The in stream work was performed in the summer of 1990, a critically dry year. When the river was moved into a temporary diversion channel the stream dried up subjecting us to public criticism. We think that the river would have stopped flowing at about the same time but since we were working in the river it didn't look good for us. We filed a water rights complaint stating our belief that the real reason the river dried up was the excessive underflow was being withdrawn to irrigate an adjacent pasture. "

It appears that DPR further filed a protest to El Sur Ranch water application 30166 based upon the conclusions offered in the Zembsch Report. In a letter written by Mary Wright, the District Superintendent, dated September 12, 1994, DPR protested the application stating:

> "In August 1990 State Parks submitted a complaint to the State Board regarding the pumping of Big Sur River underflow by Mr. Hill. In the summer of 1990 about 3000 lineal feet of the lower Big Sur River went dry. The summer of 1990 was a critically dry drought period in the Big Sur area. We believe that Mr. Hill's continued pumping during this dry period caused the elimination of all surface flow in the river. During other dry years, including 1994, the river flow is low but continues to the river mouth lagoon. The low flows may be insufficient to provide optimum habitat for Steelhead and other aquatic organisms in the lower river and lagoon and to sustain the riparian habitat."

The filed protest makes no mention of the stream channel work, the rerouting of water out of the riverbed, or any potential for correlated loss of river flow. Additionally, the length of river that was dry changed from 600 feet as reported by Mr. Zembsch to 3,000 feet as reported by the DPR in their official complaint letter (Appendix P). (Some 3,700 feet is the approximate distance from the area of DPR stream rerouting to the location of the ESR New Well).

In summary, data, reviewed and analyzed along with consideration of other studies compel the conclusion that the flow disruption was caused by the act of redirecting the river into a channel cut into

---

downstream reach had also sunk into its gravels euphemistically leaving the gill-dependent resources in an overly dry environment."
Within the same report Mr. Zembsch further concludes:
"The DFG warden insisted that a diversion channel be used as a condition of the agreement (1601). The unexpected loss of the surface flow downstream from the project was a major impact that was avoidable."
"This situation was exacerbated by the groundwater pumping downstream."
No supporting information or data is provided by Mr. Zembsch, to explain how subsurface pumping some 3,600 feet downstream could either cause or exacerbate flow disruption.

a coarse cobble bar during a critically dry lowest flow month of a critically dry year. There exists no evidence that groundwater pumping 0.7 miles downstream caused or contributed to the flow disruption.

5.4 Alternatives for Management and/or Mitigation

The 2004 irrigation season observations and data conclusively indicate that the surface flow of the Big Sur River combined with the accompanying subterranean underflow is adequate to support normal irrigation season pumping at least 20% above average without any measurable impacts to surface water flow continuity or water quality for USGS river gauge flows equal to and above 10 cfs as seen during the 2004 irrigation season.

The only reported condition of discontinuous flow in the Big Sur River that we are currently aware of occurred in 1990 as discussed in section 5.3. Based on the reported construction activities and our analysis, this occurrence was initiated by re-routing of the low water flow from the main channel. During the following summer of 1991 (after the river was returned to its original channel), USGS gauge river flow conditions reached a low of 5.3 cfs in October while irrigation pumping continued. A USGS gauge flow of 5.3 cfs is well below the historic summer low flow average of 11.65 cfs. No discontinuity of river flow was noted during the 1991-pumping year as a result of this low river flow rate. This fact is especially significant for long-term management planning given that the 1991 pumping year was preceded by four years of low rainfall and low total summer river flows. Review of historic USGS gauge average monthly flow data (1950-2003) indicates that flows below 5.3 cfs have been recorded in only six years (1950, 1961, 1976, 1977, 1998, 1990) since irrigation well pumping began in 1950. Note that 1990, the only year of known flow discontinuity, is included in this group.

Considering these 54 years of data, observations and analyses presented above and throughout this report, and specifically considering the 1991 low flow data discussed above, it can conservatively be concluded that pumping of the ESR wells consistent with current practices during the irrigation season will not result in surface flow disruption in the Study Area when USGS gauge flows equal or exceed 5.3 cfs. This knowledge can be used to create a trigger point for making management decisions regarding future irrigation season pumping when USGS gauged river flows are expected to reach historically low flow rates. This conclusion is predicated on the assumption that no net increase in water use or diversion occurs in the area between the ESR pumping wells and the USGS gauge.

Due to the nature of the Big Sur River watershed, there is a strong correlation between annual winter rainfall totals and the resulting low summer flow condition. This condition allows for development of predictive tools based on precipitation totals, which can be used to estimate the likelihood of surface flow at the USGS gauge falling to levels below 5.3 cfs. Others have investigated this correlation and developed a methodology for predicting summer low flow at the USGS gauge based on preceding winter rainfall records. A complete copy of the technical memorandum titled "Forecasting of Low Flows of the Big Sur River, California" is included as Appendix Q (NRCE, March 2005).

Use of the methodology developed by NRCE provides the ability to forecast, in advance, the possible need for special irrigation pumping management when the forecasted summer flow condition falls to below 5.3 cfs. This condition has occurred only six years during the last 54 years. The NRCE report includes simple tables that allow correlation of recorded winter rainfalls to a predicted September USGS flow rate and its associated probability of occurrence. During such forecasted low stream flow years (less than 5.3 cfs), monitoring of stream flow conditions in combination with development of an irrigation management plan can be implemented to ensure that ESR pumping does not contribute to any surface flow disruption in the Study Area portion of the Big Sur River.

An alternative option for monitoring Streamflow rates during years when low flow conditions are reached may be the monitoring of river temperatures at the base of the water column in the area of the river directly up and cross-gradient from the New Well. Temperature, EC and DO monitoring data combined with Streamflow measurements have indicated conclusively that this section of river was a gaining stream experiencing significant upwelling of groundwater in the bed of the river during the entire irrigation season (Figure 3-31 and section 3.4.6). Prior to the ability of pumping to de-water this closest portion of river, aquifer hydraulics dictate that the river must experience a reversal from a gaining to a losing stream. The occurrence of this reversal would provide an indication for the possibility of discontinuation of stream flow, and as such, could serve as a trigger point to modify or reduce irrigation pumping. Based on monitoring conducted during the 2004 season, the effect of a reversal of the river condition would be directly measurable via comparison of river temperature along this stretch of river during the warmer months of August and September to the river temperature up gradient near the State Park Parking lot.

6.0 REFERENCES

Bear, Jacob. Hydraulics of Groundwater, Water Resources Center Archives, University of California Los Angeles, Chapter Nine – Fresh Water-Salt Water Interface in Coastal Aquifers.

Bond, Linda D. and Bredehoeft, Johm D. Origins of Seawater Intrusion in a Coastal Aquifer – A Case Study of the Pajaro Valley, California, Journal of Hydrology, 92 (1987) 363-388. December 1986.

Brooke, Robert C. Jr. Stratigraphy and Structure of the Point Sur Area, Stanford University, Stanford, California, June 1, 1957.

California Department of Water Resources. The Landscape Coefficient Method, August 2000.

Caltrans District 5. Corridor Inventory Executive Summaries, Highway 1 in Monterey and San Luis Obispo Counties, SLO-1-71.4/74.3, MON-1-0.0/72.3, December 2001.

Clark, Joseph C. and Rosenberg, Lewis I. Final Technical Report for Southern San Gregorio Fault Displacement: Stepover Segmentation vs. Through-Going Tectonics. USGS Award No. 1434-HQ-98-GR-00007, National Earthquake Hazards Reduction Program, Program Element I: Evaluating National and Regional Hazard and Risk, March 1999.

Cleveland, George B. Fire + Rain = Mudflows, Big Sur, 1972, California Division of Mines and Geology, 1973.

Cleveland, George B. Marble Cone Fire..... Effect on Erosion, California Division of Mines and Geology, California Geology, December 1977.

Dames and Moore. Preliminary Engineering and Geologic Investigation, Two Proposed Harbor Sites, Near Point Sur, California, April 1964.

DeSimone, Sandra. California's Coastal Sage Scrub, Volume 23, No. 4, Fremontia 3.

Dyer, Kenneth L. and Behnke, Jerold J. Sea Water Intrusion into a Fresh Water Forebay Due to Wave Action, Journal of Hydrology, 6 (1968) 95-101.

Fetter, C.W., Applied Hydrogeology, Charles E. Merrill Publishing Co., Columbus, Ohio, 1980.

Freeland, R.E., American Cement Corporation. Laboratory Analyses, Big Sur Aggregate Deposit, June 30, 1964.

Geoconsultants, Inc. Geophysical Characterization of El Sur Ranch, Monterey County, California, October 1998.

Geoconsultants, Inc. Preliminary Results Report, Geophysical Characterization of El Sur Ranch, Monterey County, California, August 1997.

Geomatrix Consultants, Inc. Source Evaluation for Groundwater Extracted from Garrapata Water Company Wells, December 1998.

Gilbert, Wyatt Graves. Sur Fault Zone, Monterey County, California. A Dissertation Submitted to the Department of Geology and the Committee on Graduate Studies of Stanford University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy, March 1971.

Gordon, Thomas R.; Wikler, Karen R.; Storer, Andrew J. and Wood, David L. Pitch. Canker and its Potential Impacts on Monterey Pine Forests in California, Volume 25:2, Fremontia 5, April 1997.

Greene, Gary H. Regional Tetonics and Structural Evolution Offshore Monterey Bay Region.

Hall, Clarence A., Jr. Geology of the Point Sur-Lopez Point Region, Coast Ranges, California: A Part of the Southern California Allochthon, Department of Earth and Space Science, University of California, Los Angeles, 1991.

Hapke, C.; Dalls, K. and Green, K. Estimated Sediment Yield from Coastal Landslides and Active Slope Distribution along the Big Sur Coast and Addendum: Coastal Cliff Erosion Rates, Big Sur, California, U.S. Geological Survey, Pacific Science Center and University of California, Santa Cruz, May 2003.

Hecht, Barry. Drought, Fire and Geology: Key Watershed Influences in the Northern Santa Lucia Mountains, Sediment Yield Variations in the Northern Santa Lucia Mountains.

Hecht, Barry. South of the Spotted Owl: Restoration Strategies for Episodic Channels and Riparian Corridors in Central California, Balance Hydrologics, Inc., Berekley, California.

Jackson, Lionel E, Jr. Dating and Recurrence Frequency of Prehistoric Mudflows Near Big Sur, Monterey County, California, Journal of Research of the U.S. Geological Survey, Jan – Feb 1977, Vol. 5 No. 1, page 17 – 32.

Jenks, James S; Snow, Gerald E. and Wagner, Philip L.. Seawater Intrusion in Salinas Valley, California, Water Forum'86: World Water Issues in Evolution, Volume 1, August 1986.

Johnson, J.W. Wave Action on the Pt. Sur Area. Berkeley, California, January 28, 1966.

Johnson, Nick. Hydrogeology of Coastal Watersheds: Southern Santa Cruz and Northern Monterey Counties.

Jones and Stokes Associates, Inc. Technical Memorandum 1, El Sur Ranch, August 1997.

Jones and Stokes. El Sur Ranch Hydrogeologic Assessment, April 1999.

Kondolf, Mathias G. and Matthews, Graham W.V. Transport of Tracer Gravels on a Coastal California River, Journal of Hydrology, 85 (1986) 265-280, February 1986.

Leeds, Hill and Jewett, Inc. Interim Analysis of the Relative Merits of Harbor Sites at Big Sur and Little Sur, American Cement Corporation, California.

Leeds, Hill and Jewett, Inc. The Relative Merits of Harbor Sites in the Vicinity of Point Sur, Monterey County, California, March 31, 1965

Mathews, Mary Ann and Nedeff, Nicole. California's Native Monterey Pine Forest: Can it be Saved? Volume 23, No. 1, Fremontia 3.

McKittrick, Mary Anne. Elevated Marine Terraces Near Monterey, California, 1988.

Mills, Theodore; Hoeskstra, Peter; Blohm, Mark and Evans, Lauren. Time Domain Electromagnetic Soundings for Mapping Sea-Water Intrusion in Monterey County, California, Vol. 26, No. 6, Ground Water, November-December 1988.

Mussetter Engineering, Inc. Geomorphology Report, November 1998.

Natural Resources Consulting Engineers, Inc. Technical Memorandum – Activity and Task Update concerning El Sur Ranch Water Right Application, Fort Collins, Colorado, May 17, 2004.

Natural Resources Consulting Engineers, Inc. Water Use Assessment for El Sur Ranch, Fort Collins, Colorado, 2005.

NORCAL Geophysical Consultants. Time Domain Electromagnetic Survey - Phase I, Andrew Molera State Park, Big Sur, California, May 2004

NORCAL Geophysical Consultants. Time Domain Electromagnetic Survey - Phase II, Andrew Molera State Park, Big Sur, California, January 2005.

Oakeshott, Gordon B. Guide to the Geology of Pfeiffer Big Sur State Park, Monterey County, California. State of California, Department of Natural Resources, Division of Mines, San Francisco, Special Report 11, July 1951.

Roberson, Don. Big Sur River Mouth and Pt. Sur. www.montereybay.com/creagus/bsrm.html, 2000.

Rogers, David. The Santa Lucia Mountains: Diversity, Endemism, and Austere Beauty, Volume 19, No. 4, Fremontia 3.

Serafini, D. and Richman, R. Potential Slope Instabilities in the Highway 1 Corridor: Road Condition and Hazard Potential at Sites Between San Carpoforo Creek and Carmel Highlands, San Luis Obispo and Monterey Counties, California, SLO-1-71.4/74.3, MON-1-0.0/72.3, California Department of Transportation, September 2001

Showalter, Patricia. Developing Objectives for the Ground Water Quality Monitoring Network of the Salinas River Drainage Basin, Ground Water Monitoring Review, Volume 5, No. 2, Spring 1985.

Snyder, R.L. and Eching, S. Penman-Monteith (hourly) Reference Evapotranspiration Equations for Estimating ETo with Hourly Weather Data, Regents of the University of California, 2002.

State of California, State Water Resources Control Board, Decision 1639. Decision Determining that Water in the Alluvium of the Valley of Garrapata Creek is a Subterranean Stream and that Application 29664 is not Exempt from the California Environmental Quality Act, October 1998.

State of California, State Water Resources Control Board, 2001, Data downloaded from SWRCB website http://www.waterrights.ca.gov/WaterAvailability/ in April 2005, Contained in the document titled "Evalaution of State Water Resources Control Board Water Availability Analysis, June, 2001.

Sutherland, Mark. James. Petrology and Provenance of Miocene Sedimentary Rocks, Point Sur, California: Implications for Offset Along the San Gregorio-Hosgri Fault Zone, University of California, Los Angeles, 1990.

The Source Group, Inc (SGI). Phase 1 (Reconnaissance) Data Transmittal, Water Right Application 30166, El Sur Ranch, April, 2004.

The Source Group, Inc. (SGI). Pump Testing Report, El Sur Ranch, March 8, 2004.

The Source Group, Inc. (SGI); Interim Monitoring Plan, Water Right Application #30166, El Sur Ranch, May 13, 2004.

The Source Group, Inc. (SGI); PD040752 Site Restoration Plan – Revised, El Sur Ranch, August 3, 2004.

Trask, Parker D. Geology of Point Sur Quadrangle, California, November 10, 1926.

USGS, 1996 (Document Referenced by Jones and Stokes, 1999)

Wills, C.J.; Manson, M.W.; Brown, K.D.; Davenport, C.W. and Domrose, C.J. Landslines in the Highway 1 Corridor: Geology and Slope Stability along the Big Sur Coast Between Point Lobos and San Carpoforo Creek, Monterey and San Luis Obispo Counties, California.

Zatkin, Robert. Salinia/Nacimiento Amalgamated Terrane, Big Sur Coast, Central California – Guidebook for the Spring Field Trip, May 19-21, 2000.

7.0 ACRONYMS AND GLOSSARY

List of Abbreviations and Acronyms

ac-ft	Acre-feet
ac-ft/yr	Acre-feet per year
ACOE	Army Corps of Engineers
bgs	Below ground surface
CDWR	California Department of Water Resources
cfs	Cubic feet per second
CO-OPS	Center for Operational and Oceanographic Products and Services
DFG	Department of Fish and Game
DO	Dissolved oxygen
DPR	Department of Parks and Recreation
EC	Electrical conductivity
ESR	El Sur Ranch
ET	Evapotranspiration
ft/day	Feet per day
ft/ft	Feet per foot
gpd/ft	Gallons per day per foot
gpm	Gallons per minute
in/hr	Inches per hour
K	Hydraulic conductivity
MCHD	Monterey County Health Department
mg/L	Milligrams per liter
msl	Mean sea level
NBS	National Bureau of Standards
NOAA	National Oceanic and Atmospheric Administration
NRCE	Natural Resources Consulting Engineers, Inc.
NWP	Nationwide Permit (Army Corp of Engineers)
PDA	Personal Data Assistant
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control

RWQCB	Regional Water Quality Control Board
SGI	The Source Group, Inc.
SWRCB	State Water Resources Control Board
SWRCB-DWR	State Water Resources Control Board Division of Water Rights
TEM	Time-domain Electromagnetic Survey
USGS	United States Geological Survey
µS/cm	Micro-Siemens per centimeter

Glossary

Acre	A measure of area equal to 43,560 square feet (4,047 square meters). One square mile equals 640 acres, and is also referred to as a section.
Alluvial	An adjective referring to soil or earth material which has been deposited by running water, as in a riverbed, flood plain, or delta.
Amphibole	Any of a large group of structurally similar hydrated double silicate minerals, such as hornblende, containing various combinations of sodium, calcium, magnesium, iron, and aluminum.
Annular	Shaped like or forming a ring.
Aquifer	An underground layer of porous rock, sand, or gravel containing large amounts of water. Use of the term is usually restricted to those water-bearing structures capable of yielding water in sufficient quantity to constitute a usable supply.
Aquifer test	A test to determine hydrologic properties of an aquifer, involving the withdrawal of measured quantities of water from, or the addition of water to, a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or addition (recharge).
Augite	A dark-green to black pyroxene mineral, $(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$, that contains large amounts of aluminum, iron, and magnesium.
Base flow	The flow that a perennially flowing stream reduces to during the dry season. It is supported by groundwater seepage into the channel.
Bedrock	The solid rock beneath the soil (*Zone of Aeration* or *Zone of Saturation*) and superficial rock. A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material.

Bi weekly	Happening every two weeks.
Blueschist	Rock subjected to lower temperature, high pressure regional metamorphism.
Clasts	Pertaining to a rock or sediment composed principally of broken fragments that are derived from pre-existing rocks or minerals and that have been transported some distance from their places of origin.
Cobble bar	A bar or ridge of cobbles built up to or near the surface of the water by currents in a river or wave action in coastal waters.
Colluvial material	Material consisting of *Alluvium* in part and also containing angular fragments of the original rocks. Typically found at the bottom or on the lower slopes of a hill.
Colluvium	A general term applied to any loose, heterogeneous, and incoherent mass of soil material or rock fragments deposited chiefly by gravity-driven masswasting usually at the base of a steep slope or cliff, for example, talus, cliff debris, and avalanche material.
Conceptual model	See groundwater conceptual model.
Conductivity	See electrical conductivity.
Conformity	The relationship between adjacent sedimentary strata that have been deposited in orderly sequence with little or no evidence of time lapse.
Conglomerate	A rock consisting of pebbles and gravel embedded in natural cement.
Contour lines	A line on a map that joins points of equal elevation. Groundwater contour lines join points of equal groundwater elevation.
Cretaceous	Of or belonging to the geologic time, system of rocks, and sedimentary deposits of the third and last period of the Mesozoic Era, characterized by the development of flowering plants and ending with the sudden extinction of the dinosaurs and many other forms of life.
Crop coefficient	The ratio of evapotranspiration occurring with a specific crop at a specific stage of growth to potential evapotranspiration at that time.
Cubic feet per second (cfs)	A unit expressing rate of discharge, typically used in measuring streamflow. One cubic foot per second is equal to the discharge of a stream having a cross section of 1 square foot and flowing at an average velocity of 1 foot per second. It also equals a rate of approximately 7.48 gallons per second, 449 gallons per minute, 1.98 acre-feet per day, or 724 acre-feet per year.
Data logging	(Data acquisition) Storing a series of measurements over time, usually from a

	sensor that converts a physical quantity such as temperature or pressure, into a voltage that is then converted by a digital to analog converter (DAC) into a binary number. This number is stored electronically pending retrieval via portable computer or similar device.
Discharge	To pour forth, emit, or release contents.
Dissolved oxygen	The amount of free (not chemically combined) oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation.
Diurnal	Having a 24-hour period or cycle; daily.
Diurnal events	Events that reoccur on a 24-hour period or cycle; daily
Diversion	A structure in a river or canal that diverts water from the river or canal to another watercourse.
Effective porosity	The amount of interconnected pore space through which fluids can pass, expressed as a percentage of the total volume occupied by the interconnecting interstices. Porosity may be primary, formed during deposition or cementation of the material, or secondary, formed after deposition or cementation, such as fractures. Part of the total porosity will be occupied by static fluid being held to the mineral surface by surface tension, so effective porosity will be less than total porosity.
Electrical conductivity	A measure of the ability of a solution or media to carry an electrical current.
Evapotranspiration	(1) The process by which plants take in water through their roots and then give it off through the leaves as a by-product of respiration; the loss of water to the atmosphere from the earth's surface by evaporation and by transpiration through plants. (2) The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces. (3) The sum of *Evaporation* and *Transpiration* from a unit land area. (4) The combined processes by which water is transferred from the earth surface to the atmosphere; evaporation of liquid or solid water plus transpiration from plants. (5) The combined evaporative-type processes, including evaporation, interception, and transpiration, usually applied to biological systems. Evapotranspiration occurs through evaporation of water from the surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants (*Phreatophytes*) whose roots tap the capillary fringe of the groundwater table. The sum of evaporation plus transpiration.
Fault zone	A fault that is expressed as a zone of numerous small fractures or of fault breccia or gouge. A fault zone may be hundreds of meters wide.

Feldspar	Any of a group of abundant rock-forming minerals occurring principally in igneous, plutonic, and some metamorphic rocks, and consisting of silicates of aluminum with potassium, sodium, calcium, and, rarely, barium. About 60 percent of the earth's outer crust is composed of feldspar.
Field measurements	Data manually collected by field personnel within a specified Study Area.
Flow gauging	Measuring the rate of water discharged from a source given in volume with respect to time.
Fluctuations	To vary irregularly.
Gallons per minute (GPM)	A unit expressing rate of discharge, used in measuring well capacity. Typically used for rates of flow less than a few cubic feet per second (CFS)
Geomorphology	That branch of both physiography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place in the evolution of land forms. The term usually applies to the origins and dynamic morphology (changing structure and form) of the earth's land surfaces, but it can also include the morphology of the sea floor and the analysis of extraterrestrial terrains. Sometimes included in the field of physical geography, geomorphology is really the geological aspect of the visible landscape.
Geophysical studies	The study of the physical characteristics and properties of the earth, including geodesy, seismology, meteorology, oceanography, atmospheric electricity, terrestrial magnetism, and tidal phenomena.
Gneiss	A banded or foliated metamorphic rock, usually of the same composition as granite.
gorge	A deep narrow passage with steep rocky sides; a ravine.
Gradient	Degree of incline; slope of a stream bed. The vertical distance that water falls while traveling a horizontal distance downstream or through an aquifer.
Granitic	Of or pertaining to granite, a common, coarse-grained, light-colored, hard igneous rock consisting chiefly of quartz, orthoclase or microcline, and mica.
Granofels	A metamorphic rock of similar composition to gneiss, though more massive and little to no banding of different colored minerals.
graywacke	Any of various dark gray sandstones that contain shale.
Greenschist	rock subjected to low grade regional metamorphism. Characterized by greenstone (greenschist) rocks if a mafic parent, slates and phyllites if a complex

	siliciclastic sedimentary parent, plus other metamorphic rocks from other parents.
Greenstone	A field term for any compact dark-green altered or metamorphosed basic igneous rock that owes its color to chlorite, actinolite, or epidote.
Groundwater	(1) Generally, all subsurface water as distinct from *Surface Water*; specifically, the part that is in the saturated zone of a defined aquifer. (2) Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper level of the saturated zone is called the Water Table. (3) Water stored underground in rock crevices and in the pores of geologic materials that make up the earth's crust. Ground water lies under the surface in the ground's *Zone of Saturation*, and is also referred to as *Phreatic Water*.
Groundwater conceptual model	A collection of data that describe a set of relationships between factors that lead to a general understanding of groundwater flow in the area of study.
Groundwater flux	(1) Water that moves through the subsurface soil and rocks. (2) The movement of water through openings in sediment and rock that occurs in the *Zone of Saturation*.
Groundwater gradient	The gradient or slope of a water table or *Piezometric Surface* in the direction of the greatest slope, generally expressed in feet per mile or feet per feet. Specifically, the change in static head per unit of distance in a given direction, generally the direction of the maximum rate of decrease in head. The difference in hydraulic heads (h1 – h2), divided by the distance (L) along the flowpath, or, expressed in percentage terms: $I = (h1 - h2) / L \times 100$. A hydraulic gradient of 100 percent means a one foot drop in head in one foot of flow distance.
Holocene	The present epoch of time, beginning about 11,000 years ago.
Hydraulic conductivity	Simply, a coefficient of proportionality describing the rate at which water can move through an aquifer or other permeable medium. The density and kinematic viscosity of the water must be considered in determining hydraulic conductivity. More specifically, the volume of water at the existing kinematic viscosity that will move, in unit time, under a unit *Hydraulic Gradient* through a unit area measured at right angles to the direction of flow, assuming the medium is isotropic and the fluid is homogeneous. In the Standard International System, the units are cubic meters per day per square meter of medium (m3/day/m2) or m/day (for unit measures).
Hydraulic head	(1) The height of the free surface of a body of water above a given point beneath the surface. (2) The height of the water level at the headworks or an upstream point of a waterway, and the water surface at a given point downstream.
Hydrogeology	The part of geology concerned with the functions of water in modifying the earth, especially by erosion and deposition; geology of ground water, with particular

	emphasis on the chemistry and movement of water.
Hydrograph	(1) A graphic representation or plot of changes in the flow of water or in the elevation of water level plotted against time. (2) The trace of stage (height) or discharge of a stream over time, sometimes restricted to the short period during storm flow.
Hydrologic	Of or pertaining to hydrology, that is the science dealing with water, its properties, phenomena, and distribution over the earth's surface.
Igneous	A rock formed by the solidification of molten materials (magma). The rock is extrusive (or volcanic) if it solidifies on the surface and intrusive (or plutonic) if it solidifies beneath the surface.
Intrusive rock	See igneous.
Irrigation period	The irrigation period is defined as the time of operation of pumping from irrigation wells during 2004. This period was from April 21st through October 15th as detailed on Table 2-2 of the report.
Kayak	A small boat similar to a canoe.
longitudinal gradient	A graphic presentation of elevation versus distance; in channel hydraulics it is a plot of water surface elevation against upstream to downstream distance.
Massive	Said of rocks of any origin that are more or less homogenous in texture or fabric, displaying an absence of flow layering, foliation, cleavage, joints, fissility, or thin bedding.
Mean lower water datum	A tidal datum. The average of all the low water heights observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent or accepted values of the National Tidal Datum Epoch. The elevation of this datum on the shore is the MLW line.
Mélange	A mappable body of rock that includes fragments and blocks of all sizes, both exotic and native, embedded in a generally fragmented and sheared matrix.
Metamorphic rock	A sedimentary or igneous rock that has been changed by pressure, heat, or chemical action. For example, limestone, a sedimentary rock, is converted to marble, a metamorphic rock.
Metamorphism	A change in the constitution of rock; specifically a pronounced change effected by pressure, heat, and water that results in a more compact and more highly crystalline condition.

Metasedimentary	A sediment or sedimentary rock that shows evidence of having been subjected to metamorphism.
Metavolcanic	A volcanic rock that shows evidence of having been subjected to metamorphism.
Monitoring well	A well used to obtain water quality samples or measure groundwater levels.
Monitoring well cluster	A collection of monitoring wells drilled to varying depths located in close proximity to one another. This arrangement is generally used to determine vertical groundwater gradients.
Percolation	The movement, under hydrostatic pressure, of water through the interstices of a rock or soil. Also, the movement of water within a porous medium such as soil toward the water table without a definite channel.
Petrographic	Pertaining to the description and classification of rocks.
Phenocrysts	one of the relatively large and ordinarily conspicuous crystals of the earliest generation in a prophyritic igneous rock
Pile driving	A large stake, or piece of timber, pointed and driven into the earth, as at the bottom of a river, or in a harbor where the ground is soft, for the support of a building, a pier, or other superstructure, or to form a cofferdam, etc.
Pillow basalt	a general term for those lavas displaying pillow structure and considered to have formed underwater.
Plagioclase	Any of a common rock-forming series of triclinic feldspars, consisting of mixtures of sodium and calcium aluminum silicates. Also called oligoclase.
Plume	A relatively concentrated mass of material spreading in the environment. In surface water, the effluent added to a receiving stream near a point source. For example, when a heated-water discharge is added to a stream, the heated water does not mix immediately with the stream water. The mass of hot water remains detectable for some distance downstream.
Poorly sorted	said of a clastic sediment or rock that consists of particles of many sizes mixed together in an unsystematic manner so that no one size class predominates
Potential evapotranspiration	(1) The maximum quantity of water capable of being evaporated from the soil and transpired from the vegetation of a specified region in a given time interval under existing climatic conditions, expressed as depth of water. (2) The water loss that will occur if at no time there is a deficiency of water in the soil for use by vegetation.
Potentiometric	A surface which represents the static head of ground water in tightly cased wells

surface	that tap a water-bearing rock unit (i.e., aquifer). In relation to an aquifer, the potentiometric surface is defined by the levels to which water will rise in tightly cased wells. If the head varies significantly with depth in the aquifer, then there may be more than one potentiometric surface. The *Water Table* is a particular potentiometric surface for an *Unconfined Aquifer*.
Precipitation	As used in *Hydrology*, precipitation is the discharge of water, in liquid or solid state, from the atmosphere, generally onto a land or water surface. It is the common process by which atmospheric water becomes surface or subsurface water. The term "precipitation" is also commonly used to designate the quantity of water that is precipitated. Forms of precipitation include drizzle, rainfall, glaze, sleet, snow, graupel, small hail, and hail.
Pre-cretaceous	Occurring prior to the cretaceous period (see cretaceous).
Pressure transducers	A data logger that measures and records water pressure (head of water over the sensor). See data logging.
Promontories	A high ridge of land or rock jutting out into a body of water; a headland.
Public domain	Land owned and controlled by the state or federal government.
Pumping test	See aquifer testing.
Quartz diorite	A group of plutonic rocks having the composition of diorite but with appreciable amounts of quartz.
Quartzite	A granoblastic metamorphic rock consisting mainly of quartz, formed by the recrystallization of sandstone by regional or thermal metamorphism.
Quaternary	A period consisting of approximately the last 2 million years of earth history, encompassing both the *Pleistocene* and the *Holocene* epochs.
Recharge	(1) The downward movement of water through soil to groundwater. (2) The process by which water is added to the *Zone of Saturation*. (3) The introduction of surface or ground water to groundwater storage such as an aquifer.
Relief	The variations in elevation of an area of the earth's surface.
River stage	The elevation of the water surface at a specified station above some arbitrary zero datum (level).
River transect	A surveyed line (generally constructed with two surveyed posts connected by a string) emplaced perpendicular to river flow across which river velocity data is collected

Robust	Referring to the health, strength and durability of something. In computing terms, being robust is reliability.
Runoff	That portion of precipitation that moves from the land to surface water bodies.
Saltwater intrusion	The invasion of a body of fresh water by a body of salt water, due to its greater density. It can occur either in surface or ground-water bodies. The term is applied to the flooding of freshwater marshes by seawater, the migration of seawater up rivers and navigation channels, and the movement of seawater into freshwater aquifers along coastal regions.
Saltwater wedge	The wedge shaped body of saltier water that underlies fresher water in poorly mixed estuaries, or underlies fresher groundwater in coastal or estuary situations where the fresher groundwater is discharging to the ocean or estuary over and through a fresh/salt water interface.
Schist	Any of various medium-grained to coarse-grained metamorphic rocks composed of laminated, often flaky parallel layers of chiefly micaceous minerals.
Sedimentary	Of or relating to rocks formed by the deposition of sediment.
Seepage velocity	The rate at which water or other fluid moves through a porous medium.
Site	Generally refers to the Study Area and may refer specifically to areas of data collection within the Study Area.
Soil profile	The arrangement of soil horizons or layers below the ground surface.
Spring tide	The exceptionally high and low tides that occur at the time of the new moon or the full moon when the sun, moon, and earth are approximately aligned.
Specific yield	The volume of water available per unit volume of aquifer, if drawn by gravity. Specific yield is expressed as a percent. For example, if 0.2 cubic meter of water will drain from 1 cubic meter of aquifer sand, the specific yield is 20 percent.
Stage height	The height of a water surface above some established reference point or *Datum* (not the bottom) at a given location. Also referred to as *Gage Height*.
Stilling well	A device used to allow monitoring of water levels in turbulent flow.
Storage capacity	Water naturally detained in a drainage basin, such as ground water, channel storage, and depression storage. The term *Drainage Basin Storage*, or simply *Basin Storage*, is sometimes used to refer collectively to the amount of water in natural storage in a drainage basin.
Stratigraphy	The study of rock strata, especially the distribution, deposition, and age of

	sedimentary rocks
Strike	The direction taken by a structural surface (e.g. a bedding or fault plane).
Study Area	The Study Area includes the portion of Andrew Molera State Park from the parking lot to the ocean and a portion of the adjacent EL Sur Ranch property to the north as depicted on Figure 1-2 of this report.
Study period	The period of field data collection for this report that is inclusive of the time between April 15th and October 31st, 2004.
Submarine canyon	A steep sided, V-profile trench or valley winding along the continental shelf or continental slope, having tributaries and resembling a river-cut land canyon.
Surface flow	Flowing water that remains on the earth's surface; all waters whose surface is naturally exposed to the atmosphere, for example, rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc., and all springs, wells, or other collectors directly influenced by surface water.
Synoptic	Of or relating to data obtained nearly simultaneously over a large area.
Tectonically	Relating to, causing, or resulting from structural deformation of the earth's crust.
Thrust fault	A fault with a dip less than 45 degrees or less over much of its extent, on which the hanging wall appears to have moved upward relative to the foot wall.
Transducer	A substance or device, such as a piezoelectric crystal, microphone, or photoelectric cell that converts input energy of one form into output energy of another. See data logging.
Transmissivity	The ability of an aquifer to transmit water. The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit *Hydraulic Gradient*.
Trend	a general term for the direction or bearing of the outcrop of a geological feature.
Tributary	A stream or other body of water, surface or underground, which contributes its water, even though intermittently and in small quantities, to another and larger stream or body of water.
Underflow	The downstream flow of water through the permeable deposits underlying a stream.
Velocity transect	see river transect
Wacke	A soft, earthy, dark-colored rock or clay derived from the alteration of basalt.

Water balance	An accounting of the inflows to, the outflows from, and the storage changes of water in a hydrologic unit or system.
Water table	The surface of a groundwater body at which the water is at atmospheric pressure; the upper surface of the ground water reservoir.
Watershed	An area that, because of topographic slope, contributes water to a specified surface water drainage system, such as a stream or river. An area confined by topographic divides that drains a given stream or river.
Wave overwash	Wave overwash: When water, thrown up by waves and storm surge, flows into the lagoon via the mouth or over the sandbar.

FIGURE INDEX

Figure #	Referenced Location
1-1	Section 1.0, 1.2
1-2	Section 1.2, Glossary under Study Area
1-3	Section 1.2
2-1	Section 2.0
2-2	Section 2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 2.4.5, 2.4.7, 2.6, 2.6.1, 2.6.2, 3.4.2, 3.4.3, 3.4.5, 3.4.6,
2-3	Section 2.5
2-4	Section 2.6.7.1, 2.6.7.2, 2.6.7.3,
2-5	Section 2.7.1
2-6	Section 2.8, 3.5.3
3-1	Section 3.1, 3.1.1, 3.1.2, 3.4.4
3-2	Section 3.1.2, 3.1.3, 3.2, 3.2.2, 3.2.3, 3.3.1
3-3	Section 3.2, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 5.1
3-4	Section 3.2.1
3-5	Section 3.2.1, 3.3.1
3-6	Section 3.2.2
3-7	Section 3.3.1
3-8	Section 3.3.1, 3.5.2, 3.5.3, 5.1
3-9	Section 3.3.1, 3.5.2, 3.5.3
3-10	Section 3.3.1
3-11	Section 3.3.1, 3.3.2
3-12	Section 3.3.1
3-13	Section 3.3.1
3-14	Section 3.3.3
3-15	Section 3.3.3
3-16	Section 3.3.3
3-17	Section 3.3.3
3-18	Section 3.3.3, 5.1
3-19	Section 3.4.1, 3.4.7, 3.4.7.1, 3.4.7.2, 3.4.7.4
3-20	Section 3.4.2
3-21	Section 3.4.2
3-22	Section 3.4.2

Figure #	Referenced Location
3-23	Section 3.4.2
3-24	Section 3.4.3.1
3-25	Section 3.4.3.1
3-26	Section 3.4.3.1
3-27	Section 3.4.3.2
3-28	Section 3.4.3.2
3-29	Section 3.4.3.2
3-30	Section 3.4.5
3-31	Section 3.4.6.1, 3.4.6.2, 3.4.6.3, 5.1, 5.4
3-32	Section 3.4.6.3
3-33	Section 3.4.8.1
3-34	Section 3.4.8.2
3-35	Section 3.4.8.2
3-36	Section 3.4.8.2
3-37	Section 3.4.8.2
3-38	Section 3.4.8.2
3-39	Section 3.4.8.2
3-40	Section 3.4.8.3
3-41	Section 3.4.8.3
3-42	Section 3.4.8.3, 5.1
3-43	Section 3.4.8.3, 5.1
3-44	Section 3.4.8.3
3-45	Section 3.5.2
3-46	Section 3.5.2
3-47	Section 3.5.2, 5.1
3-48	Section 3.5.2, 3.5.3, 5.1
3-49	Section 3.5.3
3-50	Section 3.5.3
3-51	Section 3.5.3
5-1	Section 5.3

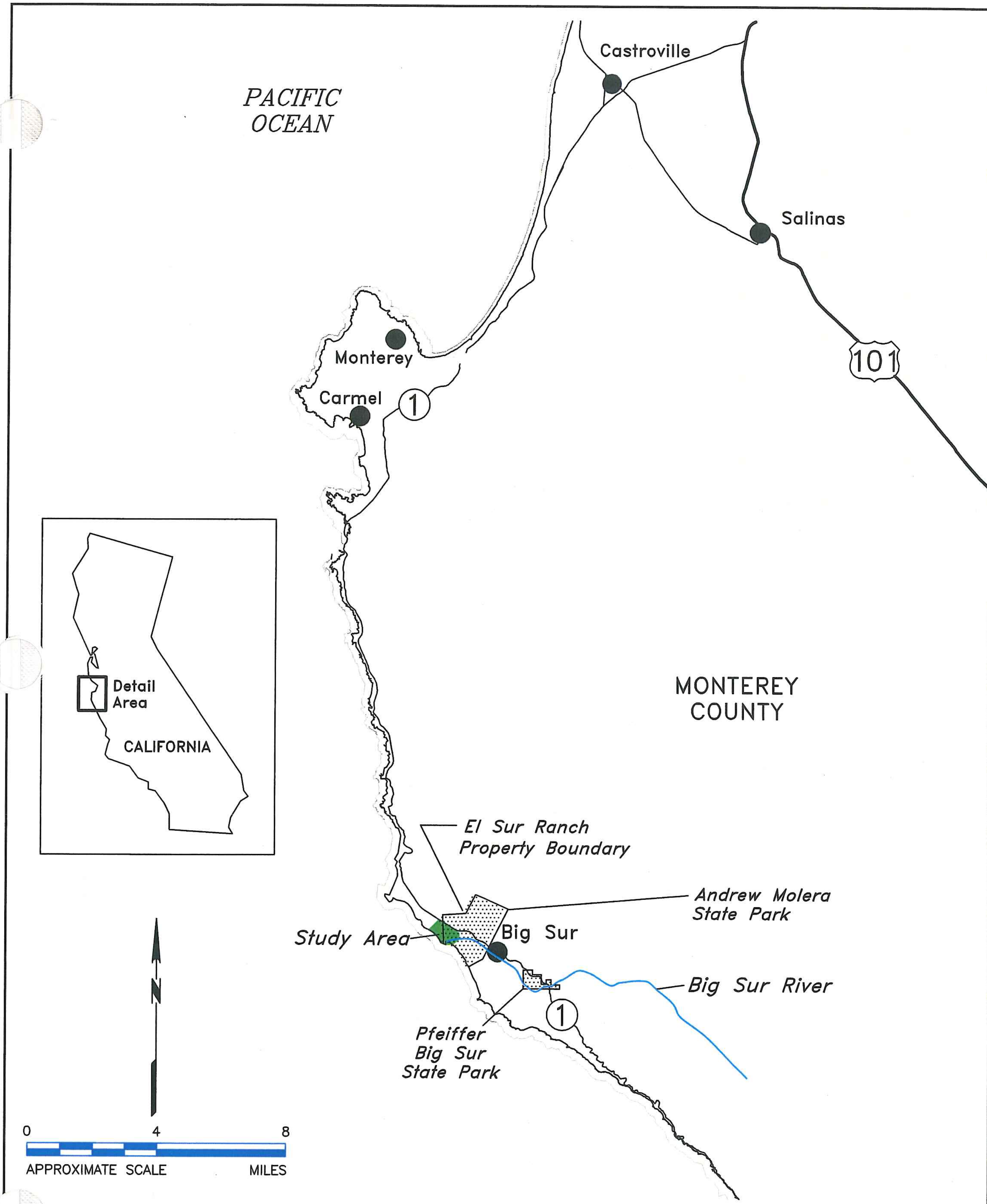
TABLE INDEX

APPENDIX INDEX

Appendices #	Referenced Location
A	Section 2.2, 2.4.2
B	Section 2.4.2, 3.2.1, 3.2.2, 3.3.1, 3.3.2
C	Section 2.4.4
D	Section 2.4.6
E	Section 2.5, 3.3.1, 3.5.1
F	Section 2.7.1
G	Section 2.7.3.9, 3.4.2, 3.4.7.4
H	Section 2.7.3.4, 2.7.3.6, 3.4.6, 3.4.6.2
I	Section 2.7.3.5
J	Section 2.7.3.6, 3.4.6, 3.4.8.3
K	Section 2.7.3.7
L	Section 2.7.3.8, 3.4.3.2
M	Section 2.7.3.10, 3.4.6, 3.4.6.1, 3.4.6.3, 3.5.2
N	Section 3.3.2
O	Section 3.4.2
P	Section 5.3
Q	Section 3.4.2, 3.4.7.2, 3.4.7.4, 5.4,

FIGURES

FIGURES



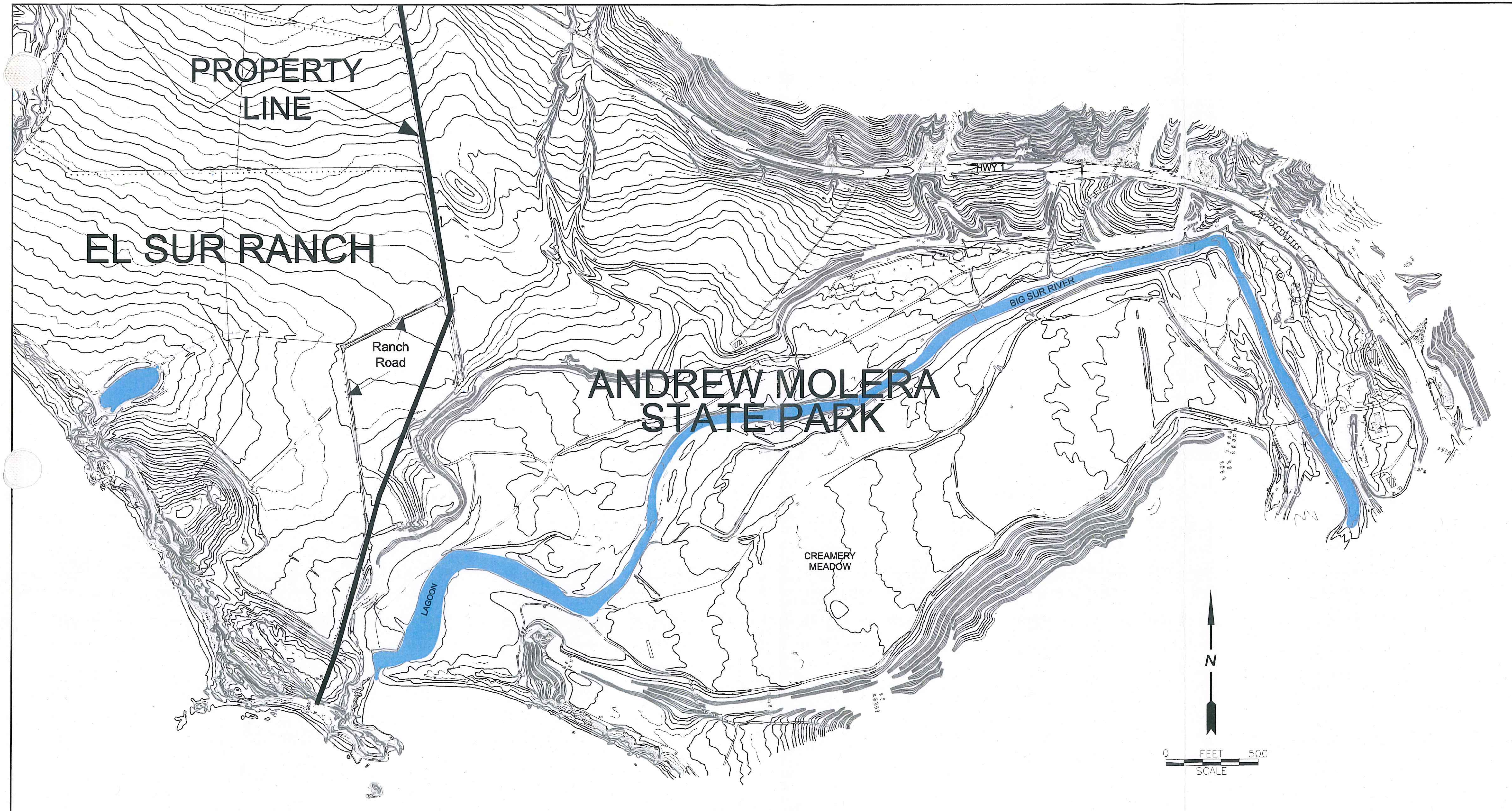
SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

STUDY AREA LOCATION

DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	SB	DRAFT	01-ESR-001	1-1

ESR-4



Map Source File by Rasmussen Land Surveying, Inc.
File Name: APS_Contours_Planimetric.dwg

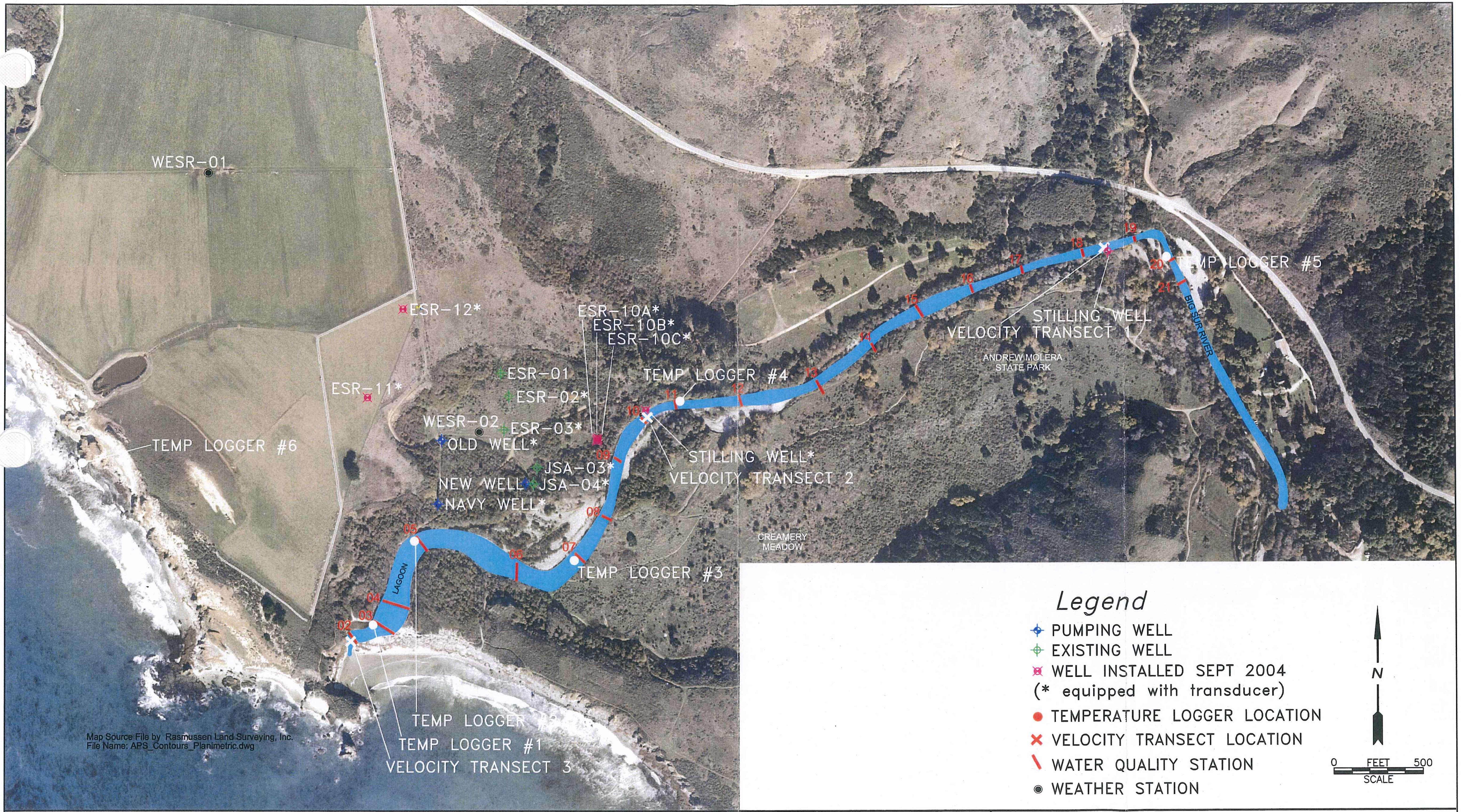
SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	ML/jp	PH

FIGURE 1–2

STUDY AREA BASE MAP



SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA				FIGURE 1-3 SITE PLAN OVERLAY WITH AIR PHOTO
	PROJECT NO. 01-ESR-001	DATE 3/11/05	DR. BY SB	APP. BY PH	

ESR--4

Figure 2-1
Project Implementation Schedule
El Sur Ranch

ID	Task Name	Start	Finish
1	Initial Field Visit - Collect Water Level Data	Wed 4/14/04	Thu 4/15/04
2	Geophysical Survey 1	Wed 4/14/04	Thu 4/15/04
3	Temperature Transducer in Temp 1 Bottom	Mon 4/19/04	Thu 10/28/04
4	Temperature Transducer in Temp 3 Bottom	Mon 4/19/04	Fri 10/29/04
5	Temperature Transducer in Temp 4 Bottom	Mon 4/19/04	Fri 10/29/04
6	Temperature Transducer in Temp 5 Bottom	Mon 4/19/04	Fri 10/29/04
7	Submittal of Interim Monitoring Work Plan, Water Rights Application #30166 to SWRCB	Thu 5/13/04	Thu 5/13/04
8	Start of El Sur Ranch Groundwater Extraction	Wed 4/21/04	Sat 10/16/04
9	Submittal of Permit to Conduct Biological, Geological or Soil Investigations to CDPR	Thu 6/17/04	Thu 6/17/04
10	Permit to Conduct Biological, Geological or Soil Investigations Issued by CDPR	Mon 6/21/04	Mon 6/21/04
11	Temperature/Pressure Transducers in ESR-03	Thu 6/24/04	Wed 12/29/04
12	Temperature/Pressure Transducers in JSA-04	Thu 6/24/04	Wed 12/29/04
13	Field Monitoring	Fri 6/25/04	Fri 6/25/04
14	Temperature/Pressure Transducers in Old Well	Fri 6/25/04	Wed 12/29/04
15	Field Monitoring	Fri 7/2/04	Fri 7/2/04
16	Submittal of Permit Applications for Five Monitoring Wells to MCHD	Thu 7/8/04	Thu 7/8/04
17	Submittal of Streambed Alteration Agreement/Waiver to CDFG	Thu 7/8/04	Thu 7/8/04
18	Field Visit	Mon 7/12/04	Tue 7/13/04
19	Temperature/Pressure Transducers in JSA-03	Mon 7/12/04	Wed 12/29/04
20	Temperature/Pressure Transducers in ESR-02	Mon 7/12/04	Wed 12/29/04
21	Temperature Transducer in Temp 1 Surface	Mon 7/12/04	Thu 10/28/04
22	Temperature Transducer in Temp 5 Surface	Mon 7/12/04	Thu 10/14/04
23	Submittal of Section 404 Clean Water Act Nationwide Permit No. 5 to ACOE	Thu 7/15/04	Thu 7/15/04
24	Submittal of Section 404 Clean Water Act Nationwide Permit No. 5 to CRWQCB	Mon 7/19/04	Mon 7/19/04
25	Water Well Construction Permit 04-07840 was Issued by MCHD	Tue 7/20/04	Tue 7/20/04
26	Field Visit	Thu 7/22/04	Fri 7/23/04
27	Installation of Weather Station WESR-02	Thu 7/22/04	Thu 7/22/04
28	Installation of River Gauge Transect #1, #2, and #3	Fri 7/23/04	Fri 7/23/04
29	Temperature Transducer in Temp 2 Bottom	Fri 7/23/04	Thu 10/28/04
30	Temperature Transducer in Temp 2 Surface	Fri 7/23/04	Thu 10/28/04
31	Temperature Transducer in Temp 3 Surface	Fri 7/23/04	Fri 10/29/04
32	Temperature Transducer in Temp 4 Surface	Fri 7/23/04	Fri 10/29/04

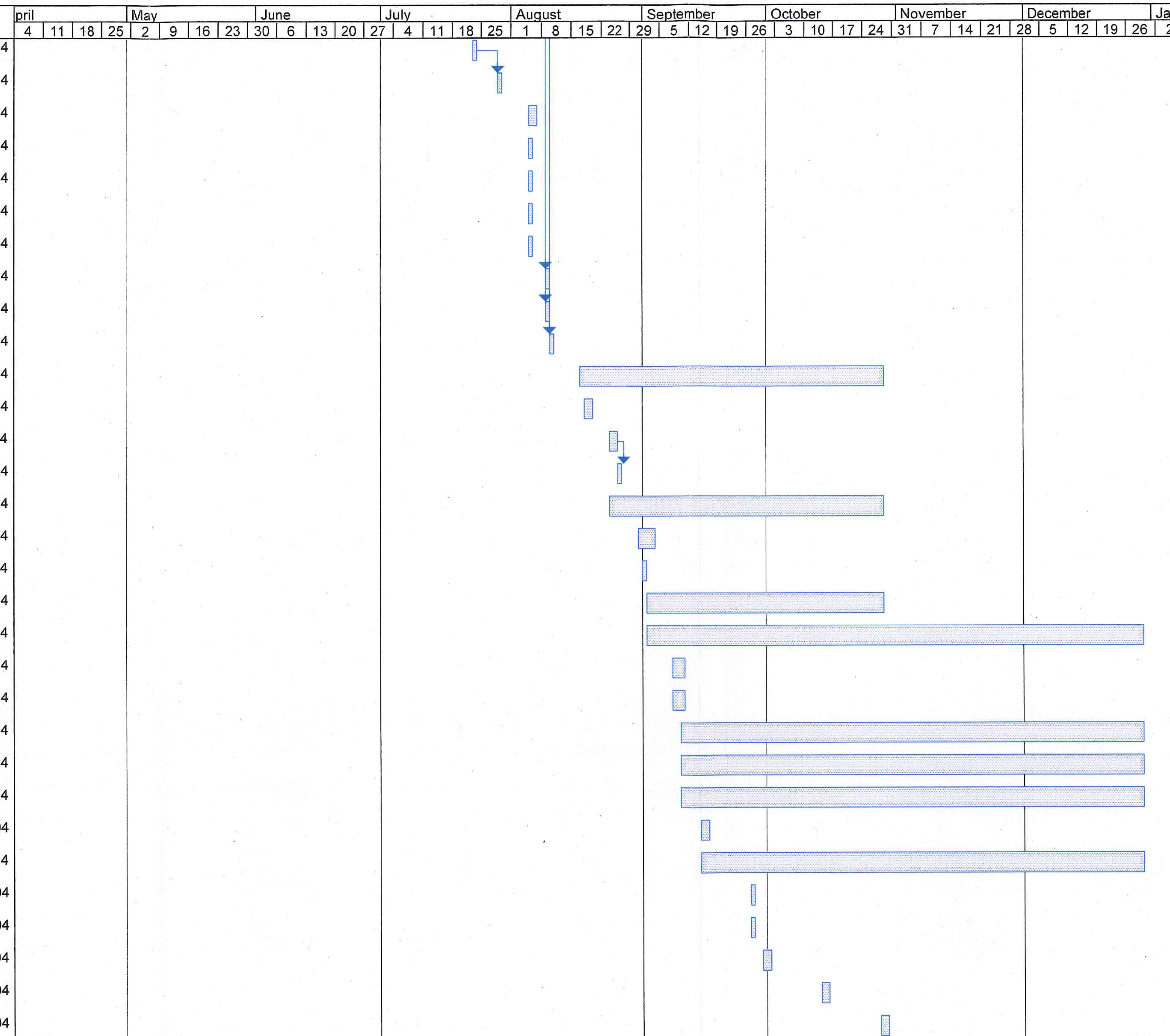
ject: Project ESR 2 pages
ate: Tue 5/24/05

Task		Milestone		Rolled Up Split		External Tasks	
Split		Summary		Rolled Up Milestone		Project Summary	
Progress		Rolled Up Task		Rolled Up Progress		External Milestone	

Deadline

Figure 2-1
Project Implementation Schedule
El Sur Ranch

ID	Task Name	Start	Finish
3	Submittal of Section 404 Clean Water Act Nationwide Permit No. 5 to SWRCB	Fri 7/23/04	Fri 7/23/04
34	NWP No. 5 Approval by SWRCB	Thu 7/29/04	Thu 7/29/04
35	Field Visit	Thu 8/5/04	Fri 8/6/04
36	Geophysical Survey 2	Thu 8/5/04	Thu 8/5/04
37	Installation of Stilling Wells (Transect #1 and Transect #2)	Thu 8/5/04	Thu 8/5/04
38	Temperature Transducer in Ocean Surf Zone 1	Thu 8/5/04	Thu 8/5/04
39	Installation of Weather Station WESR-01	Thu 8/5/04	Thu 8/5/04
40	NWP No. 5 Approval by CRWQCB	Mon 8/9/04	Mon 8/9/04
41	No SAA required by CDFG	Mon 8/9/04	Mon 8/9/04
42	NWP No. 5 Approval by ACOE	Tue 8/10/04	Tue 8/10/04
43	Temperature/Pressure Transducers in Stilling Well	Tue 8/17/04	Thu 10/28/04
44	Field Visit	Wed 8/18/04	Thu 8/19/04
45	Field Visit	Tue 8/24/04	Wed 8/25/04
46	Lagoon Closure	Thu 8/26/04	Thu 8/26/04
47	Temperature/Pressure Transducers in Navy Well	Tue 8/24/04	Thu 10/28/04
48	Field Visit	Tue 8/31/04	Fri 9/3/04
9	Installation of Monitoring Well Cluster ESR-10A, ESR-10B, and ESR-10C	Wed 9/1/04	Wed 9/1/04
0	Temperature Transducer in Ocean Surf Zone 2	Thu 9/2/04	Thu 10/28/04
51	Temperature/Pressure Transducers in ESR-10	Thu 9/2/04	Wed 12/29/04
52	Field Visit	Wed 9/8/04	Fri 9/10/04
53	Installation ofTwo Monitoring Wells ESR-11 and ESR-12	Wed 9/8/04	Fri 9/10/04
54	Temperature/Pressure Transducers in ESR-10A	Fri 9/10/04	Wed 12/29/04
55	Temperature/Pressure Transducers in ESR-10B	Fri 9/10/04	Wed 12/29/04
56	Temperature/Pressure Transducers in ESR-11	Fri 9/10/04	Wed 12/29/04
57	Field Visit	Wed 9/15/04	Thu 9/16/04
58	Temperature/Pressure Transducers in ESR-12	Wed 9/15/04	Wed 12/29/04
59	Field Visit	Mon 9/27/04	Mon 9/27/04
60	Location Survey	Mon 9/27/04	Mon 9/27/04
61	Field Visit	Thu 9/30/04	Fri 10/1/04
62	Field Visit	Thu 10/14/04	Fri 10/15/04
63	Field Visit	Thu 10/28/04	Fri 10/29/04

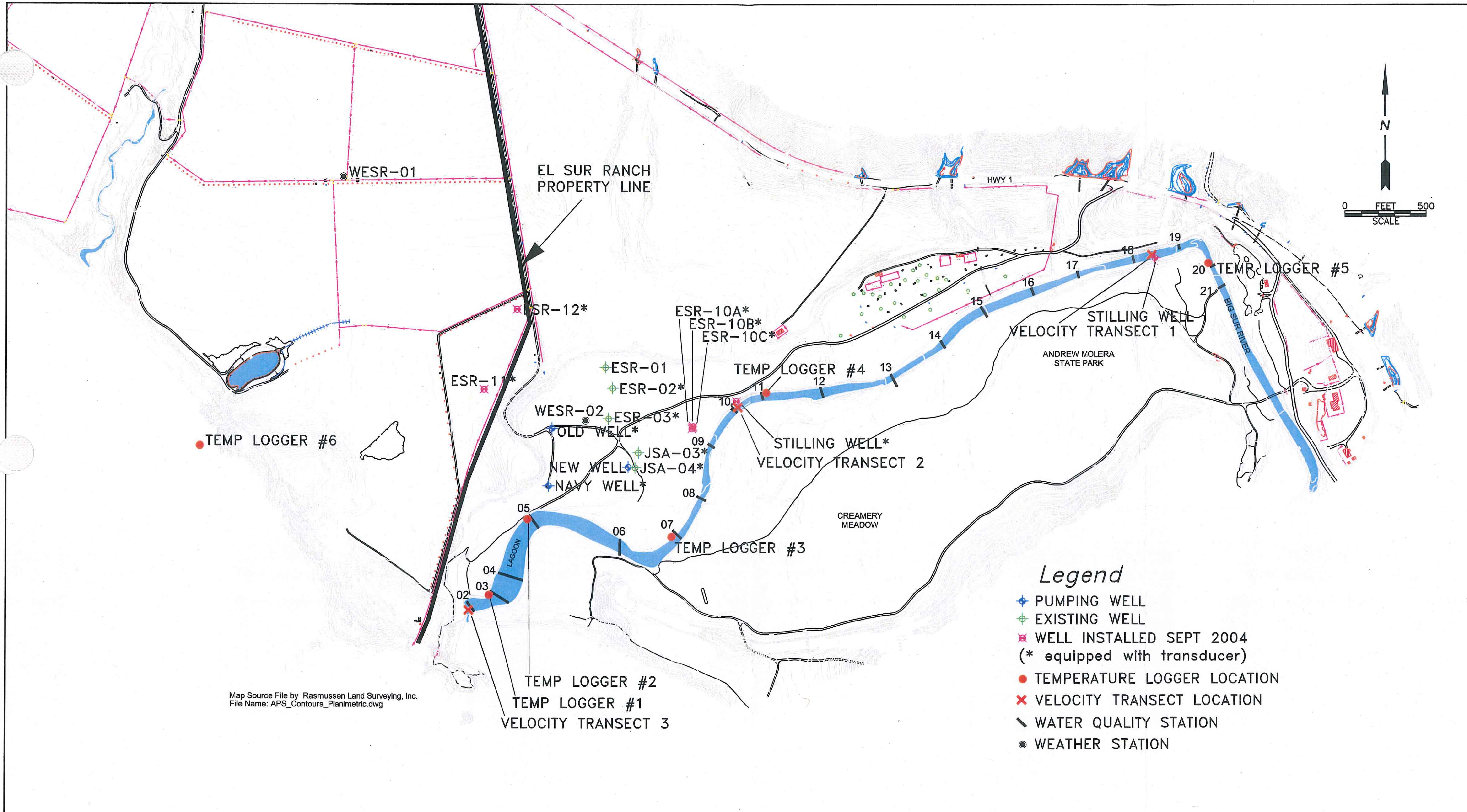


ect: Project ESR 2 pages
te: Tue 5/24/05

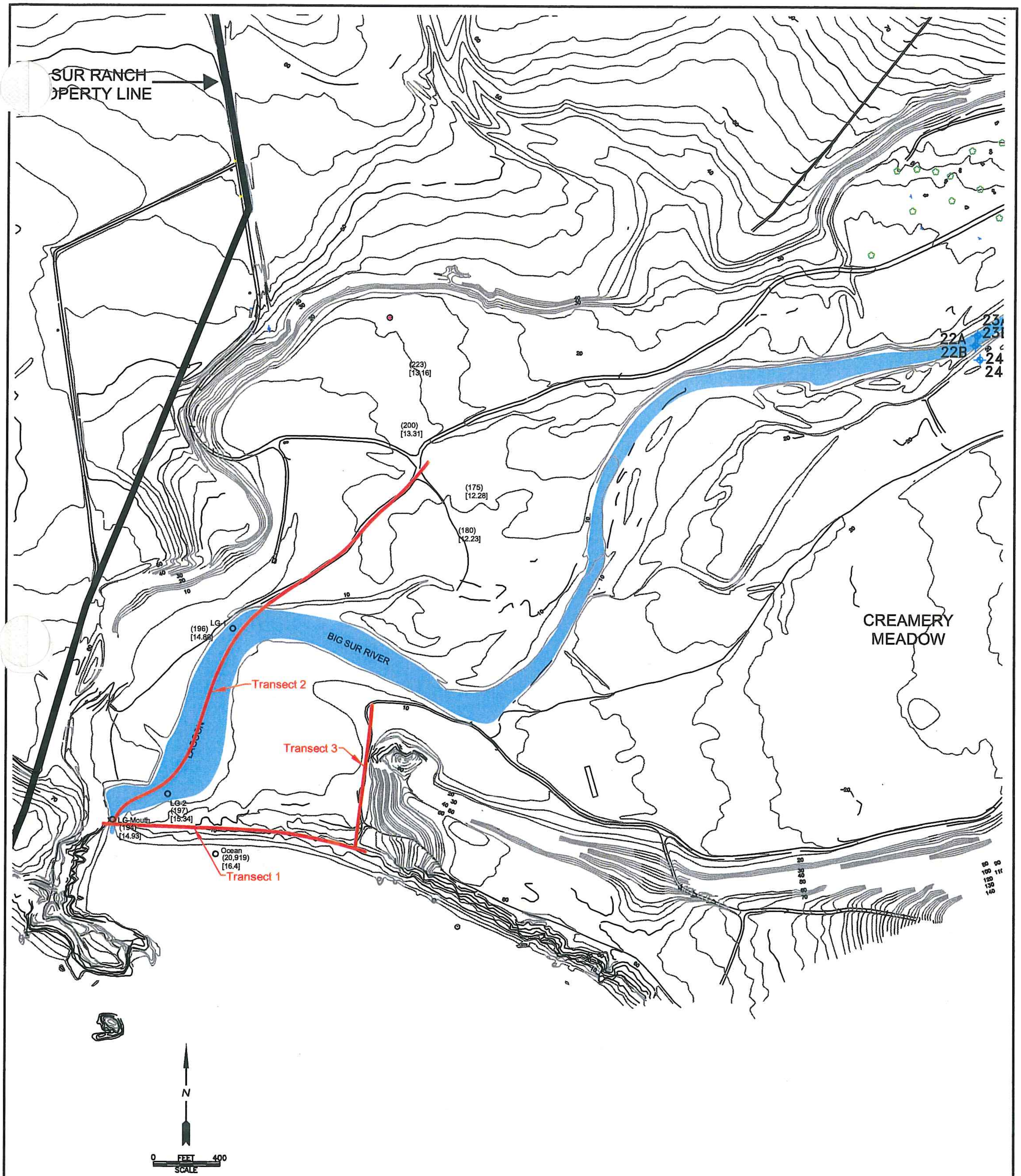
Task		Milestone		Rolled Up Split		External Tasks		Deadline
Split		Summary		Rolled Up Milestone		Project Summary		
Progress		Rolled Up Task		Rolled Up Progress		External Milestone		

The Source Group, Inc.

ESR-4



SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA			FIGURE 2-2 MONITORING STATION MAP
	PROJECT NO. 01-ESR-001	DATE 3/11/05	DR. BY ML/jp	APP. BY PH



rce File by Rasmussen Land Surveying, Inc.
e: APS_Contours_Planimetric.dwg

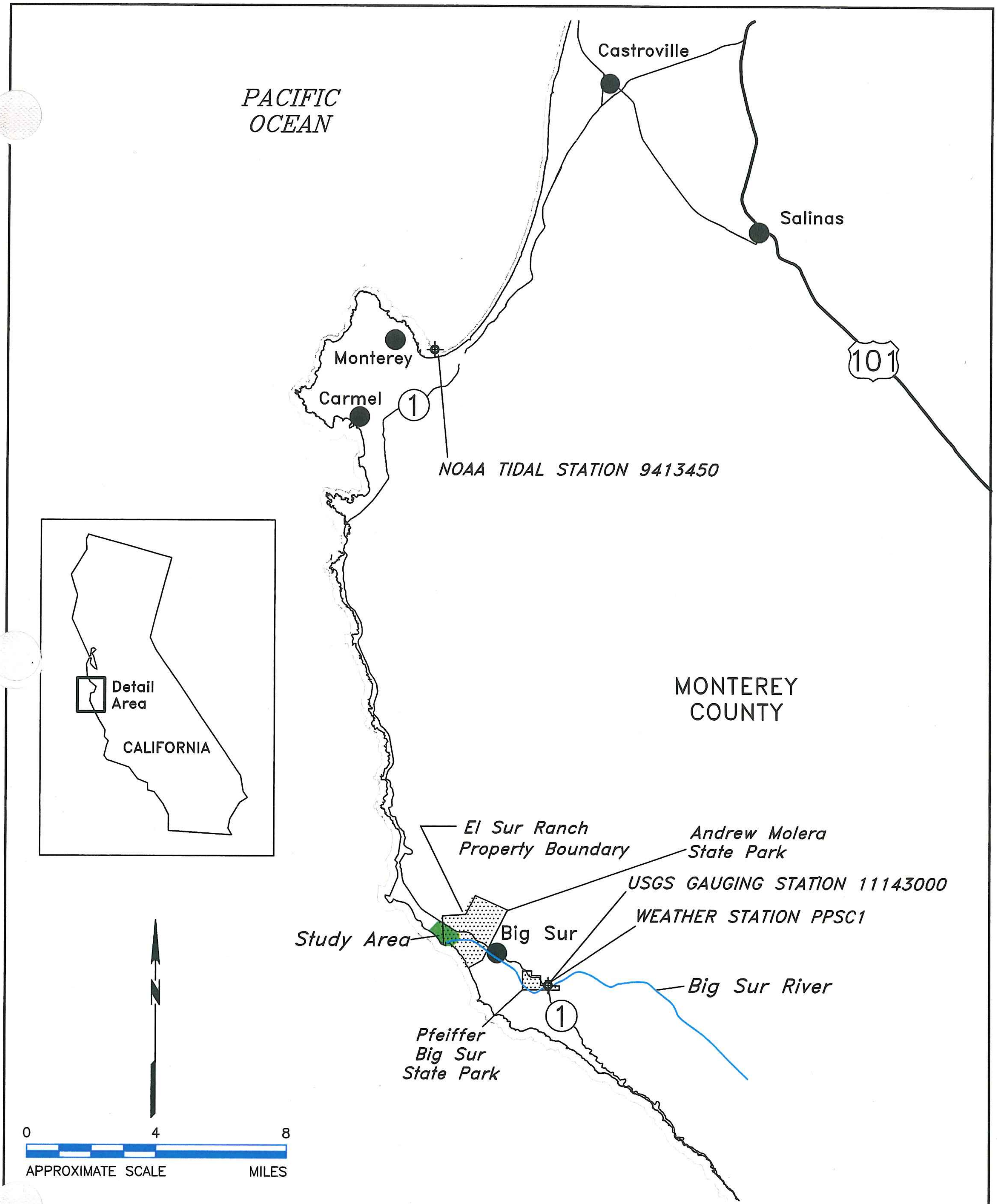
SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

GEOPHYSICAL SURVEY
TRANSECTS

ESR--4

DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	CP	SM	01-ESR-001	2-3

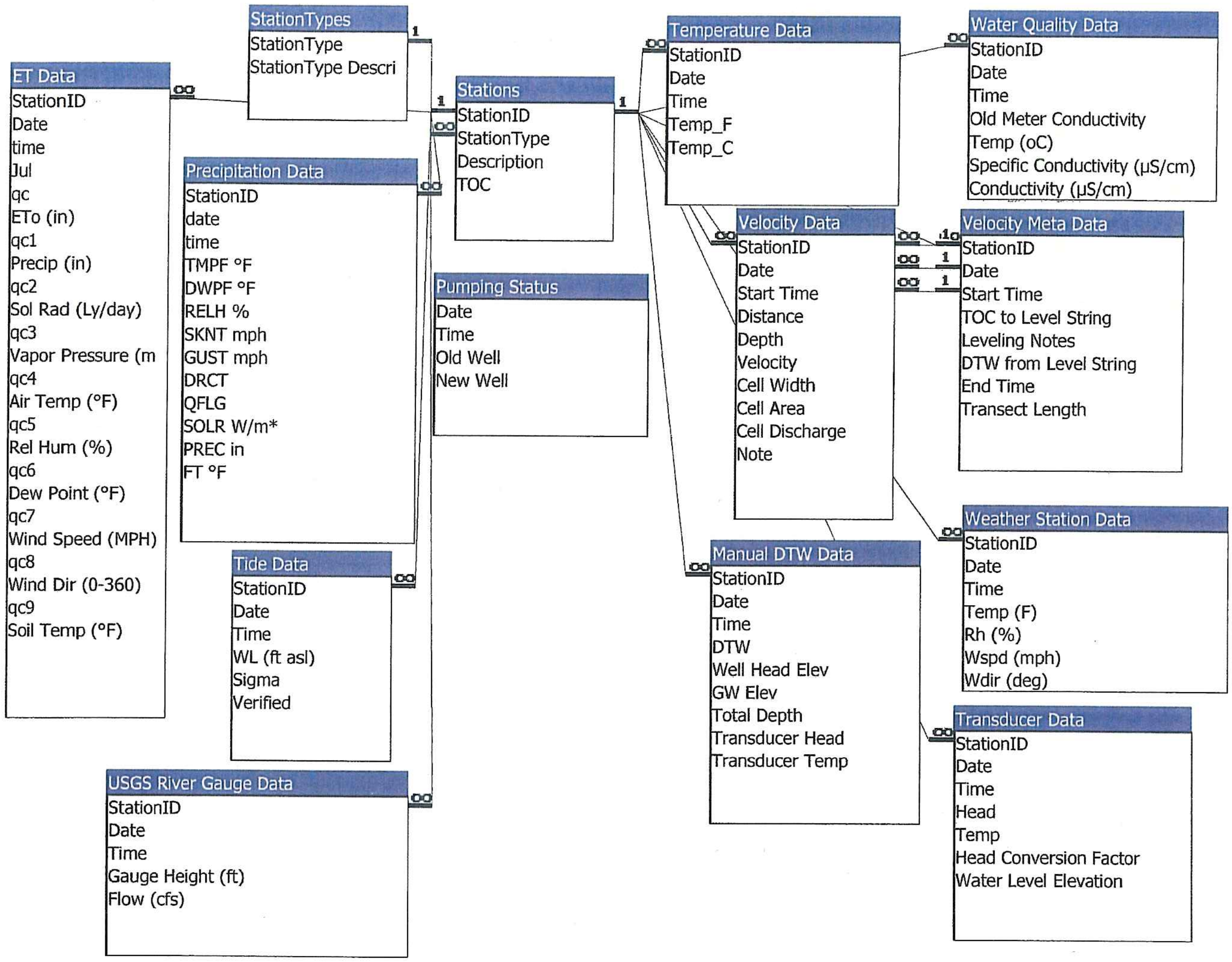


THE SOURCE GROUP, INC.
SGI environmental

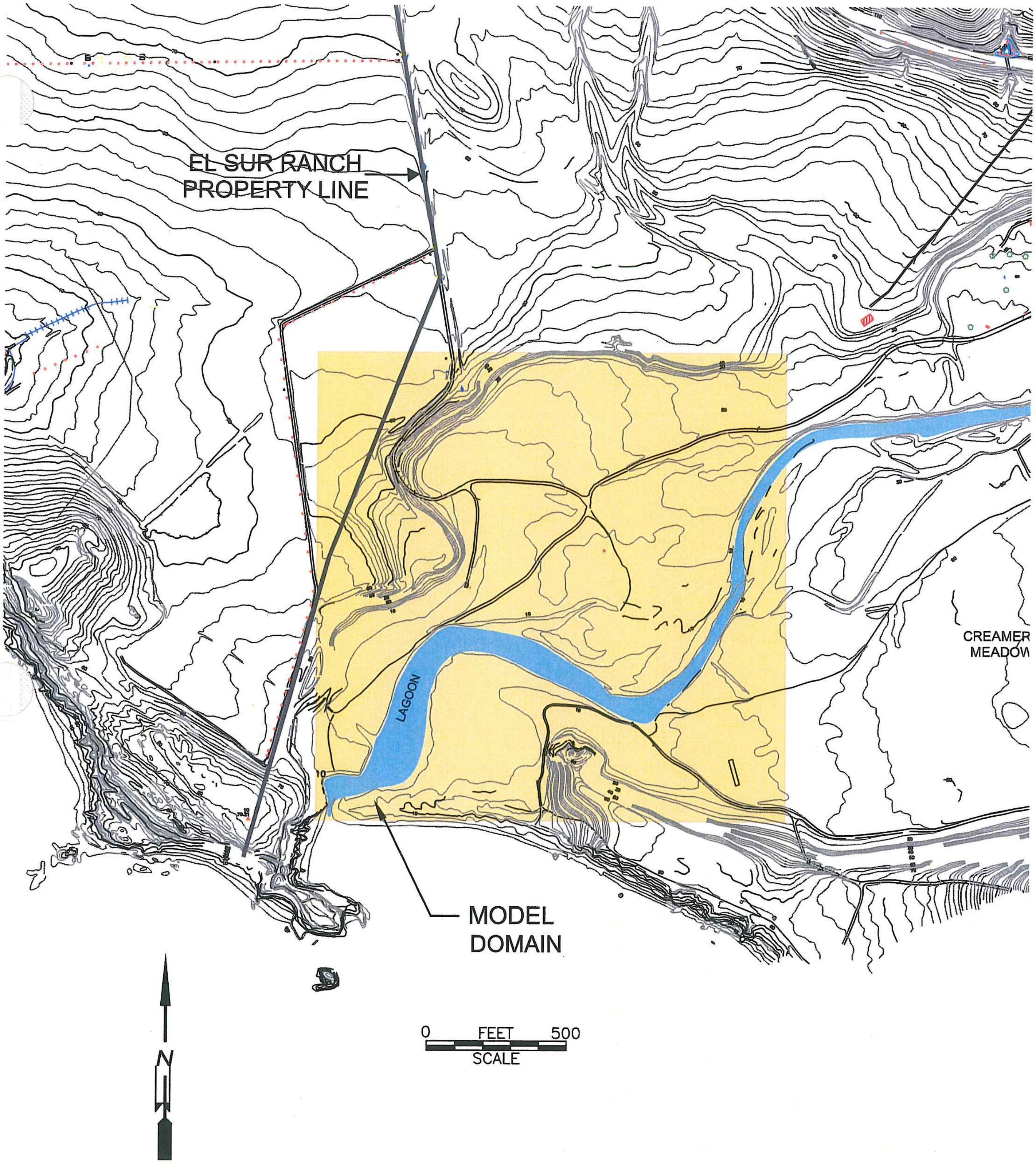
EL SUR RANCH
BIG SUR, CALIFORNIA

GAUGING STATION LOCATIONS

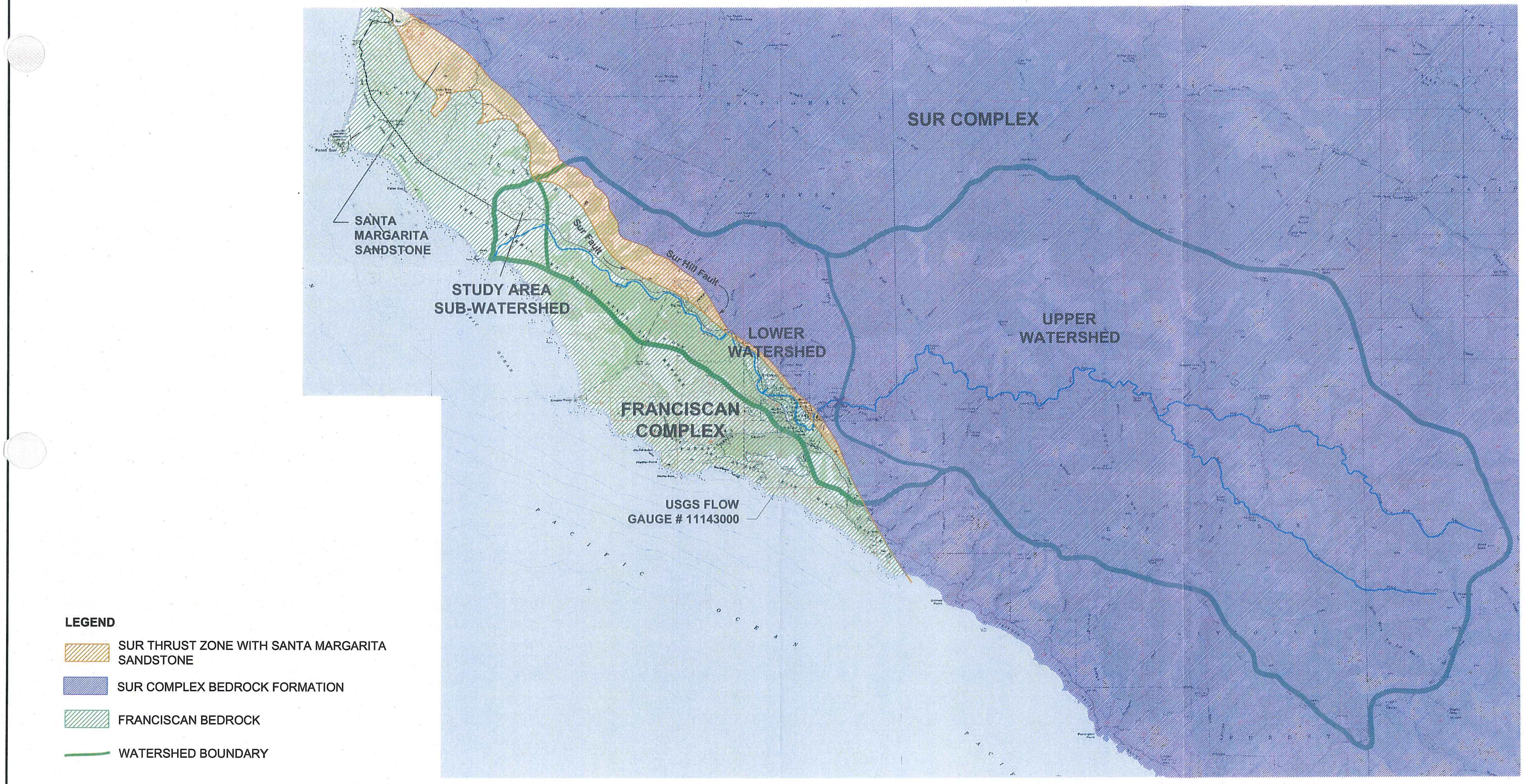
DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	SB	DRAFT	01-ESR-001	ESR--42-4



THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA			DATABASE STRUCTURE DIAGRAM	
	DATE 3/11/05	DR. BY SB	APP. BY	PROJECT NO. 01-ESR-00ESR--4	FIGURE NO. 2-5



SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA			NUMERICAL MODEL GRID
	DATE 3/11/05	DR. BY CP	APP. BY SM	PROJECT NO. 01-ESR-001 · FIGURE NO. ESR--4 2-6



SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	SB	PH

FIGURE 3-1

GENERALIZED BEDROCK GEOLOGY

ESR--4

SGI environmental THE SOURCE GROUP, INC.

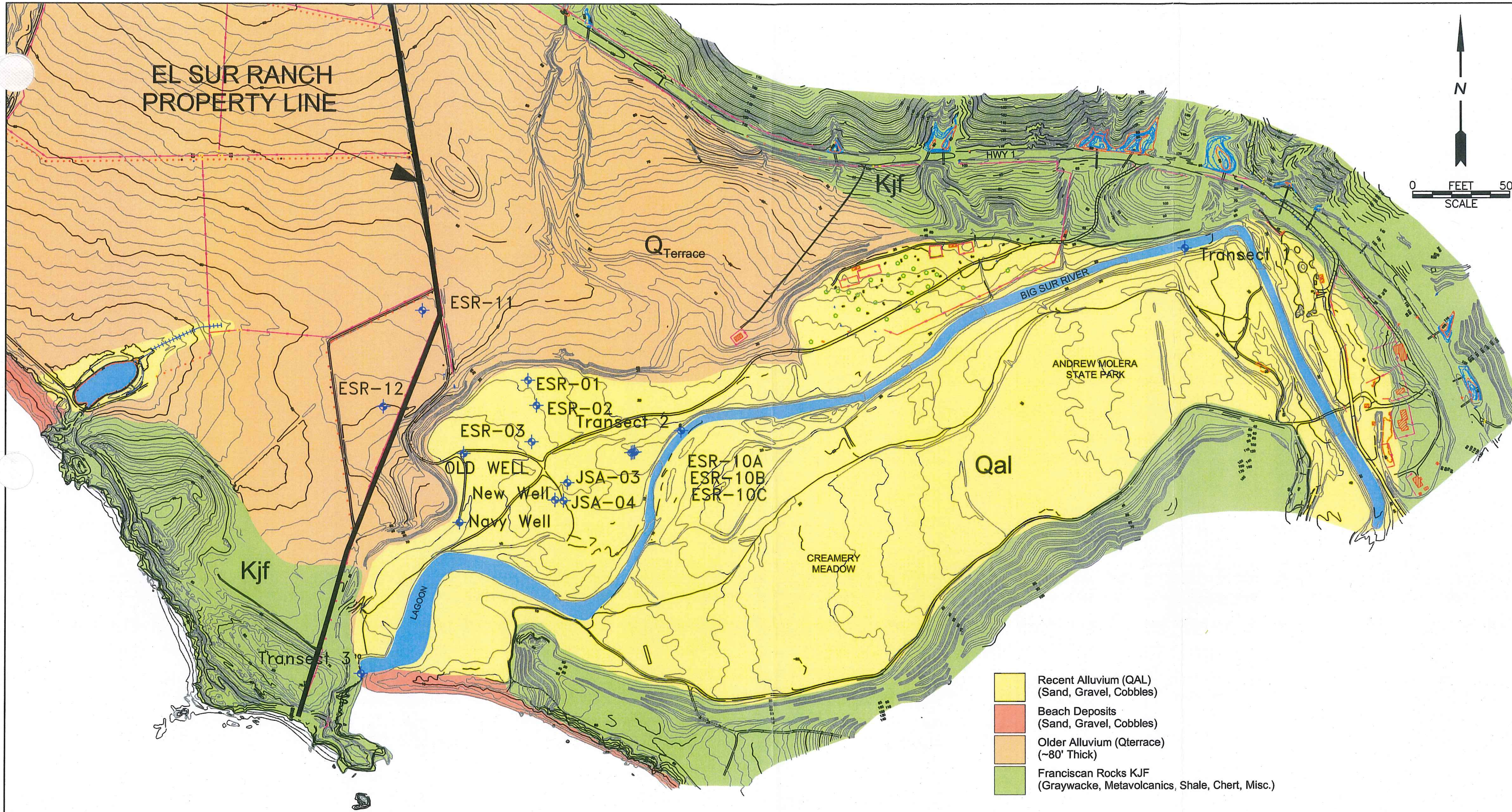
EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	SB	PH

FIGURE 3-2

SURFICIAL GEOLOGICAL MAP
(Excerpted from Hall, 1991)

ESR--4



Map Source File by Rasmussen Land Surveying, Inc.
File Name: APS_Contours_Planimetric.dwg

SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	SB	SM

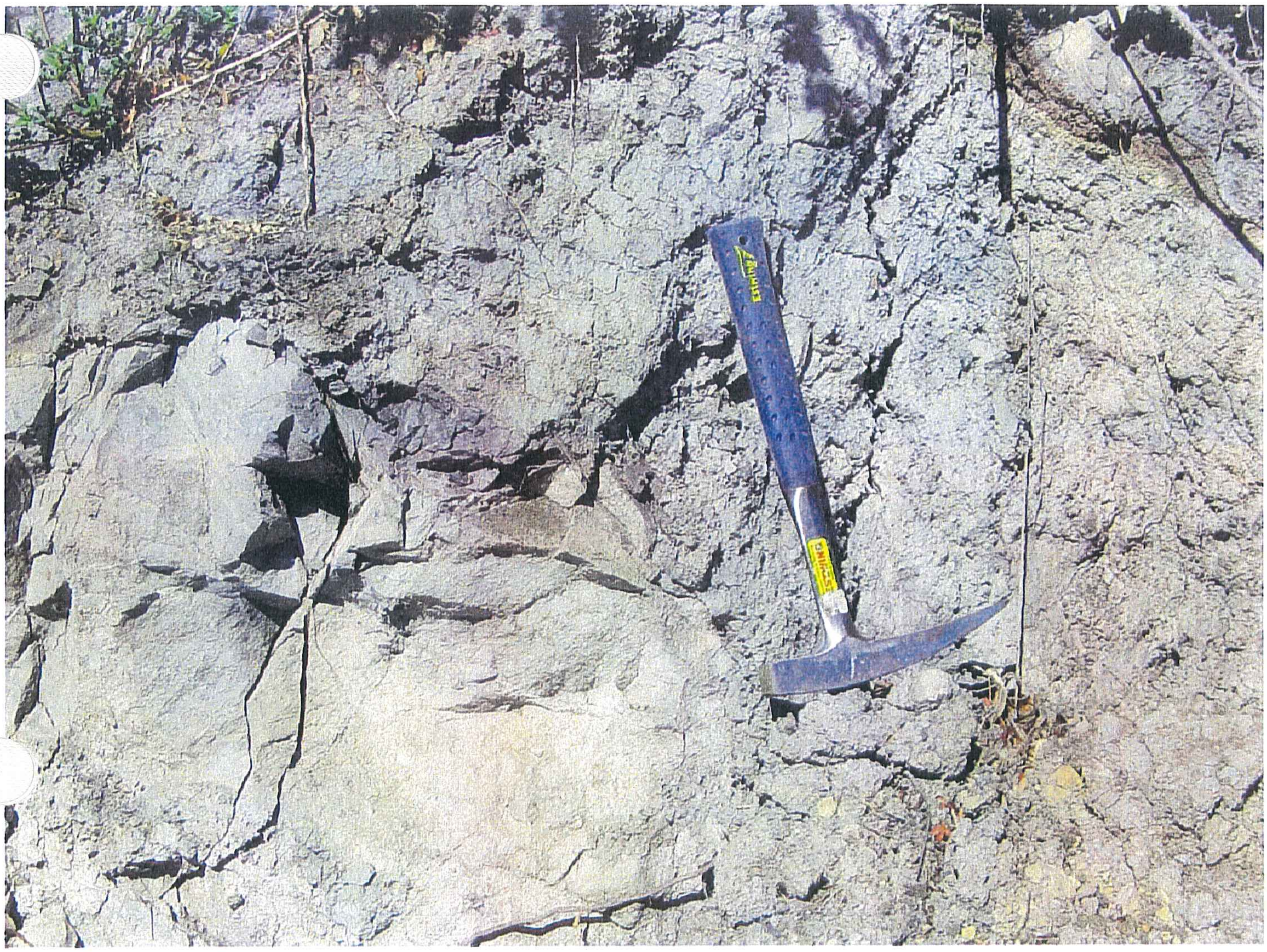
FIGURE 3-3
STUDY AREA GEOLOGIC MAP

THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

FRANCISCAN NOTCH ROCK

DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	SB		01-ESR-001	3-4



Micro—graywacke weathering to grey sandy Clay
Hwy 1 Roadcut Across from Andrew Molera State Park

SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA	WEATHERED FRANCISCAN FORMATION

DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	CP	DRAFT		3—5

ESR--4

Marine Terrace Deposit
El Sur Ranch Just North of the V–Notch

SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA			MARINE TERRACE DEPOSIT	
	DATE 3/11/05	DR. BY CP	APP. BY DRAFT	PROJECT NO. 01–ESR–001	FIGURE NO. 3–6

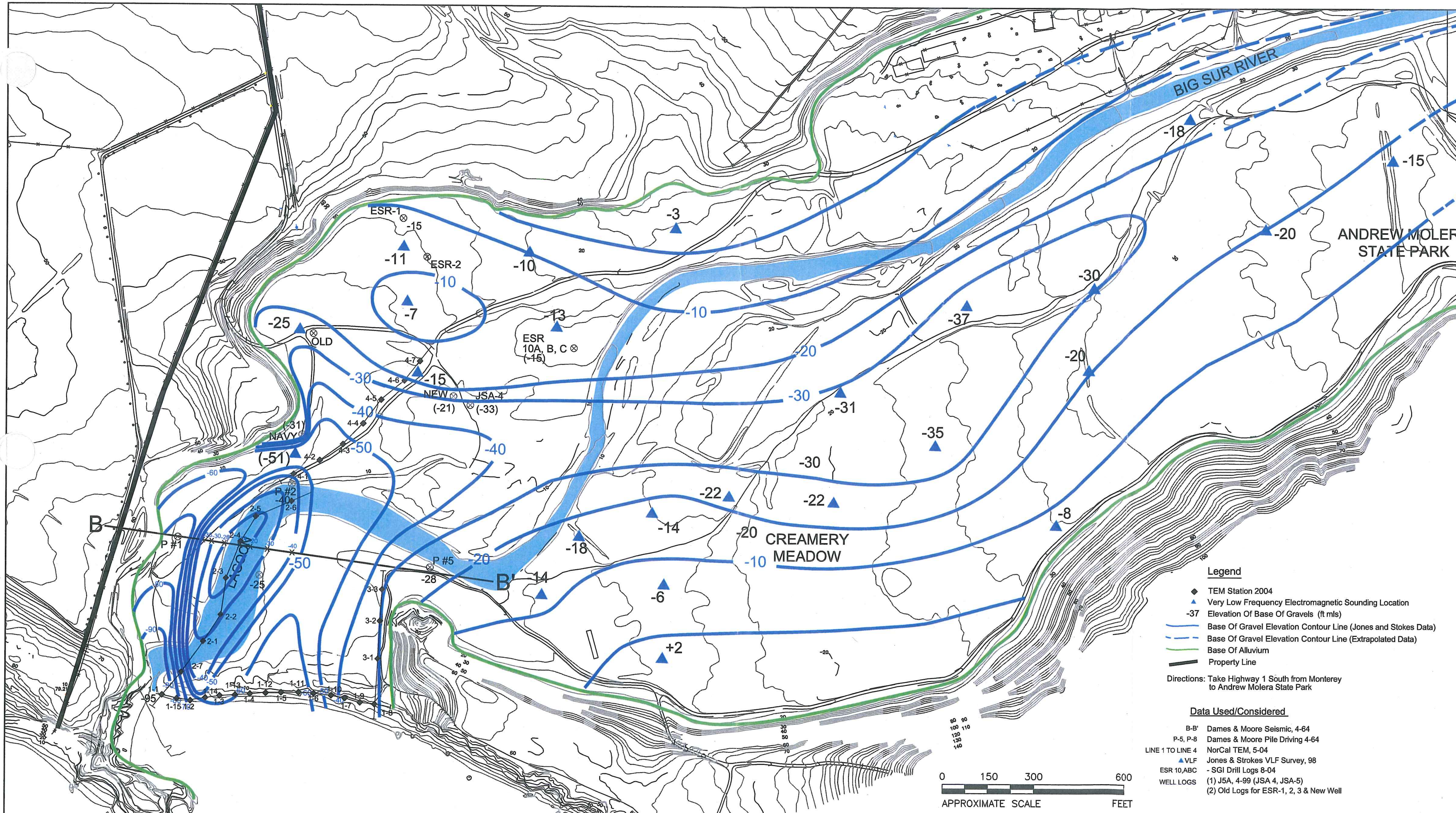
ESR--4

SGI environmental | THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

QUATERNARY ALLUVIUM
IN STUDY AREA

DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	SB		01-ESR-001	3-7



THE SOURCE GROUP, INC.
SGI environmental

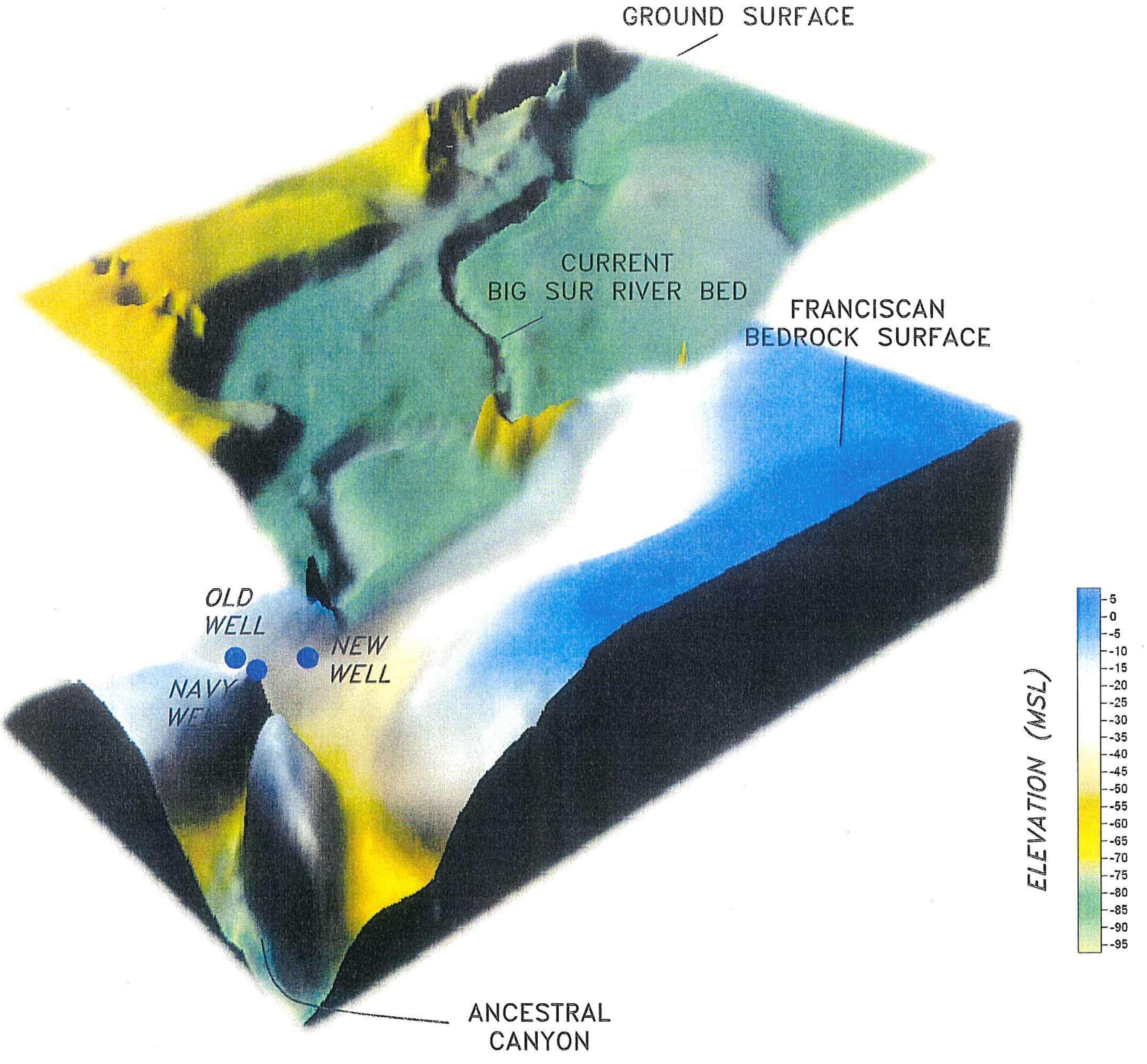
EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	MM	KT

FIGURE 3-8

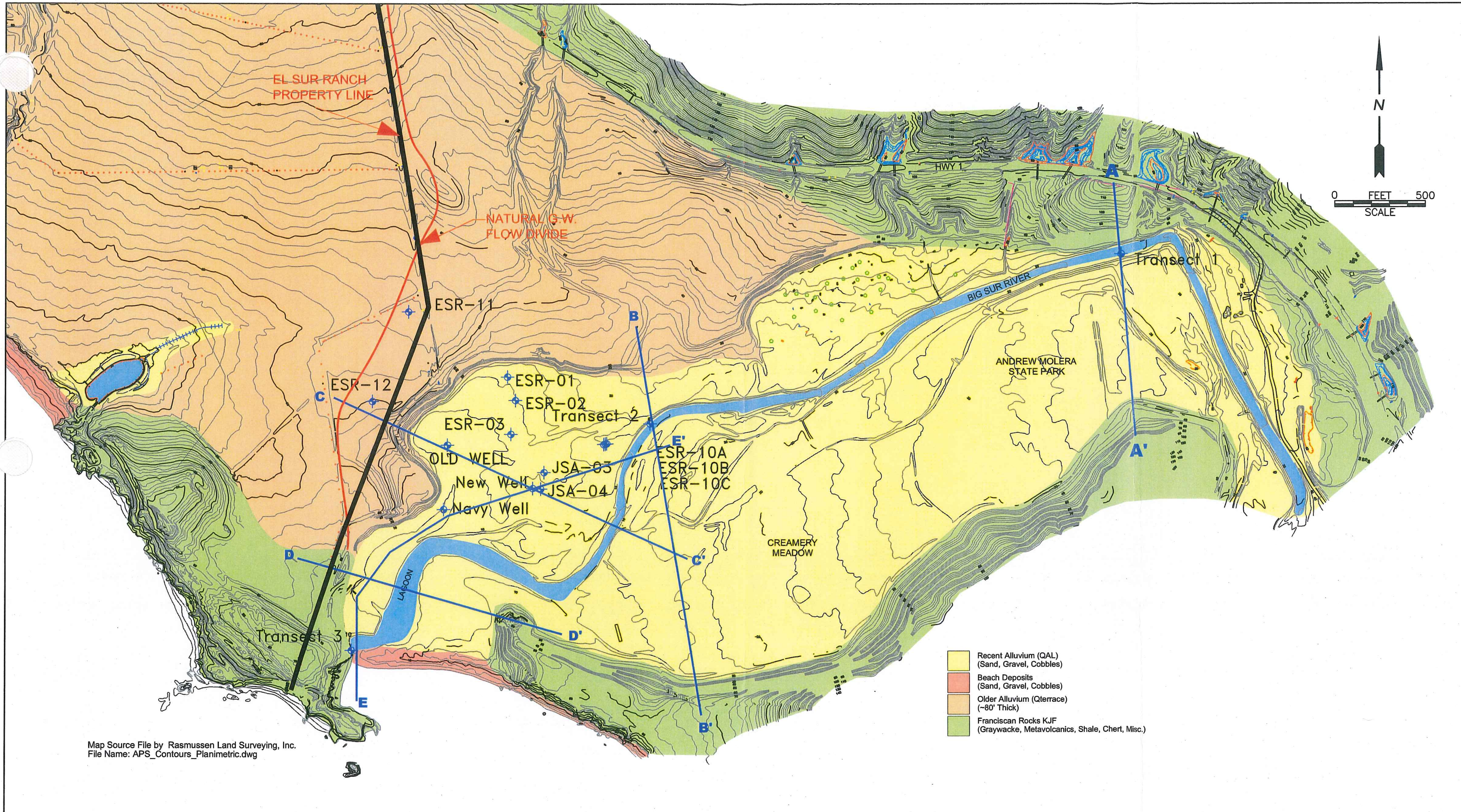
BASE OF GRAVELS ELEVATION MAP

ESR--4



Vertical Exageration (ground surface) approx. 5X
Vertical Exageration (bedrock surface) approx. 10X

SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA			3D REPRESENTATION OF BEDROCK & GROUND SURFACES	
	DATE 3/11/05	DR. BY SB	APP. BY DRAFT	PROJECT NO. 01-ESR-001	FIGURE NO. 3-9



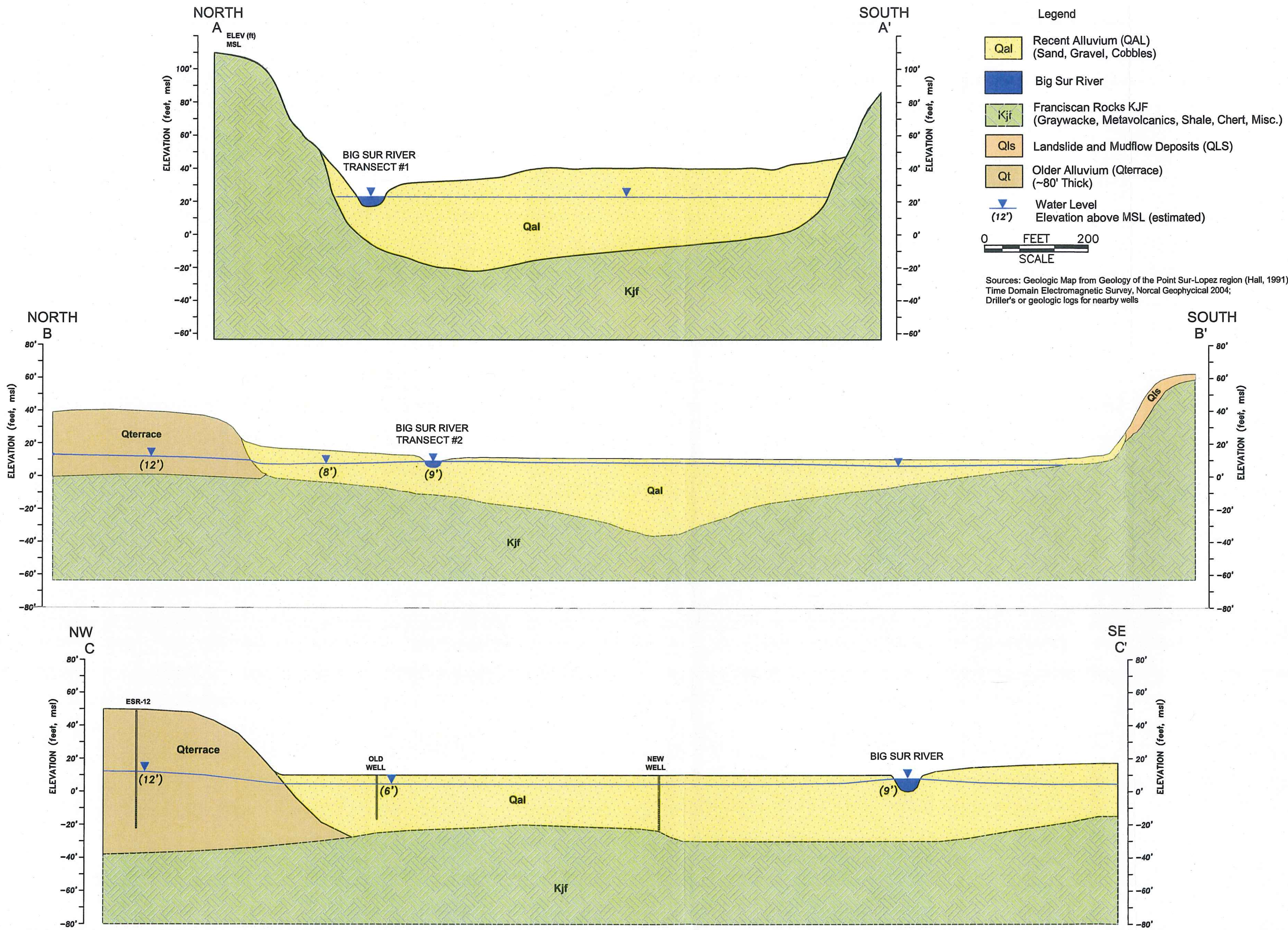
SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	SB	SM

FIGURE 3-10

CROSS SECTION LOCATION MAP



![SGI environmental — The Source Group, Inc.]

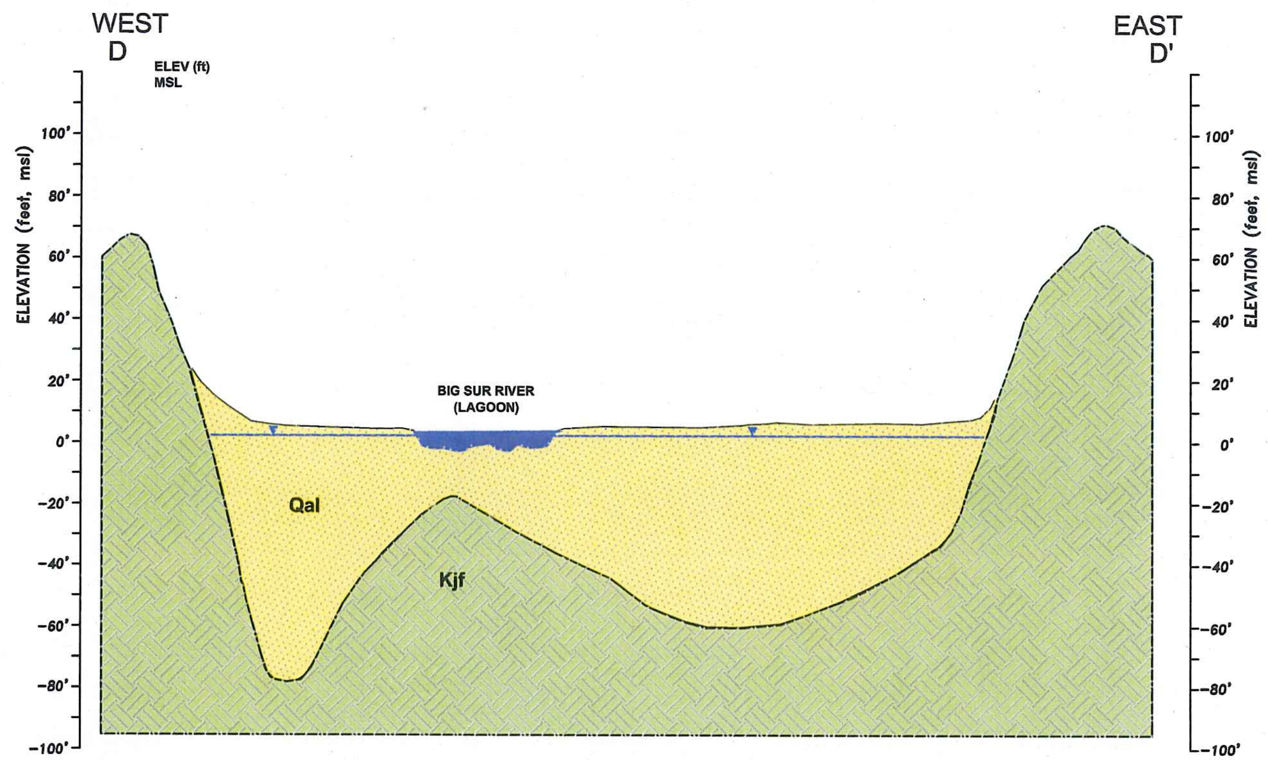
EL SUR RANCH
BIG SUR, CALIFORNIA

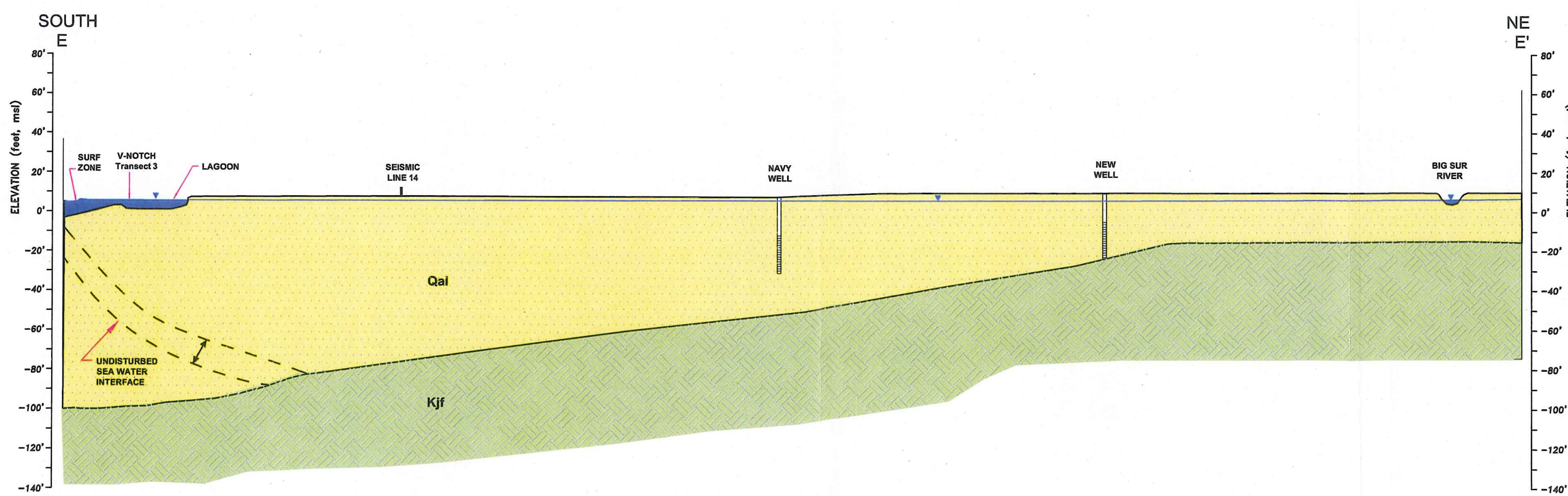
PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	SB	SM

FIGURE 3-11

CROSS SECTION A-A' THRU C-C'

ESR--4





Legend

- Qal — Recent Alluvium (QAL) (Sand, Gravel, Cobbles)
- Big Sur River
- Kjf — Franciscan Rocks KJF (Graywacke, Metavolcanics, Shale, Chert, Misc.)
- Qt — Older Alluvium (Qterrace) (~80' Thick)
- Water Level

0 FEET 200
SCALE

Sources: Geologic Map from Geology of the Point Sur-Lopez region (Hall, 1991);
Time Domain Electromagnetic Survey, Norcal Geophycical 2004;
Driller's or geologic logs for nearby wells

SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	SB	SM

FIGURE 3-12

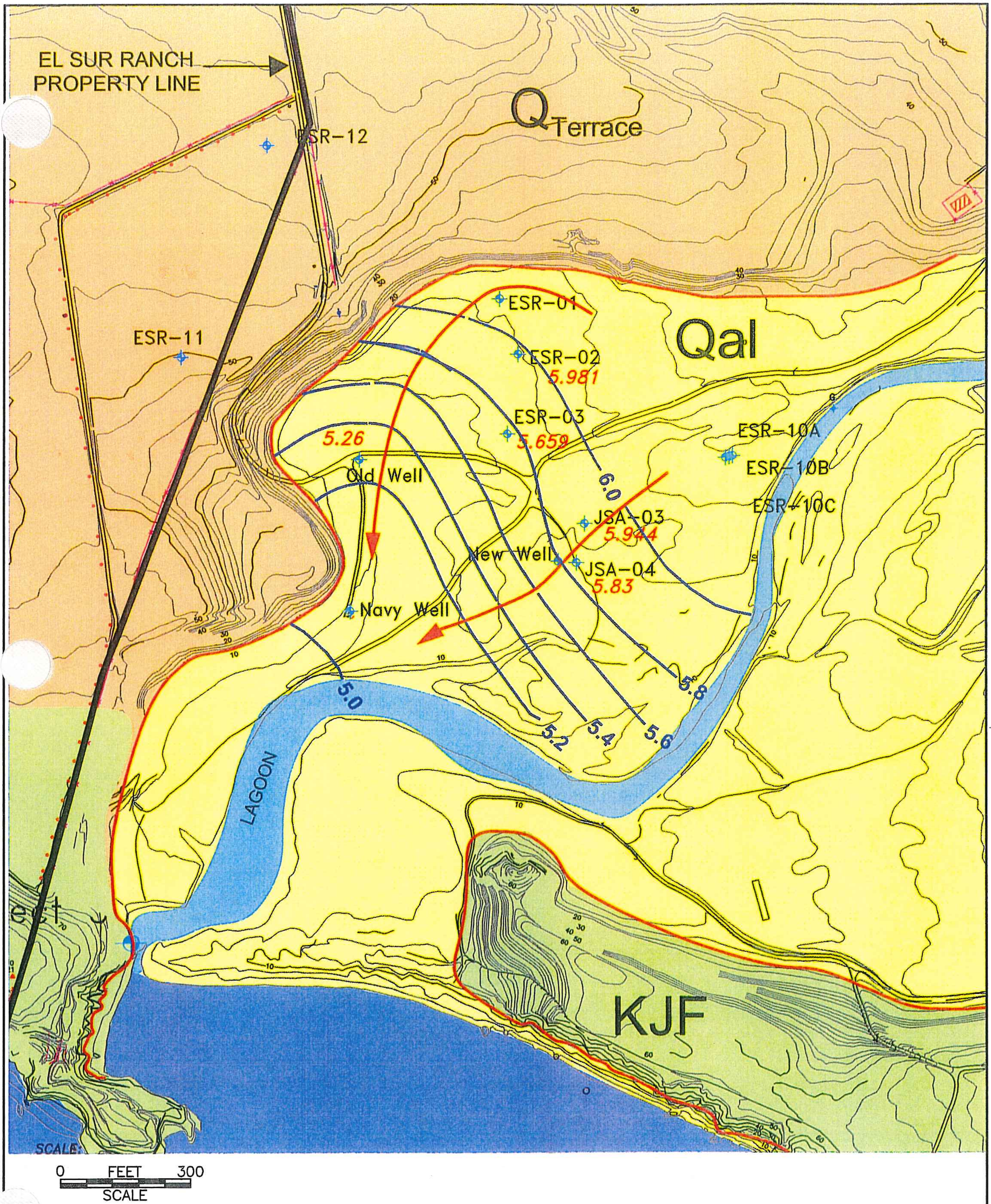
CROSS SECTION D-D' THRU E-E'

ESR--4

Franciscan Meta–Volcanic Rocks on South East Boundary of Alluvial Channel

SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA		FRANCISCAN META-VOLCANIC CLIFF	
DATE 3/11/05	DR. BY SB	APP. BY	PROJECT NO. 01–ESR–001	FIGURE NO. 3–13

ESR--4



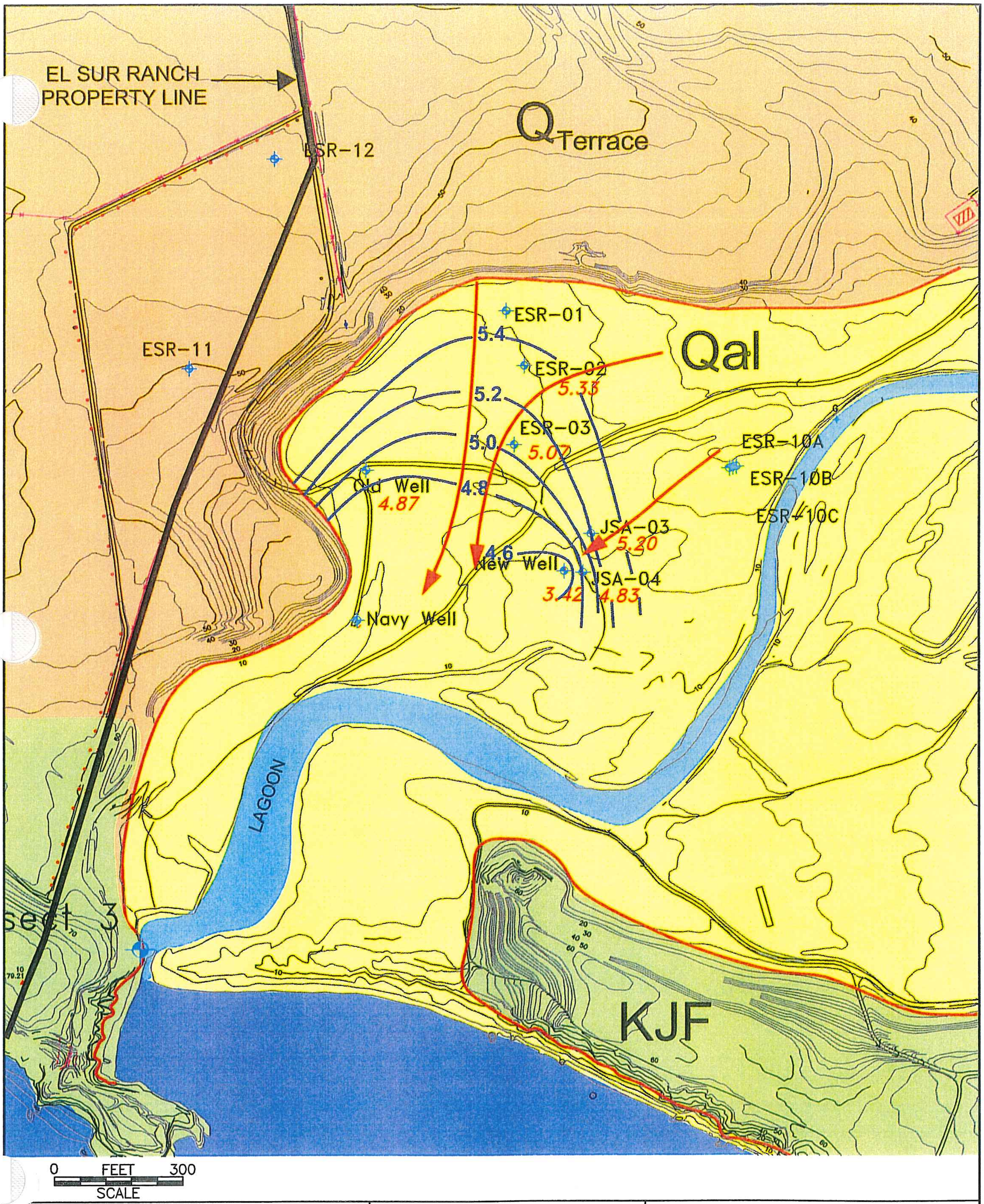
SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

GROUNDWATER ELEVATION MAP
APRIL 15, 2004
PRE-PUMPING

DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	SB	DRAFT	01-ESR-001	3-14

ESR--4

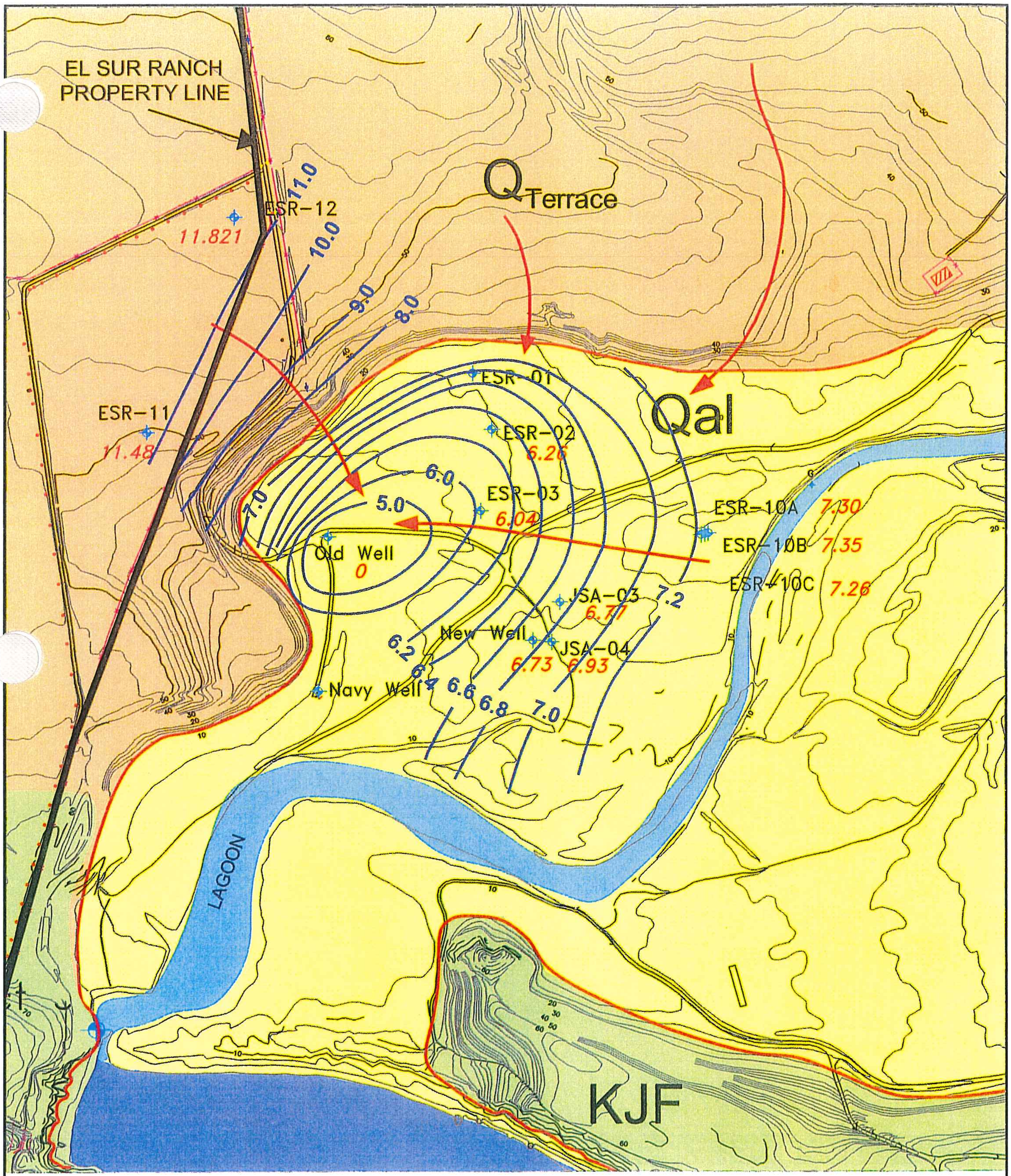


SGI environmental | THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

GROUNDWATER ELEVATION
CONTOURS (JULY 12, 2004)
NEW WELL ONLY

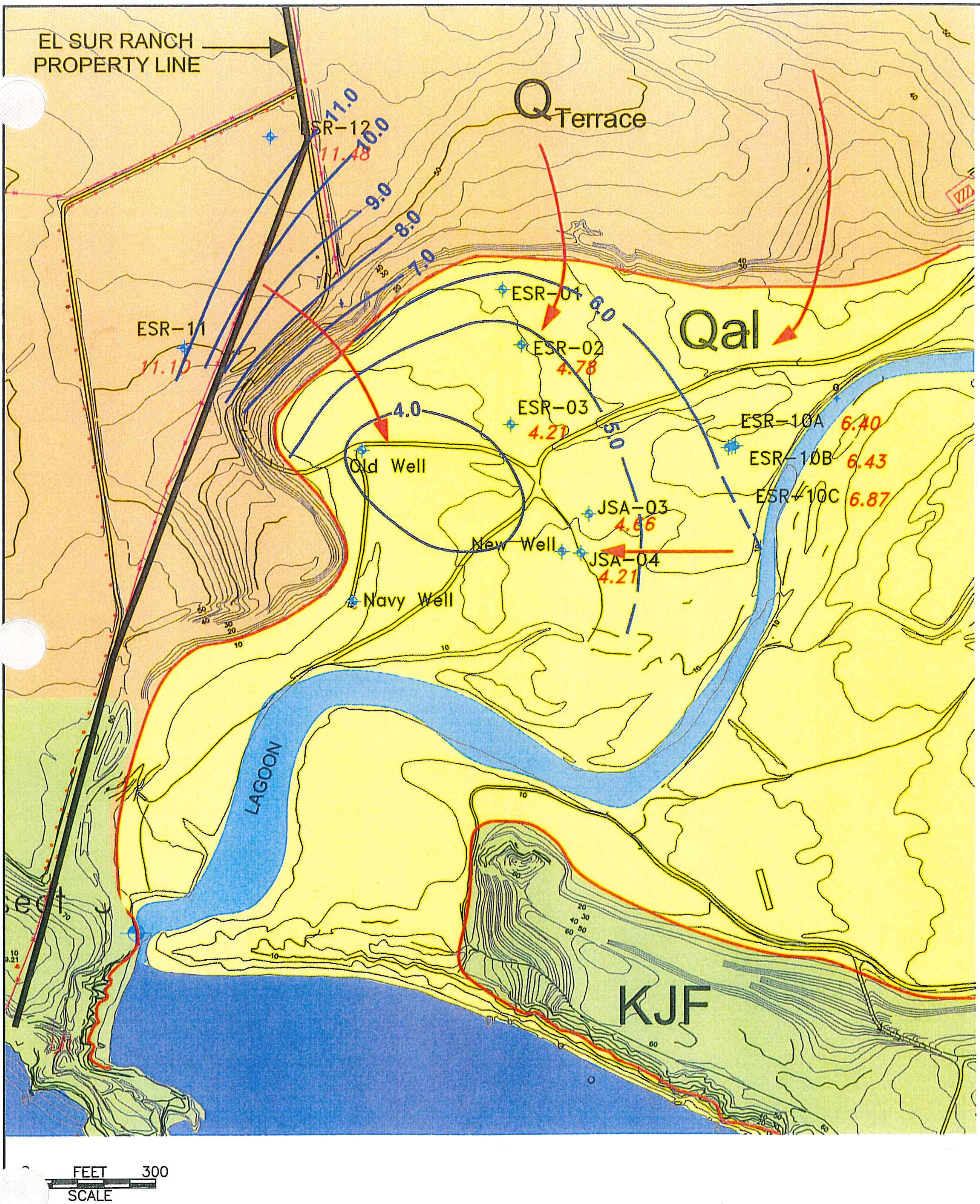
DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	SB	DRAFT	01-ESR-001	ESR-4 3-15



SGI environmental THE SOURCE GROUP, INC.

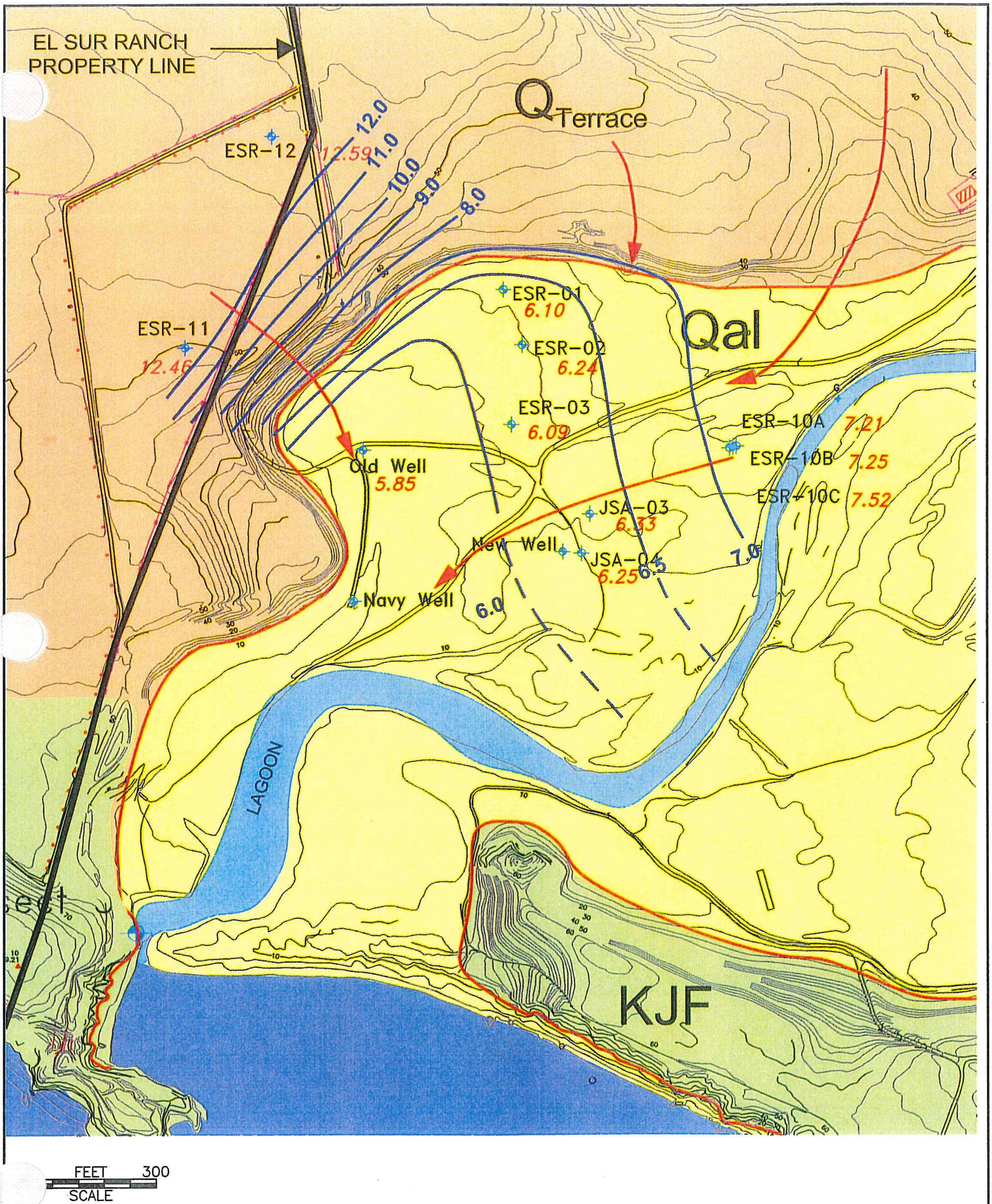
EL SUR RANCH BIG SUR, CALIFORNIA			GROUNDWATER ELEVATION CONTOURS (SEP 15, 2004) OLD WELL ONLY	
DATE 3/11/05	DR. BY SB	APP. BY DRAFT	PROJECT NO. 01-ESR-001	FIGURE NO. 3-16

ESR--4



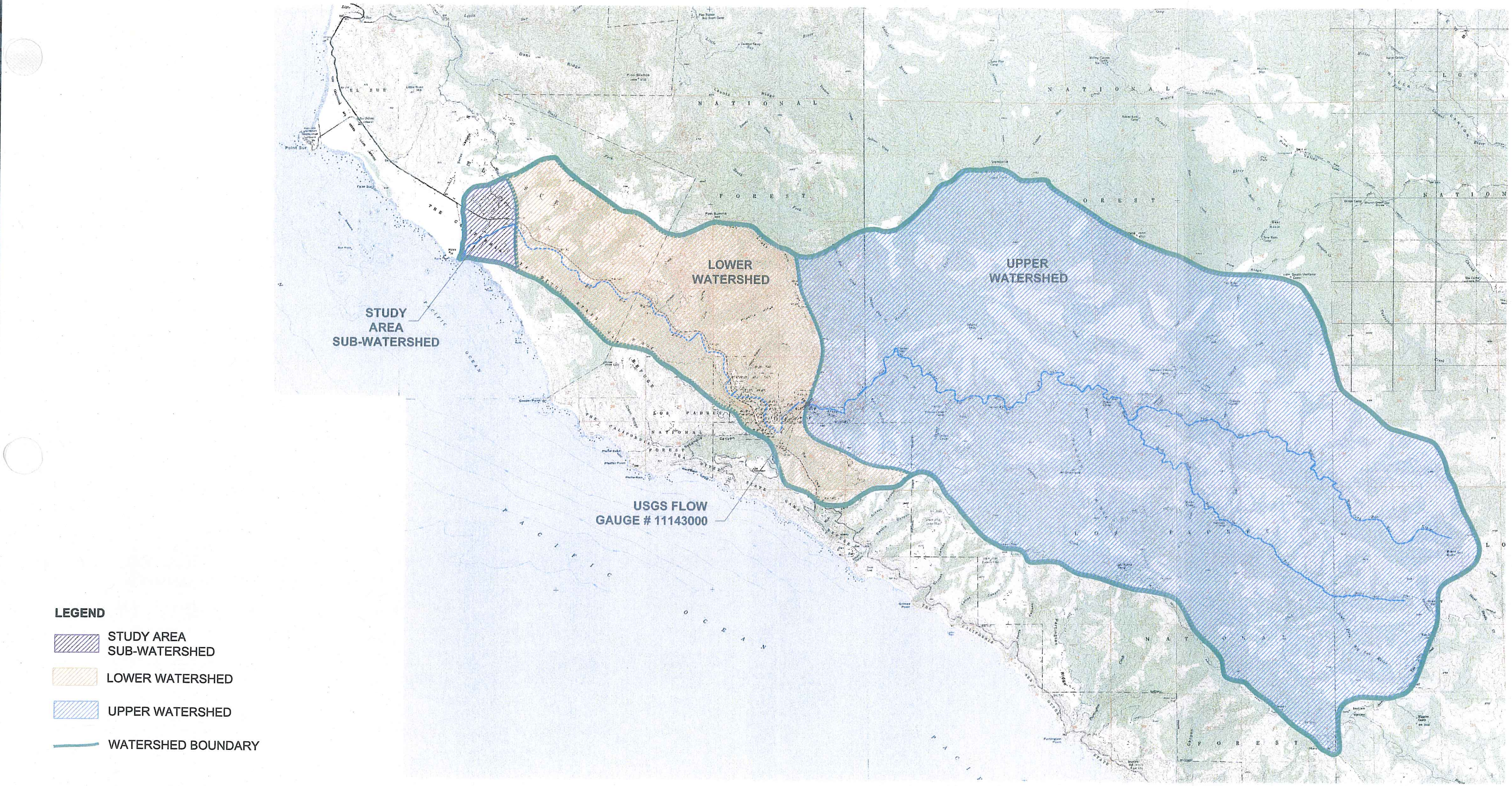
SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH BIG SUR, CALIFORNIA		*GROUNDWATER ELEVATION (SEPTEMBER 27, 2004) BOTH WELLS PUMPING*
DATE 3/11/05	DR. BY CP	APP. BY DRAFT
PROJECT NO. 01-ESR-001	FIGURE NO. 3-17	ESR-43



SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA		GROUNDWATER ELEVATION CONTOURS (OCTOBER 28, 2004) POST-PUMPING	
	DATE 3/11/05	DR. BY SB / APP. BY DRAFT	PROJECT NO. 01-ESR-001	FIGURE NO. 3-18

ESR-4



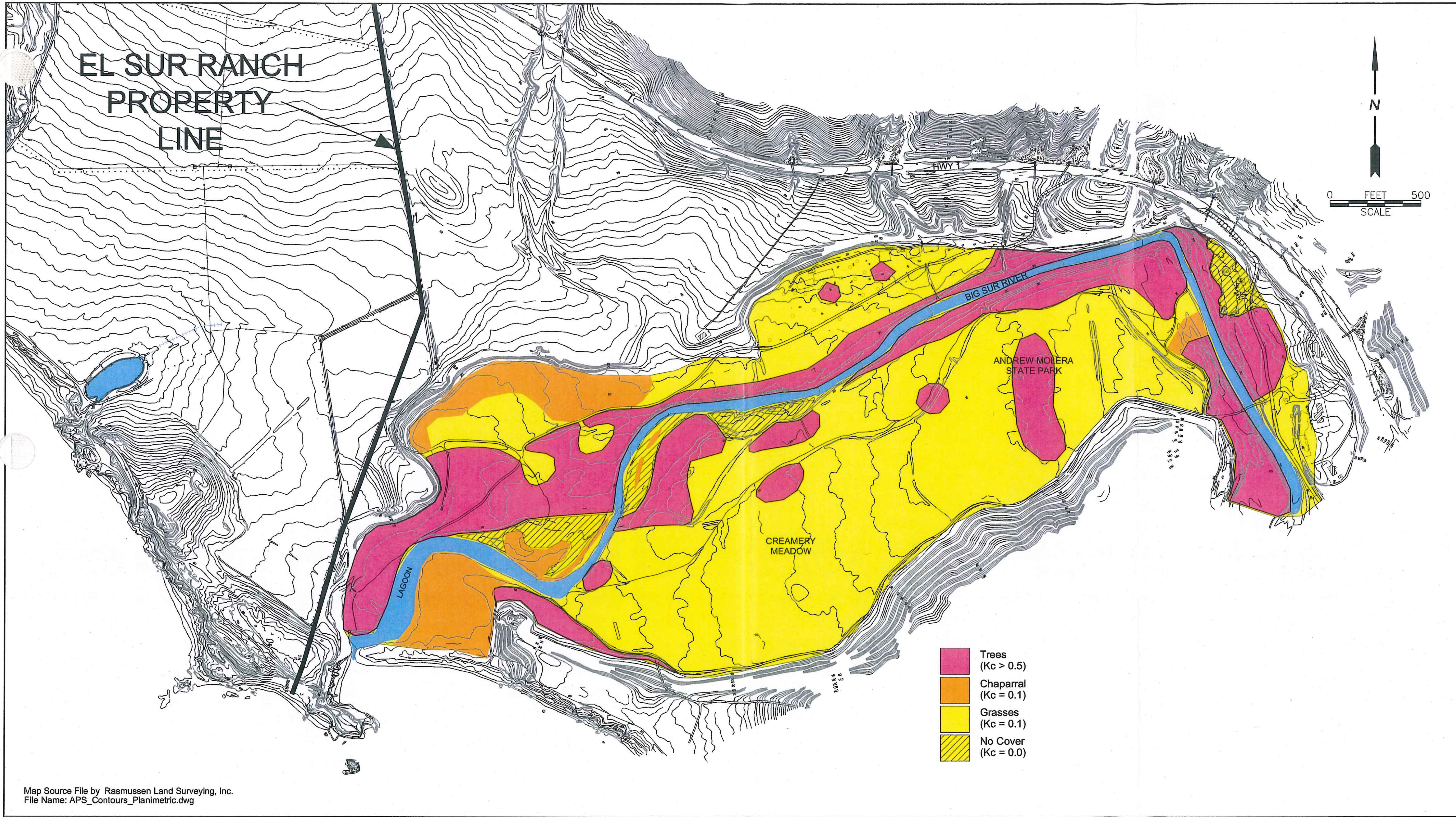
SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	ML/jp	PH

FIGURE 3-19

BIG SUR RIVER WATERSHED



SGI environmental THE SOURCE GROUP, INC.

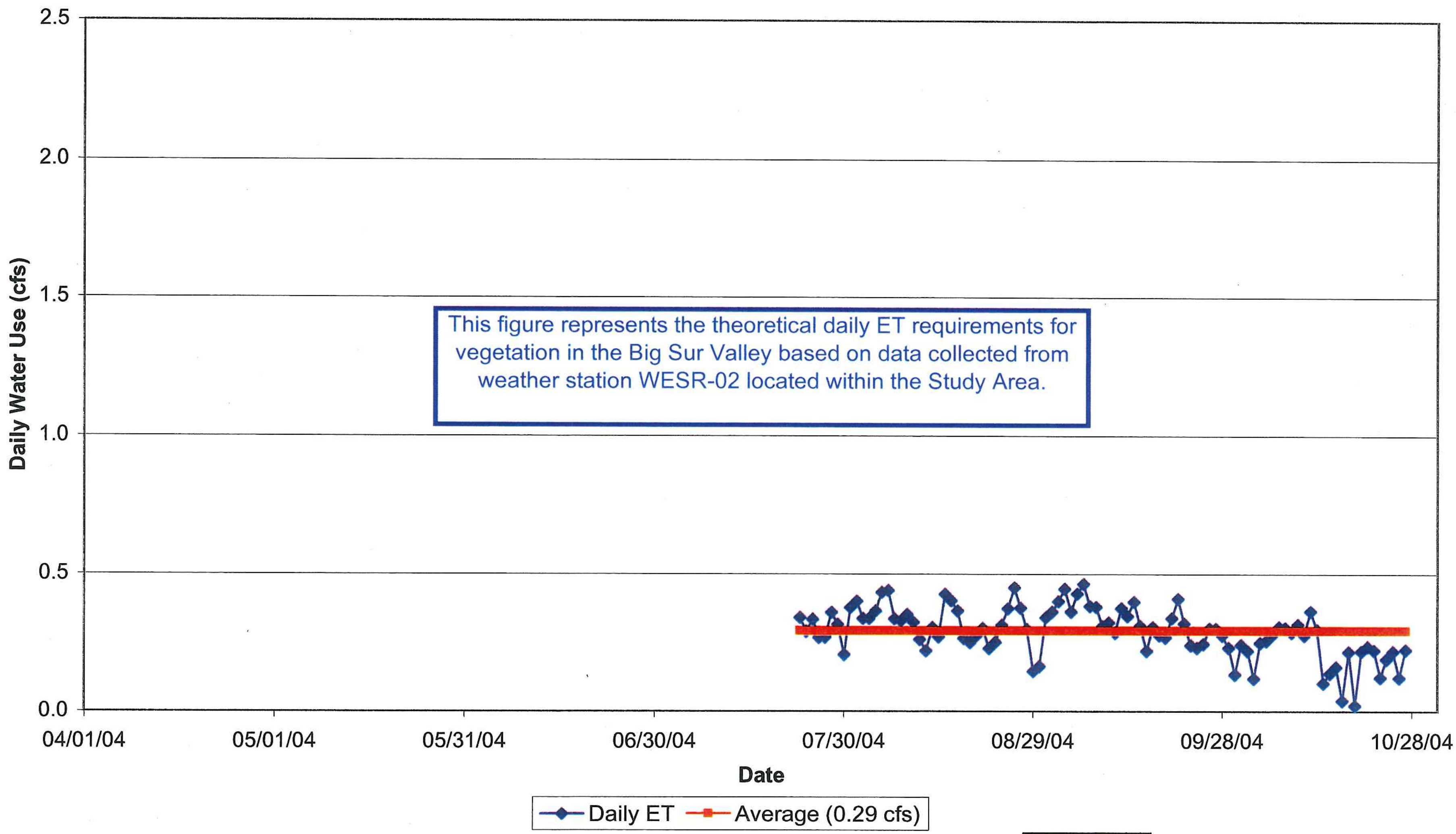
EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	ML/jp	PH

FIGURE 3-20

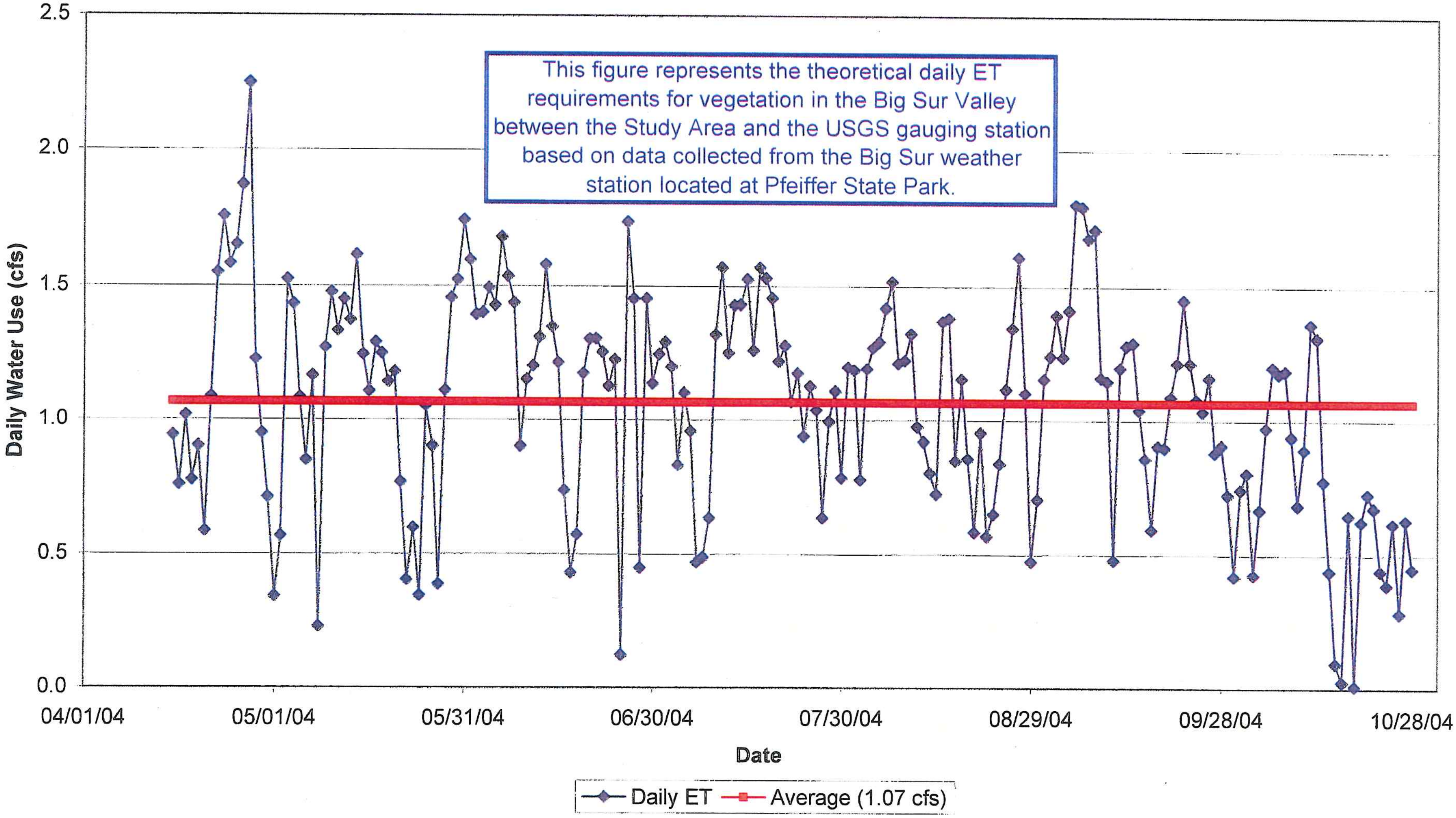
ESTIMATED VEGETATIVE COVER

Figure 3-21
Calculated Daily Evapotranspiration (ET) - WESR-02 Weather Station (Study Area)
El Sur Ranch



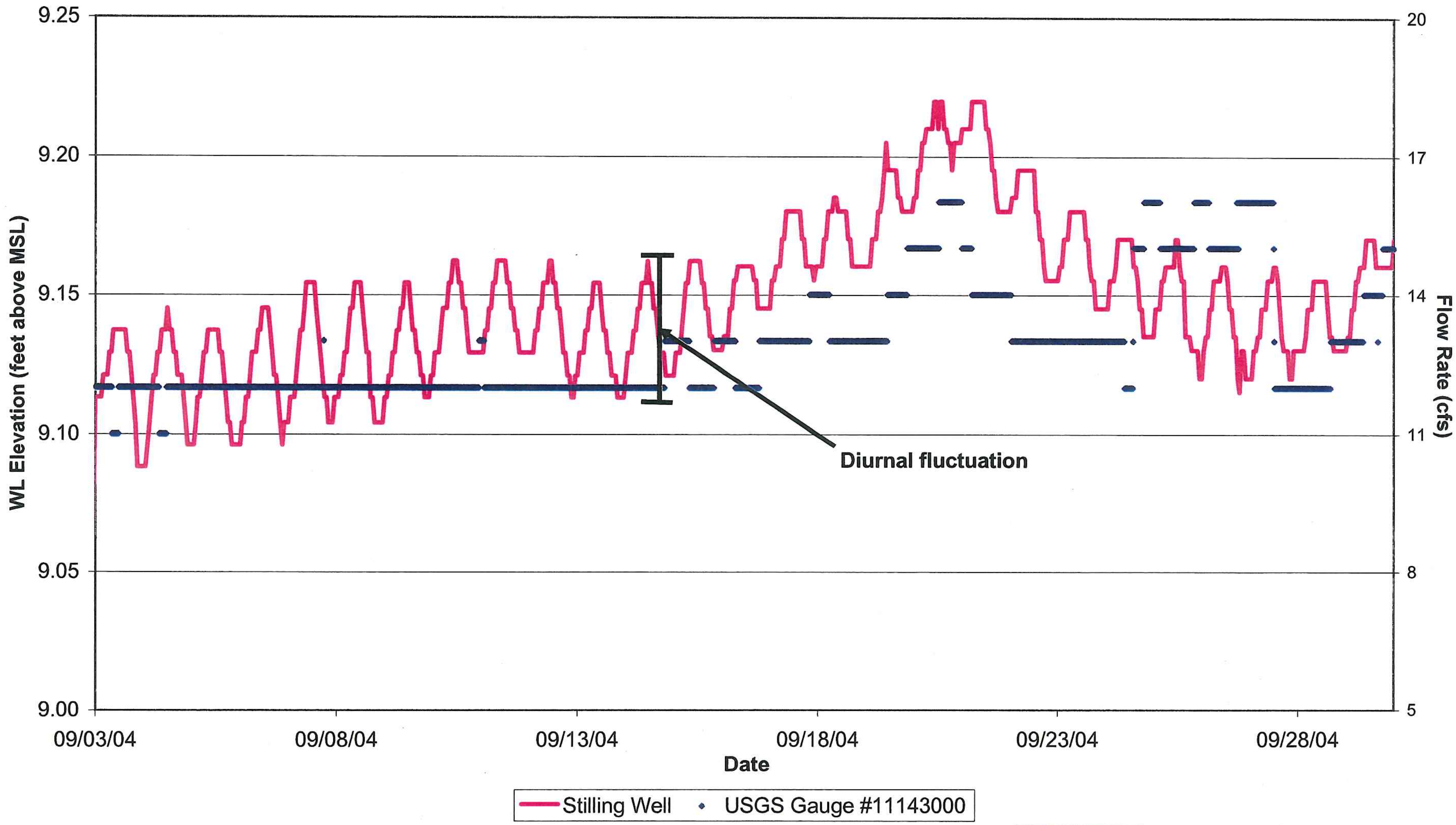
SGI environmental THE SOURCE GROUP, INC.

Figure 3-22
Calculated Daily Evapotranspiration (ET) - Big Sur Weather Station (Above Study Area & Below Big Sur Gauge)
El Sur Ranch



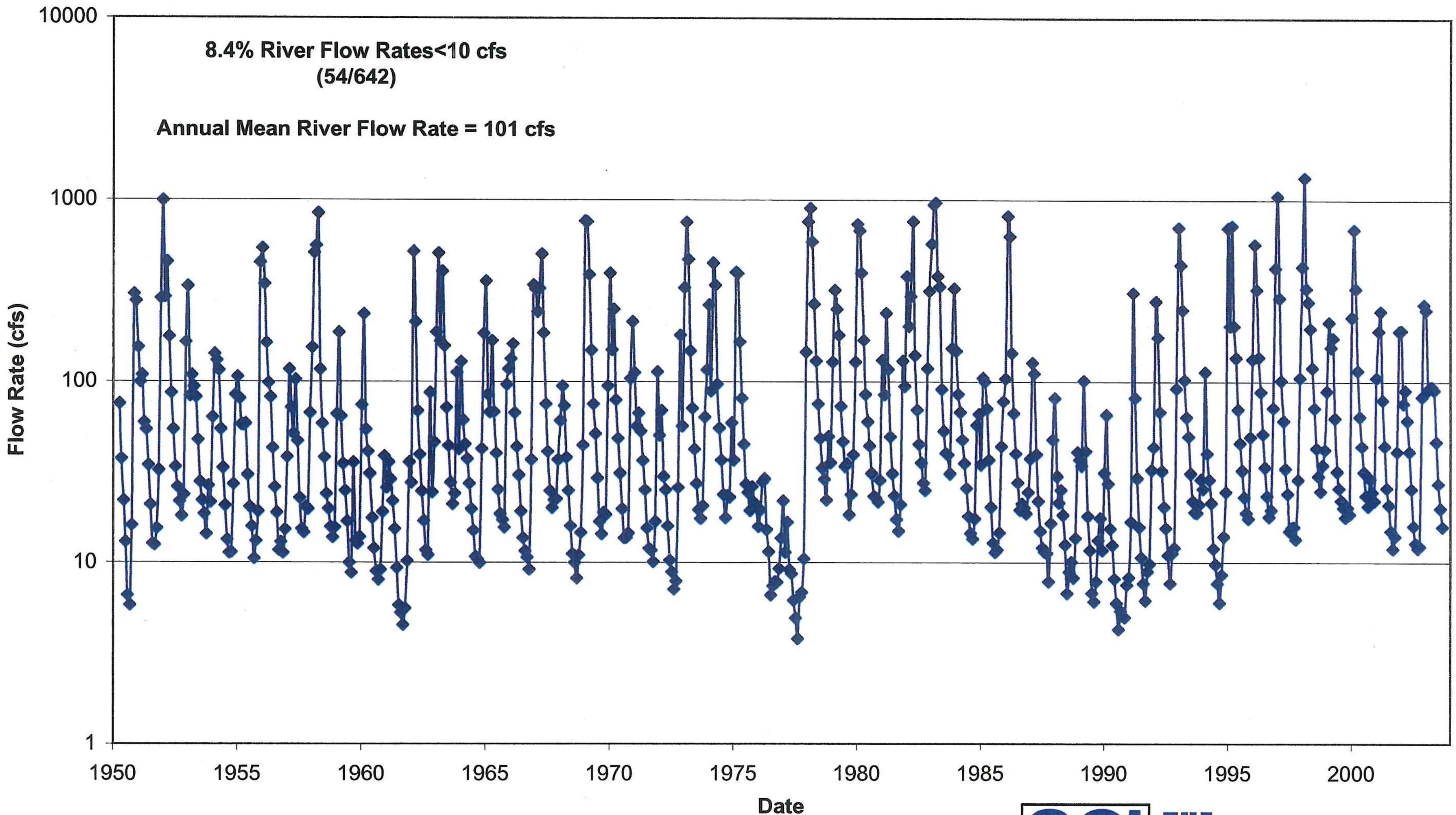
SGI environmental
THE SOURCE GROUP, INC.

Figure 3-23
River Elevation at Transect #2 with USGS Gauge Flow Rate
USGS Gauge #11143000
El Sur Ranch



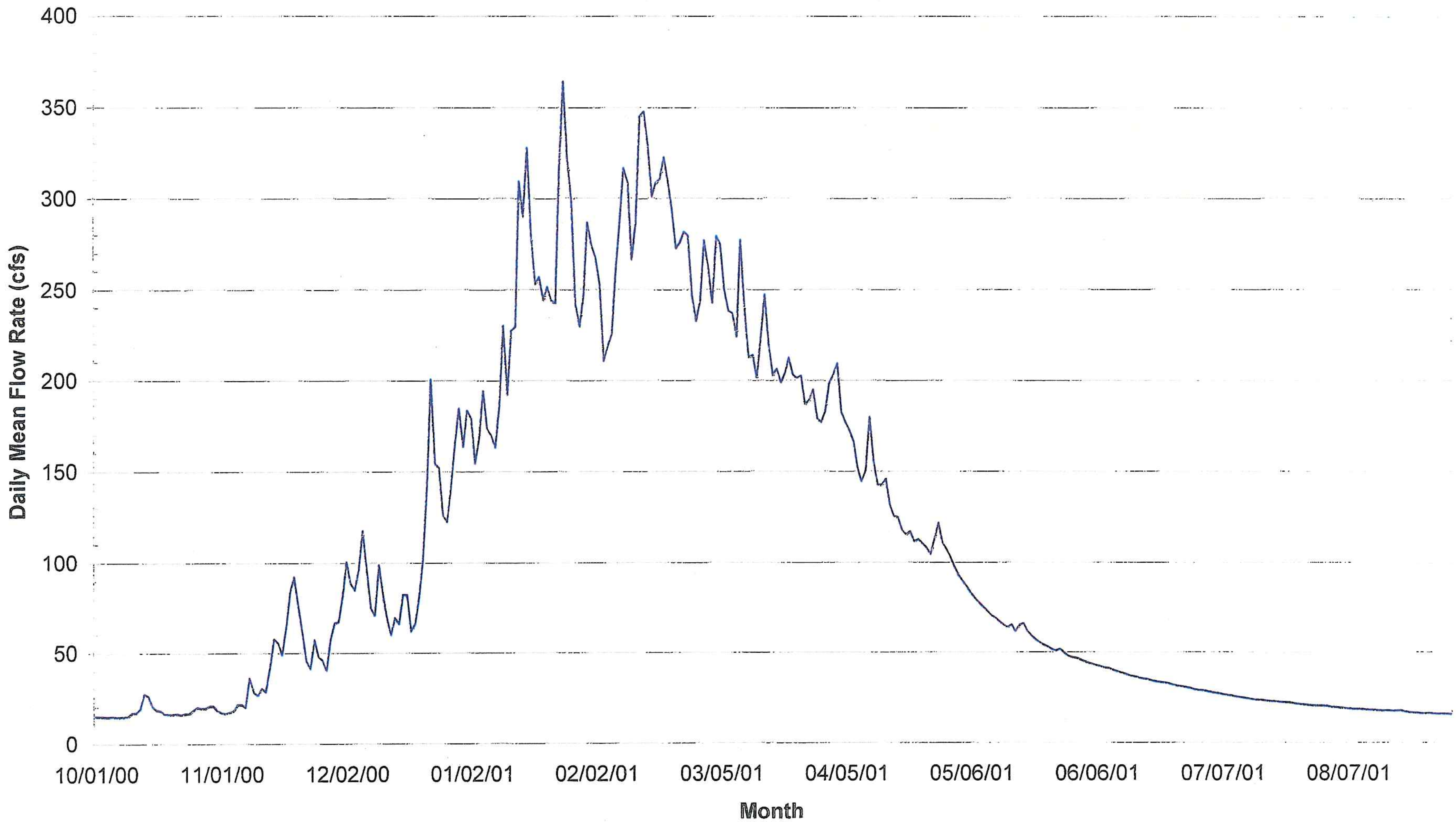
SGI environmental THE SOURCE GROUP, INC.

Figure 3-24
Historical River Flow Rate
USGS Gauge #11143000
(Average Monthly Flows)
El Sur Ranch



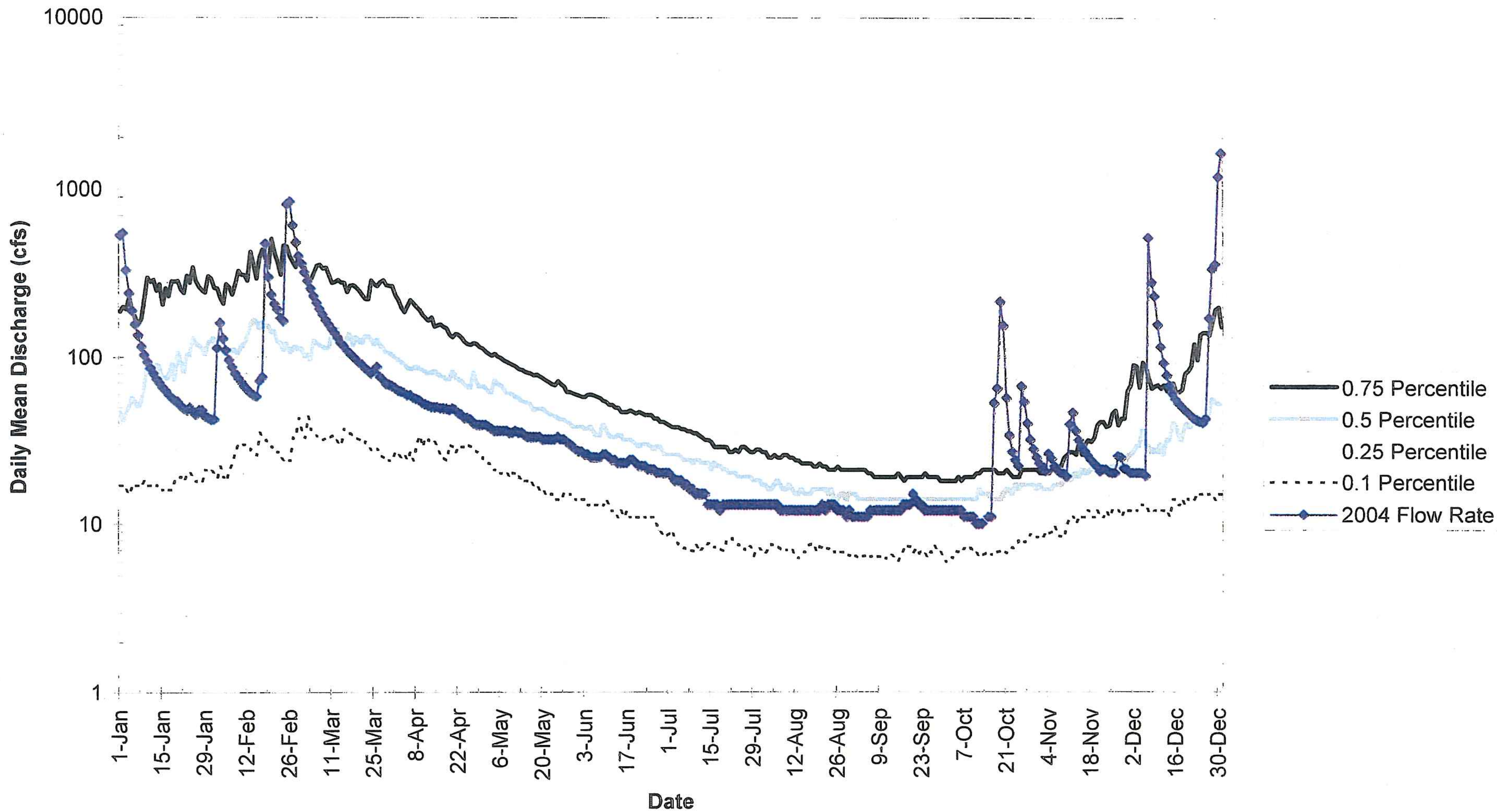
SGI environmental THE SOURCE GROUP, INC.

Figure 3-25
Big Sur River Mean Daily Flow Rates (April 1950 to March 2004)
USGS Gauge #11143000
El Sur Ranch



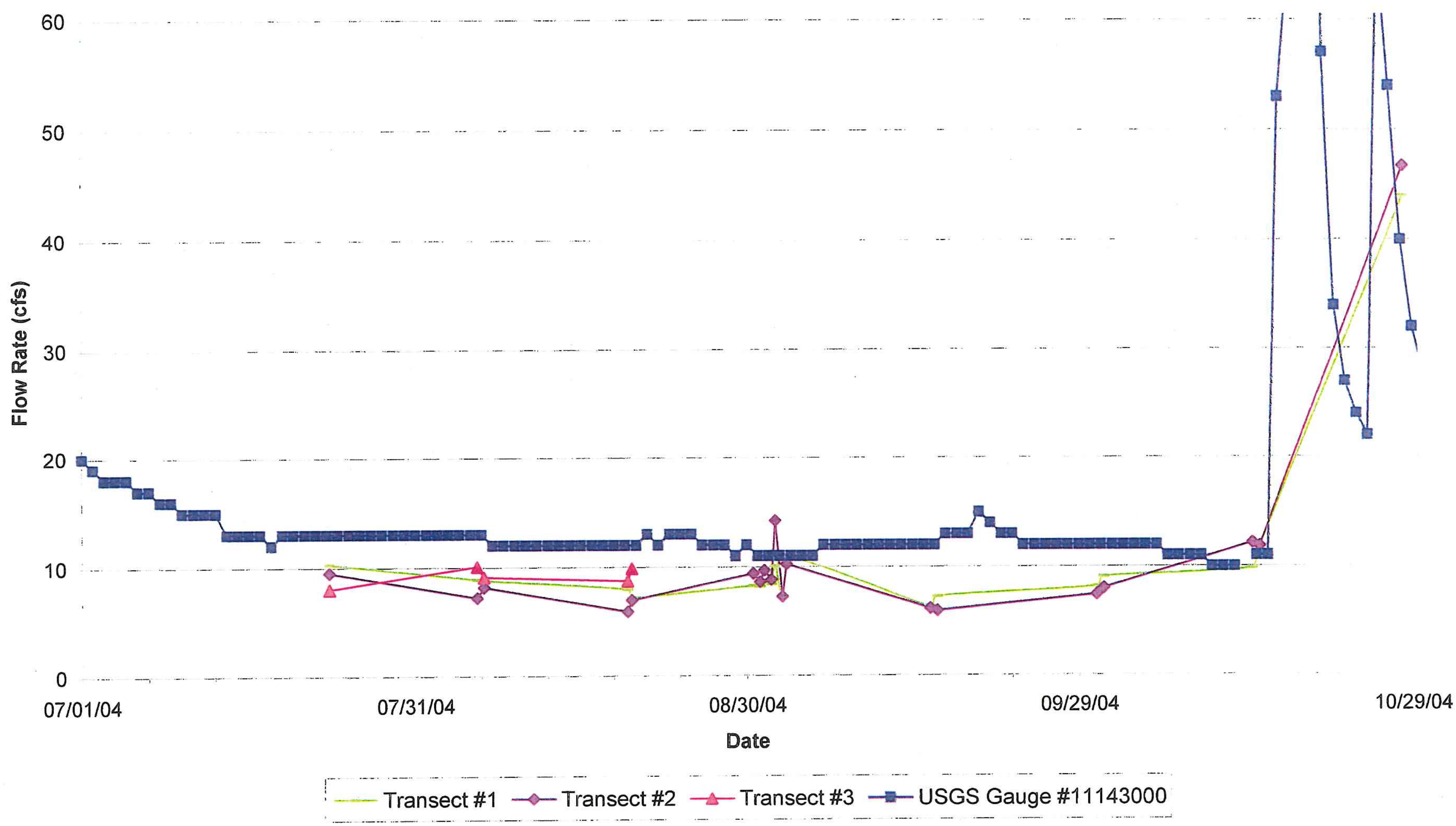
SGI environmental THE SOURCE GROUP, INC.

Figure 3-26
Big Sur River Daily Mean Discharge with 2004 USGS Gauge Flow Rate
USGS Gauge #11143000
El Sur Ranch

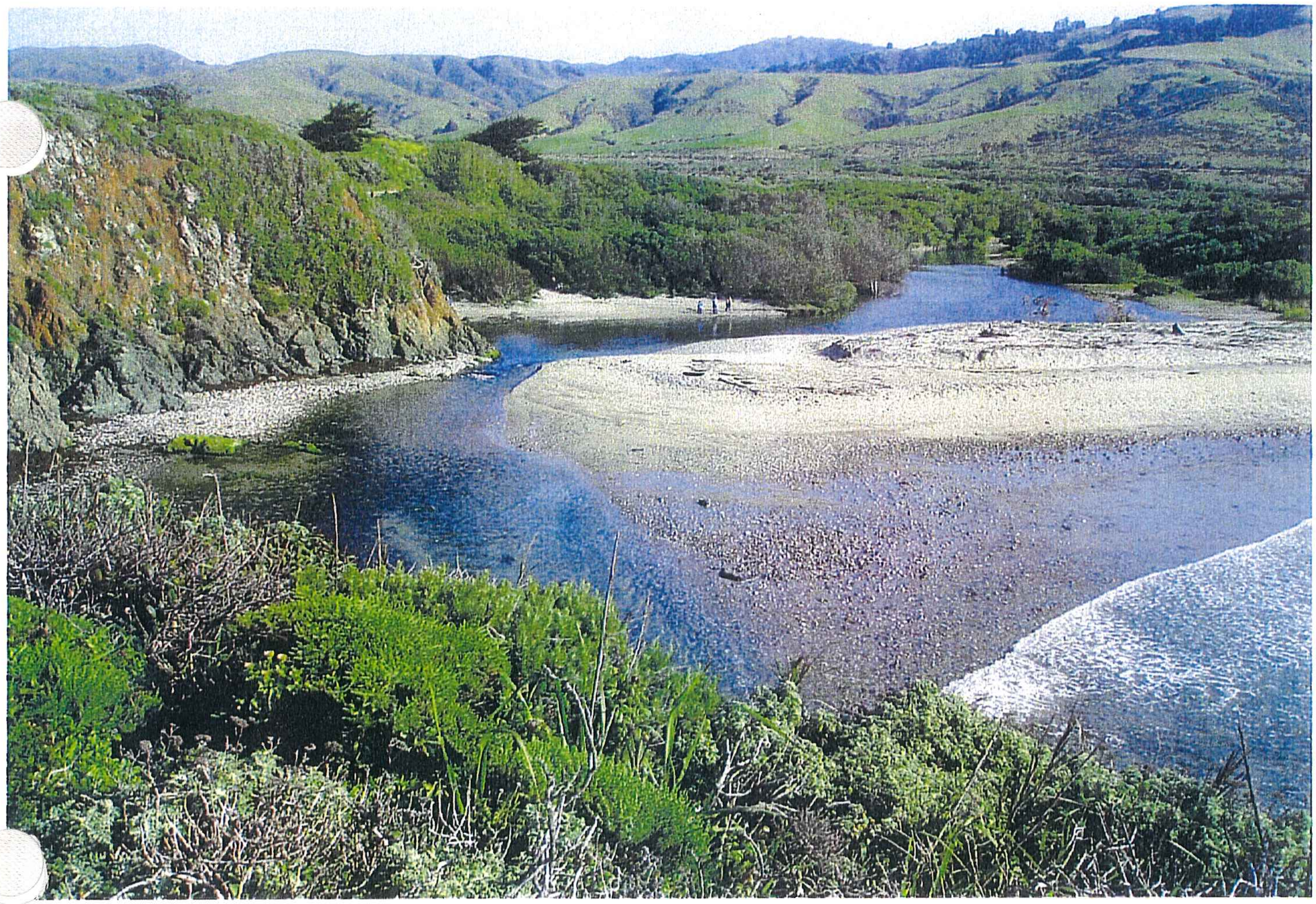


SGI environmental THE SOURCE GROUP, INC.

Figure 3-27
Transects #1, #2, and #3 and USGS Gauge Flow Rates
USGS Gauge #11143000
El Sur Ranch



SGI environmental THE SOURCE GROUP, INC.



SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

PRE LAGOON CLOSURE

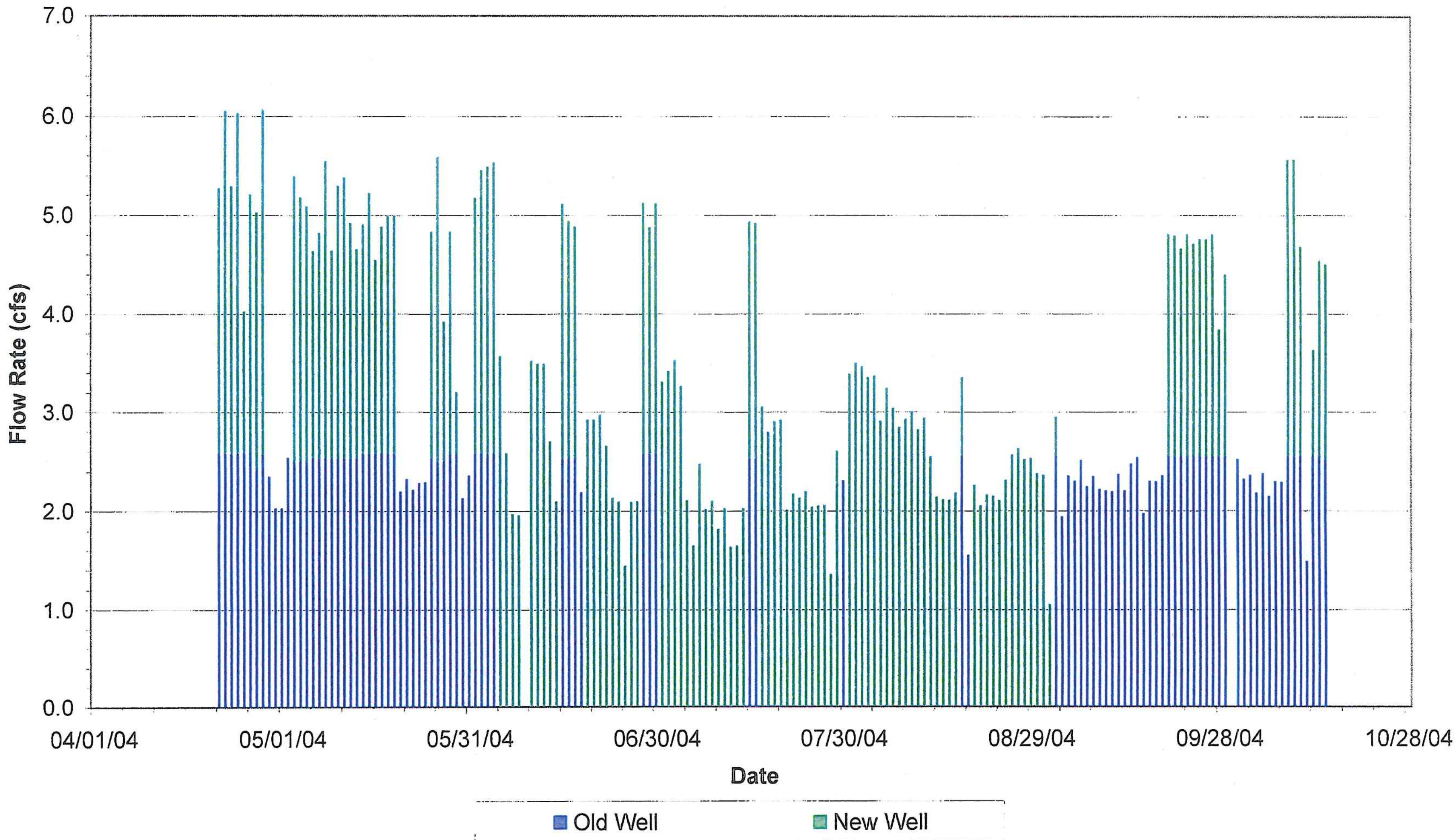
DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	SB		01-ESR-001	3-28

ESR--4

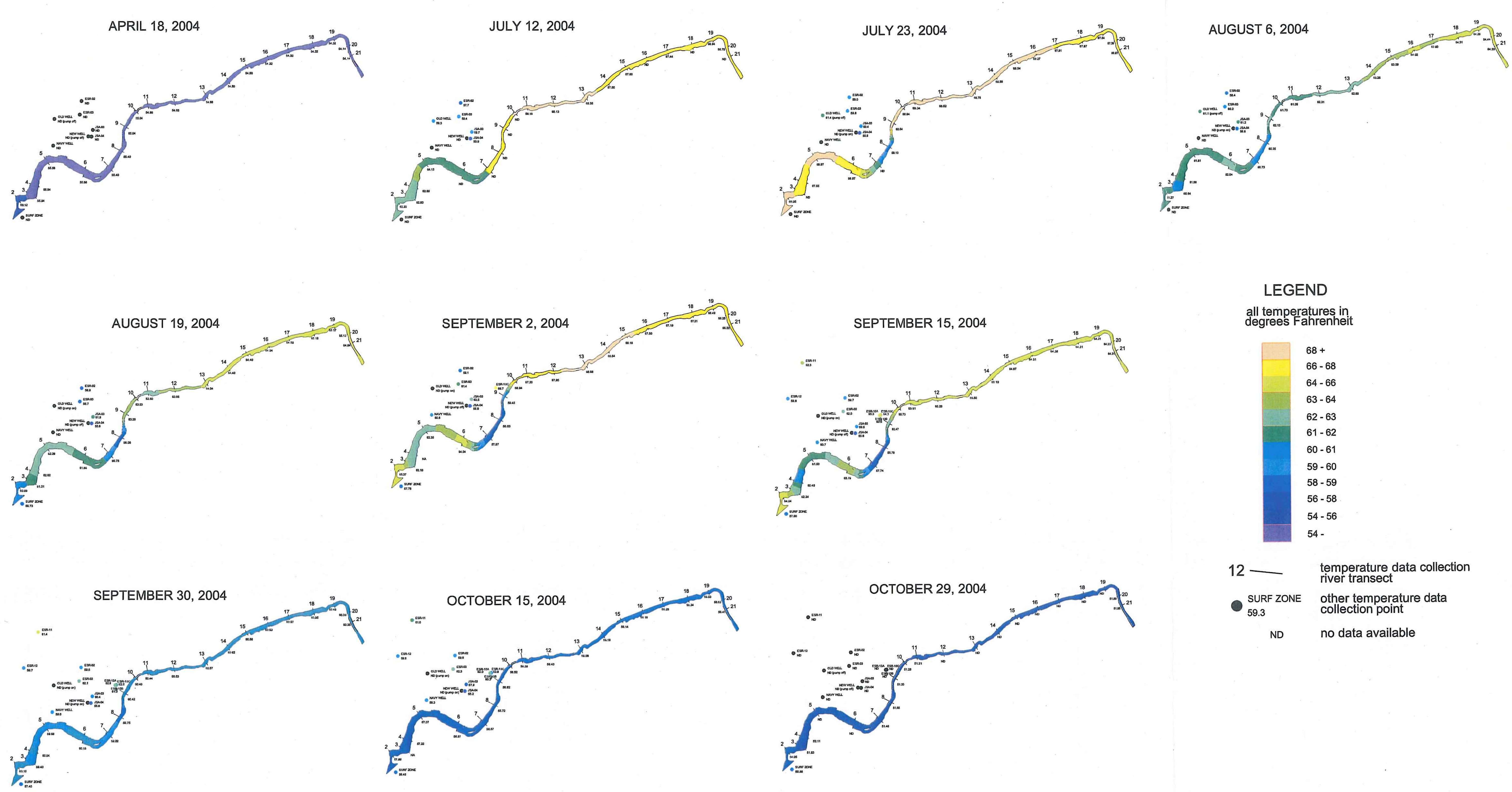
SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA			POST LAGOON CLOSURE	
	DATE 3/11/05	DR. BY SB	APP. BY	PROJECT NO. 01-ESR-001	FIGURE NO. 3-29

ESR--4

Figure 3-30
Daily Pumping Rate for El Sur Ranch
El Sur Ranch



SGI environmental — THE SOURCE GROUP, INC.



THE SOURCE GROUP, INC.
SGI environmental

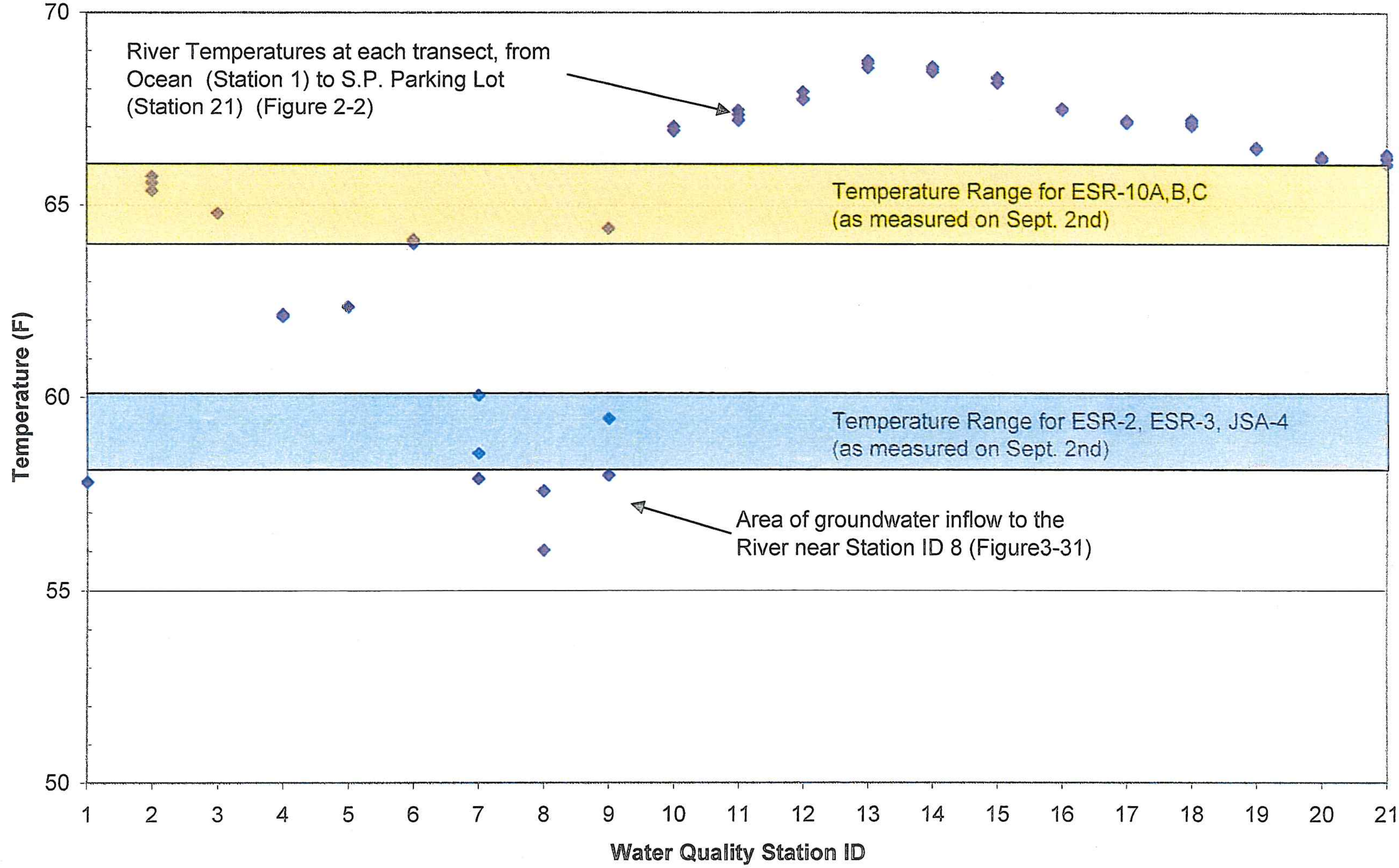
EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	4/27/05	JP	PH

FIGURE 3-31
RIVER TEMPERATURE PROFILES

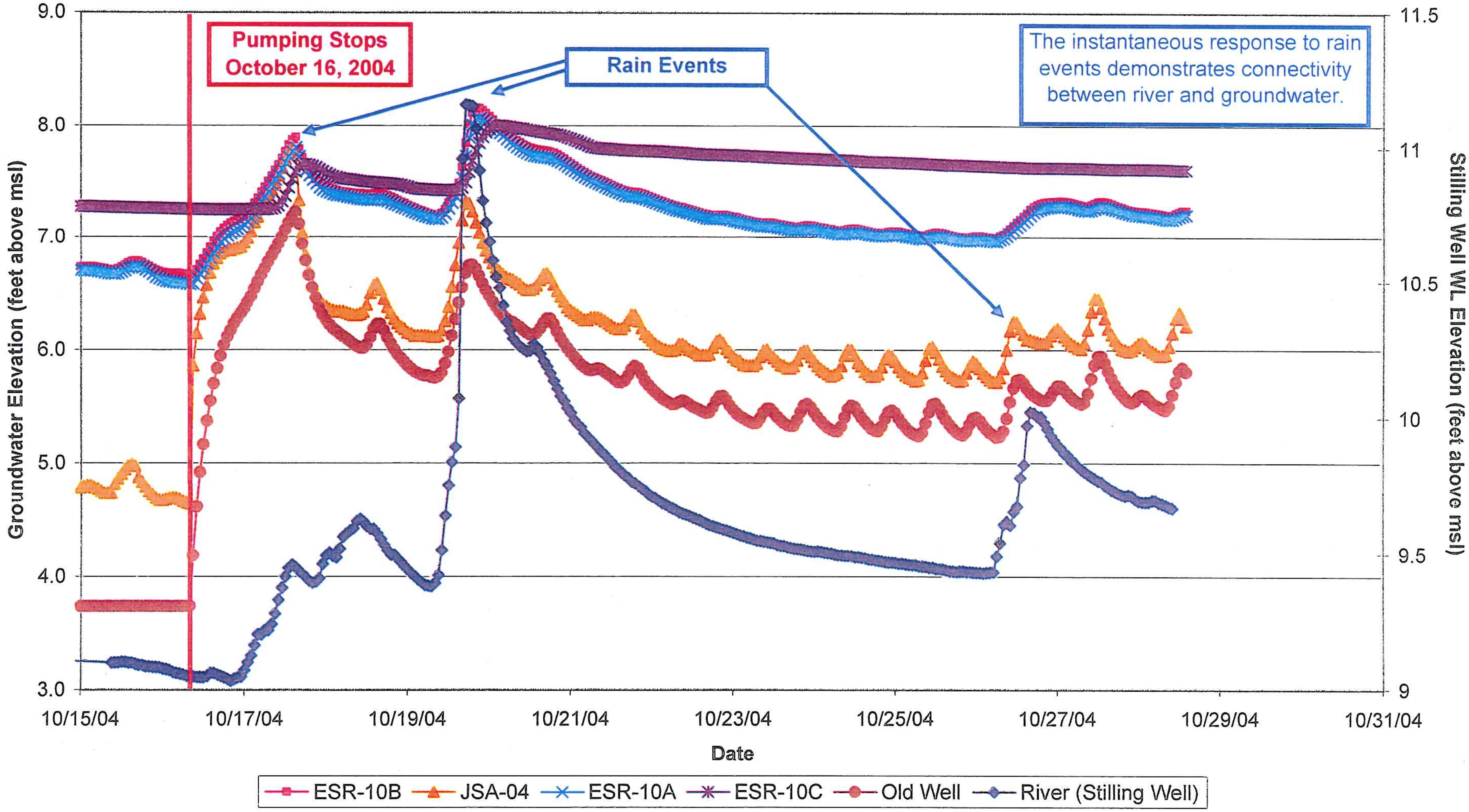
ESR--4

Figure 3-32
Groundwater and Big Sur River Temperatures
September 2, 2004
El Sur Ranch



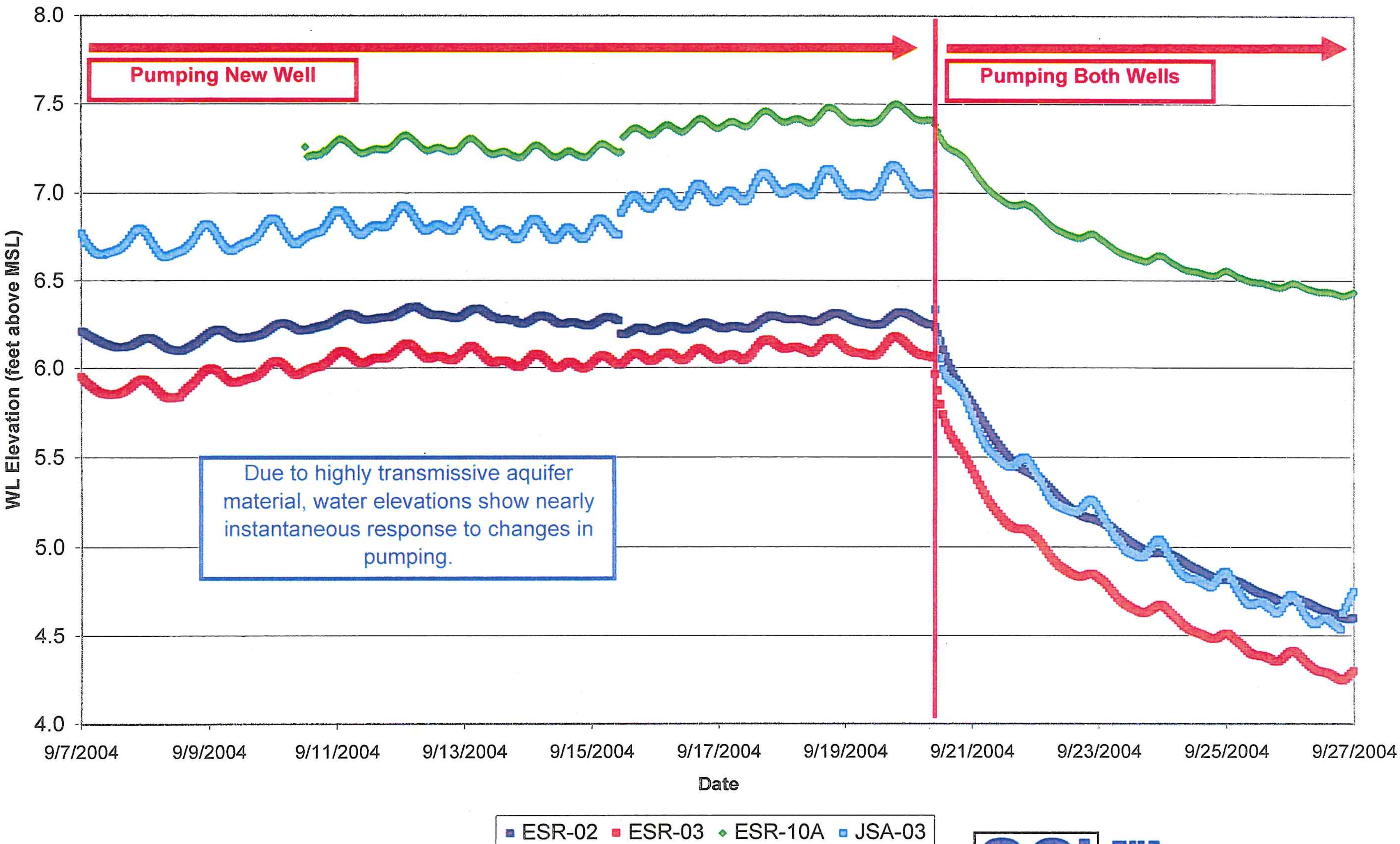
SGI environmental THE SOURCE GROUP, INC.

Figure 3-33
River Level and Groundwater Level Response to Rain Events
El Sur Ranch



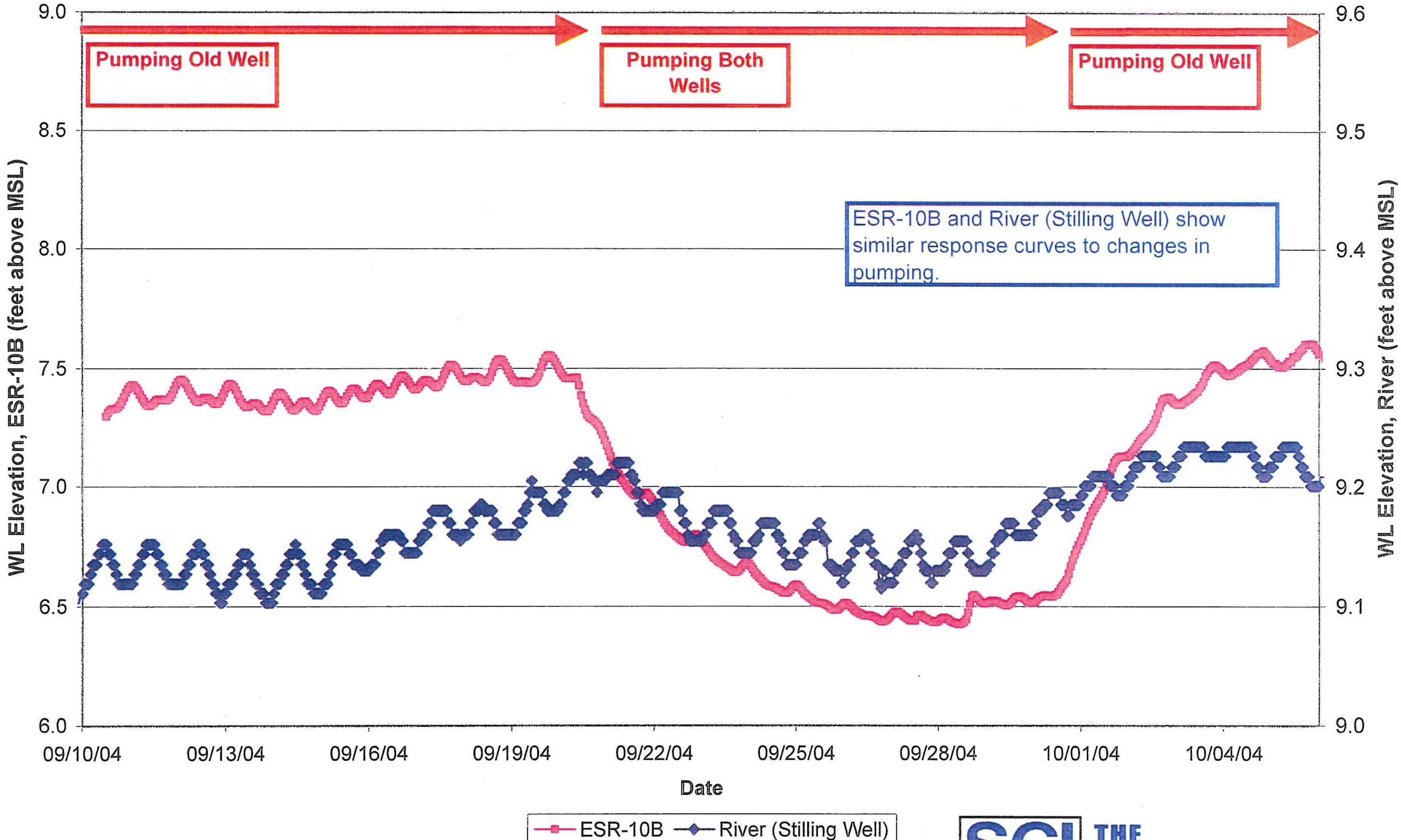
SGI environmental THE SOURCE GROUP, INC.

Figure 3-34
Effect of Pumping on Groundwater Elevations
El Sur Ranch



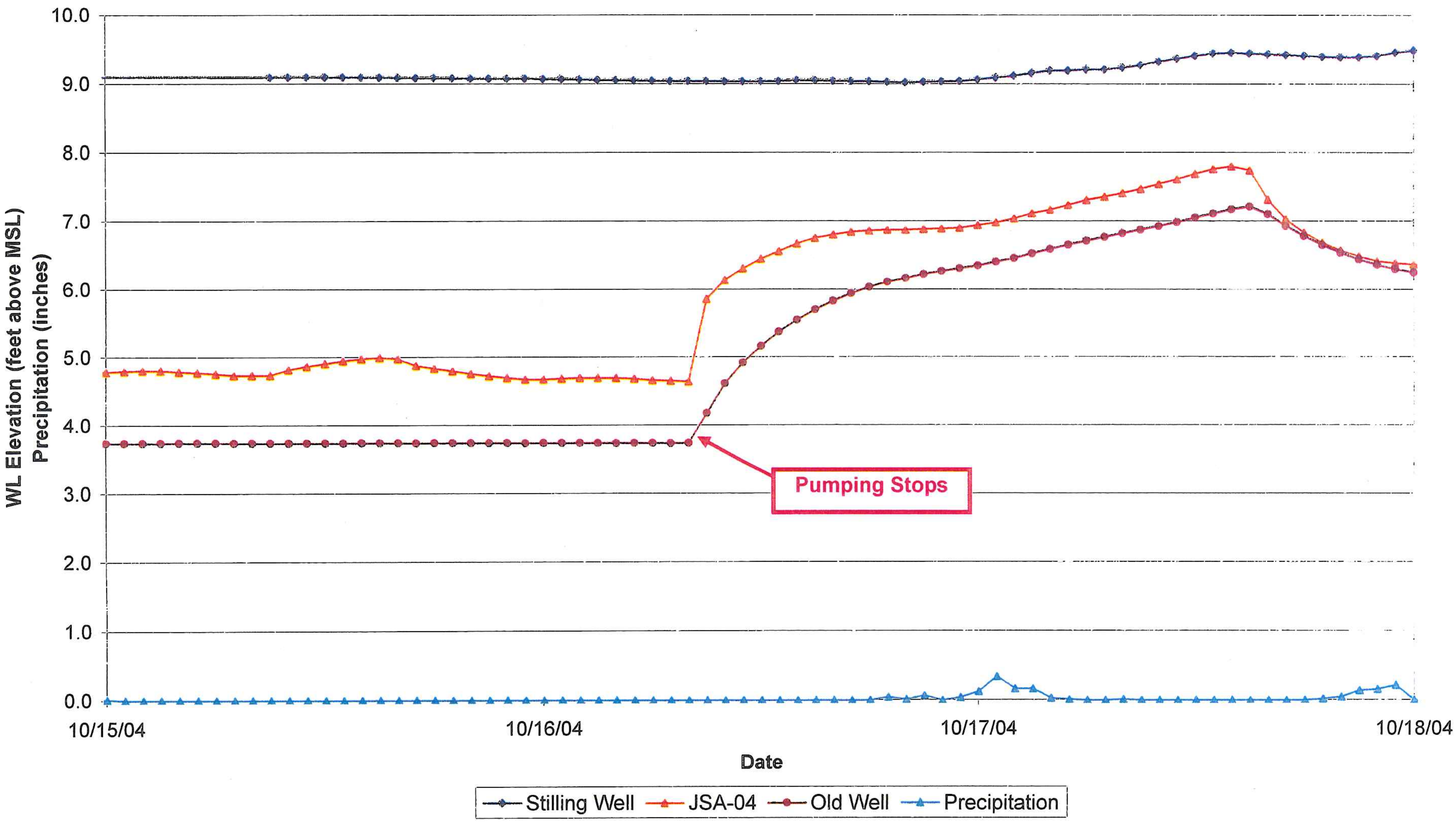
SGI environmental THE SOURCE GROUP, INC.

Figure 3-35
Effect of Pumping on River Elevation and Selected Groundwater Elevation
El Sur Ranch



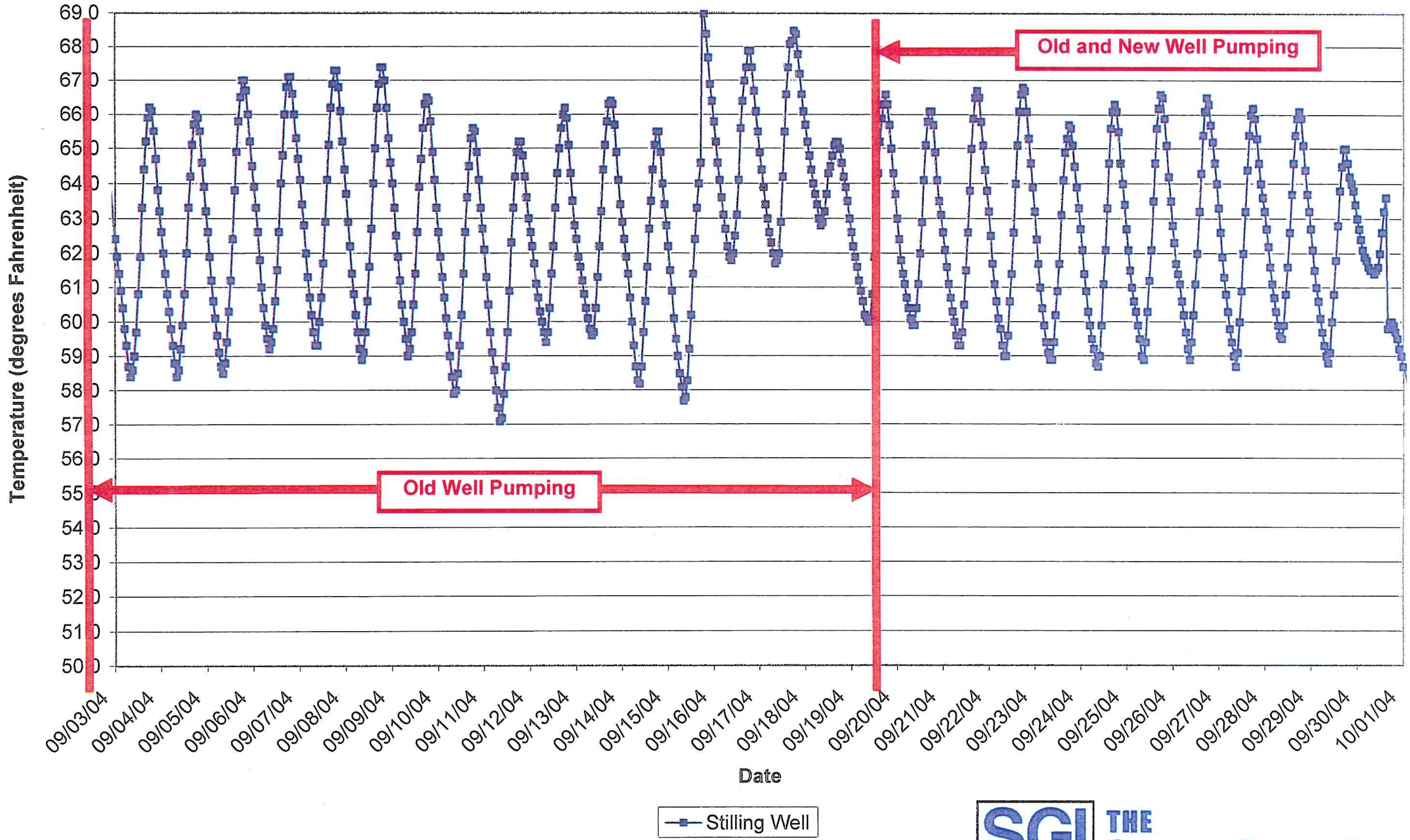
THE SOURCE GROUP, INC.

Figure 3-36
Groundwater and Surface Water Elevation Response to the Cessation of Pumping
El Sur Ranch



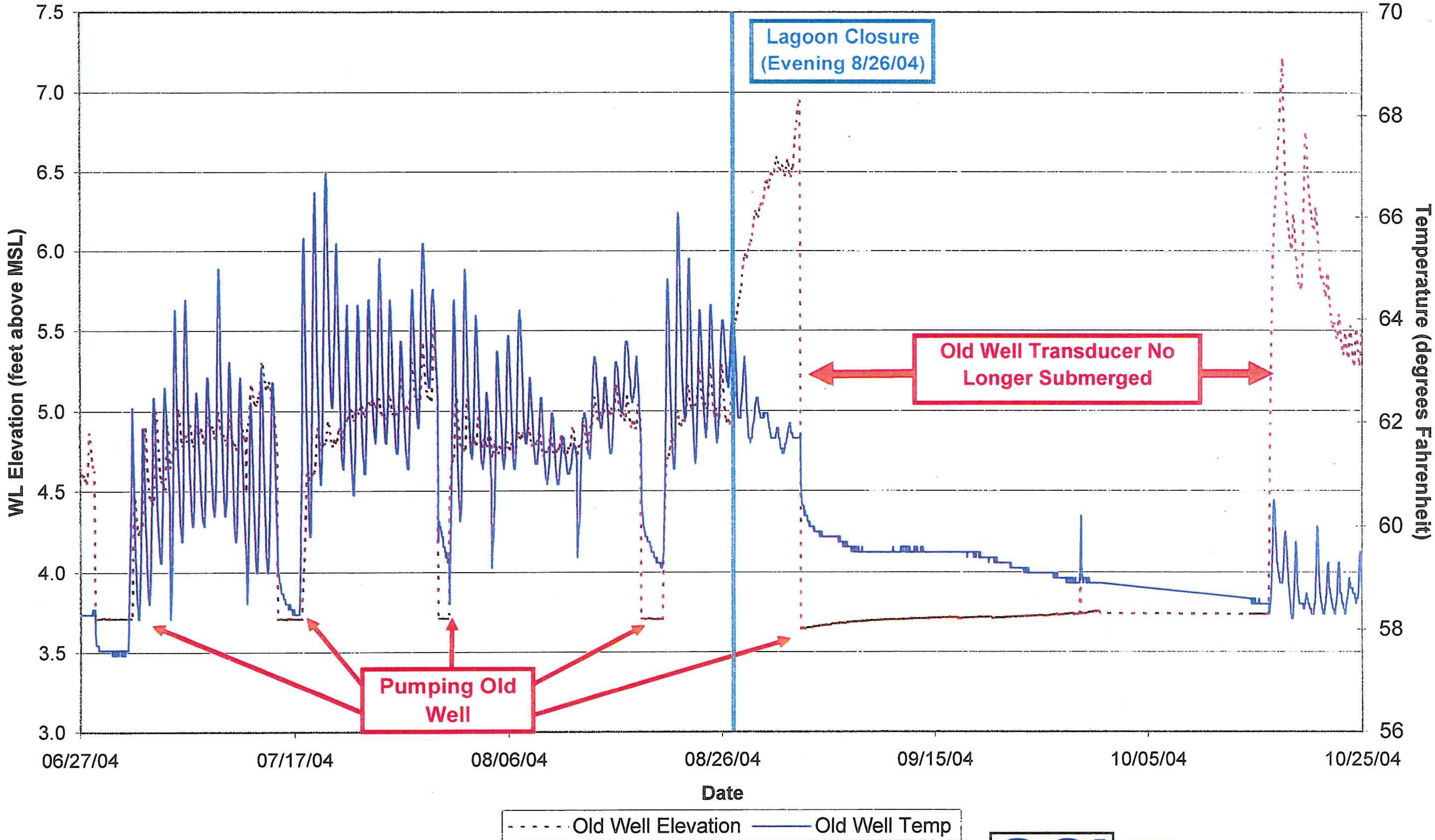
THE SOURCE GROUP, INC.
SGI environmental

Figure 3-37
Effects of Pumping On Stilling Well Temperature
El Sur Ranch



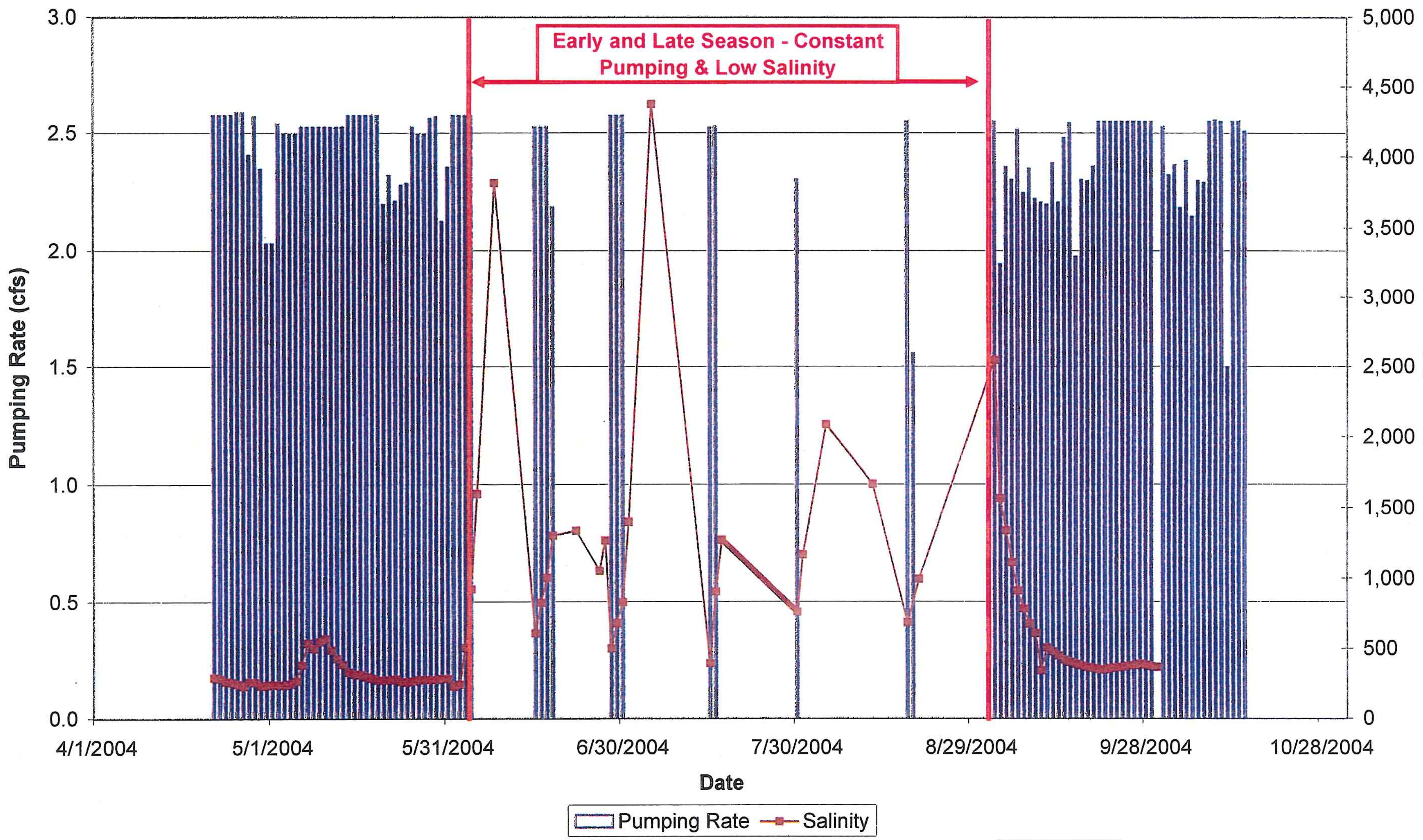
THE SOURCE GROUP, INC.
SGI environmental

Figure 3-38
Effects of Pumping on Old Well Groundwater Elevation and Temperature
El Sur Ranch



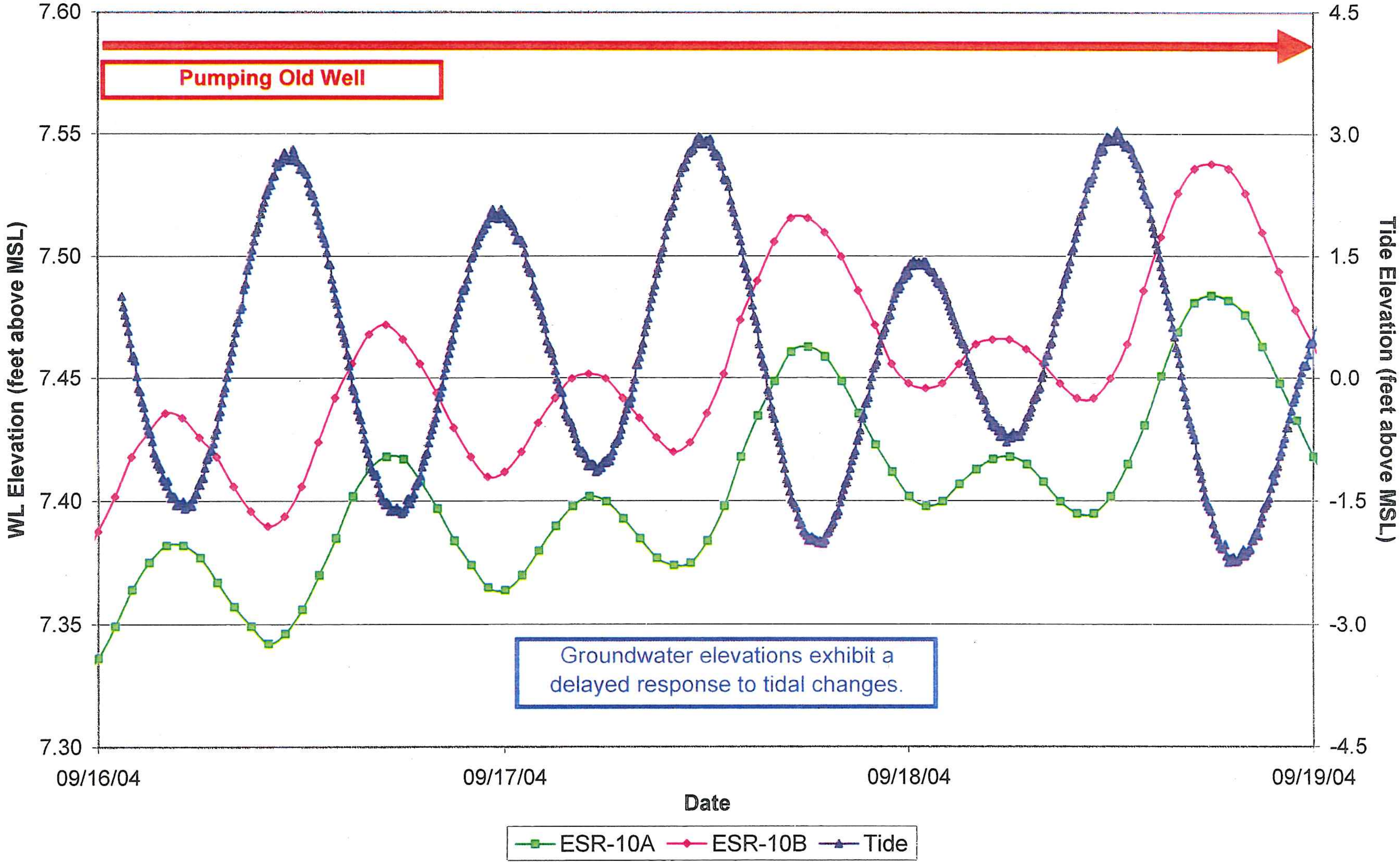
SGI environmental THE SOURCE GROUP, INC.

Figure 3-39
Old Well Pumping Rate and Effects on Salinity Level
El Sur Ranch



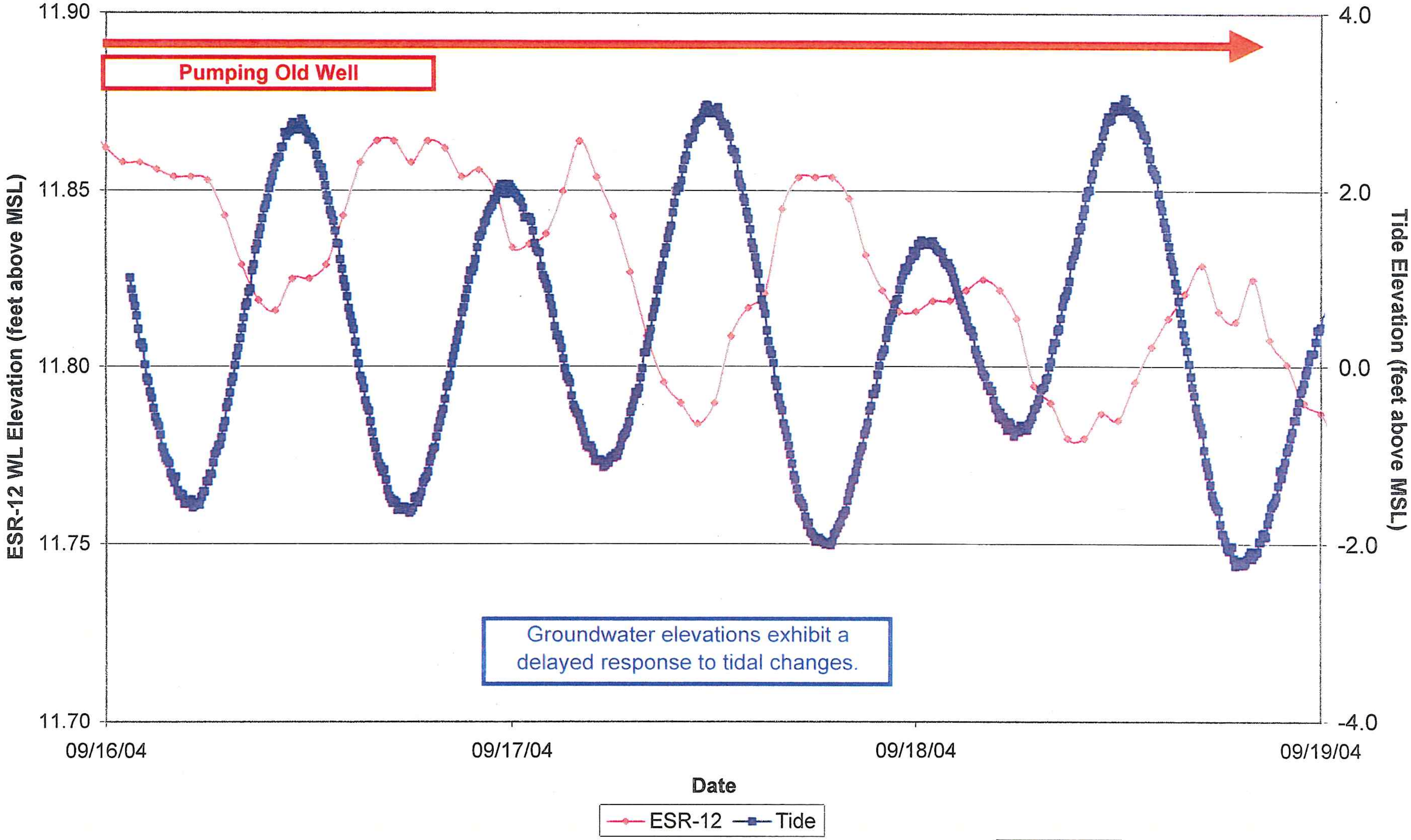
SGI environmental THE SOURCE GROUP, INC.

Figure 3-40
Tidal Influence in Aquifer Wells (ESR-10A and ESR-10B)
El Sur Ranch



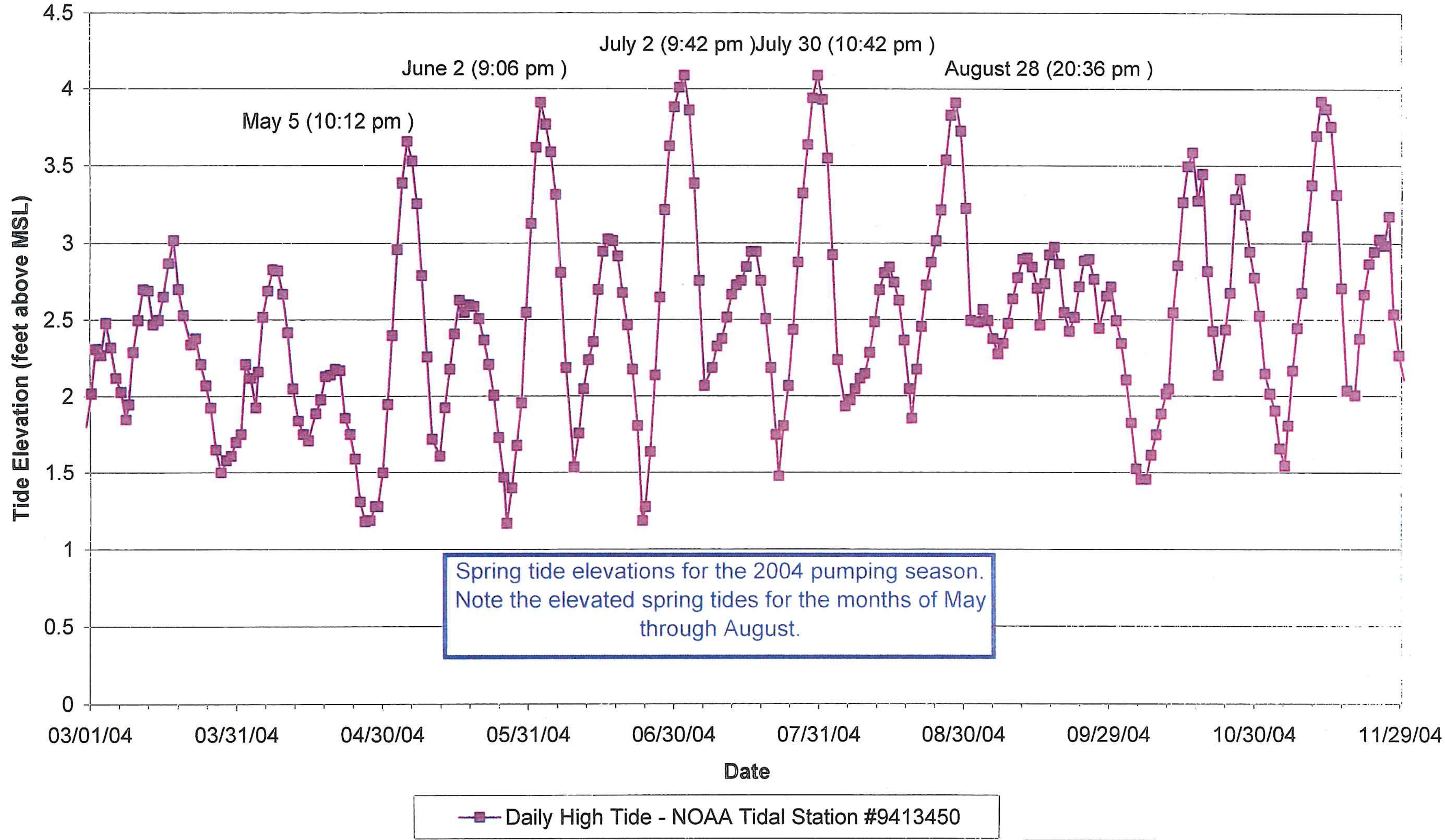
THE SOURCE GROUP, INC.

Figure 3-41
Tidal Influence in Terrace Well (ESR-12)
El Sur Ranch



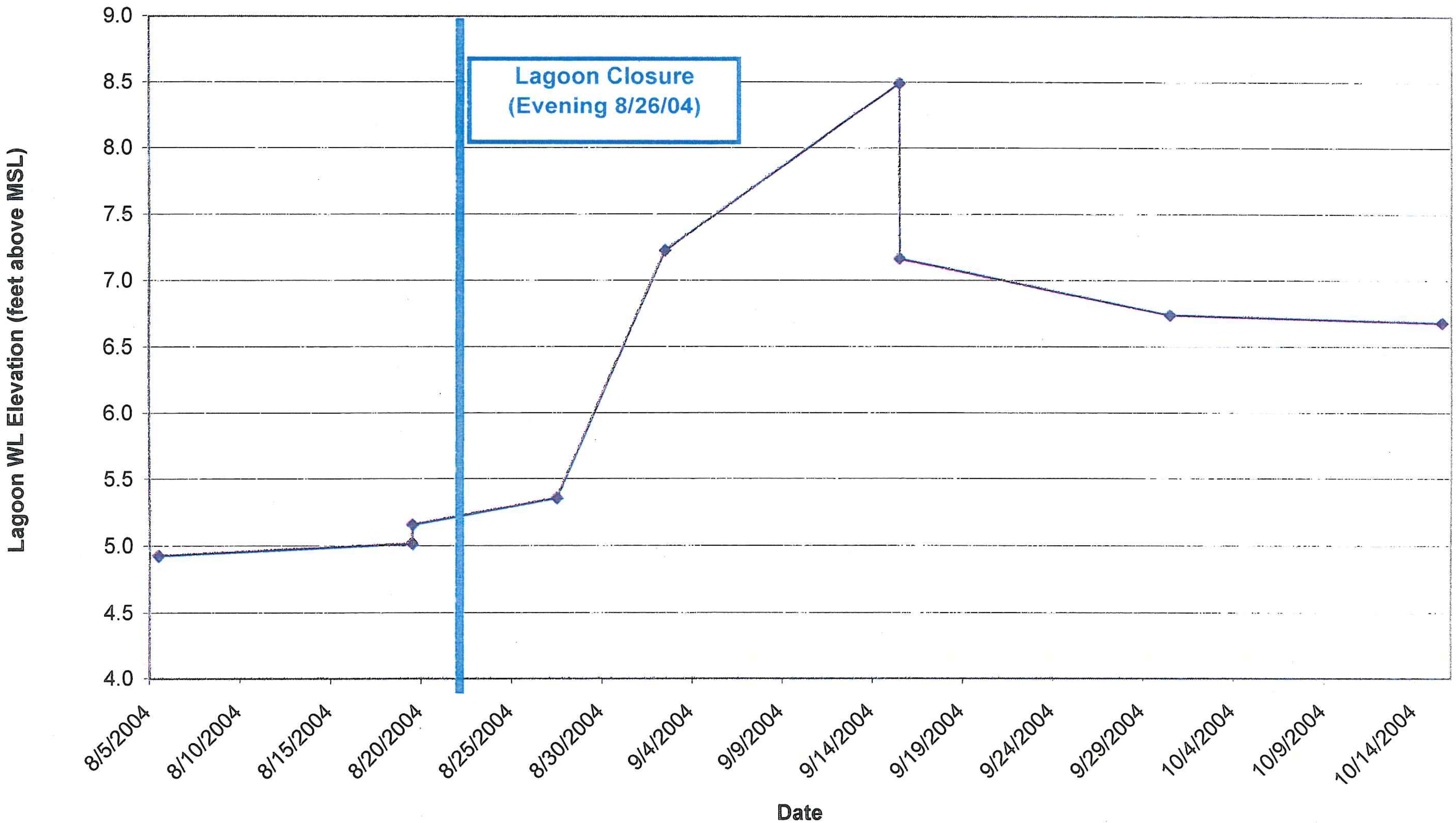
THE SOURCE GROUP, INC.
SGI environmental

Figure 3-42
Spring Tide Elevation
NOAA Tidal Station #9413450
Monterey Harbor, California



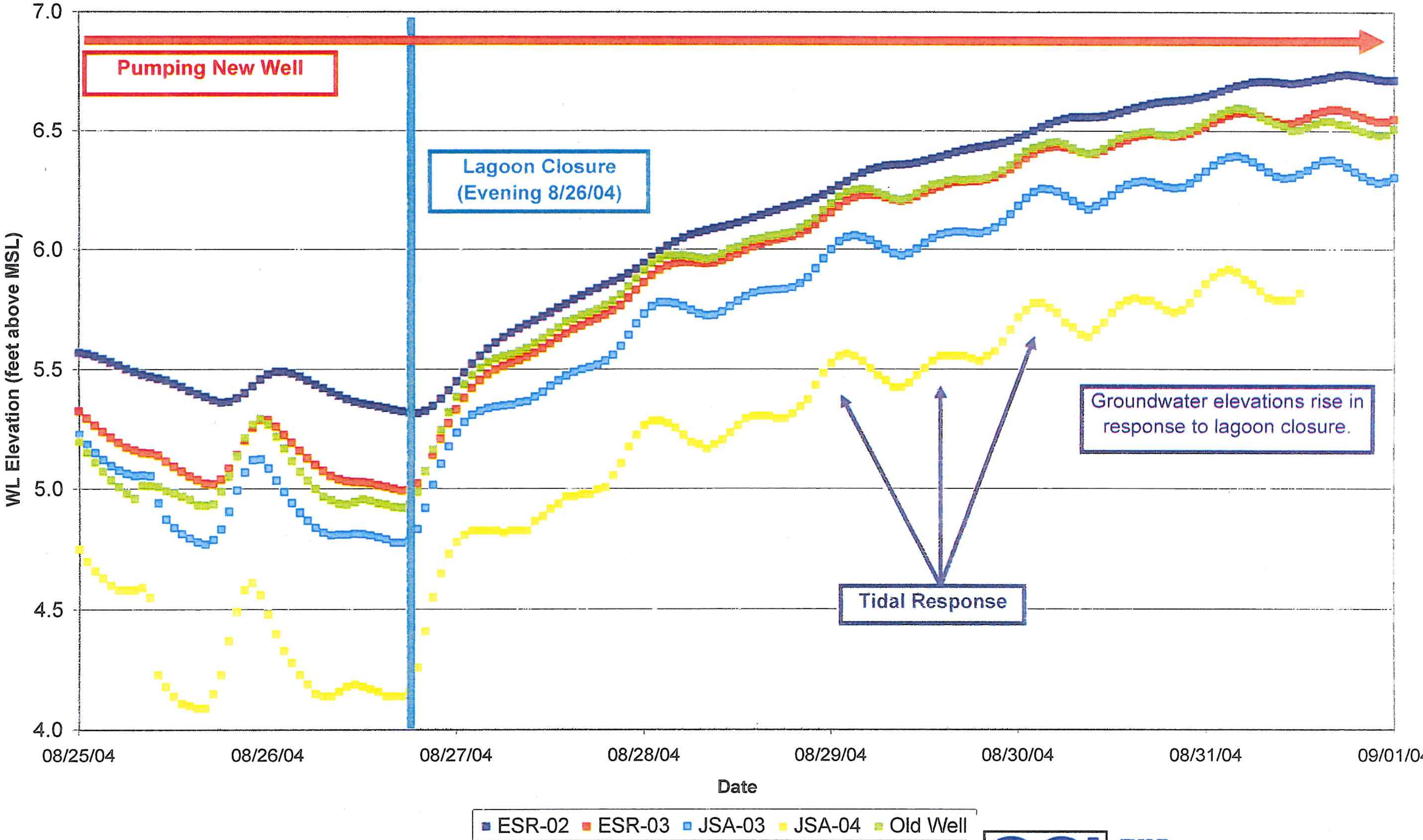
SGI environmental THE SOURCE GROUP, INC.

Figure 3-43
Lagoon Water Elevations
El Sur Ranch



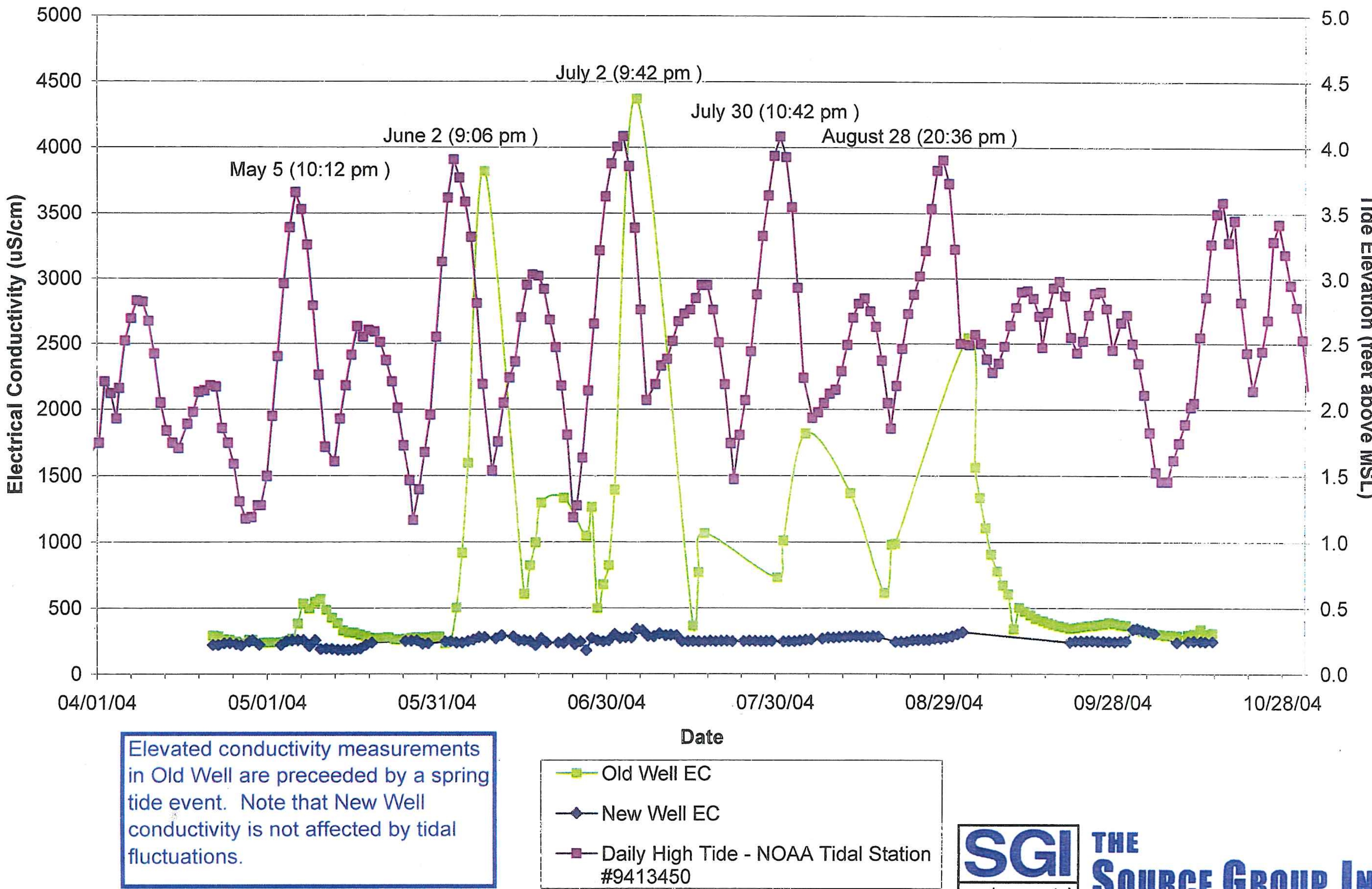
SGI environmental THE SOURCE GROUP, INC.

Figure 3-44
Effect of Lagoon Closure on Groundwater Elevations
El Sur Ranch



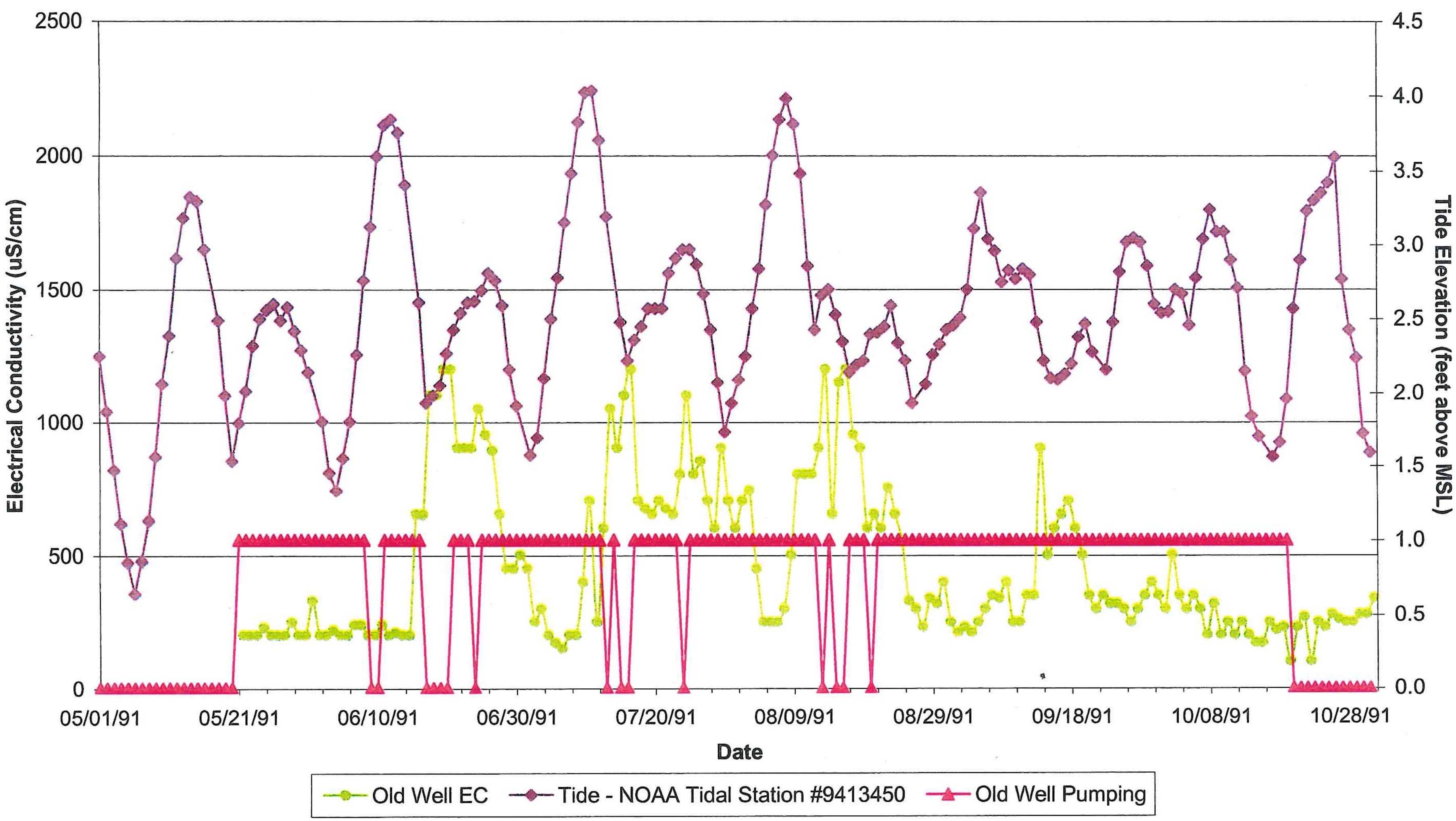
SGI environmental THE SOURCE GROUP, INC.

Figure 3-45
Spring Tide Effects on Electrical Conductivity in Old Well/New Well - 2004
El Sur Ranch



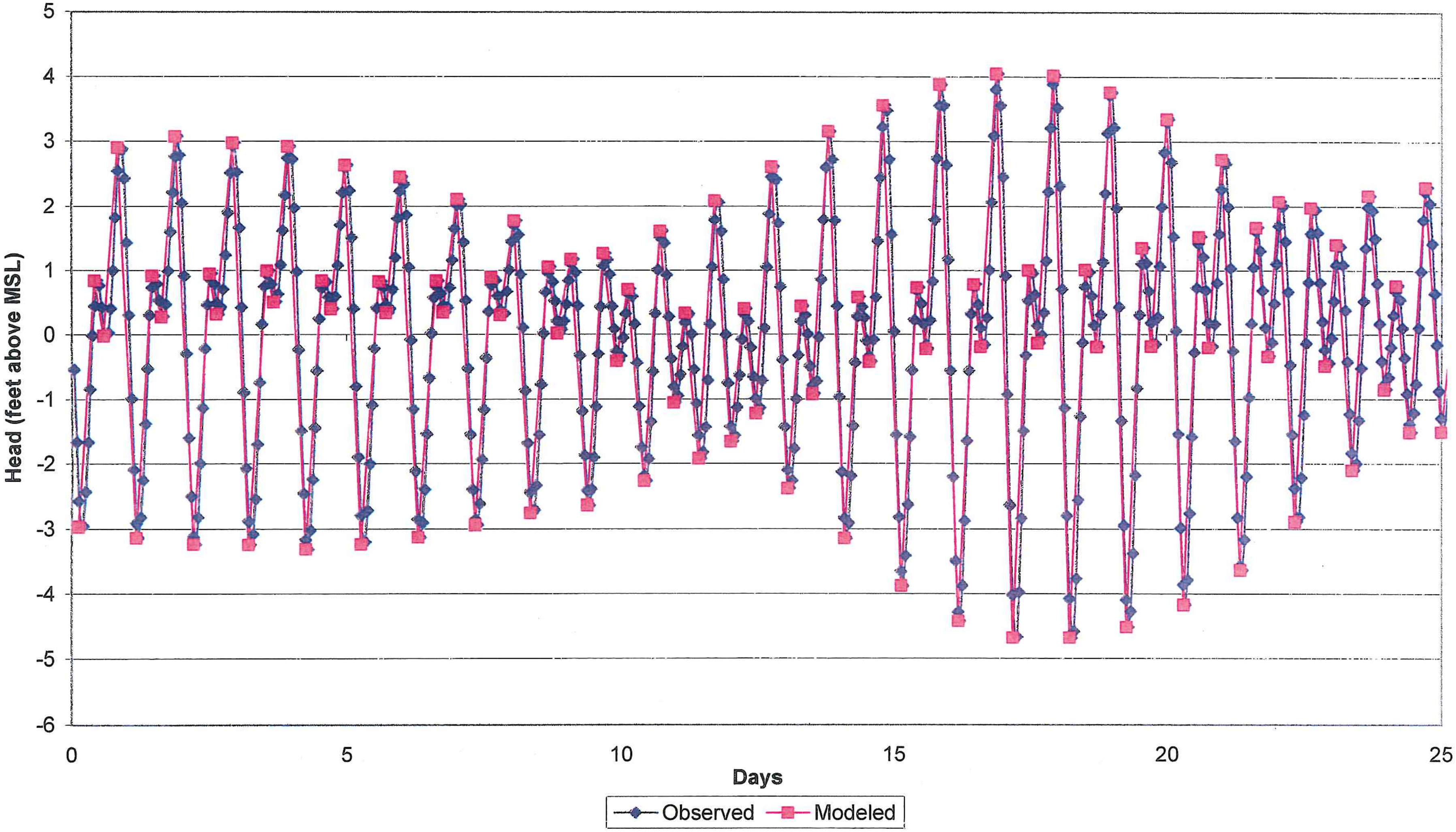
SGI environmental THE SOURCE GROUP, INC.

Figure 3-46
Spring Tide Effects on Electrical Conductivity in Old Well - 1991
El Sur Ranch

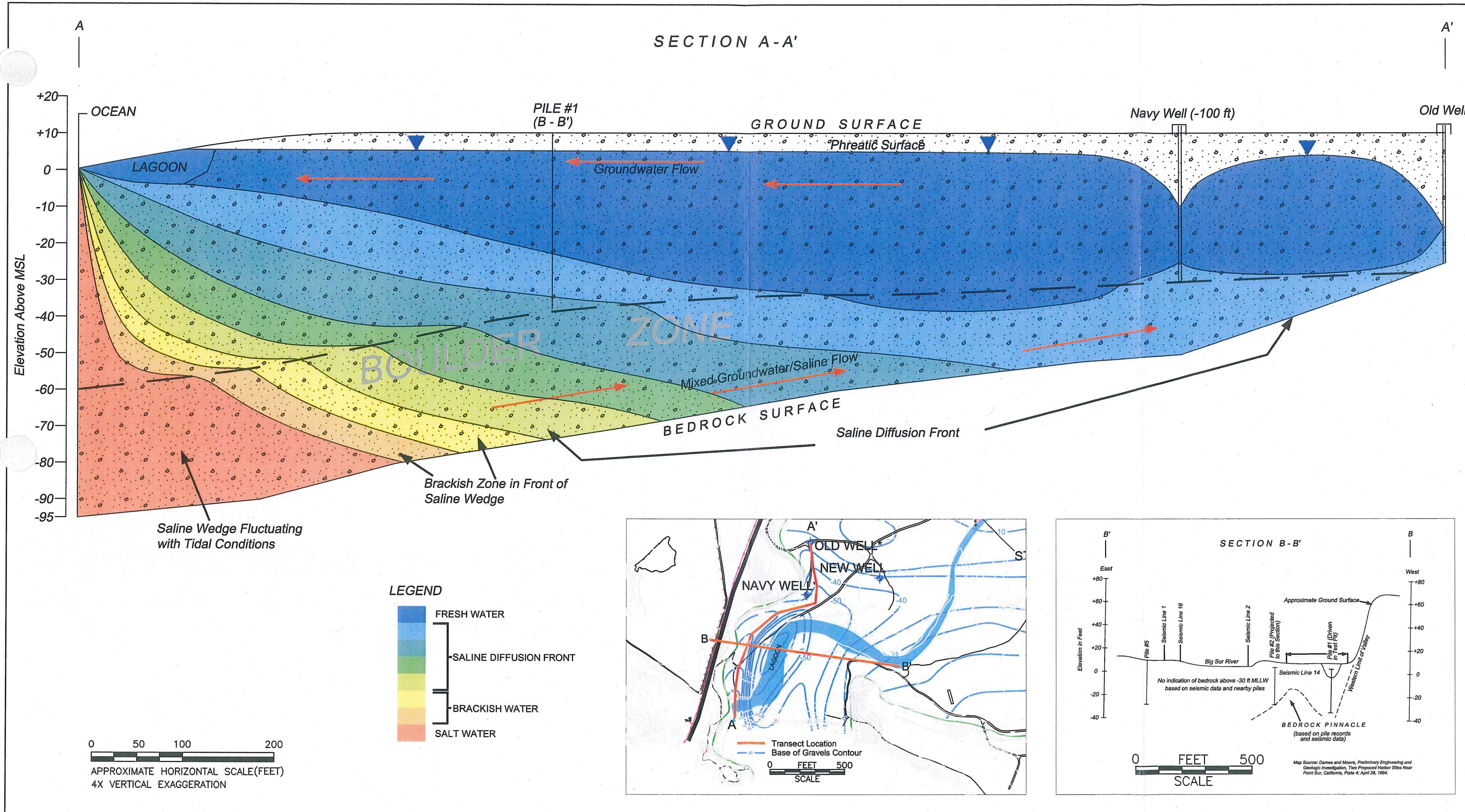


SGI environmental THE SOURCE GROUP, INC.

Figure 3-49
Outflow Constant Head Boundary Values
El Sur Ranch



SGI environmental THE SOURCE GROUP, INC.



SGI environmental THE SOURCE GROUP, INC.

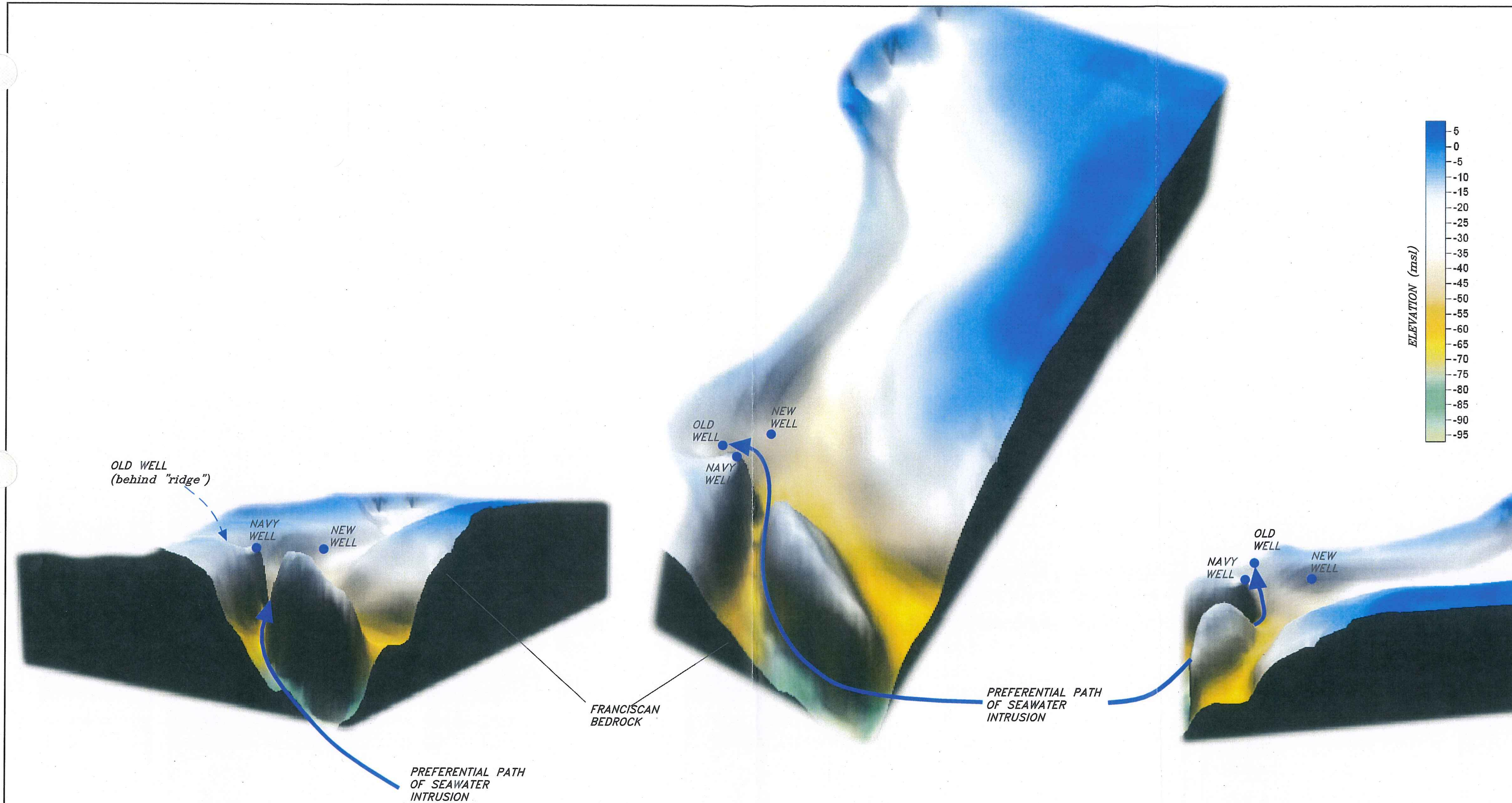
EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	4/30/05	JP	PH

FIGURE 3-47

CONCEPTUALIZED VIEW OF SALTWATER INTRUSION

ESR--4

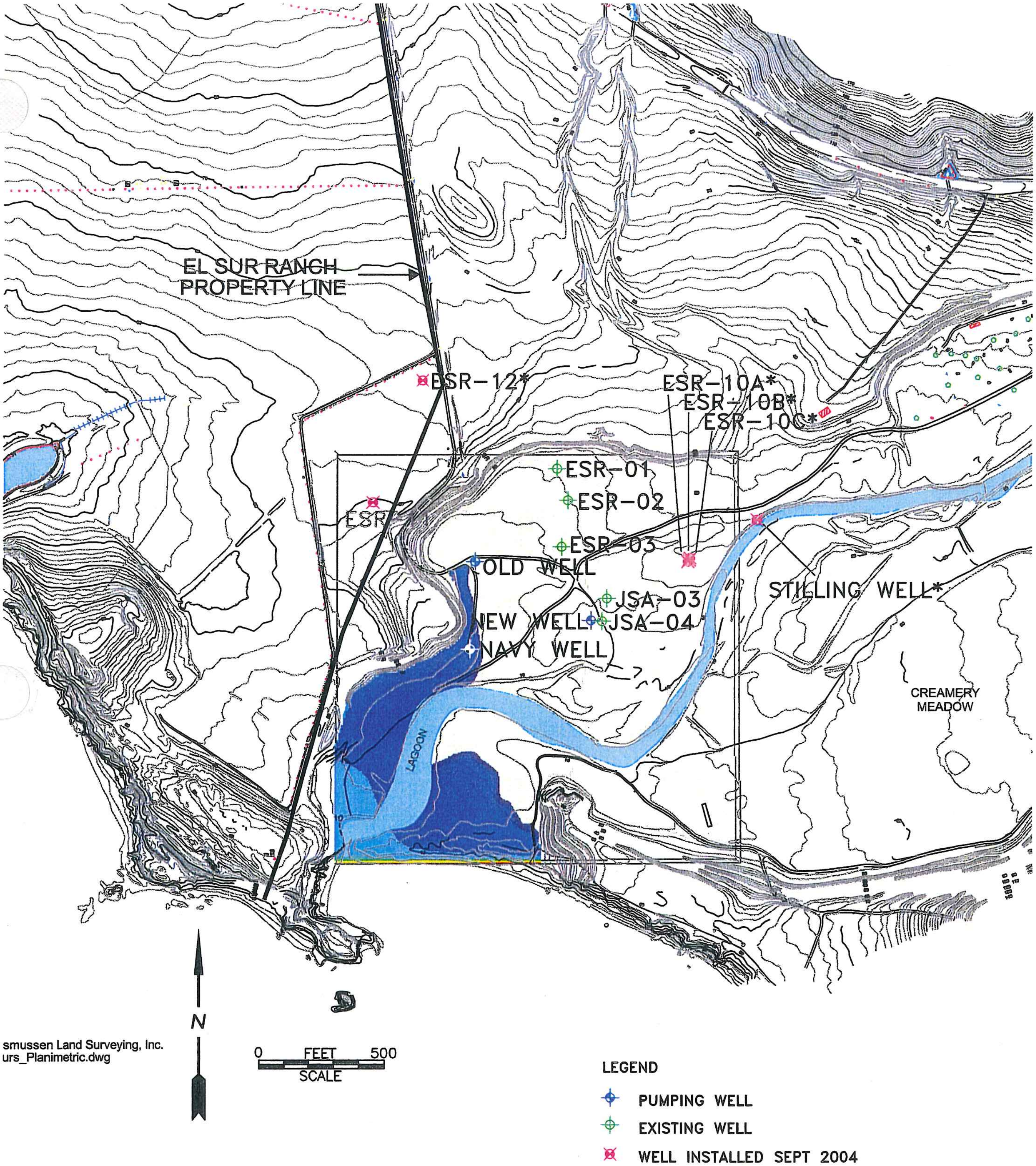


SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

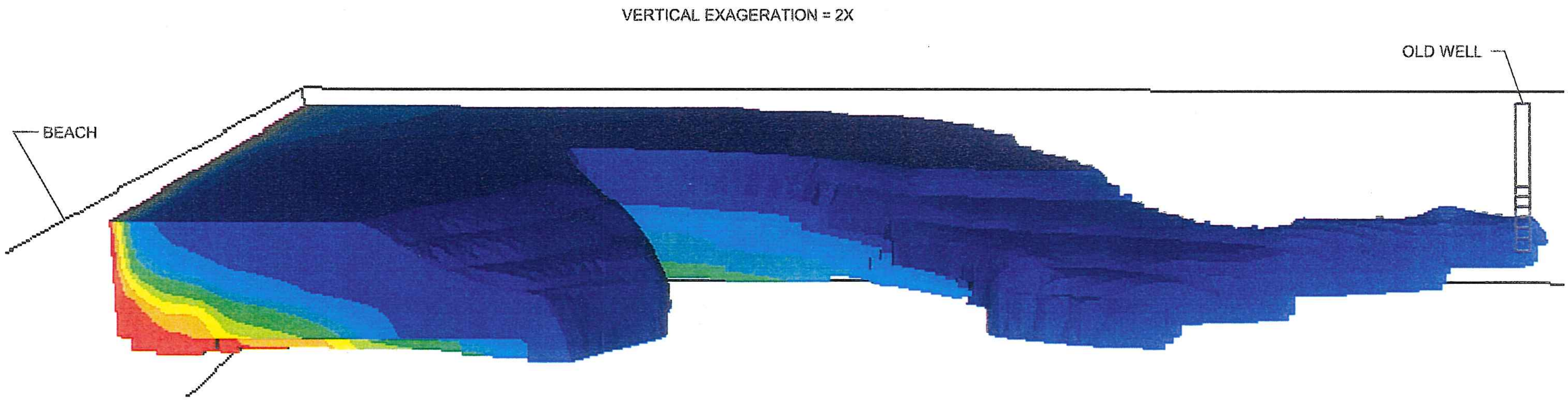
PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	5/3/05	SM	SM

FIGURE 3-48
THREE ROTATED VIEWS OF A 3D REPRESENTATION OF THE BEDROCK SURFACE

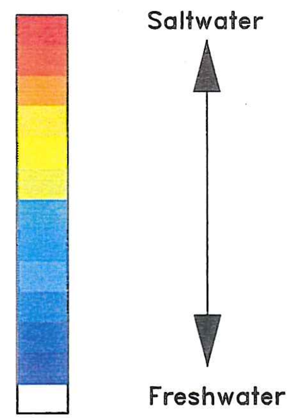


SGI environmental THE SOURCE GROUP, INC.	EL SUR RANCH BIG SUR, CALIFORNIA			MODEL PREDICTED SALINE DIFFUSION FRONT LOCATION 26 DAYS
	DATE 3/11/05	DR. BY SB	APP. BY SM	PROJECT NO. 01-ESR-001 / FIGURE NO. 3-50

ESR--4



LEGEND
Saline Concentration



ESR--4

SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

MODELED 3-D CUT-AWAY IMAGE OF
SALINE FRONT ENCROACHMENT
26 DAYS

DATE	DR. BY	APP. BY	PROJECT NO.	FIGURE NO.
3/11/05	SB	SM	01-ESR-001	3-51

Source: Natural Heritage Stewardship Program Project Status Report
Big Sur River Restoration Andrew Molera State Park 1990

SGI environmental THE SOURCE GROUP, INC.

EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	3/11/05	SM	PH

FIGURE 5-1

1990 STREAM RESTORATION WORK

TABLES

TABLES

Table 2-1
Summary of Well Construction Details
El Sur Ranch
Point Sur, California

StationID	TOC (ft-msl)	Transducer (Yes/No)	Diameter (inches)	Well Depth (ft bgs)	Year Installed	DWR Designation
ESR-01	15.44	No	10	32	1972	86691
ESR-02	15.13	Yes	10	32	1972	86692
ESR-03	13.77	Yes	20	32	1972	86693
ESR-10A	18.06	Yes	2	12	2004	pending
ESR-10B	18.04	Yes	2	21	2004	pending
ESR-10C	17.92	Yes	2	30	2004	pending
ESR-11	49.36	Yes	2	70	2004	pending
ESR-12	54.93	Yes	2	70	2004	pending
JSA-03	13.11	Yes	2	No Log Available		
JSA-04	11.55	Yes	6	28	1998	NA
JSA-05 -Destroyed By Winter River Flows						
Navy Well (New)	13.32	Yes	10	38	1973	86694
New Well	12.60	No	16	32	1975	76690
Old Well	12.52	Yes	12	NA	1949	NA

Notes:
TOC = top of casing.
ft msl = feet above mean seal level.
ft bgs = feet below ground surface
NA = Not Available

ESR--4

Table 2-2
El Sur Daily Pumping Rate
El Sur Ranch
Point Sur, California

Date	Old Well (cfs)	New Well (cfs)	Total (cfs)
04/21/04	2.58	2.69	5.27
04/22/04	2.58	3.47	6.05
04/23/04	2.58	2.71	5.29
04/24/04	2.58	3.45	6.02
04/25/04	2.59	1.43	4.02
04/26/04	2.59	2.62[1]	5.21
04/27/04	2.41	2.62[1]	5.03
04/28/04	2.57	3.49	6.06
04/29/04	2.35	0.00	2.35
04/30/04	2.03	0.00	2.03
05/01/04	2.03	0.00	2.03
05/02/04	2.54	0.00	2.54
05/03/04	2.50	2.89	5.39
05/04/04	2.50	2.68	5.18
05/05/04	2.50	2.59	5.09
05/06/04	2.53	2.10	4.63
05/07/04	2.53	2.29	4.82
05/08/04	2.53	3.01	5.54
05/09/04	2.53	2.11	4.64
05/10/04	2.53	2.76	5.29
05/11/04	2.53	2.85	5.38
05/12/04	2.53	2.39	4.92
05/13/04	2.53	2.13	4.65
05/14/04	2.58	2.32	4.90
05/15/04	2.58	2.65	5.22
05/16/04	2.58	1.97	4.54
05/17/04	2.58	2.30	4.88
05/18/04	2.58	2.41[1]	4.99
05/19/04	2.58	2.41[1]	4.99
05/20/04	2.20	0.00	2.20
05/21/04	2.32	0.00	2.32
05/22/04	2.21	0.00	2.21
05/23/04	2.28	0.00	2.28
05/24/04	2.29	0.00	2.29
05/25/04	2.53	2.30	4.83
05/26/04	2.50	3.08	5.58
05/27/04	2.50	1.42	3.92
05/28/04	2.57	2.27	4.83
05/29/04	2.57	0.63	3.21
05/30/04	2.13	0.00	2.13
05/31/04	2.36	0.00	2.36
06/01/04	2.58	2.59	5.17
06/02/04	2.58	2.87	5.45

Date	Old Well (cfs)	New Well (cfs)	Total (cfs)
06/03/04	2.58	2.91	5.49
06/04/04	2.58	2.95	5.53
06/05/04	0.00	3.57	3.57
06/06/04	0.00	2.58	2.58
06/07/04	0.00	1.97	1.97
06/08/04	0.00	1.96	1.96
06/09/04			
06/10/04	0.00	3.52	3.52
06/11/04	0.00	3.49[1]	3.49
06/12/04		3.49[1]	3.49
06/13/04	0.00	2.70	2.70
06/14/04	0.00	2.10	2.10
06/15/04	2.53	2.58	5.11
06/16/04	2.53	2.41	4.94
06/17/04	2.53	2.36	4.88
06/18/04	2.19	0.00	2.19
06/19/04	0.00	2.92[1]	2.92
06/20/04		2.92[1]	2.92
06/21/04	0.00	2.97	2.97
06/22/04	0.00	2.65	2.65
06/23/04	0.00	2.13	2.13
06/24/04	0.00	2.10	2.10
06/25/04	0.00	1.44	1.44
06/26/04	0.00	2.09	2.09
06/27/04	0.00	2.10	2.10
06/28/04	2.58	2.54	5.12
06/29/04	2.58	2.30	4.87
06/30/04	2.58	2.54	5.12
07/01/04	0.00	3.31	3.31
07/02/04	0.00	3.42	3.42
07/03/04	0.00	3.53	3.53
07/04/04	0.00	3.27	3.27
07/05/04	0.00	2.11	2.11
07/06/04	0.00	1.65	1.65
07/07/04	0.00	2.48	2.48
07/08/04	0.00	2.02	2.02
07/09/04	0.00	2.10	2.10
07/10/04	0.00	1.82	1.82
07/11/04	0.00	2.03	2.03
07/12/04	0.00	1.63	1.63
07/13/04	0.00	1.65	1.65
07/14/04	0.00	2.03	2.03
07/15/04	2.53	2.41	4.93

Table 2-2
El Sur Daily Pumping Rate
El Sur Ranch
Point Sur, California

Date	Old Well (cfs)	New Well (cfs)	Total (cfs)
07/16/04	2.53	2.39	4.92
07/17/04	0.00	3.06	3.06
07/18/04	0.00	2.80	2.80
07/19/04	0.00	2.90	2.90
07/20/04	0.00	2.92	2.92
07/21/04	0.00	2.01	2.01
07/22/04	0.00	2.17	2.17
07/23/04	0.00	2.13	2.13
07/24/04	0.00	2.20	2.20
07/25/04	0.00	2.04	2.04
07/26/04	0.00	2.05	2.05
07/27/04	0.00	2.06	2.06
07/28/04	0.00	1.36	1.36
07/29/04	0.00	2.61	2.61
07/30/04	2.31	0.00	2.31
07/31/04	0.00	3.39	3.39
08/01/04	0.00	3.50	3.50
08/02/04	0.00	3.46	3.46
08/03/04	0.00	3.35	3.35
08/04/04	0.00	3.37	3.37
08/05/04	0.00	2.91	2.91
08/06/04	0.00	3.25	3.25
08/07/04	0.00	3.05	3.05
08/08/04	0.00	2.85	2.85
08/09/04	0.00	2.93	2.93
08/10/04	0.00	3.01	3.01
08/11/04	0.00	2.82	2.82
08/12/04	0.00	2.94	2.94
08/13/04	0.00	2.55	2.55
08/14/04	0.00	2.14	2.14
08/15/04	0.00	2.12	2.12
08/16/04	0.00	2.11	2.11
08/17/04	0.00	2.19	2.19
08/18/04	2.55	0.80	3.35
08/19/04	1.56	0.00	1.56
08/20/04	0.00	2.26	2.26
08/21/04	0.00	2.06	2.06
08/22/04	0.00	2.17	2.17
08/23/04	0.00	2.15	2.15
08/24/04	0.00	2.11	2.11
08/25/04	0.00	2.31	2.31
08/26/04	0.00	2.57	2.57
08/27/04	0.00	2.63	2.63
08/28/04	0.00	2.53	2.53
08/29/04	0.00	2.54	2.54
08/30/04	0.00	2.39	2.39
08/31/04	0.00	2.37	2.37
09/01/04	0.00	1.05	1.05
09/02/04	2.55	0.40	2.95
09/03/04	1.94	0.00	1.94
09/04/04	2.36	0.00	2.36
09/05/04	2.31	0.00	2.31
09/06/04	2.52	0.00	2.52
09/07/04	2.25	0.00	2.25
09/08/04	2.35	0.00	2.35
09/09/04	2.22	0.00	2.22
09/10/04	2.21	0.00	2.21
09/11/04	2.20	0.00	2.20
09/12/04	2.38	0.00	2.38
09/13/04	2.21	0.00	2.21
09/14/04	2.48	0.00	2.48
09/15/04	2.55	0.00	2.55
09/16/04	1.98	0.00	1.98
09/17/04	2.31	0.00	2.31
09/18/04	2.30	0.00	2.30
09/19/04	2.36	0.00	2.36
09/20/04	2.55	2.26	4.81
09/21/04	2.55	2.24	4.80
09/22/04	2.55	2.11	4.66
09/23/04	2.55	2.26	4.81
09/24/04	2.55	2.16	4.72
09/25/04	2.55	2.20[1]	4.75
09/26/04	2.55	2.20[1]	4.75
09/27/04	2.55	2.26	4.81
09/28/04	2.55	1.29	3.84
09/29/04	2.55	1.85	4.40
09/30/04	0.00	0.00	0.00
10/01/04	2.53	0.00	2.53
10/02/04	2.33	0.00	2.33
10/03/04	2.37	0.00	2.37
10/04/04	2.19	0.00	2.19
10/05/04	2.39	0.00	2.39
10/06/04	2.15	0.00	2.15
10/07/04	2.30	0.00	2.30
10/08/04	2.29	0.00	2.29
10/09/04	2.55	3.01[1]	5.56

Table 2-2
El Sur Daily Pumping Rate
El Sur Ranch
Point Sur, California

Date	Old Well (cfs)	New Well (cfs)	Total (cfs)
10/10/04	2.56[1]	3.01[1]	5.57
10/11/04	2.55	2.13	4.68
10/12/04	1.50	0.00	1.50
10/13/04	2.55	1.08	3.63
10/14/04	2.55	1.99[1]	4.54
10/15/04	2.51	1.99[1]	4.50

Notes:
cfs = cubic feet per second.
[1]Single meter readings adjusted to reflect well operation over two days.

Table 2-3
Manual Depth to Water Data
El Sur Ranch

Well ID	Date	Time	DTW	Elevation	Groundwater Elevation
ESR-01	30-Sep-04	11:00	10.89	15.435	4.545
	14-Oct-04	9:46	10.12	15.435	5.315
	28-Oct-04	13:27	9.34	15.435	6.095
ESR-02	15-Apr-04	16:41	9.15	15.131	5.981
	16-Apr-04	10:06	9.12	15.131	6.011
	25-Jun-04	10:45	9.97	15.131	5.161
	25-Jun-04	17:00	9.83	15.131	5.301
	02-Jul-04	12:05	10.42	15.131	4.711
	12-Jul-04	13:12	9.8	15.131	5.331
	22-Jul-04	10:29	9.76	15.131	5.371
	22-Jul-04	16:00	9.76	15.131	5.371
	05-Aug-04	12:31	10.01	15.131	5.121
	18-Aug-04	10:41	9.81	15.131	5.321
	24-Aug-04	14:40	9.69	15.131	5.441
	31-Aug-04	12:35	8.42	15.131	6.711
	02-Sep-04	10:34	8.12	15.131	7.011
	15-Sep-04	10:38	8.87	15.131	6.261
	27-Sep-04	10:30	10.35	15.131	4.781
	30-Sep-04	11:06	10.34	15.131	4.791
	14-Oct-04	9:44	9.74	15.131	5.391
	28-Oct-04	13:24	8.89	15.131	6.241
ESR-03	15-Apr-04	16:40	8.11	13.769	5.659
	16-Apr-04	10:10	8.03	13.769	5.739
	25-Jun-04	10:35	8.91	13.769	4.859
	25-Jun-04	17:00	8.65	13.769	5.119
	02-Jul-04	12:03	9.39	13.769	4.379
	12-Jul-04	11:53	8.7	13.769	5.069
	22-Jul-04	10:26	8.66	13.769	5.109
	22-Jul-04	15:53	8.65	13.769	5.119
	05-Aug-04	12:23	8.99	13.769	4.779
	18-Aug-04	10:37	8.8	13.769	4.969
	24-Aug-04	14:38	8.6	13.769	5.169
	31-Aug-04	12:33	7.18	13.769	6.589
	02-Sep-04	10:32	7	13.769	6.769
	15-Sep-04	10:43	7.73	13.769	6.039
	27-Sep-04	10:45	9.56	13.769	4.209
	30-Sep-04	11:07	9.29	13.769	4.479
	14-Oct-04	9:42	8.79	13.769	4.979
	28-Oct-04	13:21	7.68	13.769	6.089
ESR-10A	02-Sep-04	11:25	10.49	18.058	7.568
	10-Sep-04	11:51	10.79	18.058	7.268
	15-Sep-04	10:20	10.76	18.058	7.298
	27-Sep-04	12:15	11.66	18.058	6.398
	30-Sep-04	11:16	11.57	18.058	6.488
	14-Oct-04	9:56	11.36	18.058	6.698
	28-Oct-04	13:37	10.85	18.058	7.208

Table 2-3
Manual Depth to Water Data
El Sur Ranch

Well ID	Date	Time	DTW	Elevation	Groundwater Elevation
ESR-10B	02-Sep-04	11:23	10.55	18.042	7.492
	10-Sep-04	11:50	10.72	18.042	7.322
	15-Sep-04	10:19	10.69	18.042	7.352
	27-Sep-04	12:15	11.61	18.042	6.432
	30-Sep-04	11:17	11.51	18.042	6.532
	14-Oct-04	9:57	11.31	18.042	6.732
	28-Oct-04	13:38	10.79	18.042	7.252
ESR-10C	02-Sep-04	11:22	11.3	17.922	6.622
	10-Sep-04	11:49	10.71	17.922	7.212
	15-Sep-04	10:18	10.66	17.922	7.262
	27-Sep-04	12:15	11.05	17.922	6.872
	30-Sep-04	11:18	11.32	17.922	6.602
	14-Oct-04	9:58	10.72	17.922	7.202
	28-Oct-04	13:39	10.4	17.922	7.522
ESR-11	10-Sep-04	13:30	37.56	49.358	11.798
	15-Sep-04	9:45	37.88	49.358	11.478
	27-Sep-04	9:40	38.26	49.358	11.098
	30-Sep-04	10:35	38.07	49.358	11.288
	14-Oct-04	11:49	37.62	49.358	11.738
	14-Oct-04	17:56	37.49	49.358	11.868
	28-Oct-04	16:07	36.9	49.358	12.458
ESR-12	10-Sep-04	13:40	43.06	54.931	11.871
	15-Sep-04	9:55	43.11	54.931	11.821
	27-Sep-04	9:40	43.45	54.931	11.481
	30-Sep-04	10:30	43.33	54.931	11.601
	14-Oct-04	11:35	43	54.931	11.931
	14-Oct-04	17:50	42.9	54.931	12.031
	28-Oct-04	15:43	42.34	54.931	12.591
JSA-03	15-Apr-04	16:26	7.17	13.114	5.944
	16-Apr-04	10:17	7.08	13.114	6.034
	25-Jun-04	11:10	7.85	13.114	5.264
	25-Jun-04	17:00	7.84	13.114	5.274
	02-Jul-04	11:50	8.89	13.114	4.224
	12-Jul-04	10:29	7.96	13.114	5.154
	12-Jul-04	13:15	7.91	13.114	5.204
	22-Jul-04	10:23	8.09	13.114	5.024
	22-Jul-04	15:33	8.09	13.114	5.024
	05-Aug-04	12:38	8.62	13.114	4.494
	18-Aug-04	10:21	7.72	13.114	5.394
	24-Aug-04	14:34	8.05	13.114	5.064
	31-Aug-04	12:22	6.79	13.114	6.324
	02-Sep-04	10:45	5.93	13.114	7.184
	15-Sep-04	10:49	6.34	13.114	6.774
	27-Sep-04	11:00	8.45	13.114	4.664
	30-Sep-04	11:09	8.24	13.114	4.874
	14-Oct-04	9:50	7.91	13.114	5.204
	28-Oct-04	13:31	6.78	13.114	6.334

Table 2-3
Manual Depth to Water Data
El Sur Ranch

Well ID	Date	Time	DTW	Elevation	Groundwater Elevation
JSA-04	15-Apr-04	16:35	5.72	11.55	5.83
	16-Apr-04	10:21	5.61	11.55	5.94
	25-Jun-04	11:30	6.25	11.55	5.3
	25-Jun-04	17:00	6.85	11.55	4.7
	02-Jul-04	11:55	8.13	11.55	3.42
	12-Jul-04	10:32	6.72	11.55	4.83
	22-Jul-04	10:20	7.03	11.55	4.52
	22-Jul-04	15:38	6.97	11.55	4.58
	05-Aug-04	12:50	7.84	11.55	3.71
	18-Aug-04	10:27	6.15	11.55	5.4
	24-Aug-04	14:32	6.99	11.55	4.56
	31-Aug-04	12:12	5.78	11.55	5.77
	02-Sep-04	10:46	4.33	11.55	7.22
	15-Sep-04	10:51	4.62	11.55	6.93
	27-Sep-04	11:10	7.34	11.55	4.21
	30-Sep-04	11:11	7.06	11.55	4.49
	14-Oct-04	9:52	6.77	11.55	4.78
	28-Oct-04	13:33	5.3	11.55	6.25
Navy Well	24-Aug-04	14:20	7.74	13.32	5.58
	28-Oct-04	13:15	7.36	13.32	5.96
New Well	12-Jul-04	10:36	9.18	12.6	3.42
	05-Aug-04	12:44	13.87	12.6	-1.27
	15-Sep-04	10:59	5.87	12.6	6.73
	14-Oct-04	10:03	12.75	12.6	-0.15
	28-Oct-04	15:10	6.66	12.6	5.94
Old Well	15-Apr-04	14:52	7.26	12.52	5.26
	16-Apr-04	9:58	7.13	12.52	5.39
	25-Jun-04	10:15	7.92	12.52	4.6
	25-Jun-04	17:00	7.7	12.52	4.82
	02-Jul-04	12:10	8.28	12.52	4.24
	12-Jul-04	12:32	7.65	12.52	4.87
	22-Jul-04	10:35	7.54	12.52	4.98
	22-Jul-04	15:20	7.54	12.52	4.98
	05-Aug-04	12:15	7.85	12.52	4.67
	18-Aug-04	10:15	13.47	12.52	-0.95
	24-Aug-04	14:46	7.51	12.52	5.01
	02-Sep-04	10:27	11.4	12.52	1.12
	15-Sep-04	11:20	12.05	12.52	0.47
	30-Sep-04	11:22	13.45	12.52	-0.93
	14-Oct-04	10:09	13.15	12.52	-0.63
	28-Oct-04	13:45	6.67	12.52	5.85

Table 2-4
Station Data Collection Summary
El Sur Ranch

Station ID	Station Type	Data Type	Data Source	Reporting Interval	Data Collection Begin Date	Data Collection End Date
ESR-01	Monitoring Well	DTW	Manual	event	9/30/2004	10/28/2004
ESR-02	Monitoring Well/Transducer	temperature	Transducer	hourly	7/12/2004	10/28/2004
ESR-02	Monitoring Well/Transducer	pressure	Transducer	hourly	7/12/2004	10/28/2004
ESR-02	Monitoring Well/Transducer	DTW	Manual	event	6/25/2004	10/28/2004
ESR-03	Monitoring Well/Transducer	temperature	Transducer	hourly	6/24/2004	10/28/2004
ESR-03	Monitoring Well/Transducer	pressure	Transducer	hourly	6/24/2004	10/28/2004
ESR-03	Monitoring Well/Transducer	DTW	Manual	event	6/25/2004	10/28/2004
ESR-10a	Monitoring Well/Transducer	temperature	Transducer	hourly	9/10/2004	10/28/2004
ESR-10a	Monitoring Well/Transducer	pressure	Transducer	hourly	9/10/2004	10/28/2004
ESR-10a	Monitoring Well/Transducer	DTW	Manual	event	9/2/2004	10/28/2004
ESR-10b	Monitoring Well/Transducer	temperature	Transducer	hourly	9/10/2004	10/28/2004
ESR-10b	Monitoring Well/Transducer	pressure	Transducer	hourly	9/10/2004	10/28/2004
ESR-10b	Monitoring Well/Transducer	DTW	Manual	event	9/2/2004	10/28/2004
ESR-10c	Monitoring Well/Transducer	temperature	Transducer	hourly	9/2/2004	10/28/2004
ESR-10c	Monitoring Well/Transducer	pressure	Transducer	hourly	9/2/2004	10/28/2004
ESR-10c	Monitoring Well/Transducer	DTW	Manual	event	9/2/2004	10/28/2004
ESR-11	Monitoring Well/Transducer	temperature	Transducer	hourly	9/10/2004	10/28/2004
ESR-11	Monitoring Well/Transducer	pressure	Transducer	hourly	9/10/2004	10/28/2004
ESR-11	Monitoring Well/Transducer	DTW	Manual	event	9/10/2004	10/28/2004
ESR-12	Monitoring Well/Transducer	temperature	Transducer	hourly	9/15/2004	10/28/2004
ESR-12	Monitoring Well/Transducer	pressure	Transducer	hourly	9/15/2004	10/28/2004
ESR-12	Monitoring Well/Transducer	DTW	Manual	event	9/10/2004	10/28/2004
JSA-03	Monitoring Well/Transducer	temperature	Transducer	hourly	7/12/2004	10/28/2004
JSA-03	Monitoring Well/Transducer	pressure	Transducer	hourly	7/12/2004	10/28/2004
JSA-03	Monitoring Well/Transducer	DTW	Manual	event	6/25/2004	10/28/2004
JSA-04	Monitoring Well/Transducer	temperature	Transducer	hourly	6/24/2004	10/28/2004
JSA-04	Monitoring Well/Transducer	pressure	Transducer	hourly	6/24/2004	10/28/2004
JSA-04	Monitoring Well/Transducer	DTW	Manual	event	6/25/2004	10/28/2004
Still Well	Stilling Well/Transducer	temperature	Transducer	hourly	9/1/2004	10/28/2004
Still Well	Stilling Well/Transducer	pressure	Transducer	hourly	9/1/2004	10/28/2004
Navy Well	Pumping Well/Transducer	temperature	Transducer	hourly	8/24/2004	10/28/2004
Navy Well	Pumping Well/Transducer	pressure	Transducer	hourly	8/24/2004	10/28/2004
Navy Well	Pumping Well/Transducer	DTW	Manual	event	8/24/2004	10/28/2004
New Well	Pumping Well/Transducer	DTW	Manual	event	7/12/2004	10/28/2004
New Well	Pumping Well/Transducer	Pumping Status	Manual	daily	5/1/1989	10/16/2004

Table 2-4
Station Data Collection Summary
El Sur Ranch

Station ID	Station Type	Data Type	Data Source	Reporting Interval	Data Collection Begin Date	Data Collection End Date
Old Well	Pumping Well/Transducer	temperature	Transducer	hourly	6/25/2004	10/28/2004
Old Well	Pumping Well/Transducer	pressure	Transducer	hourly	6/25/2004	10/28/2004
Old Well	Pumping Well/Transducer	DTW	Manual	event	6/25/2004	10/28/2004
Old Well	Pumping Well/Transducer	Pumping Status	Manual	daily	5/1/1989	10/16/2004
Big Sur Gauge	River Gauge	Height/Flow	Internet	1/4 hour	6/12/2004	10/28/2004
19/Castroville	Weather Station	ETo; precipitation; solar radiation; vapor pressure; air temperature; relative humidity; dew point temperature; wind speed; wind direction; and soil temperature	Internet	hourly	6/25/2004	10/28/2004
PPSC1	Weather Station	Temperature, Dew Point, Relative Humidity, Wind Speed, Wind Gust, Solar Radiation, Fuel Temperature	Internet	hourly	6/23/2004	10/28/2004
WESR-01	Mobile Weather Station		Onsite Station	hourly	8/5/2004	11/3/2004
WESR-02	Fixed Weather Station		Onsite Station	hourly	7/22/2004	10/28/2004
9413450	Tide Data	Water Level	Internet	6 minutes	3/31/2004	10/28/2004
Station 1 - Bottom	Temp Logger	Water Temp	Hanson	hourly	4/18/2004	10/28/2004
Station 1 - Surface	Temp Logger	Water Temp	Hanson	hourly	7/12/2004	10/28/2004
Station 2 - Bottom	Temp Logger	Water Temp	Hanson	hourly	7/23/2004	10/28/2004
Station 2 - Surface	Temp Logger	Water Temp	Hanson	hourly	7/23/2004	10/28/2004
Station 3 - Bottom	Temp Logger	Water Temp	Hanson	hourly	4/18/2004	10/28/2004
Station 3 - Surface	Temp Logger	Water Temp	Hanson	hourly	7/23/2004	10/28/2004
Station 4 - Bottom	Temp Logger	Water Temp	Hanson	hourly	4/18/2004	10/28/2004
Station 4 - Surface	Temp Logger	Water Temp	Hanson	hourly	7/23/2004	10/28/2004
Station 5 - Bottom	Temp Logger	Water Temp	Hanson	hourly	4/18/2004	10/28/2004
Station 5 - Surface	Temp Logger	Water Temp	Hanson	hourly	7/12/2004	10/14/2004
Station 6 - Ocean	Temp Logger	Water Temp	Hanson	hourly	9/2/2004	10/14/2004
Velocity Transect 1	Velocity Transect	Velocity	Hanson	event	7/23/2004	10/28/2004
Valocity Transect 2	Velocity Transect	Velocity	Hanson	event	7/23/2004	10/28/2004
Velocity Transect 3	Velocity Transect	Velocity	Hanson	event	7/23/2004	10/28/2004
Transects 01-21	Field Measurement Tr.	Water Quality	Hanson	event	4/18/2004	10/28/2004

Table 2-5
Summary of Data Validation
El Sur Ranch

Monitoring Station Identification	Data Type	Flags
ESR-01	DTW	
ESR-02	temperature	1, 2, 3
ESR-02	pressure	4, 3
ESR-02	DTW	
ESR-03	temperature	5
ESR-03	pressure	
ESR-03	DTW	
ESR-10A	temperature	6, 3
ESR-10A	pressure	3
ESR-10A	DTW	
ESR-10B	temperature	7
ESR-10B	pressure	8
ESR-10B	DTW	
ESR-10C	temperature	9, 3
ESR-10C	pressure	3
ESR-10C	DTW	
ESR-11	temperature	10, 3
ESR-11	pressure	10, 3
ESR-11	DTW	
ESR-12	temperature	3
ESR-12	pressure	3
ESR-12	DTW	
JSA-03	temperature	11, 3
JSA-03	pressure	3
JSA-03	DTW	
JSA-04	temperature	11, 3
JSA-04	pressure	12, 3
JSA-04	DTW	
Stilling Well	temperature	13, 3
Stilling Well	pressure	14, 15, 16, 17, 18, 3
Navy Well	temperature	
Navy Well	pressure	
Navy Well	DTW	
New Well	DTW	
New Well	Pumping Status	
Old Well	temperature	3
Old Well	pressure	3
Old Well	DTW	
Old Well	Pumping Status	
Big Sur Gauge	Height/Flow	
19/Castroville	Weather Data	
PPSC1	Weather Data	
WESR-01	Weather Data	
WESR-02	Weather Data	
9413450	Tide Data	
Station 1 - Bottom	temperature	
Station 1 - Surface	temperature	19
Station 2 - Bottom	temperature	
Station 2 - Surface	temperature	
Station 3 - Bottom	temperature	
Station 3 - Surface	temperature	
Station 4 - Bottom	temperature	
Station 4 - Surface	temperature	
Station 5 - Bottom	temperature	19
Station 5 - Surface	temperature	20
Station 6 - Ocean	temperature	20
Velocity Transect 1	velocity	
Velocity Transect 2	velocity	
Velocity Transect 3	velocity	
Water Quality Transects	water quality	

April-15 | April-30 | May-15 | May-31 | June-15 | June-30 | July-15 | July-31 | August-15 | August-31 | September-15 | September-30 | October-15 | October-28

Table 2-5
Summary of Data Validation
El Sur Ranch
Point Sur, California

Notes:

Light green represents available data
Light blue represents data that required some form of manipulation to become available
Light yellow represents data that is unavailable over the indicated time frame
DTW = Depth to Water

1 - Temperature data from 8/18 to 9/2 required correction due to a datalogger software error
2 - Temperature data from 9/15 to 9/28 required correction due to a datalogger software error
3 - A power failure in the data collection device resulted in the loss of data.
4 - Pressure data from 8/18 to 9/2 required correction due to a datalogger software error
5 - Temperature data from 8/18 to 9/2 required correction due to a datalogger software error
6 - Temperature data from 9/10 to 9/15 required correction due to a datalogger software error
7 - Temperature data from 9/15 to 9/30 required correction due to a datalogger software error
8 - Pressure data from 9/15 to 9/30 required correction due to a datalogger software error
9 - Temperature data from 9/2 to 9/15 required correction due to a datalogger software error
10 - An error within the data collection device resulted in the loss of data
11 - Temperature data from 9/15 to 9/30 required correction due to a datalogger software error
12 - Datalogger sensor failure resulted in the loss of data
13 - An error within the data collection device resulted in the loss of data
14 - Pressure data from 8/18 to 8/24 required correction due to a datalogger software error
15 - An error within the data collection device resulted in the loss of data
16 - Pressure data from 9/1 to 9/15 required correction due to a datalogger software error
17 - Pressure data from 9/15 to 9/30 required correction due to a datalogger software error
18 - Pressure data from 9/30 to 10/6 required correction due to a datalogger software error
\- Temperature logger was found dewatered
\- Temperature logger removed from this location

Table 3-1
Summary of Flow Data for Transects #1, #2, and #3
El Sur Ranch

Date	Time	Calculated River Flow			
		USGS Gauge[1] (cfs)	Velocity Transect #1 (cfs)	Velocity Transect #2 (cfs)	Velocity Transect #3 (cfs)
Apr-04	Monthly Avg.	50	- -[2]	- -[2]	- -[2]
May-04	Monthly Avg.	34	- -[2]	- -[2]	- -[2]
Jun-04	Monthly Avg.	25	- -[2]	- -[2]	- -[2]
07/23/04	Morning	14	10.29	9.49	7.99
08/05/04	Afternoon	14	8.87	7.22	10.10
08/06/04	Morning	13	8.77	8.16	9.11
08/19/04	Morning	12	7.95	6.97	8.74
08/19/04	Afternoon	12	7.21	5.90	9.90
08/30/04	Afternoon	12	8.25	9.40	- -[7]
08/31/04	Morning	11	8.20	8.63	- -[7]
08/31/04	Afternoon	12	8.57[3]	9.68[4]	- -[7]
09/01/04	Morning	11	8.40	8.81	- -[7]
09/01/04	Afternoon	12	10.06[5]	14.25[6]	- -[7]
09/02/04	Morning	11	7.22	7.28	- -[7]
09/02/04	Afternoon	11	10.88	10.26	- -[7]
09/15/04	Afternoon	12	6.32	6.18	- -[7]
09/16/04	Morning	12	7.26	5.96	- -[7]
09/30/04	Afternoon	13	8.18	7.46	- -[7]
10/01/04	Morning	13	9.07	8.02	- -[7]
10/14/04	Afternoon	10	9.83	12.16	- -[7]
10/15/04	Morning	10	11.75	11.84	- -[7]
10/28/04	Morning	48	44.00	46.74	56.32[8]
10/28/04	Afternoon	45	40.66	45.56	- -

Notes:
cfs = cubic feet per second.
- - = Not available.
[1]Value at USGS gauge was corrected for an estimated 18-hour travel time from the gauge to Transect #1.
[2]Transects #1, #2, and #3 were not installed until July 23, 2004.
[3]Value represents average of two readings (8.31, 8.83).
[4]Value represents average of two readings (10.42, 8.93).
[5]Value represents average of two readings (10.21, 9.91).
[6]Value represents average of two readings (14.65, 13.84).
[7]Lagoon closure by storm results in the loss of Velocity Transect #3. Station is buried by beach sand.
[8]Transect not in same location as before the sand bar was established.

Table 3-2
Estimated Underflow In Alluvial Aquifer
El Sur Ranch

Location	Saturated Cross Sectional Area (ft2) (1)	Gradient (2)	Hydraulic Conductivity (ft/day) (3)	Estimated Flow Rate (cfs)
Cross Section A-A'	31,000	0.0026	3389	3.16
Cross Section A-A'	31,000	0.0026	3623	3.38
Cross Section A-A'	31,000	0.0026	4086	3.81
			Average	**3.45**

Notes:

1. Cross sectional area derived from intrepreted area of saturated alluivum as depicted in cross section A-A'.
2. Equals the surface gradient from the transect 1 to transcect 2 areas.
3. Range and average of hydraulic conductivity estimates in alluival aquifer

Table 3-3
Estimated Flow out of Terrace Deposits
El Sur Ranch

Location	Saturated Cross Sectional Area (ft2) (1)	Gradient Range (2)	Hydraulic Conductivity (ft/day) (3)	Estimated Flow Rate (cfs)
Border with Alluvium	53,201	0.0063	100	0.39
Border with Alluvium	53,201	0.0077	100	0.47
Border with Alluvium	53,201	0.017	100	1.05
			Average	**0.64**

Notes:

1. Cross sectional area derived from intrepreted subsurface interface of terrace deposits with allivual aquifer on north side of study area.
2. Gradient ranges calcualted from ESR11 and ESR 12 data as compared to data for ESR-2, 2 and 3.
3. Estimated high-side conductivity based on material type and inspection of outcrop

Table 3-4
El Sur Ranch

Table 6. Average Annual Water Budget for the Big Sur River Between the USGS Gage and Andrew Molera State Park

Month	Big Sur River at USGS Gage		Pheneger Creek	Juan Higuera Creek	Pfeiffer-Redwood Creek	Pfeiffer Creek	Post Creek	Basin Exports	Diversions	Return Flow	Big Sur River at Andrew Molera State Park	
	(cfs)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(cfs)
January	223	143999411	2132846	5708675	2902032	333751	3688026	5600	66308	53046	158745880	251
February	267	172501988	1686939	4625699	2312444	263975	2920625	5600	66308	53046	184292809	292
March	220	142125092	1284258	3647705	1780010	200963	2227616	5600	66308	53046	151246782	239
April	146	94297639	0	528624	81936	0	17424	5600	66308	53046	94906762	150
May	66	42469485	0	528624	81936	0	17424	5600	67463	53970	43078377	68
June	36	23060587	0	528624	81936	0	17424	5600	122014	97611	23658569	37
July	23	14755415	0	528624	81936	0	17424	5600	122014	97611	15353397	24
August	17	10883977	0	528624	81936	0	17424	5600	122014	97611	11481958	18
September	15	9707680	0	528624	81936	0	17424	5600	66308	53046	10316803	16
October	18	11362251	0	528624	81936	0	17424	5600	66308	53046	11971374	19
November	47	30073126	1446923	4042771	1995089	226417	2507560	5600	66308	53046	40273025	64
December	102	65924326	1843917	5006951	2520003	288539	3190782	5600	66308	53046	78755656	125

Notes: Excerpted from Jones & Stokes, 1999

Table 3-5
Estimate of Average Summer Surface Flow Loss - USGS Gauge to Transect #1
El Sur Ranch

	Jones and Stokes Measured Flow Loss in 1998 (cfs) (Note 1)	**SGI Measured Average Flow Loss in 2004 (cfs) (Note 2)**
July	NM	3.71
August	8.9	3.64
September	1.93	3.85
Averages of estimated losses	**5.42**	**3.73**

Notes:

NM Not Measured

1. Jones and Stokes 1998 measured flows at Andrew Molera State Park in the summer of 1998 were subtracted from 1998 USGS gauge flows to yeild the flow loss reported here.
2. SGI average monthly 2004 measured surface flow at Transect #1 were subtracted from the associated USGS Gauge flow measurements in 2004 to yeild the flow loss meeasurements reported here.

Table 3-6A
Simplified Annual Water Balance Analysis - Big Sur Watershed
El Sur Ranch

..per Big Sur Watershed

			Volume (Ac-ft/yr)	% of Total	Notes:
IN	Rainfall (inches) 55	Area (Sq.Miles) 46.5	136,398	100.00%	Rainfall based on USGS 1996.
		Total In	**136,398**		
OUT	USGS Gauge Flow 101 cfs		73,121	53.61%	Average of USGS Gauge flow years 1951-2004. Equals 53.61% of Precipitation.
	Evapotranspiration (ET) 46.39% of Precipitation		63,277	46.39%	Solved for in the water balance.
		Total Out	**136,398**		Note: Total IN must match Total OUT

Lower Big Sur Watershed

			Volume (Ac-ft/yr)	% of Total	Notes:
IN	USGS Gauge River Flow 101 cfs		73,121	74.58%	Average of USGS Gauge flow years 1951-2004.
	Rainfall (inches) 39.15	Area (Sq.Miles) 11.9	24,847	25.34%	Based on State Park rain gauge (NRCE, March 2005).
	Return Flow 0.1 cfs		72	0.07%	Calculated by Jones and Stokes, 1998 for Watershed above Andrew Molera State Park.
		Total In	**98,040**		
OUT	Runoff + Underflow to Ocean		85,442	87.15%	Solved for in the water balance.
	Evapotranspiration (ET) 46.39% of Precipitation		11,527	11.76%	Based on ET for Upper Watershed calculated above.
	Diversions and Basin Exports above Transect 1		94	0.10%	Calculated by Jones and Stokes, 1998 for Watershed above Andrew Molera State Park.
	Total Diversions Below Transect 1		977	1.00%	Average calculated ESR pumping rate 1975-2004 (NRCE, Jan 7, 2005) plus estimated annual navy well rate of 40 ac-ft/year.
		Total Out	**98,040**		Note: Total IN must match Total OUT

Total Watershed

			Volume (Ac-ft/yr)	% of Total	Notes:
IN	Rainfall (inches)	Area (Sq.Miles)			
	55	46.5	136,398	84.55%	Upper Watershed
	39.15	11.9	24,847	15.40%	Lower Watershed
	Return Flow to Lower Water Shed		72	0.04%	Calculated by Jones and Stokes, 1998 for Watershed above Andrew Molera State Park.
		Total In	**161,317**		
OUT	Runoff + Underflow to Ocean		85,442	52.97%	Taken from lower watershed balance above.
	Evapotranspiration (ET) 46.39% of Precipitation		74,804	46.37%	Solved for in the water balance representing blended ET for entire watershed.
	Diversions and Basin Exports above Transect 1		94	0.06%	Calculated by Jones and Stokes, 1998 for Lower Watershed.
	Total Diversions Below Transect 1		977	0.61%	Average calculated ESR pumping rate 1975-2004 (NRCE, Jan 7, 2005) plus estimated annual Navy well rate of 40 Ac-ft/year.
		Total Out	**161,317**		Note: Total IN must match Total OUT

Table 3-6B
Simplified Water Balance Analysis - Study Area
El Sur Ranch

Study Area (Annual Water Balance)

		Volume (Ac-ft/yr)	% of Total	Notes:
IN	Surface Flow at Transect 1 (Section A-A') 113.64 cfs	82,271	94.45%	Solved for in the water balance.
	Underflow at Transect 1 (Section A-A') 4.00 cfs	2,896	3.32%	Includes expected increase in saturated thickness and gradient during winter months (Table 3-2).
	Subsurface flow from Terrace Deposits 0.64 cfs	463	0.53%	Estimated as presented in Table 3-3.
	Rainfall (inches) 27.58 / Area (Sq.Miles) 1	1,471	1.69%	Portion of watershed that reports to Study Area below Transect 1 as depicted on Figure 3-19. Rainfall total from NRCE, March 2005.
	Total In	**87,101**		
OUT	Runoff + Underflow to Ocean 118.02 cfs	85,442	98.09%	Total discharge to ocean for Lower Watershed analysis (Table 3-6A).
	Evapotranspiration (ET) 46.39% of Precipitation	682	0.78%	Based on annual ET for Lower Watershed calculated in Table 3-6A.
	Total of Pumping	977	1.12%	Average calculated ESR pumping rate 1975-2004 (NRCE, Jan 7, 2005) plus estimated annual navy well rate of 40 ac-ft/year.
	Total Out	**87,101**		

Study Area (2004 Irrigation Season Water Balance)

		Volume (Ac-ft)	% of Total	Notes:
IN	Surface Flow at Transect 1 (Section A-A') 16.1 cfs	5,698	75.50%	Assumes Transect 1 running 3.73 cfs less than USGS gauge based on average of flow measurements July-September 2004 on Table 3-5.
	Underflow at Transect 1 (Section A-A') 3.45 cfs	1,218	16.14%	Based on Table 3-2 calculated underflow.
	Subsurface flow from Terrace Deposits 0.64 cfs	226	2.99%	Estimated as presented in Table 3-3 for 178 days in irrigation season.
	Rainfall (inches) 7.59 / Area (Sq.Miles) 1	405	5.36%	Portion of watershed that reports to Study Area below Transect 1 as depicted on figure 3-19. Rainfall total from Appendix G.
	Total In	**7,547**		
OUT	Runoff + Underflow to Ocean 16.7 cfs	6,286	83.29%	Solved for in the water balance.
	Evapotranspiration (ET) 0.29 cfs	102	1.36%	Based on calculated seasonal ET discussed in Report Section 3.4.2
	Total of Pumping	1,159	15.36%	Estimated total pumping volume for 2004 season including 23 Ac-ft for Navy Well.
	Total Out	**7,547**		Note: Total IN must match Total OUT

APPENDIX A

APPENDIX A

PERMITS

EL SUR RANCH INTERIM MONITORING PLAN
PERMITING STATUS

	Permit Title	Regulatory Agency	Application Date	Date Issued	Status/Comments
1	Section 404 Clean Water Act Nationwide Permit No. 5	Army Corps of Engineers	7/15/04	8/10/04	Verbally advised by Bob Quebedeaux in ACOE San Francisco District that activity is beneath NWP reporting thresholds.
2	Section 401 Clean Water Act Nationwide Permit No. 5	California Regional Water Quality Control Board	7/19/04	8/7/04	Applicability of NWP No. 5 confirmed.
3	Section 401 Clean Water Act Nationwide Permit No. 5	State Water Resources Control Board	7/23/04	7/29/04	Applicability of NWP No. 5 confirmed.
4	Streambed Alteration Agreement/Waiver	California Department of Fish and Game	7/8/04	8/9/04	Written determination that no SAA is required.
5	Section 7 Endangered Species Act Consultation	National Maine Fisheries Service	N/A	N/A	Consultation not required due to ACOE determination that Project is under NWP reporting thresholds, but NOAA NMFS was sent the IMP by SWRCB.
6	Section 7 Endangered Species Act Consultation	United States Fish and Wildlife Service	N/A	N/A	Consultation not required due to ACOE determination that Project is under NWP reporting thresholds.
7	Coastal Development Permit	Monterey County Planning and Building Inspection Department	6/15/04	7/15/04	CDP exemption issued and conditions satisfied, including Site Restoration Plan. (PBID advises as a matter of policy it does not notify the CCC of CDP exemption determinations.)
8	Permit to Conduct Biological, Geological or Soil Investigations	California Department of Parks and Recreation	6/17/04	6/21/04	Issued and prior to construction conditions satisfied.
9	Well Permit	Monterey County Department of Health	7/8/04	7/20/04	Issued and all prior to construction conditions satisfied except notice prior to moving on site.

1

Terry Tamminen
Secretary for Environmental Protection

California Regional Water Quality Control Board
Central Coast Region

Internet Address: http://www.swrcb.ca.gov/rwqcb3
895 Aerovista Place, Suite 101, San Luis Obispo, California 93401
Phone (805) 549-3147 • FAX (805) 543-0397

Arnold Schwarzenegger
Governor

August 7, 2004

Aengus Jeffers, Esq.
Horan, Lloyd Law Offices
499 Van Buren Street
Monterey, CA 93940

Dear Mr. Jeffers:

NATIONWIDE PERMIT NUMBER 5: INSTALLATION OF TWO STILLING WELLS IN BIG SUR RIVER, MONTEREY COUNTY

Regional Board staff has reviewed the information you submitted and have concluded that the above-referenced project meets the conditions of certification as stated in the letter of exemption by the State Water Resources Control Board for Army Corps Nationwide Permit No. 5, Scientific Measurement Devices. The Regional Water Quality Control Board (RWQCB) has received notification of coverage for your project under NWP 5 dated July 21, 2004. Activities under NWP 5 are subject to any Corps of Engineers Special Conditions contained within the General Permit. This office does not anticipate any further action on this project.

If you have questions, please contact **Amanda Schmidt at (805) 549-3876** or via e-mail at ASchmidt@rb3.swrcb.ca.gov.

Sincerely,

for Roger W. Briggs
Executive Officer

S:\Section 401 Certification\Certifications by County\Monterey Co\Installation of Stilling Wells NWP 5 Notification.doc

Cc:

California Department of Fish and Game
Lake and Streambed Alteration Program
Post Office Box 47
Yountville, CA 94599

U.S. Army Corps of Engineers
Ventura Office
Regulatory Section
2151 Allesandro Drive, Suite 110
Ventura, CA 93301

RECEIVED
AUG - 9 2004
HLKD&S AND L&C, INC.

2

MONTEREY COUNTY

DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
1270 Natividad Road
Salinas, CA 93906
(831) 755-4507

WATER WELL CONSTRUCTION PERMIT

WELL PERMIT NO. #04-07840

ISSUED: 07-20-04
EXPIRES: 07-20-05
RECEIPT: ------
APN: 159-031-05/08

SITE LOCATION:(Andrew Molera State Park) Hwy 1
TYPE: Six (6) Monitoring Wells
OWNER: Andrew Molera State Park
ADDRESS: Hwy 1
CITY: Big Sur, CA 93920
PHONE: ------
DRILLING CONTRACTOR :Resonant Sonic International
LICENSE:802334

ISSUED BY: ______________________

CONDITIONS OF APPROVAL:

1. Notify the Monterey County Health Department, Division of Environmental Health (MCHD, DEH) prior to moving on site.

2. Must meet conditions 1, 2 and 3 of attached coastal permit exemption (PB040752).

3. Boreholes or wells shall be at least 100 feet from any septic tank, any portion of any leach field or animal enclosure; 50 feet from any sewer main, line or lateral, and 150 feet from any seepage pit. If type of absorption field is unknown, the distance shall be 150 feet.

END

MONTEREY COUNTY HEALTH DEPARTMENT

DIVISION OF ENVIRONMEN[illegible] HEALTH
RESOURCE PROTECTION [illegible]NCH

1270 NATIVIDAD RD.,[illegible]M 109, Salinas, CA 93906
Phone: (831) 755-450[illegible] [illegible]AX: (831) 755-8929

APPLICATION TO CONSTRUCT, REPAIR OR ALTER A WATER WELL, MONITORING WELL OR CATHODIC PROTECTION WELL

OWNER: James J. Hill, III ("Easement Holder")
Mailing address: ESR: PO Box 1588
City/Town: Monterey, CA Zip 93942
Phone: (925) 944-2856 x302 (Paul Horton)

CONTRACTOR: Resonant Sonic International
Mailing address: 220 N. East Street
City/Town: Woodland, CA Zip: 95776
Phone: (530) 668-2424 C-57 License: 802334

PROPOSED SITE ADDRESS: Andrew Molera State Park APN: 159-031-005 ACRES: ___

Construction(X) Repair( ) Alteration( ) If Repair/Alteration, please describe: ___

Intended Use: Irrigation( ) Domestic/Single Connection( ) Domestic/Multiple Connection( ) Geothermal( ) Cathodic Protection( ) Monitoring(X) Industrial( ) Stock( ) Other ___ GPM needed: ___ If well is for Multiple Connections, give name of water system: ___

Special Zones: Monterey County Water Resources Agency: 2A-Salinas Valley( ) 6-Saltwater Intrusion( ) Coastal (X) Monterey Peninsula WMD( ) Pajaro Valley WMD( ) Consultation Zone:

Total number of wells on property: 8 Number of wells in use? 3 Inactive? 5 Abandoned? 0

Distance to nearest: Property line 1,250 ft. Leach line >1,000 ft. Seepage pit >1,000 ft. Septic tank >1,000 ft. Sewer lines, mains, or laterals >1,000 ft. Existing well 350 ft Animal enclosure >1,000 ft.

Estimated Work: Start 7/26/04 Finish 7/30/04 Receive Permit: By Mail(X) Pick Up( )

A map containing the following information must accompany this application: Written directions to the proposed site; nearest crossroad; arrow indicating north; property lines; distance from proposed well to property lines; location of other wells on property; location of septic tanks, seepage pits and leach lines on property *and within 150 feet of the property line*. If an inadequate map is provided and a second well site field visit is required, a charge at the current hourly rate may be required for the additional site visit. Flag the precise site location of the proposed well with a surveyor's stake with the words "Proposed Well."

PROPOSED DESIGN/CONSTRUCTION FEATURES:

Type of well construction: Mud Rotary( ) Reverse Rotary( ) Air Rotary(X) Cable Tool( ) Other(X) Sonic
Bore hole depth 12 ft. Bore hole diameter 7 in. Seal width 7 in.

Conductor casing: To be installed? No If yes: Length ___ in. Diameter ___ in. Thickness ___ in.

Production casing: Standard or line pipe( ) Structural steel( ) Thermoplastics(X) Thermoset plastic( ) Diameter 2 in. Single( ) Double( ) Type of joint ___

Logging to be used: Electric ( ) Caliper( ) Fluid movement( ) Geologic(X) Other ___

Proposed seals:

Material	Volume	Length	Location
Cement Grout	___ cu. yds.	5 ft.	0 to 5 ft.
Bentonite	___ cu. yds.	2 ft.	5 to 7 ft.

Proposed location of perforations or screens: 8 to 12 ft. -- to -- ft. -- to -- ft.

Concrete pump base: Length -- in. Width -- in. Thickness -- in.

Method of disinfecting gravel-pack and completed well: Surge and purge development

Pump: Deep well turbine( ) Submersible( ) Jet( ) Centrifugal( ) Airlift( ) Piston( ) HP ___

Type of seal, if top mounted pump: Pump head-based gasket( ) Pump base-casing rim gasket( ) Well cap( )

I hereby agree to comply with all conditions, laws and regulations of the County of Monterey and the State of California pertaining to well construction. I understand approval of a well permit does not indicate whether this property is suitable for an individual sewage disposal system or that a permit to install such a system is granted. I understand fees submitted with this application are non-refundable.

SIGNATURE OF PROPERTY OWNER
X [signature] Date 7/8/04

SIGNATURE OF CONTRACTOR
X [signature] Date 7/6/04

OFFICE USE ONLY

Date 7/9/04 Time [illegible] Receipt # [illegible]14710 Amount $ 480. Violations? None see attached( )

H.D. Approval ___ W.A. Approval ___ CA Well # or Location Coordinates ___

Site Inspection: Date ___ EHS ___ Construction Inspection: Date ___ EHS ___

Seal Inspection(s): Date ___ EHS ___ Date ___ EHS ___ Date ___ EHS ___

Final Inspection: Date ___ EHS ___ GPS Coordinates: ___ Date ___ EHS ___

Conditions: 1___ 2___ 3___ 4___ 5___ 6___ 7___ 8___ 9___ 10___ 11___ 12___ 13___ 14___ 15___ 16___ 17___

Special Conditions: ___

Comments: ___

Permit # 04-0794 Invoice # 0838457

ESR--4

3

From: Mark Blum
To: Carl P. x7593 Holm
Date: 8/5/2004 8:30:34 AM
Subject: RE: ESR Revised Site Restoration Plan for Exempt Interim Monitoring Plan

Carl,

Thanks very much for your quick review. We have all permits now except DFG and are closing on that.

Best regards,
Mark

>>> "Holm, Carl P. x7593" <HolmCP@co.monterey.ca.us> 8/5/2004 7:08:52 AM >>>
I have reviewed the revised Restoration Plan and find that it adequately addresses my comments. This clears all Planning conditions required to be met prior to beginning work provided you have all other required permits (Env Health, DFG).

Carl P. Holm, AICP
Senior Planner
831-883-7593

-----Original Message-----
From: Mark Blum [mailto:Blum@horanlegal.com]
Sent: Wednesday, August 04, 2004 9:18 AM
To: HolmCP@co.monterey.ca.us
Cc: NTFIRE@aol.com; nviro@cwo.com; derhr@earthlink.net; jgoldsmith@kmtg.com; phorton@thesourcegroup.net; smccabe@thesourcegroup.net
Subject: ESR Revised Site Restoration Plan for Exempt Interim Monitoring Plan

Carl,

I am attaching the Revised Site Restoration Plan for the Interim Monitoring Plan. Per your 7/27 request, The Source Group has added to the Restoration Plan more detailed plan(s) and text discussion of each of the three components discussed in the Plan to better illustrate and describe what is being proposed. With the further assistance of our consulting biologist a single spoils receptor site has been identified and Figure 1 now
locates that site. As described, the equipment design and selection allows operation without need for an equipment staging areas. Road access to each well is described and now illustrated on Figure 1.

We have consulted our consulting biologist concerning the re-vegetation of the spoils disposal site as part of the restoration plan, and his recommendation has been incorporated.

I am waiting only on the digital images of the existing hole which will serve as the spoils disposal site. I expect those today or tomorrow and will forward them immediately. However, I wanted to get you this revised plan today in light of our intended August 9 start date.

Please call me to discuss the revised plan at your opportunity.

MONTEREY COUNTY

PLANNING & BUILDING INSPECTION DEPARTMENT
2620 1st AVENUE MARINA, CA 93933
(831) 883-7522 FAX: (831)384-3261

July 15, 2004

Law Offices of Horan Lloyd, Karachale, Dyer, Schwartz, Law & Cook
Attn: Mark Blum
P.O. Box 3350
Monterey, CA 93942-3350

SUBJECT: PD040752/El Sur Ranch
Interim Monitoring Plan – CDP Exemption

We have received and considered your request to install one to two temporary testing wells at the El Sur Ranch (APN: 159-011-008-000) plus a well cluster of three monitoring wells and three steam gauge/stilling wells at Andrew Molera State Park (APN: 159-031-003/005-000). The El Sur Ranch is designated as WSC/40(CZ) and the State park is designated RC(CZ). Both are located within the Big Sur Coast Land Use Plan.

FINDINGS:

- Section 20.70.120.G exempts installation, testing, and placement in services or replacement of any necessary utility connection between an existing service facility and any development. El Sur Ranch (ESR) is seeking a permit to appropriate from the State Water Resource Control Board (SWRCB) and is undergoing CEQA review by that agency. This monitoring proposal is to obtain technical data for facilitating SWRCB's CEQA review and the formulation of conditions on the SWRCB to protect the environment and the public trust resources.

- Development within the critical viewshed and or within 100 feet of ESHA (e.g. riparian corridor) is non-exempt development. In addition, any project within 750 feet of known archaeological resource is considered development.
    - ESHA: A biological report was completed by Sycamore Environmental Consultants on June 30, 2004. This report reviewed areas where wells are proposed as well as access to the well sites and locations where the spoils would be distributed. All three wells in the cluster to be located in Andrew Molera State Park are in an open area dominated by non-native annual grasses and poison oak. The well or wells on ESR are to be located within irrigated pasture lands that have been recontoured in the past. No well on ESR will be located in/near a riparian corridor or other ESHA. No State or Federally listed species were found in any of the impact areas.
    - Critical Viewshed: The monitoring well or wells on ESR are at such a great distance from the highway, at a lower elevation, and would be of such

minimal structure above ground, if any, that there would be no visibility in the critical viewshed.

- Archaeological: The well(s) in the pasture would be within a 1,200+ acres of disturbed agricultural field. A report prepared by Archaeological Consulting, dated July 6, 2004, found no evidence in any of the anticipated impact areas on El Sur Ranch or within Andrew Molera State Park. A standard condition to monitor the project during construction would be in place since there is a possibility of finding unidentified resources.

- Section 15306 of the CEQA Guidelines (Class 6) categorically exempts projects consisting of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource. The proposed wells are strictly for information gathering purposes, or as part of a study leading to an action which has not yet been approved, adopted, or funded. No adverse environmental impacts were identified during review of the proposed project including the professional biological and archaeological assessments prepared for this project.

DETERMINATION:
Section 20.70.120.G CIP allows granting an exemption subject to conditions to mitigate and adverse impacts on coastal resources. Based on the information provided, staff determines that the proposed test well or wells on ESR would be exempt from a Coastal Permit, subject to the following conditions:

1. Temporary wells authorized under this exemption are for test purposes only. They shall be allowed to operate for a period not to exceed one year (from the date of a permit from environmental health) unless otherwise approved by the Director of Planning and Building Inspection. No water will be drawn for private use from any of these wells and none of the testing wells identified as part of this study may become permanent wells.
2. Prior to beginning work, the applicant must provide PBI with a Restoration Plan for all impact areas (area of impact for installation and removal including how/where trucks will access the site, where spoils will be deposited, etc.), subject to review and approval of PBI.
3. During construction, the contractor shall monitor the project. If any archaeological resources or human remains are accidentally discovered, work shall be halted within 150 feet of the find until it can be evaluated by a qualified professional archaeologist. If the find is determined to be significant, appropriate actions shall be formulated and implemented with a report of said actions submitted to the satisfaction of the Director of Planning and Building Inspection..

If you have any questions, please feel free to contact me at 831-883-7593 or via email at holmcp@co.monterey.ca.us.

Sincerely,

Carl P. Holm, AICP
Senior Planner

August 3, 2004

Carl P. Holm, AICP
Monterey County PBI
2620 1st Avenue
Marina, CA 93942

**Subject: PD040752 Site Restoration Plan - Revised
El Sur Ranch/Andrew Molera State Park**

Dear Carl:

The revised Site Restoration Plan described in this letter is in response to the comments in your e-mail of July 27. The revised Site Restoration Plan is designed to satisfy the site restoration requirements of PD040752 for our planned installation of monitoring wells on the El Sur Ranch (Ranch) property and on the neighboring Andrew Molera State Park (Park) property (see Figure 1). A total of seven wells will be installed within the two properties. Wells ESR-10a, ESR-10b and ESR-10c will be installed in immediate adjacent locations approximately 200-ft north of the Big Sur River within the Park. Two stilling wells will be located at separate locations on the bank of the Big Sir River, also within the Park. Lastly, wells ESR-11 and ESR-12 will be individually located in a field within the boundary of El Sur Ranch (see Figure 1)

ESR-10 Well Cluster

The ESR-10 well cluster will be located in a grassy field approximately 200-ft north of the Big Sur River. Vehicular access to the field is from the hiking trail/service road that runs along the north side of the Big Sur River. This trail/road can be accessed through the Park from Highway 1 or from the Ranch property. Access to the field requires crossing a shallow but wide ditch that parallels the south side of the trail/road as shown on Figure 1. All drilling equipment will be contained on either the drilling rig, or a support vehicle, so staging areas will not be required. The proposed well configurations are shown on Figure 2. The spoils receptor site is shown on Figure 1, and is described in more detail below.

It is expected that the field vehicles used to install the well cluster will cause some unwanted alterations to the soil and vegetation in the area between the trail/road and the well location. Though the utmost care will be taken to minimize damage, some shallow ruts and stressed vegetation will likely result. Site restoration will include removing the ruts caused by the trucks using hand tools. Restoring the top soil in these locations to its original state should set the stage for natural revegetation which, based on the vegetation in the area, is expected to be quite prolific.

During the construction of the well, some spoils will be generated. These spoils will be promptly transported to the location on the El Sur Ranch property shown on Figure 1, and illustrated by the attached digital image files, where they will not pose an erosion threat or require site

3451-C Vincent Road
Pleasant Hill, California 94523

Telephone: (925) 944-2856
Facsimile: (925) 944-2859

restoration for the following reasons. The spoils disposal site is an existing hole next to the mailbox at the ranch driveway intersection with Highway One, which is topographically upgradient, and away from all surface water bodies (see Figure 1). The disposal site is immediately south of the highway fence, on the ocean side of the ESR property. It is boarded by the fence on the up hill side and by the ranch access road on the other. Less than a 1.2% grade in any direction. It has grass all around it, and is currently a hole 3 feet deep, 10 feet long and 6 feet wide roughly. It is away from pedestrian, animal and vehicular traffic thereby minimizing the need for restoration. On the recommendation of project biologist Sycamore Environmental Consultants, Inc., the spoils will be seeded with an appropriate grass seed mix, as determined by ESR, within one week after the soil is deposited. When the time comes for the wells to be destroyed, the well monuments and all well casings will be removed. The remaining boreholes will be backfilled with a Bentonite slurry to within approximately 2-feet of the surface grade, and backfilled with native soil to match the existing grade with the expectation that natural revegetation will occur.

It is anticipated that the well cluster will be in place for at least two seasons, with a possible removal date of October 2005.

Stilling Wells

The stilling wells will be installed in the riverbed and extend onto the bank of the Big Sur River using nothing but hand tools. It is expected that minor amounts (approximately enough to fill one or two 5-gallon buckets) of riverbed material will be displaced, but not removed from these areas. No vegetation should be impacted. Site restoration will occur when the wells are removed and consist of realigning the displaced rocks back to their natural state. The proposed stilling well configurations are shown on Figure 3. The stilling wells will be accessed by foot for both the installation and subsequent data collection activities.

If it seems unlikely that the stilling wells would be lost in the winter, and the data collection this season suggests that another season of collection is necessary, we will leave the well housings in the river and simply remove the instruments for reinstallation in the spring. If a well housing is then lost over the winter we would replace it during the winter season.

If it seems likely that one or more of the stilling well housings would be lost in the winter we will remove the housing(s) at the end of the dry season and, if necessary for data collection, reinstall the stilling wells in the early spring.

ESR 11 and ESR 12

Both of these wells will be installed within existing pasture on the El Sur Ranch property. They will look similar to the wells shown in Figure 2. It is expected that any vehicular damage to the field will be removed when the field is plowed. Well destruction will likely occur in a similar timeframe as wells ESR-10a,b and c and will be conducted in accordance with the conditions of approval imposed by the County Health Department on the Well and /or Boring Permits.

It is estimated that a total of three to five cubic yards of spoils will be generated during the installation of wells ESR10a,b,c, ESR-11 and ESR-12 (i.e., less than one cubic yard generated per well). The spoils disposal site will be an existing hole (that was created when looking for some piping) next to the mailbox at the ranch driveway intersection with Highway One, which is topographically upgradient, and away from all surface water bodies (see Figure 1). The disposal site is immediately south of the highway fence, on the ocean side of the ESR property. It is boarded by the fence on the up hill side and by the ranch access road on the other. Less than a 1.2% grade in any direction. It has grass all around it, and is currently a hole 3 feet deep, 10 feet long and 6 feet wide roughly. It is away from pedestrian, animal and vehicular traffic thereby minimizing the need for restoration. On the recommendation of project biologist Sycamore Environmental Consultants, Inc., the spoils will be seeded with an appropriate grass seed mix, as determined by ESR, within one week after the soil is deposited.

If you have any further questions or concerns regarding the restoration of any areas affected by the upcoming drilling operations, please contact me at 925-944-2856 x302. Based on the data requirements of the Monitoring Plan, we need to commence work by August 9. Please let me know at your earliest opportunity if this Site Restoration Plan is approved.

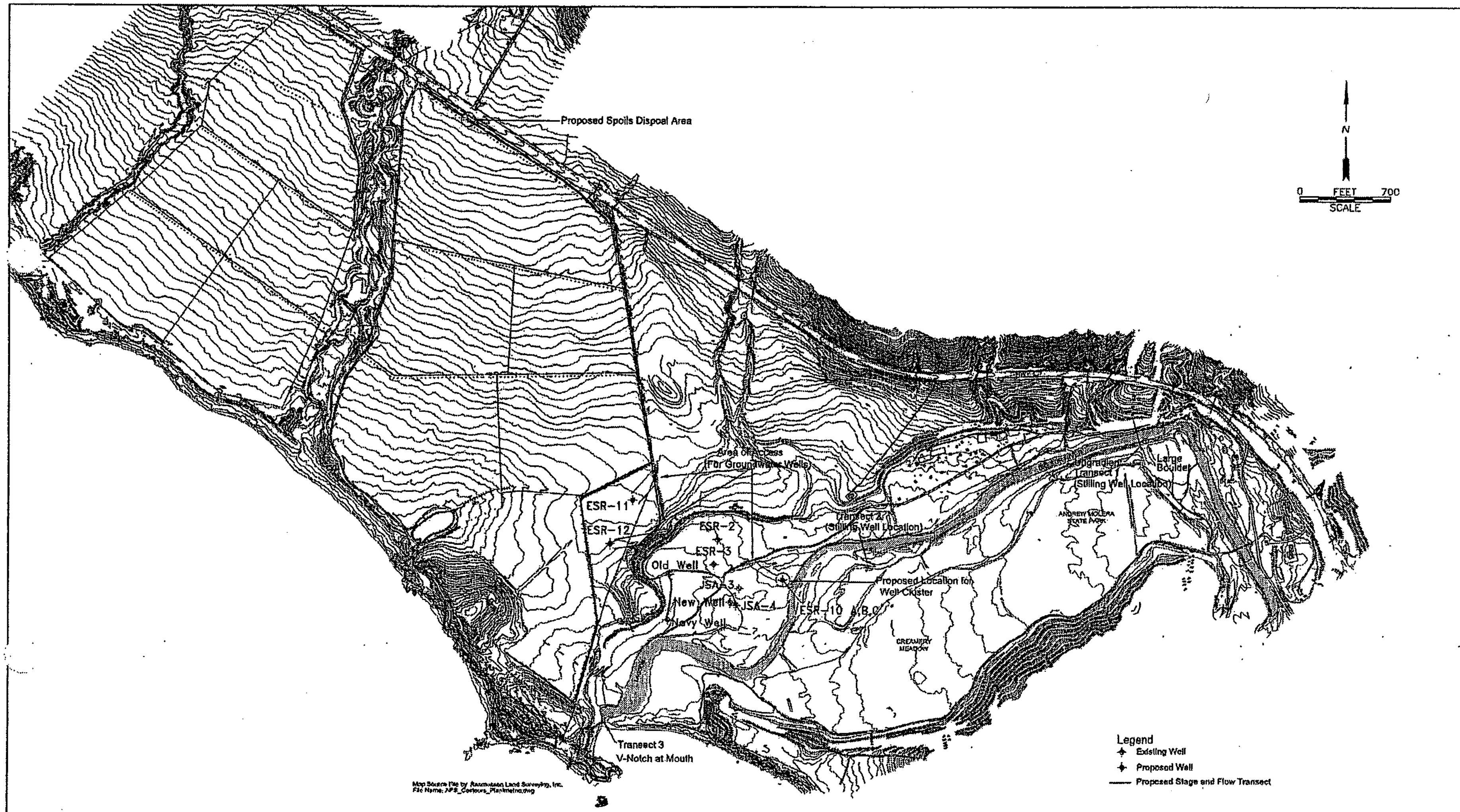
Sincerely,

The Source Group, Inc.

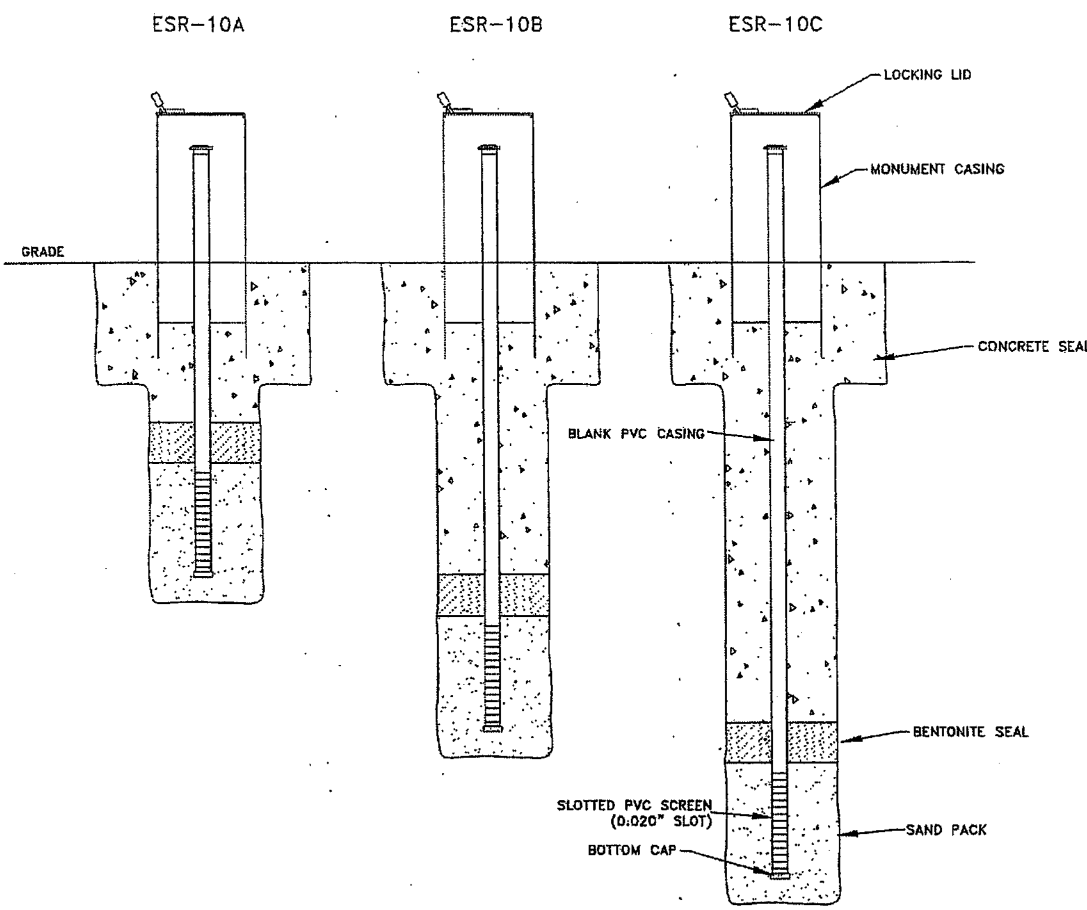
Paul D. Horton

Paul Horton, R.G., C.H.G.
Principal Hydrogeologist

cc: Mark Blum, Horan Legal

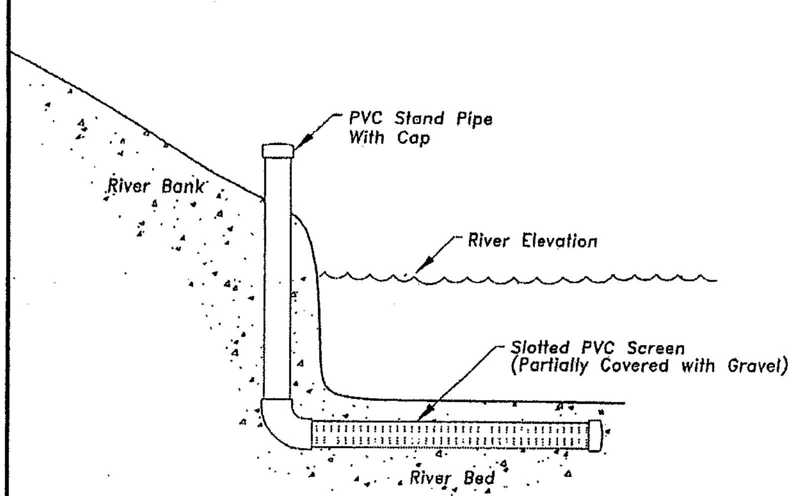


The Source Group, Inc. 3451-C VINCENT ROAD PLEASANT HILL, CALIFORNIA 94523	EL SUR RANCH BIG SUR, CALIFORNIA				FIGURE 1 SITE PLAN AND PROPOSED WELL LOCATIONS
	PROJECT NO. 01-ESR-001	DATE 8/02/04	DR. BY ML	APP. BY POH	

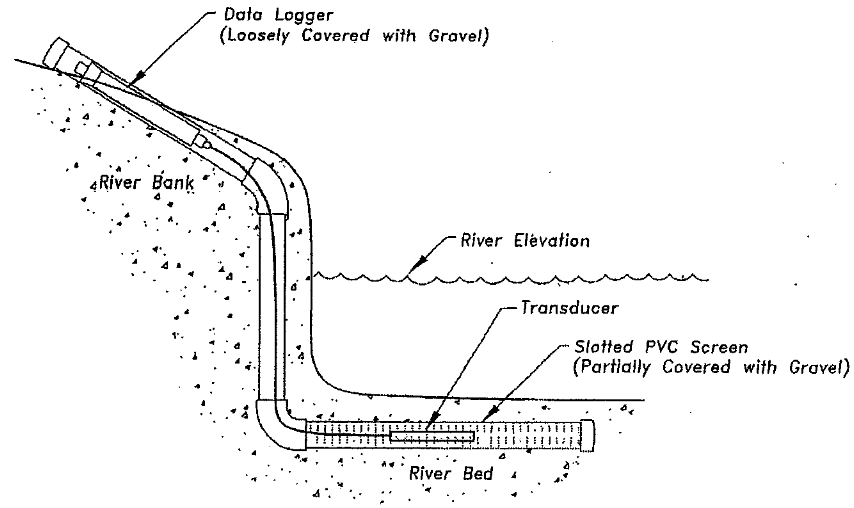


The Source Group, Inc.
3451-C VINCENT ROAD
PLEASANT HILL, CA 94523

SCALE:	WELL CLUSTER DIAGRAM
CLIENT: EL SUR RANCH	DATE: 8/2/2004
LOCATION: BIG SUR, CALIFORNIA	FIGURE: 2



Stilling Well



Stilling Well
with Transducer

The Source Group, Inc. 3451-C VINCENT ROAD PLEASANT HILL, CA 94523	EL SUR RANCH BIG SUR, CALIFORNIA		FIGURE 3 SIMPLIFIED STILLING WELL DIAGRAMS		
	FILE NAME STILLING WELL 5 04	PROJECT NO. 01-ESR-001	DATE 8/02/04	DR. BY ML	APP. BY SM

4

STATE OF CALIFORNIA THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME
CENTRAL COAST REGION
(707) 944-5520
Mailing address:
POST OFFICE BOX 47
YOUNTVILLE, CALIFORNIA 94599
Street address:
7329 SILVERADO TRAIL
NAPA, CALIFORNIA 9455

August 9, 2004

Notification Number: 1600-2004-0548-3

Mr. Peter A. Fuller
The Source Group, Inc.
3451-C Vincent Road
Pleasant Hill, CA 94523

Results of a Lake or Streambed Alteration Agreement Notification Review

We have received and evaluated your Notification of Lake or Streambed Alteration package and determined that it was complete. Using the information from your attached description, plans, maps, questionnaire, correspondence and revised notification (received by email on August 5, 2004 and fax on August 6 and 9, 2004) and site visit, we have determined the following:

You are proposing work within the riverbed of the Big Sur River, located in Andrew Molera State Park, in Monterey County.

Your project consists of installation and removal of two stilling well housing casings for monitoring devices (at Transects 1 and 2, identified on the attached map). Installation of these housing casings will occur in August of 2004 and removal shall occur only between the dates of July 1 and October 15 of 2005 or 2006. Installation and removal will not require access by vehicle, the use of heavy equipment, or the use of cement in flowing waters.

The possibility of substantial impacts from this project as described is unlikely or the activity is outside the jurisdiction of the Department under Section 1600 *et. seq.* of the Fish and Game Code.

If you conduct your project as described and according to plans submitted in the Notification, including any measures in the Notification that are intended to protect fish and wildlife resources, no Streambed Alteration Agreement is required. Our findings are limited to the assessment of the installation of the still well housing casing at two sites, and do not reflect Department concurrence with, or approval of, the monitoring plan associated with the stilling well installation.

Please be advised that other permits or California Environmental Quality Act (CEQA) review of your project may be required by another State or Federal agencies.

RETAIN A COPY OF THIS LETTER AND YOUR ATTACHED NOTIFICATION PACKAGE AT THE WORK SITE AND PROVIDE TO DEPARTMENT REPRESENTATIVE IF REQUESTED.

If you have any questions, please contact Serge Glushkoff, Environmental Scientist at SGlushkoff@dfg.ca.gov, (707)944-5597 or Linda Hanson, Staff Environmental Scientist, at LHanson@dfg.ca.gov, (707)944-5562.

Sincerely,

for Robert W. Floerke
Regional Manager
Central Coast Region

cc: Lieutenant Fox
Mike Hill
Debra Hillyard
Linda Hanson

1600-2004	For Department Use Only				
Notification Number:	0548-3	Date Received	7-16-04	Date Completed	
Fee Enclosed?	☑ Yes $ 154	☐ No			
Action Taken/Notes	#154 Law Offices of Horan Lloyd Karachale Dyer Schwartz, Law & Cook Incorp.				

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

Fox Hill

NOTIFICATION OF LAKE OR STREAMBED ALTERATION

All fields must be completed unless otherwise indicated.
(See enclosures for instructions.)

Notification Type	
☐ Timber Harvesting Plan (No. ________)	X Water Application (No. 30166)
☐ Commercial Gravel Extraction (No. ________)	☐ Other

Application Information

	Name	Address	Telephone/FAX
Applicant:	Aengus L. Jeffers, Esq.	499 Van Buren Street Monterey, CA 93940	Business: 831-373-4131 Fax: 831-373-8302
Operator:	Paul Horton The Source Group, Inc.	3451-C Vincent Road Pleasant Hill, CA 94523	Business: 925-944-2856 Fax: 925-944-2859
Contractor: (if known)	Paul Horton The Source Group, Inc.	3451-C Vincent Road Pleasant Hill, CA 94523	Business: 925-944-2856 Fax: 925-944-2859
Contact Person: (if not applicant)	Aengus L. Jeffers, Esq.	499 Van Buren Street Monterey, CA 93940	Business: 831-373-4131 Fax: 831-373-8302
Property Owner:	James J. Hill, III	Post Office Box 1588 Monterey, CA 93942-1588	Business: 831-624-2719 Fax: N/A

Project Location

Location Description:	Mouth of the Big Sur River			
County	**Assessor's Parcel Number**			
Monterey	159-031-003 and 159-031-005			
USGS Map	**Township**	**Range**	**Section**	**Latitude/Longitude**
Big Sur	19 South	1 East	N/A	36N 17' 01" and 121W 51' 35"
Name of River, Stream, or Lake:	Big Sur River			
Tributary To?	N/A			

Name of Applicant: Aengus L. Jeffers, Esq.

Project Description							
Project Name:	Big Sur River Mouth Stilling Wells						
Start Date:	ASAP	Completion Date:	Same Day	Project Cost:	$2,000	Number of Stream Encroachments: (Timber Harvesting Plans Only)	

Describe project below: (Attach separate pages if necessary)

Installation of 2 Stilling Wells near the mouth of the Big Sur River to gauge flow stages: The attached Site Plan describes the location of the proposed Stilling Wells to be located at Transects 1 and 2. Each Stilling Well will be located on the North bank of the watercourse. Transect 3 will not require the installation of a Stilling Well and therefore is not a part of this permit application. Flow stages at Transect 3 will be measured against a surveyed monument located beyond the banks of the Big Sur River. The schematic attached hereto describes the configuration of each Stilling Well. Installation of each Stilling Well will require a hand dug trench starting about 2 to 3 feet from the bank of the water course and continuing into the bed the minimal distance required for each transect. It is estimated that each trench will extend 3 to 6 feet into the watercourse. The depth of each Stilling Well trench will be approximately 6 inches. The width of each Stilling Well trench will be approximately 6 inches. A Stilling Well (2 inch perforated pipe) will be placed within each hand dug trench and covered with native streambed materials originating from the trench work. The Stilling Wells will be installed in August 2004 and will be removed and the streambed and bank restored between July 1 and October 31 of 2005 or 2006, to avoid winter rains and high river flows.

CONTINUED ON SEPARATE PAGE.

X Continued on separate page (s)

Attachments/Enclosures		
Attach or enclose the required documents listed below and check the corresponding boxes.		
X Project Description	X Map showing project location, including distances and/or directions from nearest city or town	X Construction plans and drawings pertaining to the project
Completed CEQA documents:	X Notice of Exemption ☐ Negative Declaration ☐ Draft or Final Environmental Impact Report	☐ Mitigated Negative Declaration ☐ Notice of Determination
Copies of applicable local, State, or federal permits, agreements, or other authorizations:	X Local. Describe: County of Monterey Notice of Combined Development Permit and CEQA Exemption	
	X State. Describe: California Department of Parks and Recreation: Permit to Conduct Biological, Geological or Soil Investigations/Collections	

I hereby certify that all information contained in this notification is true and correct and that I am authorized to sign this document. I understand that in the event this information is found to be untrue or incorrect, I may be subject to civil or criminal prosecution and the Department may consider this notification to be incomplete and/or cancel any Lake or Streambed Alteration Agreement issued pursuant to this notification. I understand that this notification is valid only for the project described herein and that I may be subject to civil or criminal prosecution for undertaking a project that differs from the one described herein, unless I have notified the Department of that project in accordance with Fish and Game Code Section 1602.

I understand that a Department representative may need to inspect the property where the project described herein will take place before issuing a Lake or Streambed Alteration Agreement pursuant to this notification. In the event the Department determines that a site inspection is necessary, I hereby authorize the Department to enter the property where the project described herein will take place to inspect the property at any reasonable time and certify that I am authorized to grant the Department permission to access the property.

X I request the Department to first contact me at (insert telephone number) 831-373-4131 to schedule a date and time to enter the property where the project described herein will take place and understand that this may delay the Department's evaluation of the project described herein.

[signature] / Peter A. Fuller — August 9, 2004

Operator or Operator's Representative — Date

Form FG2023 — (Effective January 12, 2004)

NOTIFICATION NO. 2004-0568
Water Application No. 30166

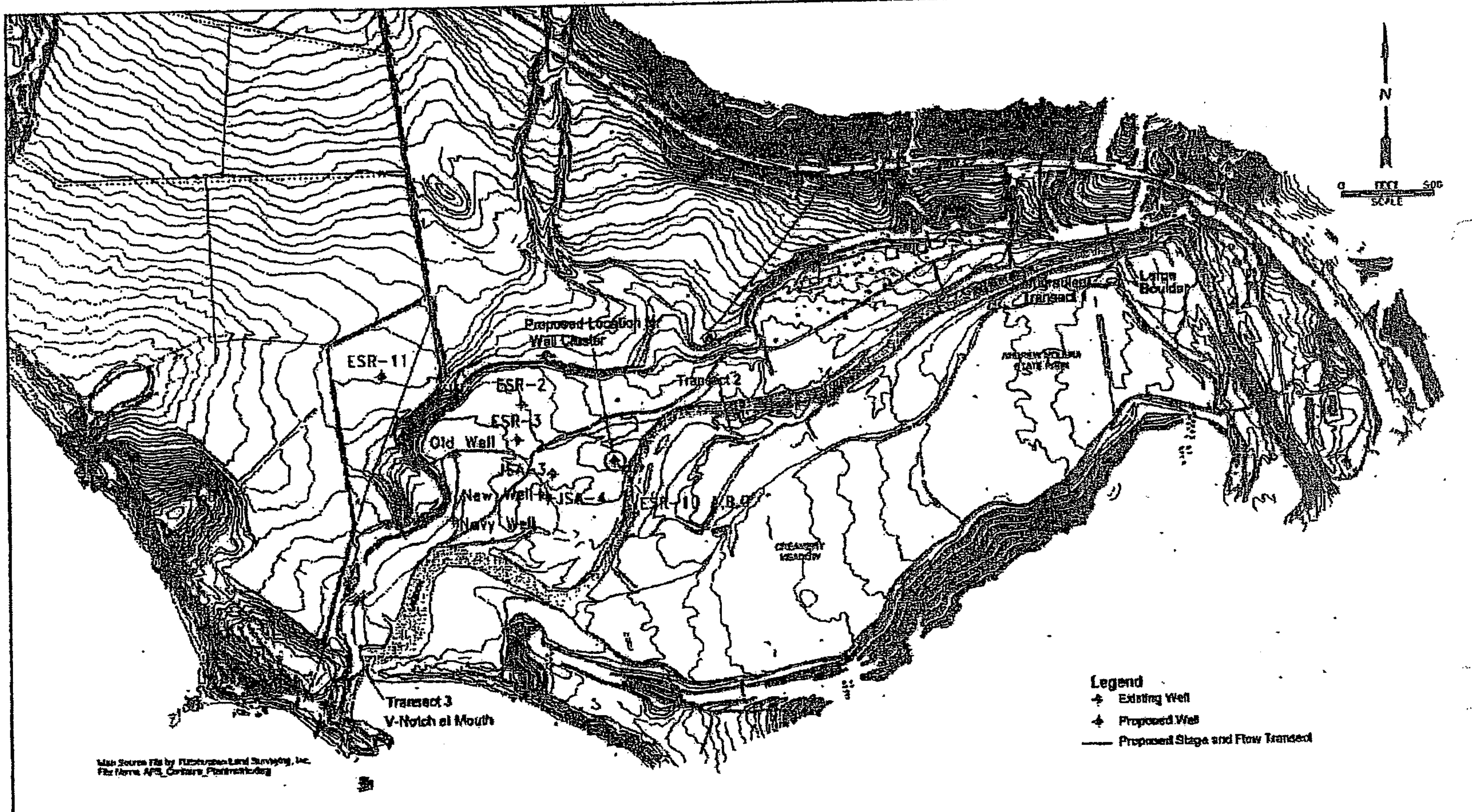
Project Description Continued

Placing, removing and replacing the monitoring devices inside the stilling well casings has no potential to disturb bed, bank, channel or flow. One stilling well casing is simply an empty "L" shaped pipe with a cap on it. Testing consists of removing the cap and hand lowering a probe into the pipe to measure water level. Once the measurement is taken, the probe is removed and the cap is replaced.

The second well casing is fitted with a transducer and a data logger. This monitoring equipment is contained in metal cylinders connected by an electrical cable which are hand lowered into the well casing. The data logger also serves as the cap on the well casing. When the monitoring equipment is to be removed, the cap is unscrewed and the cylinders are pulled out as a unit. Then a blank cap is hand placed on the well casing.

The monitoring equipment will be installed in the second well at the time that well casing is installed. Thereafter, the monitoring equipment will be removed on or about October 31 and replaced on or about April 1, until such time as the well casings are removed as specified herein.

Peter A. Fuller
The Source Group, Inc.



The Source Group, Inc.
3451-C VINCENT ROAD
PLEASANT HILL, CALIFORNIA 94523

EL SUR RANCH
BIG SUR, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01-ESR-001	5/6/04	UL	SM

FIGURE 2
PROPOSED WELL & RIVER STAGE/FLOW TRANSECTS

TOTAL P.07

5

State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

APPLICATION AND PERMIT TO CONDUCT BIOLOGICAL, GEOLOGICAL, OR SOIL INVESTIGATIONS/COLLECTIONS

☑ NEW
☐ RENEWAL

FOR DEPARTMENT USE ONLY

APPLICATION NO.	DATE RECEIVED
DISTRICT	CEQA

PERMIT TYPE
☐ Biological ☐ Geological
☐ Soil

APPLICATION

Instructions: Applications must be TYPEWRITTEN with original signatures. Precise location of proposed work must be shown on attached USGS topographic map and other maps. Application should be sent to the District Office that administers the park unit where the collection/investigation will take place, or to the Resource Management Division for multi-District requests.

APPLICANT ORGANIZATION
El Sur Ranch - Jim Hill

TELEPHONE NO.
831-624-2719

STREET ADDRESS/CITY/STATE/ZIP CODE
P.O. Box 1588 Monterey, CA 93942

NAME, TITLE, ADDRESS, TELEPHONE NO., AND AFFILIATION OF PRINCIPAL INVESTIGATOR *(Attach resume or curriculum vitae.)*

Paul Horton, R.G., C.HG. Principal Hydrogeologist
3451- C Vincent Road, Pleasant Hill, CA 94523
925-944-2856 ext. 302

Charles H. Hanson, Ph.D, Biologist
132 Cottage Creek, Walnut Creek, CA 94595
925-937-4606

NAME, ADDRESS, TELEPHONE NO., AND AFFILIATION OF PERSON IN ACTUAL DIRECT CHARGE OF FIELD WORK *(Attach resume and curriculum vitae if different from investigator.)*
Same as Investigator(s)

COLLECTING ASSISTANT NAME(S)	STREET ADDRESS/CITY/STATE/ZIP CODE	TELEPHONE NO.
Steve McCabe, R.G.	3451- C Vincent Road, Pleasant Hill, CA 94523	925-944-2856 330
Jon Phillip	3451- C Vincent Road, Pleasant Hill, CA 94523	925-944-2856 316
Charles Hanson/Justin Taplin	132 Cottage Creek, Walnut Creek, CA 94595	925-937-4606

The above applicant hereby applies to the Department of Parks and Recreation for a permit under Title XIV, California Code of Regulations, Section 4309, and Public Resources Code Section 5097.5, to conduct investigations on lands of the State of California as follows:

STATE PARK UNIT(S)
Andrew Molera

COUNTY(IES)
Monterey

TYPE OF HABITAT, GEOLOGICAL FORMATION NAME, OR SOIL TYPE
Riparian - Alluvium - Sand & Gravel

USGS QUADRANGLE(S)
Big Sur, California

LEGAL DESCRIPTION *(Township, Range, and Section of each distinct location.)*
T19S, R1E Latitude 36 17.056 Longitude -121 51.290

1. AIM AND PURPOSE OF COLLECTION ACTIVITY, AND METHODS OF THIS INVESTIGATION *(For excavations, provide a research design and an outline of the report. Attach continuation sheets as necessary.)*
See Attached Work Plan - (Interim Monitoring Plan Water Right Application #30166)

2. METHOD OF COLLECTION
See Attached Work Plan - (Interim Monitoring Plan Water Right Application #30166)

3. TYPES OF SPECIMENS *(Species, quantity, size, condition.)*
See Attached Work Plan - (Interim Monitoring Plan Water Right Application #30166)

4. EXPECTED DURATION OF THE PROJECT *(Specify dates of field investigations, laboratory study, and report completion.)*
See Attached Work Plan - (Interim Monitoring Plan Water Right Application #30166)

5. GENERAL SCOPE AND NATURE OF APPLICANT ORGANIZATION'S ACTIVITIES AND GOALS
See Attached Work Plan - (Interim Monitoring Plan Water Right Application #30166)

6. PLACE AT WHICH LABORATORY WORK WILL BE PERFORMED *(Institution, address, telephone numbers, contact person.)*
Not Applicable (no laboratory work)

7. NAME AND LOCATION OF FACILITY THAT HAS AGREED TO CURATE MATERIALS COLLECTED UNDER THIS PERMIT.
El Sur Ranch

PERMIT

STANDARD CONDITIONS AND RESTRICTIONS

It is the intention of the Department of Parks and Recreation to further scientific research within the areas administered by it, and to cooperate with authorized workers to the fullest extent compatible with its charge to preserve all species of flora and fauna and all soil and geologic material in a natural state insofar as is possible.

1. General classroom collection is not allowed under this or any other permit.
2. This permit applies only to non-cultural materials, and is limited to the kind, number, and sizes of specimens described on the front of this form. Archeological material may NOT be collected under this permit.
3. The collections shall be used for scientific or interpretive purposes only, shall be dedicated to the public benefit, and shall not be used for commercial purposes.
4. The collecting must be done away from roads, trails, and developed areas unless such localities are specified in the permit. This collecting shall be done in an inconspicuous manner, and shall not cause damage to the environment. Because of the scarcity or importance of some specimens, the Department of Parks and Recreation may designate other restrictions necessary for the preservation of the area.
5. The permittee shall submit a summary of information gathered to the applicable District where the investigations took place, and to the Chief, Resource Management Division, Department of Parks and Recreation in Sacramento. The Department further requires that the collector make available to the Department any material published as a result of this permit.
6. The collector is to contact the appropriate District Superintendent before collecting, and to present a copy of this permit together with evidences of additional collecting licenses and collecting permits, if required.
7. If collections are not made to the satisfaction of the Department, this permit may be immediately cancelled.
8. All applicable laws and regulations must be observed by the permittee in exercising the privileges granted in this permit.
9. Questions regarding this permit may be directed to the District Superintendent.

I have read the Standard Conditions and Restrictions above.

APPLICANT'S SIGNATURE	APPLICANT'S NAME (Print or type.)	DATE
▶ [signature]	MARK BLUM	6-17-04

REVIEWER	SIGNATURE	DATE
District Resource Ecologist	▶ [signature]	6/22/04
~~District~~ Sector Superintendent	▶ Lois Hart	6/28/04
APPROVAL SIGNATURE* ▶ [signature]	TITLE Dist. Supt.	DATE 7/1/04

APPLICANT MUST CARRY THIS PERMIT AT ALL TIMES WHILE COLLECTING.

PERMIT VALID FROM 7/1/04 TO 12/31/04

PERMIT CONDITIONS:
1) Provide a copy of monitoring report to State Parks.
2) Notify State Parks staff at 667-0193 before entering park.
3) Do not disrupt use of State Park well unless approved in advance.
4) All sites and facilities to be restored to pre-existing conditions at conclusion of study.
5) Obtain permits & approvals of other agencies if needed; check with Fish & Game.

*NOTE: The District Superintendent has the permit authority if one District is involved; the Supervisor, Natural Heritage Section, if more than one District is involved.

DPR 65 (Back)

Copies to: Resource Management Division and District
(Distribute both approved and denied permits.)

U S Army Corps of Engineers
Sacramento District

Nationwide Permit Summary

33 CFR Part 330; Issuance of Nationwide Permits – January 15, 2002, including Correction – February 13, 2002

5. **Scientific Measurement Devices.** Devices, whose purpose is to measure and record scientific data such as staff gages, tide gages, water recording devices, water quality testing and improvement devices and similar structures. Small weirs and flumes constructed primarily to record water quantity and velocity are also authorized provided the discharge is limited to 25 cubic yards and further for discharges of 10 to 25 cubic yards provided the permittee notifies the District Engineer in accordance with the "*Notification*" General Condition. (Sections 10 and 404)

A. __General Conditions.__ The following general conditions must be followed in order for any authorization by an NWP to be valid:

☐ 1. **Navigation.** No activity may cause more than a minimal adverse effect on navigation.

☐ 2. **Proper Maintenance.** Any structure or fill authorized shall be properly maintained, including maintenance to ensure public safety.

☐ 3. **Soil Erosion and Sediment Controls.** Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.

☐ 4. **Aquatic Life Movements.** No activity may substantially disrupt the necessary life-cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. Culverts placed in streams must be installed to maintain low flow conditions.

☐ 5. **Equipment.** Heavy equipment working in wetlands must be placed on mats, or other measures must be taken to minimize soil disturbance.

☐ 6. **Regional and Case-By-Case Conditions.** The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state or tribe in its Section 401 Water Quality Certification and Coastal Zone Management Act consistency determination.

☐ 7. **Wild and Scenic Rivers.** No activity may occur in a component of the National Wild and Scenic River System; or in a river officially designated by Congress as a "study river" for possible inclusion in the system, while the river is in an official study status; unless the appropriate Federal agency, with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation, or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency in the area (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service).

☐ 8. **Tribal Rights.** No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

☐ 9. **Water Quality.**

☐ (a) In certain states and tribal lands an individual 401 Water Quality Certification must be obtained or waived (See 33 CFR 330.4(c)).

☐ (b) For NWPs 12, 14, 17, 18, 32, 39, 40, 42, 43, and 44, where the state or tribal 401 certification (either generically or individually) does not require or approve water quality management measures, the permittee must provide water quality management measures that will ensure that the authorized work does not result in more than minimal degradation of water quality (or the Corps determines that compliance with state or local standards, where applicable, will ensure no more than minimal adverse effect on water quality). An important component of water quality management includes stormwater management that minimizes degradation of the downstream aquatic system, including water quality (refer to General Condition 21 for stormwater management requirements). Another important component of water quality management is the establishment and maintenance of vegetated buffers next to open waters, including streams (refer to General Condition 19 for vegetated buffer requirements for the NWPs).

This condition is only applicable to projects that have the potential to affect water quality. While appropriate measures must be taken, in most cases it is not necessary to conduct detailed studies to identify such measures or to require monitoring.

☐ 10. **Coastal Zone Management.** In certain states, an individual state coastal zone management consistency concurrence must be obtained or waived (see 33 CFR 330.4(d)).

☐ **11. Endangered Species.**

☐ (a) No activity is authorized under any NWP which is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will destroy or adversely modify the critical habitat of such species. Non-federal permittees shall notify the District Engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the project, or is located in the designated critical habitat and shall not begin work on the activity until notified by the District Engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that may affect Federally-listed endangered or threatened species or designated critical habitat, the notification must include the name(s) of the endangered or threatened species that may be affected by the proposed work or that utilize the designated critical habitat that may be affected by the proposed work. As a result of formal or informal consultation with the FWS or NMFS the District Engineer may add species-specific regional endangered species conditions to the NWPs.

☐ (b) Authorization of an activity by a NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the USFWS or the NMFS, both lethal and non-lethal "takes" of protected species are in violation of the ESA. Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the USFWS and NMFS or their world wide web pages at http://www.fws.gov/r9endspp/endspp.html and http://www.nfms.noaa.gov/prot_res/overview/es.html respectively.

☐ **12. Historic Properties.** No activity which may affect historic properties listed, or eligible for listing, in the National Register of Historic Places is authorized, until the District Engineer has complied with the provisions of 33 CFR Part 325, Appendix C. The prospective permittee must notify the District Engineer if the authorized activity may affect any historic properties listed, determined to be eligible, or which the prospective permittee has reason to believe may be eligible for listing on the National Register of Historic Places, and shall not begin the activity until notified by the District Engineer that the requirements of the National Historic Preservation Act have been satisfied and that the activity is authorized. Information on the location and existence of historic resources can be obtained from the State Historic Preservation Office and the National Register of Historic Places (see 33 CFR 330.4(g)). For activities that may affect historic properties listed in, or eligible for listing in, the National Register of Historic Places, the notification must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property.

☐ **13. Notification.**

☐ (a) Timing; where required by the terms of the NWP, the prospective permittee must notify the District Engineer with a preconstruction notification (PCN) as early as possible. The District Engineer must determine if the notification is complete within 30 days of the date of receipt and can request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the District Engineer will notify the prospective permittee that the notification is still incomplete and the PCN review process will not commence until all of the requested information has been received by the District Engineer. The prospective permittee shall not begin the activity:

☐ (1) Until notified in writing by the District Engineer that the activity may proceed under the NWP with any special conditions imposed by the District or Division Engineer; or

☐ (2) If notified in writing by the District or Division Engineer that an Individual Permit is required; or

☐ (3) Unless 45 days have passed from the District Engineer's receipt of the complete notification and the prospective permittee has not received written notice from the District or Division Engineer. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

☐ (b) Contents of Notification: The notification must be in writing and include the following information:

☐ (1) Name, address and telephone numbers of the prospective permittee;

☐ (2) Location of the proposed project;

☐ (3) Brief description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause; any other NWP(s), Regional General Permit(s), or Individual Permit(s) used or intended to be used to authorize any part of the proposed project or any related activity. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP (Sketches usually clarify the project and when provided result in a quicker decision.);

☐ (4) For NWPs 7, 12, 14, 18, 21, 34, 38, 39, 40, 41, 42, and 43, the PCN must also include a delineation of affected special aquatic sites, including wetlands, vegetated shallows (e.g., submerged aquatic vegetation, seagrass beds), and riffle and pool complexes (see paragraph 13(f));

☐ (5) For NWP 7 (Outfall Structures and Maintenance), the PCN must include information regarding the original design capacities and configurations of those areas of the facility where maintenance dredging or excavation is proposed;

☐ (6) For NWP 14 (Linear Transportation Projects), The PCN must include a compensatory mitigation proposal to offset permanent losses of waters of the US and a statement describing how temporary losses of waters of the US will be minimized to the maximum extent practicable;

☐ (7) For NWP 21 (Surface Coal Mining Activities), the PCN must include an Office of Surface Mining (OSM) or state-approved mitigation plan, if applicable. To be authorized by this NWP, the District Engineer must determine that the activity complies with the terms and conditions of the NWP and that the adverse environmental effects are minimal both individually and cumulatively and must notify the project sponsor of this determination in writing;

☐ (8) For NWP 27 (Stream and Wetland Restoration Activities), the PCN must include documentation of the prior condition of the site that will be reverted by the permittee;

☐ (9) For NWP 29 (Single-Family Housing), the PCN must also include:

☐ (i) Any past use of this NWP by the Individual Permittee and/or the permittee's spouse;

☐ (ii) A statement that the single-family housing activity is for a personal residence of the permittee;

☐ (iii) A description of the entire parcel, including its size, and a delineation of wetlands. For the purpose of this NWP, parcels of land measuring ¼-acre or less will not require a formal on-site delineation. However, the applicant shall provide an indication of where the wetlands are and the amount of wetlands that exists on the property. For parcels greater than ¼-acre in size, formal wetland delineation must be prepared in accordance with the current method required by the Corps. (See paragraph 13(f));

☐ (iv) A written description of all land (including, if available, legal descriptions) owned by the prospective permittee and/or the prospective permittee's spouse, within a one mile radius of the parcel, in any form of ownership (including any land owned as a partner, corporation, joint tenant, co-tenant, or as a tenant-by-the-entirety) and any land on which a purchase and sale agreement or other contract for sale or purchase has been executed;

☐ (10) For NWP 31 (Maintenance of Existing Flood Control Facilities), the prospective permittee must either notify the District Engineer with a PCN prior to each maintenance activity or submit a five year (or less) maintenance plan. In addition, the PCN must include all of the following:

☐ (i) Sufficient baseline information identifying the approved channel depths and configurations and existing facilities. Minor deviations are authorized, provided the approved flood control protection or drainage is not increased;

☐ (ii) A delineation of any affected special aquatic sites, including wetlands; and,

☐ (iii) Location of the dredged material disposal site;

☐ (11) For NWP 33 (Temporary Construction, Access, and Dewatering), the PCN must also include a restoration plan of reasonable measures to avoid and minimize adverse effects to aquatic resources;

☐ (12) For NWPs 39, 43 and 44, the PCN must also include a written statement to the District Engineer explaining how avoidance and minimization for losses of waters of the US were achieved on the project site;

☐ (13) For NWP 39 and NWP 42, the PCN must include a compensatory mitigation proposal to offset losses of waters of the US or justification explaining why compensatory mitigation should not be required. For discharges that cause the loss of greater than 300 linear feet of an intermittent stream bed, to be authorized, the District Engineer must determine that the activity complies with the other terms and conditions of the NWP, determine adverse environmental effects are minimal both individually and cumulatively, and waive the limitation on stream impacts in writing before the permittee may proceed;

☐ (14) For NWP 40 (Agricultural Activities), the PCN must include a compensatory mitigation proposal to offset losses of waters of the US. This NWP does not authorize the relocation of greater than 300 linear-feet of existing serviceable drainage ditches constructed in non-tidal streams unless, for drainage ditches constructed in intermittent non-tidal streams, the District Engineer waives this criterion in writing, and the District Engineer has determined that the project complies with all terms and conditions of this NWP, and that any adverse impacts of the project on the aquatic environment are minimal, both individually and cumulatively;

☐ (15) For NWP 43 (Stormwater Management Facilities), the PCN must include, for the construction of new stormwater management facilities, a maintenance plan (in accordance with state and local requirements, if applicable) and a compensatory mitigation proposal to offset losses of waters of the US. For discharges that cause the loss of greater than 300 linear feet of an intermittent stream bed, to be authorized, the District Engineer must determine that the activity complies with the other terms and conditions of the NWP, determine adverse environmental effects are minimal both individually and cumulatively, and waive the limitation on stream impacts in writing before the permittee may proceed;

☐ (16) For NWP 44 (Mining Activities), the PCN must include a description of all waters of the US adversely affected by the project, a description of measures taken to minimize adverse effects to waters of the US, a description of measures taken to comply with the criteria of the NWP, and a reclamation plan (for all aggregate mining activities in isolated waters and non-tidal wetlands adjacent to headwaters and any hard rock/mineral mining activities);

☐ (17) For activities that may adversely affect Federally-listed endangered or threatened species, the PCN must include the name(s) of those endangered or threatened species that may be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work; and

☐ (18) For activities that may affect historic properties listed in, or eligible for listing in, the National Register of Historic Places, the PCN must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property.

☐ (c) Form of Notification: The standard Individual Permit application form (Form ENG 4345) may be used as the notification but must clearly indicate that it is a PCN and must include all of the information required in (b) (1)-(18) of General Condition 13. A letter containing the requisite information may also be used.

☐ (d) District Engineer's Decision: In reviewing the PCN for the proposed activity, the District Engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. The prospective permittee may submit a proposed mitigation plan with the PCN to expedite the process. The District Engineer will consider any proposed compensatory mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects to the aquatic environment of the proposed work are minimal. If the District Engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects on the aquatic environment are minimal, after considering mitigation, the District Engineer will notify the permittee and include any conditions the District Engineer deems necessary. The District Engineer must approve any compensatory mitigation proposal before the permittee commences work. If the prospective permittee is required to submit a compensatory mitigation proposal with the PCN, the proposal may be either conceptual or detailed. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the District Engineer will expeditiously review the proposed compensatory mitigation plan. The District Engineer must review the plan within 45 days of receiving a complete PCN and determine whether the conceptual or specific proposed mitigation would ensure no more than minimal adverse effects on the aquatic environment. If the net adverse effects of the project on the aquatic environment (after consideration of the compensatory mitigation proposal) are determined by the District Engineer to be minimal, the District Engineer will provide a timely written response to the applicant. The response will state that the project can proceed under the terms and conditions of the NWP.

☐ If the District Engineer determines that the adverse effects of the proposed work are more than minimal, then the District Engineer will notify the applicant either:

☐ (1) that the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an Individual Permit;

☐ (2) that the project is authorized under the NWP subject to the applicant's submission of a mitigation proposal that would reduce the adverse effects on the aquatic environment to the minimal level; or

☐ (3) that the project is authorized under the NWP with specific modifications or conditions. Where the District Engineer determines that mitigation is required to ensure no more than minimal adverse effects occur to the aquatic environment, the activity will be authorized within the 45-day PCN period. The authorization will include the necessary conceptual or specific mitigation or a requirement that the applicant submit a mitigation proposal that would reduce the adverse effects on the aquatic environment to the minimal level. When conceptual mitigation is included, or a mitigation plan is required under item (2) above, no work in waters of the US will occur until the District Engineer has approved a specific mitigation plan.

☐ (e) Agency Coordination: The District Engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

☐ For activities requiring notification to the District Engineer that result in the loss of greater than ½-acre of waters of the US, the District Engineer will provide immediately (e.g., via facsimile transmission, overnight mail, or other expeditious manner) a copy to the appropriate Federal or state offices (USFWS, state natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO), and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will then have 10 calendar days from the date the material is transmitted to telephone or fax the District Engineer notice that they intend to provide substantive, site-specific comments. If so contacted by an agency, the District Engineer will wait an additional 15 calendar days before making a decision on the notification. The District Engineer will fully consider agency comments received within the specified time frame, but will provide no response to the resource agency, except as provided below. The District Engineer will indicate in the administrative record associated with each notification that the resource agencies' concerns were considered. As required by Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act, the District Engineer will provide a response to NMFS within 30 days of receipt of any Essential Fish Habitat conservation recommendations. Applicants are encouraged to provide the Corps multiple copies of notifications to expedite agency notification.

☐ (f) Wetland Delineations: Wetland delineations must be prepared in accordance with the current method required by the Corps (For NWP 29 see paragraph (b)(9)(iii) for parcels less than ¼-acre in size). The permittee may ask the Corps to delineate the special aquatic site. There may be some delay if the Corps does the delineation. Furthermore, the 45-day period will not start until the wetland delineation has been completed and submitted to the Corps, where appropriate.

☐ **14. Compliance Certification.** Every permittee who has received NWP verification from the Corps will submit a signed certification regarding the completed work and any required mitigation. The certification will be forwarded by the Corps with the authorization letter and will include:

☐ (a) A statement that the authorized work was done in accordance with the Corps authorization, including any general or specific conditions;

☐ (b) A statement that any required mitigation was completed in accordance with the permit conditions; and (c) The signature of the permittee certifying the completion of the work and mitigation.

☐ **15. Use of Multiple Nationwide Permits.** The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the US authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit (e.g. if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the US for the total project cannot exceed 1/3-acre).

☐ **16. Water Supply Intakes.** No activity, including structures and work in navigable waters of the US or discharges of dredged or fill material, may occur in the proximity of a public water supply intake except where the activity is for repair of the public water supply intake structures or adjacent bank stabilization.

☐ **17. Shellfish Beds.** No activity, including structures and work in navigable waters of the US or discharges of dredged or fill material, may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWP 4.

☐ **18. Suitable Material.** No activity, including structures and work in navigable waters of the US or discharges of dredged or fill material, may consist of unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.) and material used for construction or discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the CWA).

☐ **19. Mitigation.** The District Engineer will consider the factors discussed below when determining the acceptability of appropriate and practicable mitigation necessary to offset adverse effects on the aquatic environment that are more than minimal.

☐ (a) The project must be designed and constructed to avoid and minimize adverse effects to waters of the US to the maximum extent practicable at the project site (i.e., on site).

☐ (b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing or compensating) will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.

☐ (c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland impacts requiring a PCN, unless the District Engineer determines in writing that some other form of mitigation would be more environmentally appropriate and provides a project-specific waiver of this requirement. Consistent with National policy, the District Engineer will establish a preference for restoration of wetlands as compensatory mitigation, with preservation used only in exceptional circumstances.

☐ (d) Compensatory mitigation (i.e., replacement or substitution of aquatic resources for those impacted) will not be used to increase the acreage losses allowed by the acreage limits of some of the NWPs. For example, ¼-acre of wetlands cannot be created to change a ¾-acre loss of wetlands to a ½-acre loss associated with NWP 39 verification. However, ½-acre of created wetlands can be used to reduce the impacts of a ½-acre loss of wetlands to the minimum impact level in order to meet the minimal impact requirement associated with NWPs.

☐ (e) To be practicable, the mitigation must be available and capable of being done considering costs, existing technology, and logistics in light of the overall project purposes. Examples of mitigation that may be appropriate and practicable include, but are not limited to: reducing the size of the project; establishing and maintaining wetland or upland vegetated buffers to protect open waters such as streams; and replacing losses of aquatic resource functions and values by creating, restoring, enhancing, or preserving similar functions and values, preferably in the same watershed.

☐ (f) Compensatory mitigation plans for projects in or near streams or other open waters will normally include a requirement for the establishment, maintenance, and legal protection (e.g., easements, deed restrictions) of vegetated buffers to open waters. In many cases, vegetated buffers will be the only compensatory mitigation required. Vegetated buffers should consist of native species. The width of the vegetated buffers required will address documented water quality or aquatic habitat loss concerns. Normally, the vegetated buffer will be 25 to 50 feet wide on each side of the stream, but the District Engineers may require slightly wider vegetated buffers to address documented water quality or habitat loss concerns. Where both wetlands and open waters exist on the project site, the Corps will determine the appropriate compensatory mitigation (e.g., stream buffers or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where vegetated buffers are determined to be the most appropriate form of compensatory mitigation, the District Engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland impacts.

☐ (g) Compensatory mitigation proposals submitted with the "notification" may be either conceptual or detailed. If conceptual plans are approved under the verification, then the Corps will condition the verification to require detailed plans be submitted and approved by the Corps prior to construction of the authorized activity in waters of the US.

☐ (h) Permittees may propose the use of mitigation banks, in-lieu fee arrangements or separate activity-specific compensatory mitigation. In all cases that require compensatory mitigation, the mitigation provisions will specify the party responsible for accomplishing and/or complying with the mitigation plan.

☐ **20. Spawning Areas.** Activities, including structures and work in navigable waters of the US or discharges of dredged or fill material, in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., excavate, fill, or smother downstream by substantial turbidity) of an important spawning area are not authorized.

☐ **21. Management of Water Flows.** To the maximum extent practicable, the activity must be designed to maintain preconstruction downstream flow conditions (e.g., location, capacity, and flow rates). Furthermore, the activity must not permanently restrict or impede the passage of normal or expected high flows (unless the primary purpose of the fill is to impound waters) and the structure or discharge of dredged or fill material must withstand expected high flows. The activity must, to the maximum extent practicable, provide for retaining excess flows from the site, provide for maintaining surface flow rates from the site similar to preconstruction conditions, and provide for not increasing water flows from the project site, relocating water, or redirecting water flow beyond preconstruction conditions. Stream channelizing will be reduced to the minimal amount necessary, and the activity must, to the maximum extent practicable, reduce adverse effects such as flooding or erosion downstream and upstream of the project site, unless the activity is part of a larger system designed to manage water flows. In most cases, it will not be a requirement to conduct detailed studies and monitoring of water flow.

This condition is only applicable to projects that have the potential to affect waterflows. While appropriate measures must be taken, it is not necessary to conduct detailed studies to identify such measures or require monitoring to ensure their effectiveness. Normally, the Corps will defer to state and local authorities regarding management of water flow.

☐ **22 Adverse Effects From Impoundments.** If the activity creates an impoundment of water, adverse effects to the aquatic system due to the acceleration of the passage of water, and/or the restricting its flow shall be minimized to the maximum extent practicable. This includes structures and work in navigable waters of the US, or discharges of dredged or fill material.

☐ **23. Waterfowl Breeding Areas.** Activities, including structures and work in navigable waters of the US or discharges of dredged or fill material, into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable.

☐ **24. Removal of Temporary Fills.** Any temporary fills must be removed in their entirety and the affected areas returned to their preexisting elevation.

☐ **25. Designated Critical Resource Waters.** Critical resource waters include, NOAA-designated marine sanctuaries, National Estuarine Research Reserves, National Wild and Scenic Rivers, critical habitat for Federally listed threatened and endangered species, coral reefs, state natural heritage sites, and outstanding national resource waters or other waters officially designated by a state as having particular environmental or ecological significance and identified by the District Engineer after notice and opportunity for public comment. The District Engineer may also designate additional critical resource waters after notice and opportunity for comment.

☐ (a) Except as noted below, discharges of dredged or fill material into waters of the US are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, and 44 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters. Discharges of dredged or fill materials into waters of the US may be authorized by the above NWPs in National Wild and Scenic Rivers if the activity complies with General Condition 7. Further, such discharges may be authorized in designated critical habitat for Federally listed threatened or endangered species if the activity complies with General Condition 11 and the USFWS or the NMFS has concurred in a determination of compliance with this condition.

☐ (b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, and 38, notification is required in accordance with General Condition 13, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The District Engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

☐ **26 Fills Within 100-Year Floodplains.** For purposes of this General Condition, 100-year floodplains will be identified through the existing Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps or FEMA-approved local floodplain maps.

☐ (a) Discharges in Floodplain; Below Headwaters. Discharges of dredged or fill material into waters of the US within the mapped 100-year floodplain, below headwaters (i.e. five cfs), resulting in permanent above-grade fills, are not authorized by NWPs 39, 40, 42, 43, and 44.

☐ (b) Discharges in Floodway; Above Headwaters. Discharges of dredged or fill material into waters of the US within the FEMA or locally mapped floodway, resulting in permanent above-grade fills, are not authorized by NWPs 39, 40, 42, and 44.

☐ (c) The permittee must comply with any applicable FEMA-approved state or local floodplain management requirements.

☐ **27. Construction Period.** For activities that have not been verified by the Corps and the project was commenced or under contract to commence by the expiration date of the NWP (or modification or revocation date), the work must be completed within 12-months after such date (including any modification that affects the project).

☐ For activities that have been verified and the project was commenced or under contract to commence within the verification period, the work must be completed by the date determined by the Corps.

☐ For projects that have been verified by the Corps, an extension of a Corps approved completion date may requested. This request must be submitted at least one month before the previously approved completion date.

B. <u>Further Information</u>

1. District Engineers have authority to determine if an activity complies with the terms and conditions of an NWP.
2. NWPs do not obviate the need to obtain other Federal, state, or local permits, approvals, or authorizations required by law.
3. NWPs do not grant any property rights or exclusive privileges.
4. NWPs do not authorize any injury to the property or rights of others.
5. NWPs do not authorize interference with any existing or proposed Federal project.

C. <u>Regional Conditions for Nationwide Permits – Sacramento District</u>

I. Regional Conditions to be applied across the entire Sacramento District:

☐ **1.** Nationwide Permits 14, 29, 39, 40, 41, 42, and 44 are withdrawn from used in histosols, including fens. For the used of all other nationwide permits in fens, project proponents are required to notify the Corps using the notification or PCN procedures of the nationwide permit program (General Condition 13). This will be a "Corps only" notification.

☐ **2.** For all activities using any existing and proposed nationwide permits, mitigation that is required by special condition must be completed before or concurrent with project construction. Where project mitigation involves the use of a mitigation bank or in-lieu fee, payment must be made to the bank or fee-in-lieu program before commencing construction of the permitted activity.

☐ **3.** For all nationwide permits requiring notification, except 27, the applicant must provide a written statement to the district engineer explaining how avoidance and minimization of loses of waters of the United States were achieved on the project site.

II. Regional conditions to be applied in California and Nevada.

☐ All existing and proposed nationwide permits are suspended in the Lake Tahoe basin in favor of using General Permit 16.

III. Regional conditions to be applied in Utah

☐ For use of any nationwide permit with the following attributes, notification of the Corps of Engineers' Utah Regulatory Office, using the "Notification" procedures of the Nationwide Permit Program (General Condition 13), is required, except where certain nationwide permits are restricted and can not be used as indicated in each category. This will be a "Corps only" notification.

☐ 1. All activities that will affect waters of the U.S. below the elevation 4217 feet msl adjacent to the Great Salt Lake and below 4500 feet msl adjacent to Utah Lake.

☐ 2. Bank stabilization in a perennial stream that would affect more than 100 feet of stream length as measured from the upstream portion of the affected bank to the downstream section, narrow the cross-section of the stream, substantially reduce the riparian vegetation, or increase velocities.

☐ 3. All activities that will affect springs. A spring is an aquatic feature caused by ground water being discharged to the surface, creating wetland and/or stream characteristics. Nationwide Permits 14, 16, 18, 29, 33, 36, 40, 42, 43, and 44 can not be used in spring areas.

6

State W ter Resources Contro' Board

Division of Water Rights
1001 I Street, 14th Floor ♦ Sacramento, California 95814 ♦ 916.341.5300
Mailing Address: P.O. Box 2000 ♦ Sacramento, California 95812-2000
FAX: 916.341.5400 ♦ www.waterrights.ca.gov

ry Tamminen
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

July 29, 2004

Mr. Mark Blum
Law Offices of Horan, Lloyd, Karachale,
Dyer, Schwartz, Law and Cook Inc.
P.O. Box 3350
Monterey, CA 93942-3350

Dear Mr. Blum:

APPLICABILITY OF THE U.S. ARMY CORPS OF ENGINEERS NATIONWIDE PERMIT NO. 5 FOR THE EL SUR RANCH INTERIM MONITORING PLAN (WATER RIGHT APPLICATION 30166)

Thank you for supplying the materials prepared in support of the request for confirmation of the applicability of a U.S. Army Corps of Engineers (COE) Nationwide Permit (NWP) for the proposed El Sur Ranch Interim Monitoring Plan (Monitoring Plan). The Monitoring Plan includes the installation of a total of five monitoring wells located on the El Sur Ranch and on the neighboring Andrew Molera State Park. In addition, two stilling wells will be located on separate locations on the bank of the Big Sur River within the Andrew Molera State Park.

The COE regulates certain activities that discharges dredge or fill materials to waters of the United States pursuant to the Federal Clean Water Act (CWA) section 404. (33 U.S.C. §1344.) Section 401 of the CWA (33 U.S.C. § 1341) requires every applicant for a federal license or permit to conduct an activity which may result in a discharge into navigable waters to provide the licensing or permitting federal agency with certification from the state that the project will be in compliance with specified provisions of the CWA, including water quality standards and implementation plans promulgated under section 303 of the CWA. (33 U.S.C. § 1313.) CWA section 401 directs the agency responsible for certification to prescribe effluent limitations and other limitations necessary to ensure compliance with the CWA and with any other appropriate requirement of state law.

On March 12, 2002, the SWRCB issued a statewide water quality certification covering activities for several classes of NWPs covered under CWA section 404 (33 U.S.C. §1344) and at the same time denied certification without prejudice to several classes of NWPs that were found individually or cumulatively to potentially have a significant effect on the environment. El Sur Ranch has applied for a NWP No. 5 (installation of scientific measuring devices). NWP No. 5 covers a class of activities for which water quality certification was issued subject to conditions and notification requirements based on the finding that this class of activities should not result in more than minimal individual or cumulative impacts.

I concur that the installation of five monitoring wells on lands owned by Big Sur Ranch and Andrew Molera State Park and the two stilling wells on the banks of the Big Sur River in Andrew Molera State Park as described in the Monitoring Plan is covered under a NWP No. 5.

Notwithstanding any more specific conditions in the March 12, 2002 certification, the project shall be constructed and operated in a manner consistent with all water quality standards and implementation plans adopted or approved pursuant to the Porter-Cologne Water Quality Control Act or section 303 of the CWA.

Except for activities permitted by the COE under Section 404 of the CWA, soil, silt or other organic or earthen materials shall not be placed where such materials could pass into surface waters or surface water drainage courses.

The SWRCB by confirmation of the applicability of NWP No. 5 does not intend nor shall it be construed as authorizing any act which results in the taking of a threatened or endangered species, or result in the destruction or adverse modification of habitat essential to the continued existence of those species or any act, which is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish & G. Code § 2050 - 2097) or the federal Endangered Species Act. (16 U.S.C. § 1531 - 1544.) The El Sur Ranch shall be responsible for meeting all requirements of the applicable Endangered Species Act for the project authorized under the NWP.

Finally, confirmation of the applicability of NWP No. 5 is not an endorsement of the Monitoring Plan meeting the information requirements that may be requested by the SWRCB as a result of water right application 30166 nor is it intended and shall not be construed as support for granting of the water rights sought under water right application 30166.

If you have any questions, I may be contacted by calling (916) 341-5308.

Sincerely,

Jim Canaday

Jim Canaday
Senior Environmental Scientist

cc: Ms. Darlene Ruiz
Hunter & Ruiz
1130 K Street, Suite 350
Sacramento, CA 95814

cc: (Continued)

Ms. Holly Costa
Project Manager
Army Corps of Engineers
333 Market Street
8th Floor
San Francisco, CA 94105-2197

Mr. Carl P. Holm, AICP
Senior Planner
Monterey County
Planning & Building Inspection Department
2620 1st Avenue
Marina, CA 93933

Ms. Sandy Brunson
California Department of Fish and Game
Central Coast Region
7329 Silverado Trail
P.O. Box 47
Yountville, CA 94599

7

8

9

APPENDIX B

APPENDIX B

DRILLING LOGS AND WELL CONSTRUCTION DETAILS

PROJECT NAME AND ADDRESS:	El Sur Ranch		
BORING LOCATION (AT SITE):	Glade within Andrew Molera State Park		Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	Test America	CME-85	Logged By: J. Philipp
SAMPLING METHOD:	California Split Spoon	MONITORING DEVICE:	None
START DATE/ (TIME):	9/1/2004	FINISH DATE/ (TIME):	9/1/2004
FIRST WATER (BGS):	8-ft	STABILIZED WATER LEVEL:	
SURFACE ELEVATION:	~15-ft	CASING TOP ELEVATION:	~18-ft
TOTAL WELL DEPTH(S):	12-ft	BORING DIAMETER/DEPTH:	8-inch/12-ft
CASING DIAMETER(S):	2-inch	SCREEN INTERVAL(S):	7-12 SLOT (IN): 0.020-inch
ANNULUS FILL MATERIAL:		BORING ANGLE:	TREND:

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	0						
	1						
	2					Boring not logged due to proximity to ESR-10C	
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13					End of boring @ 12-feet bgs	
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						
	25						

The Source Group, Inc. BORING/WELL ID: ESR-10B

PROJECT NAME AND ADDRESS:	El Sur Ranch		
BORING LOCATION (AT SITE):	Glade within Andrew Molera State Park		Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	Test America	CME-85	Logged By: J. Philipp
SAMPLING METHOD:	California Split Spoon	MONITORING DEVICE:	None
START DATE/ (TIME):	9/1/2004	FINISH DATE/ (TIME):	9/1/2004
FIRST WATER (BGS):	8-ft	STABILIZED WATER LEVEL:	
SURFACE ELEVATION:	~15-ft	CASING TOP ELEVATION:	~18-ft
TOTAL WELL DEPTH(S):	21-ft	BORING DIAMETER/DEPTH:	8-inch/21-ft
CASING DIAMETER(S):	2-inch	SCREEN INTERVAL(S):	16-21 SLOT (IN): 0.020-inch
ANNULUS FILL MATERIAL:		BORING ANGLE:	TREND:

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	0						
	1						
	2					Boring not logged due to proximity to ESR-10C	
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22					End of boring @ 21-feet bgs	
	23						
	24						
	25						

The Source Group, Inc. BORING/WELL ID: ESR-10C

PROJECT NAME AND ADDRESS:	El Sur Ranch		
BORING LOCATION (AT SITE):	Glade within Andrew Molera State Park		Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	Test America	CME-85	Logged By: J. Philipp
SAMPLING METHOD:	California Split Spoon	MONITORING DEVICE:	None
START DATE/ (TIME):	9/1/2004	FINISH DATE/ (TIME):	9/1/2004
FIRST WATER (BGS):	8-ft	STABILIZED WATER LEVEL:	
SURFACE ELEVATION:	~15-ft	CASING TOP ELEVATION:	~18-ft
TOTAL WELL DEPTH(S):	30-ft	BORING DIAMETER/DEPTH:	8-inch/30-ft
CASING DIAMETER(S):	2-inch	SCREEN INTERVAL(S):	25-30 SLOT (IN): 0.020-inch
ANNULUS FILL MATERIAL:		BORING ANGLE:	TREND:

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	0						
	1						
	2						
	3						
	4						
	5						
	6			50 for 1"		No recovery. Sampler damaged.	
	7						
	8						
	9					Driller reports drilling gets easier at 8-ft (probably water table)	
	10						
	11			10 12 22		6-inches of recovery. Coarse sand (100) with gravel, multicolored sand grains, wet, loose, with few fines.	
	12						
	13						
	14						
	15						
	16			50 for 4"		1-foot of recovery. Medium to coarse sand (100) with gravel, multicolored sand grains, wet, loose, very few fines.	
	17						
	18						
	19						
	20						
	21			50 for 5"		6-inches of recovery. Silty medium to coarse sand (5,95), no gravel, multicolored sand grains, wet, loose.	
	22						
	23						
	24						
	25						

The Source Group, Inc. BORING/WELL ID: ESR-10C

PROJECT NAME AND ADDRESS: El Sur Ranch	
BORING LOCATION (AT SITE):	Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	Logged By: J. Philipp

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	25						
	26					No Recovery	
	27					At 26-ft, driller reports lithology change to something really hard like weathered bedrock. Drilling is very slow	
	28						
	29						
	30						
	31					Minimal sample recovery. Gray (N5/8/1) clay. Clay grades into weathered hard siltstone/graywacke (retained sample of this material).	
	32						
	33						
	34					Note that at this point, the boring location was moved about 100-ft closer to the river. The new boring was advanced without sampling other than at the bottom of the hole to confirm that the gray clay and weathered bedrock was encountered at 30 feet below grade.	
	35						
	36					Directly adjacent to this well ESR-10B and ESR-10A were installed to 21-ft and 12-ft, respectively. These borings were not sampled due to their proximity to ESR-10C.	
	37						
	38						
	39						
	40						
	41						
	42						
	43						
	44						
	45						
	46						
	47						
	48						
	49						
	50						
	51						
	52						
	53						
	54						
	55						

The Source Group, Inc.

BORING/WELL ID: ESR-11

PROJECT NAME AND ADDRESS:	El Sur Ranch		
BORING LOCATION (AT SITE):	Southern border next to Park		Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	ResonantSonic Drilling	Sonic Drill Rig	Logged By: J. Philipp
SAMPLING METHOD:	Sonic Coring	MONITORING DEVICE:	None
START DATE/ (TIME):	9/8/2004	FINISH DATE/ (TIME):	9/10/2004
FIRST WATER (BGS):	42-ft	STABILIZED WATER LEVEL:	~ 37-ft
SURFACE ELEVATION:	~ 55-ft	CASING TOP ELEVATION:	~ 55-ft
TOTAL WELL DEPTH(S):	70-ft	BORING DIAMETER/DEPTH:	6-inches/90-ft
CASING DIAMETER(S):	2-inch	SCREEN INTERVAL(S):	50-70 SLOT (IN): 0.020-inches
ANNULUS FILL MATERIAL:		BORING ANGLE:	TREND:

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	0						
	1					fine sandy clay (10,90), medium to dark brown, stiff, dry	
	2						
	3						
	4					grades: fine to medium sandy clay (50,50), medium brown with white mottling, dry, stiff, crumbly. [degraded sand]	
	5						
	6						
	7						
	8					medium sandy clay (50,50) w/degraded pebbles [pebbles rounded and up to 3" in diameter and quite weathered], dry, stiff, crumbly. [the clay obviously derived from degraded sand and pebbles]	
	9						
	10						
	11						
	12						
	13						
	14					grades: medium to coarse sandy clay (50,50)	
	15						
	16						
	17						
	18						
	19						
	20					fine sand (100), light brown, dry, very compact but not cemented, some layering evident. Compacted material preferentially fractures horizontally [perpendicular to drilling direction]	
	21						
	22						
	23						
	24						
	25					[Driller reports it got really hard at 24-ft, then broke through to something softer]	

The Source Group, Inc.

BORING/WELL ID: ESR-11

PROJECT NAME AND ADDRESS:	El Sur Ranch		
BORING LOCATION (AT SITE):	Southern border next to Park		Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	ResonantSonic Drilling	Sonic Drill Rig	Logged By: J. Philipp

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	25						
	26					pebbly fine to medium sand (30,70), medium brown, dry, loose, pebbles up to 3" in diameter and rounded. [sample completely loose, though probably very compact in-situ. No layering evident]	
	27						
	28						
	29						
	30						
	31						
	32					grades: [sample recovered almost powderlike]	
	33						
	34						
	35					pebbly fine to medium sand (20,80), mottled brown/white/pink, dry, stiff, compacted (not cemented), pebbles less than 0.5" in diameter, subrounded to subangluar.	
	36						
	37						
	38		▼			grades: moist, pebbles greater than 3" in diameter, rounded, very small clay content as pebbles degrade.	
	39						
	40						
	41						
	42		▽			grades: moist to wet [samples are recovered too hot to touch so water content is difficult to determine (i.e. water is driven off by the extreme heat)]	
	43						
	44						
	45						
	46					pebbly fine sandy clay (5,35,60), medium brown, moist to wet, plastic. [this seems like the above formation just highly degraded by the presence of water]	
	47						
	48					grades: less clay [driller reports it got really hard at 48-ft, switch to different shoe and case hole with 6" pipe down to 50-ft]	
	49						
	50						
	51					pebbly fine to medium sand (20,80), medium brown, slightly moist, compacted (not cemented), minimal clay component.	
	52						
	53					grades: much larger pebbles (greater than 4" and rounded), dry	
	54						
	55					[sand is compacted with faint layering evident]	

PROJECT NAME AND ADDRESS:	El Sur Ranch	
BORING LOCATION (AT SITE):	Southern border next to Park	Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	ResonantSonic Drilling Sonic Drill Rig	Logged By: J. Philipp

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	55						
	56					↓	
	57						
	58					grades: large rock fragments	
	59					↓	
	60						
	61						
	62					fine sand (100), moist to wet, very minor clay, medium brown, stiff	
	63					grades: medium sand (100), with pebbles (2" in diameter, rounded), loose, no clay. [this sand is very similar to #2/12 Monterey sand]	
	64						
	65					pebbly fine to medium sand (20,80), medium brown, minor clay, moist to wet, compacted (not cemented).	
	66						
	67					grades: larger pebbles	
	68					grades: slightly moist (less wet)	
	69					↓	
	70						
	71					[cased to 70-ft with 6" pipe]	
	72					fine to coarse sand (100), light tan, dry, consolidated (not cemented). [degraded granite?]	
	73						
	74					gravelly fine to medium sand (30,70), medium brown, moist, gravel ~3" in diameter and rounded, loose.	
	75						
	76					medium to coarse sand (100), medium brown, no pebbles, compacted (not cemented), micaceous.	
	77					↓	
	78						
	79						
	80						
	81						
	82						
	83					[driller reports hitting something very hard]	
	84					grades: large cobbles (greater than 5" in diameter, rounded)	
	85					↓	

The Source Group, Inc. BORING/WELL ID: ESR-11

PROJECT NAME AND ADDRESS:	El Sur Ranch		
BORING LOCATION (AT SITE):	Southern border next to Park		Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	ResonantSonic Drilling	Sonic Drill Rig	Logged By: J. Philipp

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	85						
	86					↓	
	87						
	88						
	89						
	90					lithified fine grained material, evidence of layering, combined wit 0.25" rounded pebbles. Very broken up. [might be weathered bedrock material]	
	91					No Recovery ↓	
	92						
	93						
	94						
	95						
	96						
	97						
	98						
	99						
	100						
	101					End of Boring at 100-ft bgs. Note that 4" sampler driven to 100-ft while 6" pipe only driven to 90-ft.	
	102						
	103						
	104						
	105						
	106						
	107						
	108						
	109						
	110						
	111						
	112						
	113						
	114						
	115						

The Source Group, Inc.

BORING/WELL ID: ESR-12

PROJECT NAME AND ADDRESS:	El Sur Ranch		
BORING LOCATION (AT SITE):	Southern border next to Park		Project No. 01-ESR-001
CONTRACTOR AND EQUIPMENT:	ResonantSonic Drilling	Sonic Drill Rig	Logged By: J. Philipp
SAMPLING METHOD:	Sonic Coring	MONITORING DEVICE:	None
START DATE/ (TIME):	9/8/2004	FINISH DATE/ (TIME):	9/10/2004
FIRST WATER (BGS):	42-ft	STABILIZED WATER LEVEL:	40-ft
SURFACE ELEVATION:	~ 55-ft	CASING TOP ELEVATION:	~ 55-ft
TOTAL WELL DEPTH(S):	70-ft	BORING DIAMETER/DEPTH:	6-inches/70-ft
CASING DIAMETER(S):	2-inch	SCREEN INTERVAL(S):	50-70 SLOT (IN): 0.020-inches
ANNULUS FILL MATERIAL:		BORING ANGLE:	TREND:

Time	Depth	Interval	PID	Blow Counts	Sample Depth	LITHOLOGIC DESCRIPTION (classification, color, moisture, density, grain size/plasticity, other)	Well Construct
	0						
	1						
	2					Note:	
	3					This monitoring well was installed 530 feet from monitoring well ESR-11 The boring for this monitoring well was not continuously cored. Subsurface information was based on the core obtained from ESR-11	
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						
	25						

DUPLICATE
Retain this copy

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do Not Fill In

Nº 76690

State Well No. ESR

Other Well No. New Well

(1) OWNER:

Name C. T. Hill

Address 21 Sur Ranch Monterey, CA.

#5

(2) LOCATION OF WELL:

County Monterey Owner's number, if any

Township, Range, and Section:

Distance from cities, roads, railroads, etc.

21 Sur Ranch, Monterey, CA.

(3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Destroying ☐

If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☐
Cable ☒
Other ☐

(6) CASING INSTALLED:

STEEL: SINGLE ☒ DOUBLE ☐ OTHER:

If gravel packed

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	From ft.	To ft.
0	36	16	8			

Size of shoe or well ring: 5/8x 6" Size of gravel:

Describe joint: Weld

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
14	32	6	4	1/2x3

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☒ No ☐ To what depth 14 ft.

Were any strata sealed against pollution? Yes ☐ No ☒ If yes, note depth of strata

From ft. to ft.

From ft. to ft.

Method of sealing Cement

(9) WATER LEVELS:

Depth at which water was first found, if known 12 ft.

Standing level before perforating, if known 12 ft.

Standing level after perforating and drilling 8 ft.

(10) WELL TESTS:

Was a pump test made? Yes ☒ No ☐ If yes, by whom? Moosios

Yield: gal./min. with ft. drawdown after hrs.

Temperature of water Was a chemical analysis made? Yes ☐ No ☐

Was electric log made of well? Yes ☐ No ☐ If yes, attach copy

(11) WELL LOG:

Total depth 36 ft. Depth of completed well 36 ft.

Formation: Describe by color, character, size of material, and structure

Formation	From ft.	To ft.
TOP SOIL	0	18"
GRAVEL	18"	19'
GRAVEL & SAND	19	27
GRAVEL	27	33
GREY CLAY	33	36

SLAB ELEV. = 12.34

Work started AUG 19 75. Completed SEPT 19 75

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME DEXTER MACHINERY
(Person, firm, or corporation) (Typed or printed)

Address 4180 Canada Rd., Gilroy, CA. 95020

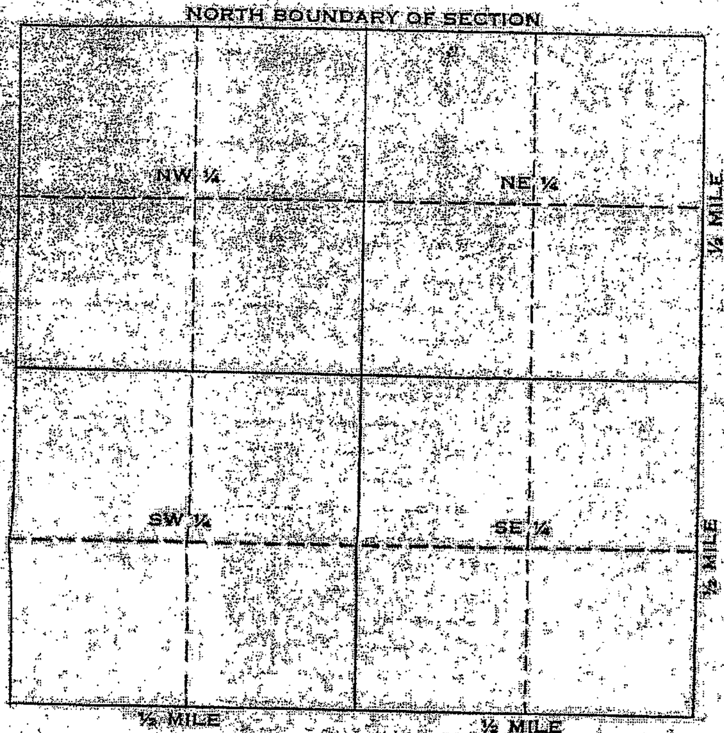
[SIGNED] [illegible signature]
(Well Driller)

License No. 216560 Dated OCT. 26, 19 75

SKETCH LOCATION OF WELL ON REVERSE SIDE

DWR 188 (REV. 4-68)

ESR--4

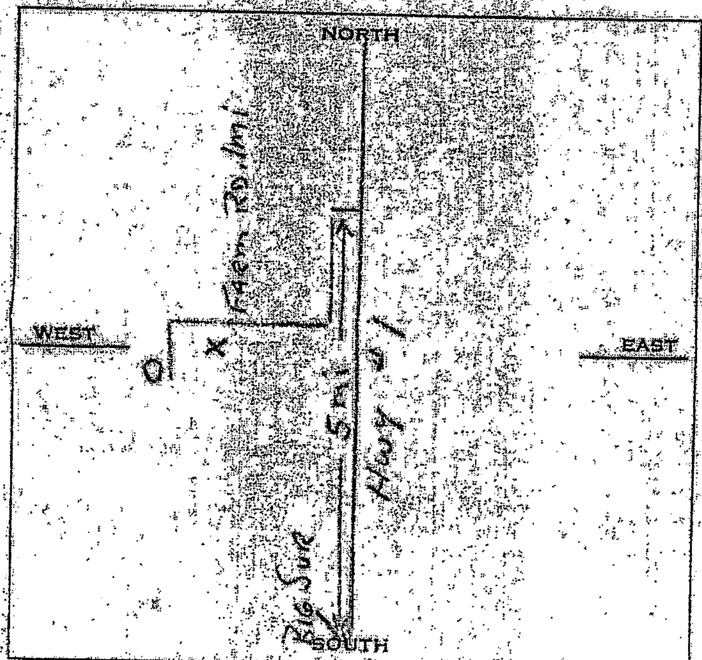


Township ____________________ N/S

Range ____________________ E/W

Section No. ____________________

A. Location of well in sectionized areas.
Sketch roads, railroads, streams, or other features as necessary.



B. Location of well in areas not sectionized.
Sketch roads, railroads, streams, or other features as necessary.
Indicate distances.

86691

Toc Elev = 15.58

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

DUPLICATE
Retain this copy

Do Not Fill In

Nº 86691

State Well No.
Other Well No. ESG-1

(1) OWNER:
Name C. T. Hill
Address Coast Rt., El Sur Ranch, Monterey CA
#1

(2) LOCATION OF WELL:
County Monterey Owner's number, if any
Township, Range, and Section
Distance from cities, roads, railroads, etc.
El Sur Ranch, Monterey, CA

(3) TYPE OF WORK *(check)*:
New Well [X] Deepening [ ] Reconditioning [ ] Destroying [ ]
If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE *(check)*:
Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]

(5) EQUIPMENT:
Rotary [ ]
Cable [X]
Other [ ]

(6) CASING INSTALLED:
STEEL: OTHER:
SINGLE [X] DOUBLE [ ]

If gravel packed

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	From ft.	To ft.
0	32	10	8			

Size of shoe or well ring: 5/8x6" Size of gravel:
Describe joint Weld

(7) PERFORATIONS OR SCREEN:
Type of perforation or name of screen

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
14	29	6	7	1x3"

(8) CONSTRUCTION:
Was a surface sanitary seal provided? Yes [X] No [ ] To what depth 12 ft.
Were any strata sealed against pollution? Yes [ ] No [X] If yes, note depth of strata
From ft. to ft.
From ft. to ft.
Method of sealing Cement

(9) WATER LEVELS:
Depth at which water was first found, if known 18 ft.
Standing level before perforating, if known 18 ft.
Standing level after perforating and developing 10 ft.

(10) WELL TESTS:
Was pump test made? Yes [X] No [ ] If yes, by whom? Dexter Mach.
Yield: 50 gal./min. with 14 ft. drawdown after 8 hrs.
Temperature of water Was a chemical analysis made? Yes [ ] No [X]
Was electric log made of well? Yes [ ] No [X] If yes, attach copy

(11) WELL LOG:
Total depth 32 ft. Depth of completed well 32 ft.
Formation: Describe by color, character, size of material, and structure

Formation	From ft.	To ft.
TOP SOIL	0	3
GRAVEL	3	4
SAND	4	11
GRAVEL	11	29
GRAY CLAY	29	32

3 - 15 to 32

Nearly dry hole

Work started Nov. 6 1972 Completed Nov. 14 1972

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME DEXTER MACHINERY
(Person, firm, or corporation) (Typed or printed)

Address 4180 Canada Rd, Gilroy, Ca., 95020

[Signed] [signature]
(Well Driller)

License No. 216500 Dated March 20, 1973

SKETCH LOCATION OF WELL ON REVERSE SIDE

ESR--4

DUPLICATE
Return this copy

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do Not Fill In

№ 86692

State Well No. ______
Other Well No. ESR-2

(1) OWNER:

Name: C. T. Hill
Address: Coast Rt El Sur Ranch Monterey CA
[illegible]

(2) LOCATION OF WELL:

County: Monterey Owner's number, if any: ______
Township, Range, and Section: ______
Distance from cities, roads, railroads, etc.: El Sur Ranch, Monterey, Ca.

(3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Destroying ☐
If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☐
Cable ☒
Other ☐

(6) CASING INSTALLED:

STEEL: SINGLE ☒ DOUBLE ☐ OTHER: ______

If gravel packed

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	From ft.	To ft.
0	32	10	8			

Size of shoe or well ring: 5/8x6" Size of gravel: ______
Describe joint: Weld

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen: ______

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
14	22	56	4	[illegible]

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☒ No ☐ To what depth 12 ft.
Were any strata sealed against pollution? Yes ☐ No ☒ If yes, note depth of strata
From ____ ft. to ____ ft.
From ____ ft. to ____ ft.
Method of sealing: Cement

(9) WATER LEVELS:

Depth at which water was first found, if known: 16 ft.
Standing level before perforating, if known: 11 ft.
Standing level after perforating and developing: 12 ft.

(10) WELL TESTS:

Was pump test made? Yes ☒ No ☐ If yes, by whom? Dexter Mach.
Yield: 350 gal./min. with 8 ft. drawdown after 8 hrs.
Temperature of water ______ Was a chemical analysis made? Yes ☒ No ☐
Was electric log made of well? Yes ☐ No ☒ If yes, attach copy

(11) WELL LOG:

Total depth 32 ft. Depth of completed well 32 ft.
Formation: Describe by color, character, size of material, and structure

Formation	From ft.	To ft.
TOP SOIL	0	2
SAND	2	10
SAND & GRAVEL	10	15
GRAVEL	15	28
GRAY CLAY	28	32

Work started Nov. [illegible] 19 72 Completed Nov. [illegible] 19 72

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

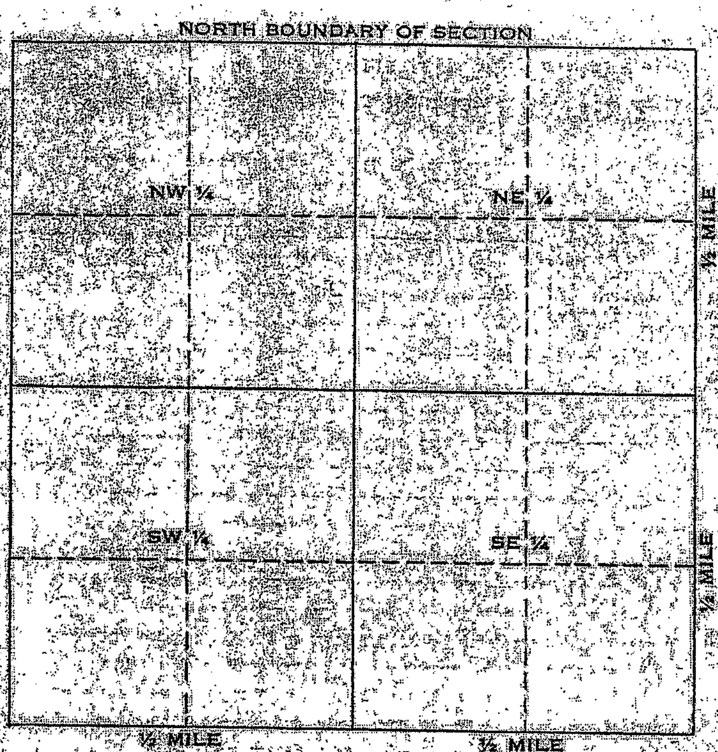
NAME: DEXTER MACHINERY
(Person, firm, or corporation) (Typed or printed)

Address: 4180 Canada Rd. Gilroy, Ca. 95020

[SIGNED] [signature]
(Well Driller)

License No. 216500 Dated March 20, 1973

SKETCH LOCATION OF WELL ON REVERSE SIDE

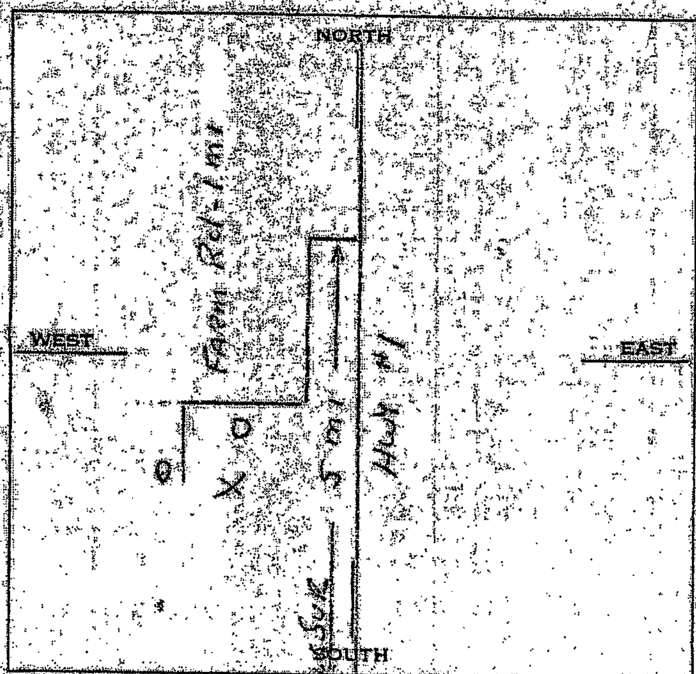


A. Location of well in sectionized areas.
Sketch roads, railroads, streams, or other features as necessary.

Township ______________ N/S

Range ______________ E/W

Section No. ______________



B. Location of well in areas not sectionized.
Sketch roads, railroads, streams, or other features as necessary.
Indicate distances.

86/92

DUPLICATE
Return this copy

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do Not Fill In

Nº 86693

State Well No.

Other Well No. ESR - 3

(1) OWNER:

Name C. T. Hill

Address Coast Rt El Sur Ranch, Monterey Ca

(2) LOCATION OF WELL:

County Monterey Owner's number, if any

Township, Range, and Section

Distance from cities, roads, railroads, etc.

El Sur Ranch, Monterey, CA

(3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Destroying ☐

If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☐
Cable ☒
Other ☐

(6) CASING INSTALLED:

STEEL: OTHER:
SINGLE ☒ DOUBLE ☐

From ft.	To ft.	Diam.	Gage or Wall	If gravel packed: Diameter of Bore	From ft.	To ft.
0	32	20	28			

Size of shoe or well ring: 5/8x6" Size of gravel:

Describe joint Weld

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
14	27	6	4	1x3"

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☒ No ☐ To what depth 12 ft.

Were any strata sealed against pollution? Yes ☐ No ☒ If yes, note depth of strata

From ft. to ft.

From ft. to ft.

Method of sealing Cement

(9) WATER LEVELS:

Depth at which water was first found, if known 15 ft.

Standing level before perforating, if known 12 ft.

Standing level after perforating and developing 8 ft.

(10) WELL TESTS:

Was pump test made? Yes ☒ No ☐ If yes, by whom? Dexter Mach

Yield: 800 gal./min. with 15 ft. drawdown after 16 hrs.

Temperature of water Was a chemical analysis made? Yes ☐ No ☒

Was electric log made of well? Yes ☐ No ☒ If yes, attach copy

(11) WELL LOG:

Total depth 32 ft. Depth of completed well 32 ft.

Formation: Describe by color, character, size of material, and structure

Formation	From ft.	To ft.
TOP SOIL	0	18"
GRAVEL	18"	25
GRAVEL & SAND	25	27
GREY CLAY	27	32

Irrigation well - monitoring water - abandoned

Work started Nov 22 1972 Completed Nov 30 1972

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME DEXTER MACHINERY
(Person, firm, or corporation) (Typed or printed)

Address 4180 Canada Rd., Gilroy, Ca., 95020

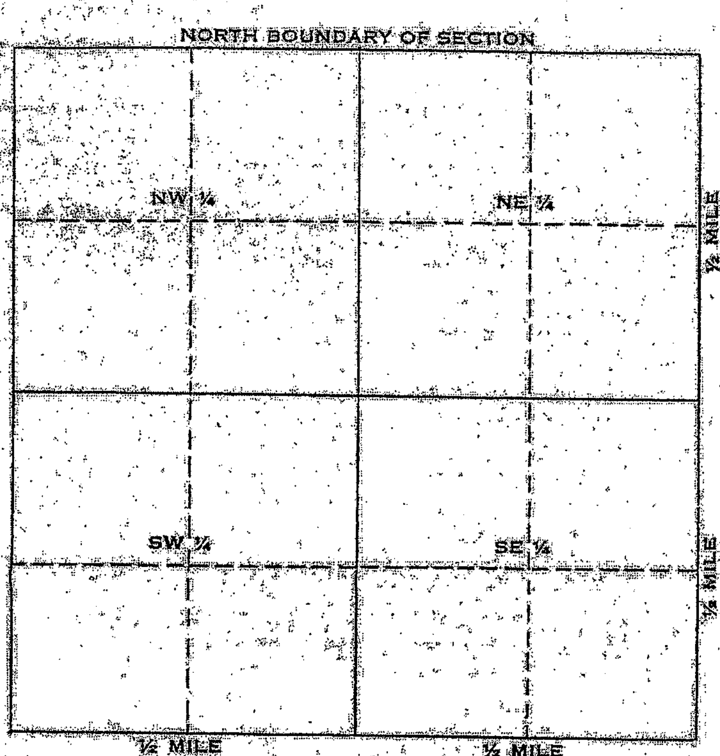
[SIGNED] [signature]
(Well Driller)

License No. 216500 Dated March 20 1973

SKETCH LOCATION OF WELL ON REVERSE SIDE

DWR 188 (REV. 8/68)

ESR--4

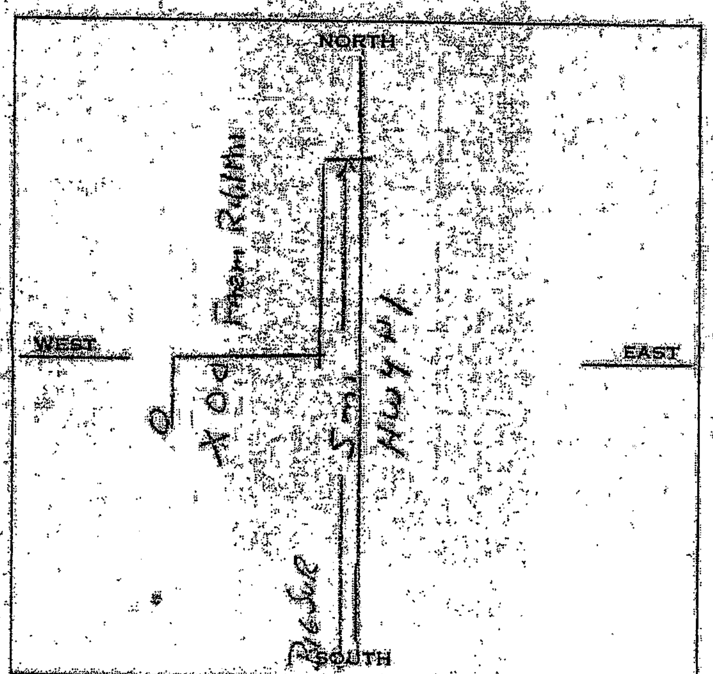


A. Location of well in sectionized areas.
Sketch roads, railroads, streams, or other features as necessary.

Township ________________ N/S

Range ________________ E/W

Section No. ________________



B. Location of well in areas not sectionized.
Sketch roads, railroads, streams, or other features as necessary.
Indicate distances.

86693

DUPLICATE
Return this copy

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do Not Fill In

№ 86694

State Well No.
Other Well No. Navy Well

(1) OWNER:
Name: C. T. Hill
Address: Coast Rt., El Sur Ranch, Monterey, Ca.
#7

(2) LOCATION OF WELL:
County: Monterey Owner's number, if any
Township, Range, and Section
Distance from cities, roads, railroads, etc.: Molera Ranch Big Sur

(3) TYPE OF WORK (check):
New Well [X] Deepening [ ] Reconditioning [ ] Destroying [ ]
If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]

(5) EQUIPMENT:
Rotary [ ]
Cable [X]
Other [ ]

(6) CASING INSTALLED:
STEEL: OTHER:
SINGLE [X] DOUBLE [ ]

From ft.	To ft.	Diam.	Gage or Wall
0	40	10	8

If gravel packed

Diameter of Bore	From ft.	To ft.

Size of shoe or well ring: 5/8x6"
Size of gravel:
Describe joint

(7) PERFORATIONS OR SCREEN:
Type of perforation or name of screen

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
20	38	6	4	1x3"

(8) CONSTRUCTION:
Was a surface sanitary seal provided? Yes [X] No [ ] To what depth 20 ft.
Were any strata sealed against pollution? Yes [ ] No [X] If yes, note depth of strata
From ft. to ft.
From ft. to ft.
Method of sealing: Cement

(9) WATER LEVELS:
Depth at which water was first found, if known 24 ft.
Standing level before perforating, if known 20 ft.
Standing level after perforating and developing 16 ft.

(10) WELL TESTS:
Was pump test made? Yes [X] No [ ] If yes, by whom? Dexter Mach.
Yield: 165 gal./min. with 16 ft. drawdown after 8 hrs.
Temperature of water Was a chemical analysis made? Yes [X] No [ ]
Was electric log made of well? Yes [ ] No [X] If yes, attach copy

(11) WELL LOG:
Total depth 40 ft. Depth of completed well 40 ft.
Formation: *Describe by color, character, size of material, and structure*

Formation	From ft.	To ft.
TOP SOIL	0	2
SAND & GRAVEL	2	5
GRAVEL	5	38
GREY CLAY	38	40

State Parks Hq well

Navy well
Elev. = 8.84

Work started Feb. 28 19 73, Completed Mar. 7 19 73

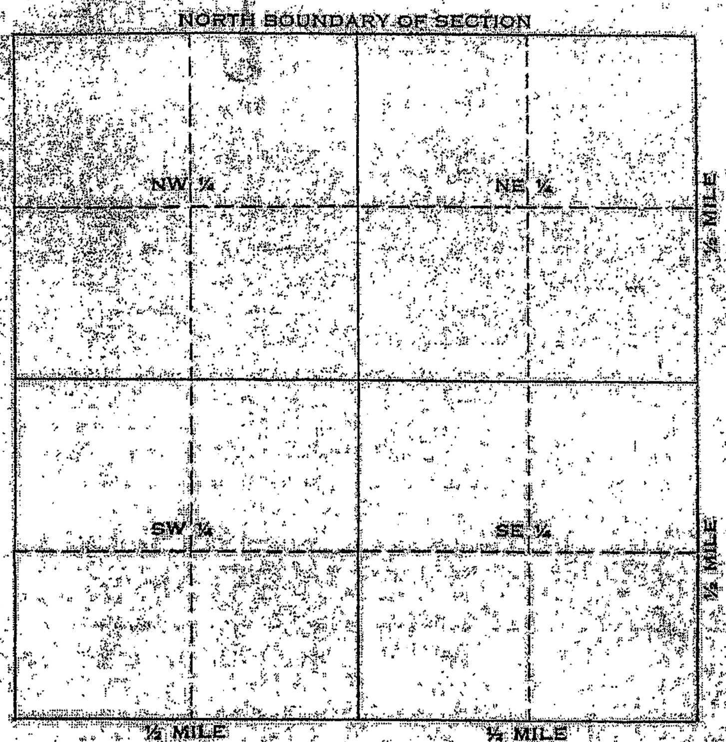
WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME DEXTER MACHINERY
(Person, firm, or corporation) (Typed or printed)
Address 4180 Cañada Rd., Gilroy, Ca. 95020
[SIGNED] [signature]
(Well Driller)
License No. 216500 Dated March 20, 19 73

SKETCH LOCATION OF WELL ON REVERSE SIDE

DWR 188 (REV. 8-68)

ESR--4

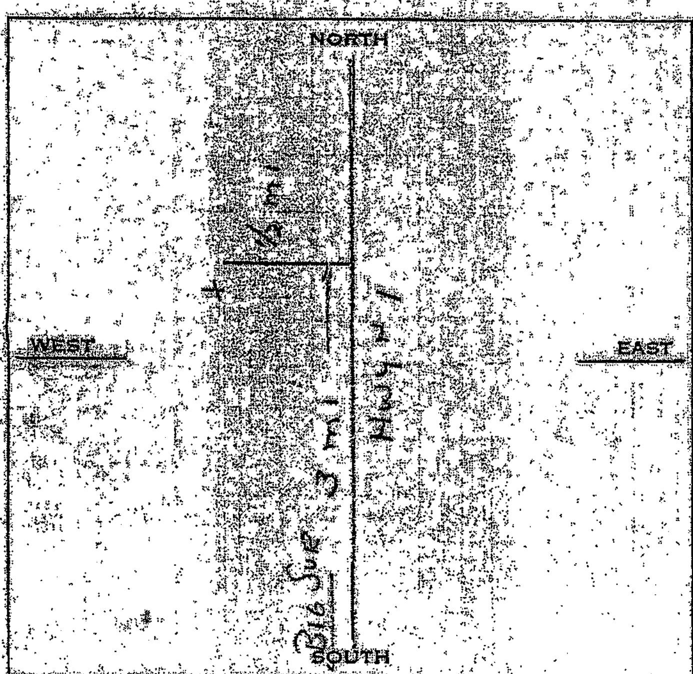


A. Location of well in sectionized areas.
Sketch roads, railroads, streams, or other features as necessary.

Township ____________ N/S

Range ____________ E/W

Section No. ____________



B. Location of well in areas not sectionized.
Sketch roads, railroads, streams, or other features as necessary.
Indicate distances.

86694

Wellhead Elev = 11.53 ft msl

WELL JSA4

WELL LOG

OWNER:
Andrew Molera State Park
Big Sur, CA

TYPE OF WORK: New monitoring well

EQUIPMENT: Mud rotary

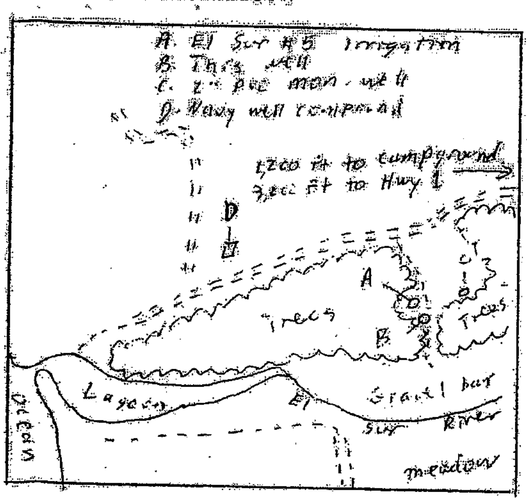
CASING AND PERFORATIONS:
Single-wall PVC
0-7 ft 6-in diam blank
7-28 ft 6-in diam .020 slot

GRAVEL PACK AND SEAL:

0-5 ft	neat cement
5-6 ft	3/8" bentonite chips
6-28 ft	Monterey sand (2/12 Lapis Lustre)
28-38 ft	Backfilled pea gravel with thick bentonite mud.
38-55 ft	Natural caved-in formation, with thick bentonite mud

WELL DEVELOPMENT:
3 hours air lift with drill rig

WELL LOCATION:



GEOLOGIC LOG: (see also attached e-log)

Depth (ft)	Lithology
0-5	Top soil and sand
5-26	Sand and gravel. Coarse sand to 2-inch gravel (larger material present [occasional heavy rig chatter] but not returned up borehole). Sand fraction (approx. 40% by volume): mostly subangular white quartz with occ. iron stains, dark gray mudstone to graywacke, granite, and minor red chert. Gravel fraction: mostly subangular dark gray mudstone to graywacke, white quartz, rounded granite.
26-30	Clay
30-35	Sand
35-40	Pea gravel
40-45	Loose caving cobbles
45-55	Sand and small gravel, with some clay near 55 ft. Dominant lithology at all sizes is angular, medium-gray, siltstone, followed by white quartz and minor rounded granite.

LOGGED BY:

Gus Yates, PHg
Jones & Stokes Associates

DATE DRILLED: Sept. 10-12, 1998

GEO-HYDRO-DATA

INCORPORATED

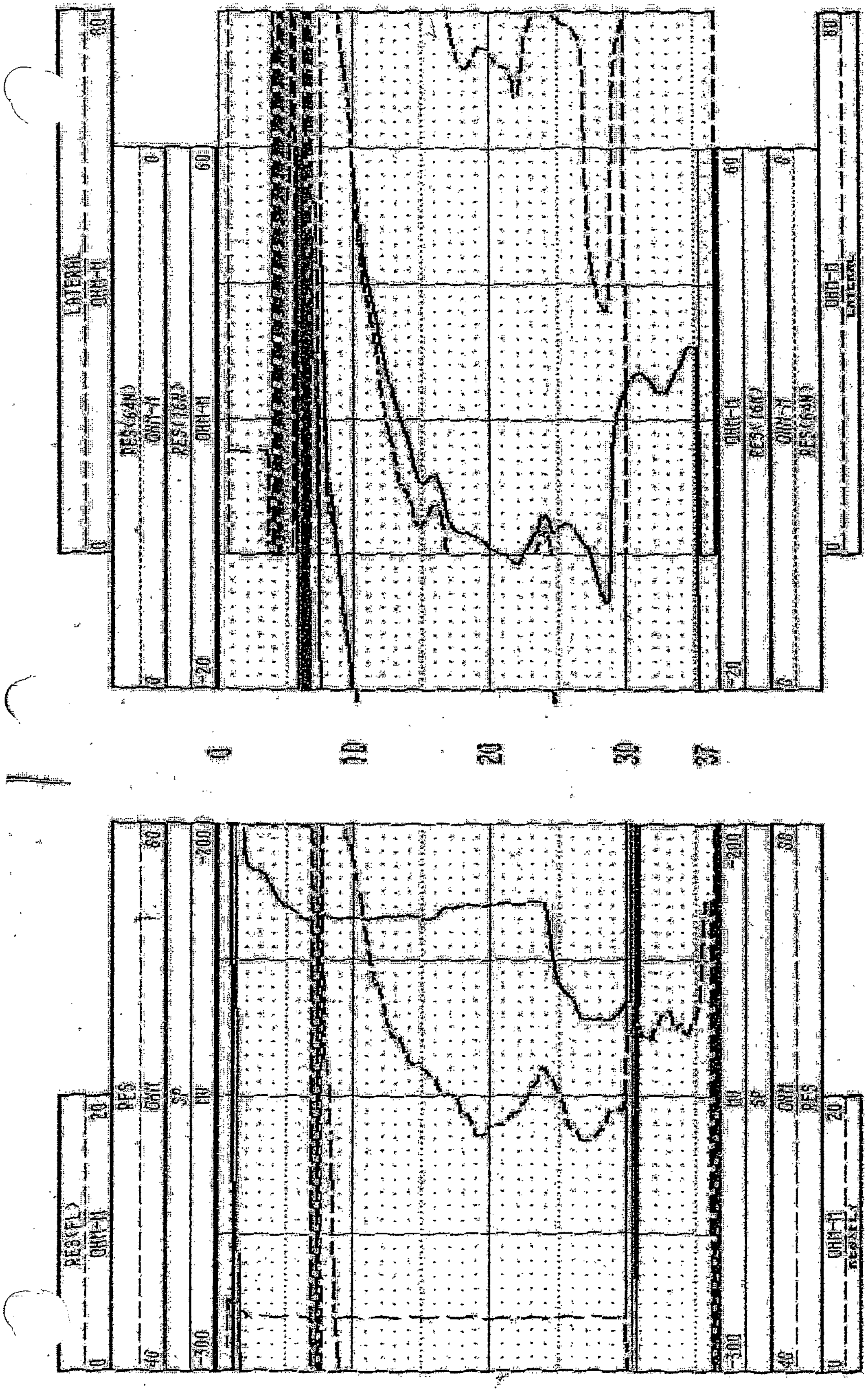
ELECTRIC WELL LOG

COMPANY	: MOLERA STATE PARK				OTHER SERVICES: INVOICE 10680		
WELL	: OBSERVATION 1 A						
LOCATION/FIELD	: MOLERA STATE LPARK						
COUNTY	: MONTEREY						
STATE	: CA.						
SECTION	: .	TOWNSHIP	: .		RANGE	: .	
DATE	: 09/11/98	PERMANENT DATUM	: G.L.		ELEVATIONS		
DEPTH DRILLER	: 55	ELEV. PERM. DATUM	: .		KB	: .	
LOG BOTTOM	: 36.80	LOG MEASURED FROM	: G.L.		DF	: .	
LOG TOP	: 0.80	DRL MEASURED FROM	: G.L.		GL	: .	
CASING DRILLER	: .	LOGGING UNIT	: 7				
CASING TYPE	: .	FIELD OFFICE	: TEHACHAPI				
CASING THICKNESS	: -	RECORDED BY	: K KEMP				
BIT SIZE	: 7.865	BOREHOLE FLUID	: BENT		FILE	: ORIGINAL	
MAGNETIC DECL.	: -	RM	: -		TYPE	: 9041A	
MATRIX DENSITY	: -	RM TEMPERATURE	: -		LOG	: 3	
FLUID DENSITY	: -	MATRIX DELTA T	: -		PLOT	: 1 9	
NEUTRON MATRIX	: .	FLUID DELTA T	: -		THRESH	: 3000	
REMARKS	:						

DDRILLED BY: MAGGIORA BROS.

CO;NSULTENT:JONES- STOKES SACRAMENTO, CA

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



ESR--4

Elev. Approx 5 ft msl

WELL JSA5

WELL LOG

OWNER:
Andrew Molera State Park
Big Sur, CA

TYPE OF WORK: New monitoring well

EQUIPMENT: Hollow-stem auger

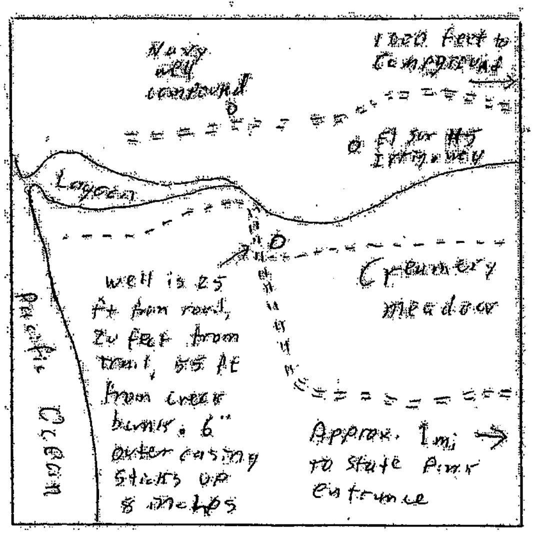
CASING AND PERFORATIONS:
Single-wall PVC
0-4 ft 2-in diam blank
4-24 ft 2-in diam .020 slot

GRAVEL PACK AND SEAL:

0-4 ft	neat cement
4-5 ft	3/8" bentonite chips
6-24 ft	Monterey sand (2/12 Lapis Lustre)
24-30 ft	Native fill (caved)

WELL DEVELOPMENT: None

WELL LOCATION:



GEOLOGIC LOG:

Depth (ft)	Lithology
0-5	Brown silty fine sand with occasional pebbles to 2 cm.
5-10	Gravelly sand. Approx. 33% by vlume is fine dark brown sand, 33% is medium sand (various lithologies, mostly < 1 mm), 33% is large gravel (1-4 cm, rounded to subangular granite and siltstone)
10-30	Coarse caving gravel and cobbles (no cuttings lifted to surface).

LOGGED BY:

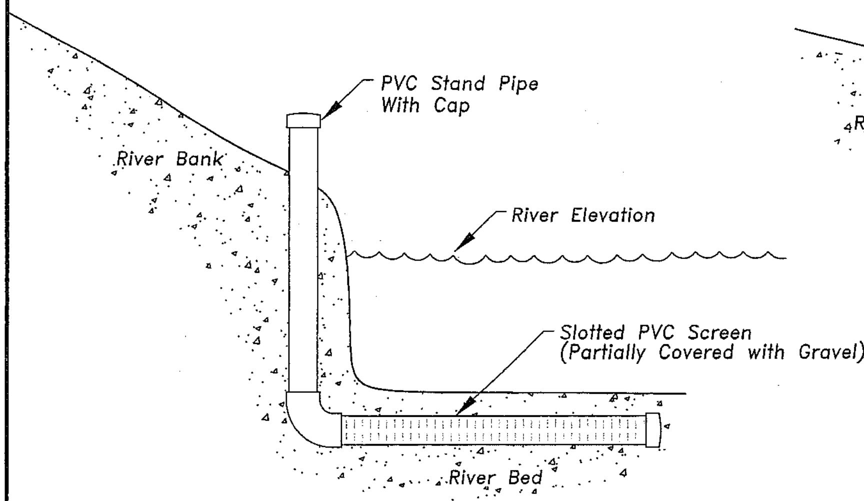
Gus Yates, PHg
Jones & Stokes Associates

DATE DRILLED: Sept. 10, 1998

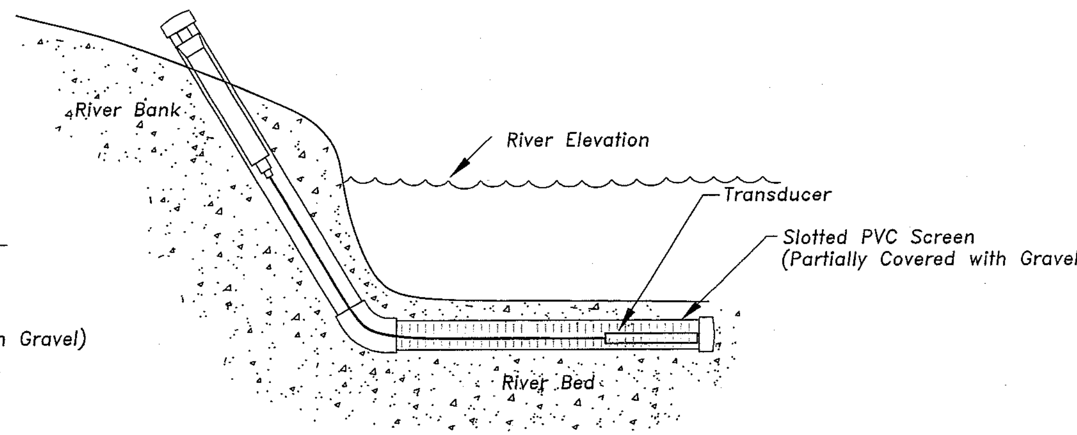
APPENDIX C

APPENDIX C

SIMPLIFIED STILLING WELL DIAGRAMS



Stilling Well



Stilling Well
with Transducer

THE SOURCE GROUP, INC.
SGI environmental
3451-C VINCENT ROAD
PLEASANT HILL, CA 94523

EL SUR RANCH
BIG SUR, CALIFORNIA

SIMPLIFIED STILLING WELL DIAGRAMS

FILE NAME	PROJECT NO.	DATE	DR. BY	APP. BY
STILLING WELL 5 04	01-ESR-001	3/11/05	ML	SM

APPENDIX D

APPENDIX D

ELEVATION SURVEY

Appendix D
Summary of Survey Data
El Sur Ranch

	Top of Casing Elevation (ft msl)	
Location Name	**April Survey**	**July Survey**
ESR-01	*	15.46
ESR-02	14.40	15.13
ESR-03	13.75	13.77
ESR-10A	**	18.06
ESR-10B	**	18.04
ESR-10C	**	17.92
ESR-11	**	49.36
ESR-12	**	54.93
JSA-03	13.05	13.11
JSA-04	11.53	11.55
Old Well	12.52	12.52
New Well	12.52	12.60
Navy Well	13.32	*
Stilling Well	**	8.19
Velocity Transect #1 - Left Bank	**	23.14 (1)
Velocity Transect #1 - Right Bank	**	24.06 (1)
Velocity Transect #2 - Left Bank	**	11.09 (2)
Velocity Transect #2 - Right Bank	**	13.41 (1)
Velocity Transect #3 - Left Bank	**	6.13 (3)
Velocity Transect #3 - Right Bank	**	see notes (4)

Notes:
* not surveyed
** survey point not yet in existance
ft msl = feet above mean sea level
1 = survey location is top of rebar stake
2 = survey location is bottom of rebar stake
3 = survey location is eye bolt attached to rock
4 = right bank survey stake located across river, due east of eyebolt location
(stake removed after each survey due to exposed location on beach)

```
1027,358780.4430,1157995.4550,11.3540,BM CHECK
1028,358426.3830,1157974.4450,8.8450,SET REF @ NAVY WELL
1029,358630.5070,1158526.1630,13.1140,FOUND JSA 3
1031,358563.3940,1158494.3100,11.5410,FOUND SPIKE @ NEW WELL
1032,358840.3350,1158344.3740,13.7690,FOUND PAINT MARK@ESR3
1033,359026.9070,1158369.1470,15.1570,FOUND PAINT MARK@ESR2
1034,359026.8960,1158369.1440,15.1390,FOUND PAINT MARK@ESR2
1035,359026.8830,1158369.1460,15.1100,FOUND PAINT MARK@ESR2
1036,359155.6760,1158325.5570,15.4260,SET@INK X@NEWLY FOUND WELL
1037,359155.6590,1158325.5520,15.4440,SET@INK X@NEWLY FOUND WELL
1038,359026.9200,1158369.1720,15.1170,FOUND PAINT@ESR2
1039,359155.5370,1158325.5170,15.5890,TOP 1-1/2 NIPPLE@NEWLY FOUND WEL
1040,359155.5170,1158325.5020,15.5740,TOP 1-1/2 NIPPLE@NEWLY FOUND WEL
1041,358785.0650,1158850.6480,18.0460,TOP WHITE PVC@ESR10A
1042,358784.9820,1158850.7730,18.0690,TOP WHITE PVC@ESR10A
1044,358788.8380,1158866.5280,17.9540,TOP WHITE PVC@ESR10C
1045,358788.8870,1158866.5840,17.8850,TOP WHITE PVC@ESR10C
1046,358788.9890,1158866.5380,17.9280,TOP WHITE PVC@ESR10C
1047,358787.1050,1158858.8970,18.0190,TOP WHITE PVC@ESR10B
1048,358787.0720,1158858.9910,18.0640,TOP WHITE PVC@ESR10B
1049,359512.7090,1157780.7470,54.9490,TOP WHITE PVC@TOP WELL 1
1050,359512.7370,1157780.7660,54.9130,TOP WHITE PVC@TOP WELL 1
1051,359020.0630,1157581.8460,49.3620,TOP WHITE PVC@TOP WELL 1
1052,359020.0460,1157581.8620,49.3530,TOP WHITE PVC@TOP WELL 2
1100,358539.0600,1158507.2400,11.5500,spot on pvc
1101,358542.5300,1158463.3900,12.0800,SET SPIKE
1102,358544.1500,1158470.0200,12.3400,NEW WELL SLAB
1103,357652.9500,1157467.8200,6.1200,FND BOLT UNDER WATER
1104,357652.9400,1157467.8200,6.1400,FND BOLT UNDER WATER
1105,358888.0600,1159102.9600,8.1900,TRANSECT
1106,358892.4000,1159096.3100,12.5200,TRANSECT
1107,358898.9200,1159104.4500,13.3900,LB TRANS 2
1108,358897.9100,1159103.7600,11.0900,G
1109,358869.8800,1159127.1300,10.4800,G AT RB
1110,358870.1000,1159126.2400,13.4100,TRANS 2 RB
1111,359834.8800,1161687.2700,19.9000,RB TRANS 1
1112,359830.0700,1161687.5000,21.4800,TOP OF PVC CAP
1113,359824.6300,1161680.8700,23.1400,TOP OF REBAR T 1
1114,359824.4800,1161680.8100,21.5800,G
1115,359866.8800,1161670.7300,24.0600,TOP OF REBAR
1116,359867.1200,1161670.6800,21.5000,G
```

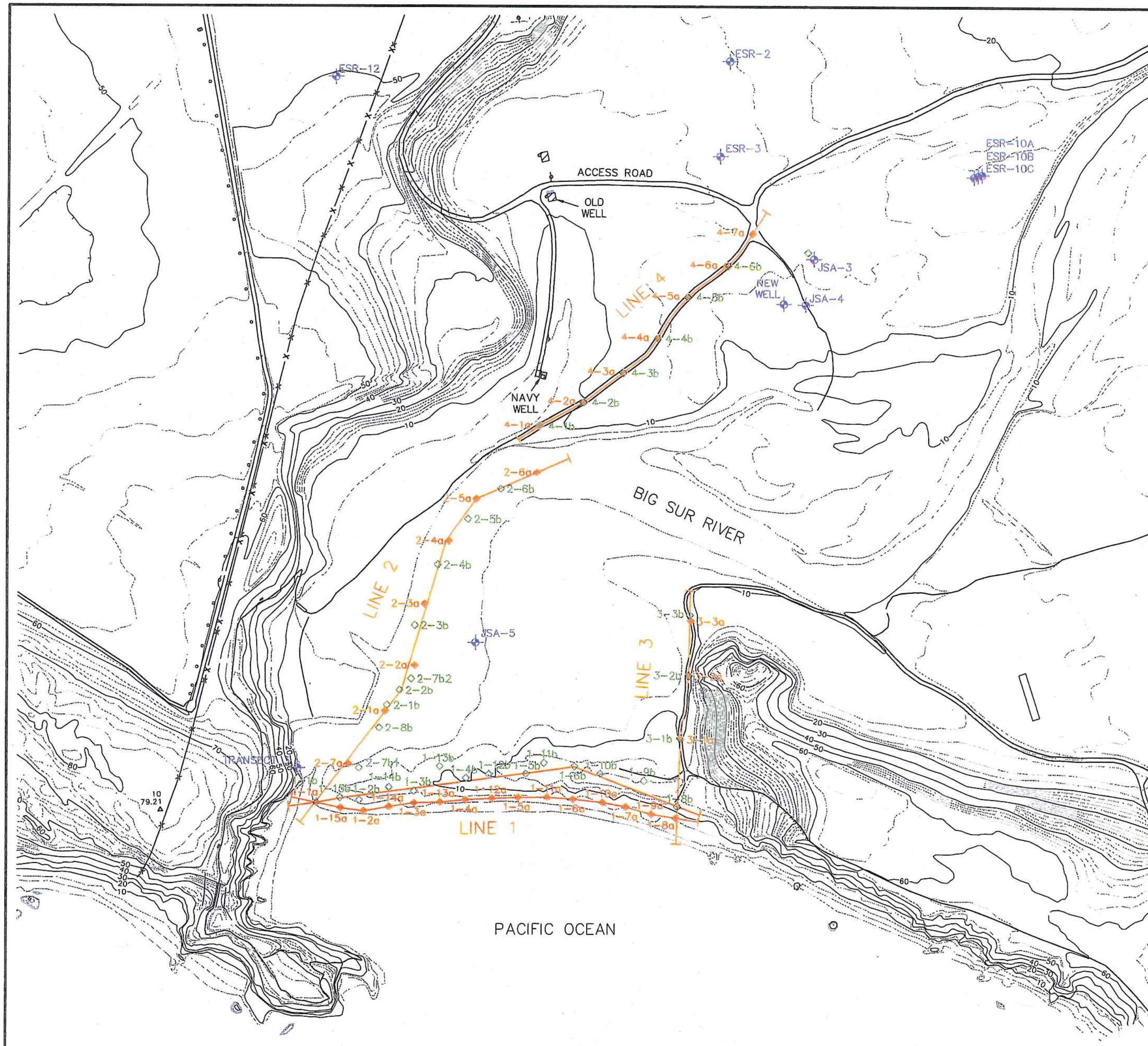
1053,359011.5630,1156075.4000,33.1250,LOWER BEVELED EDGE CONC HEADWALL
1054,359011.5030,1156075.4060,33.1070,LOWER BEVELED EDGE CONC HEADWALL

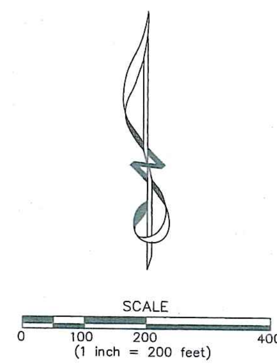
APPENDIX E

ESR--4

APPENDIX E

GEOPHYSICAL SURVEY REPORTS

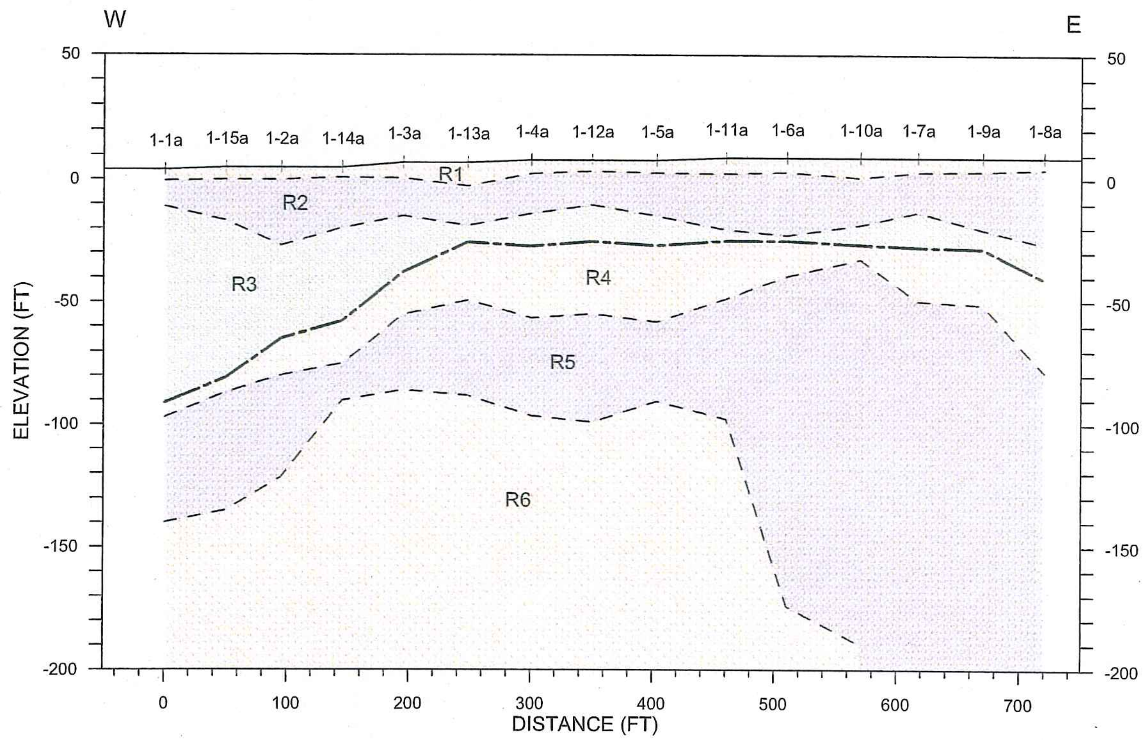




LEGEND

	TEM PROFILE
◆	TEM LOCATION – PHASE I (REVISED)
◇	TEM LOCATION – PHASE 2
⌖	WELL

NORCAL	LOCATION MAP EL SUR TEM SURVEY – PHASE 2 ANDREW MOLERA STATE PARK	
	LOCATION: BIG SUR, CALIFORNIA	
	CLIENT: THE SOURCE GROUP	PLATE
JOB #: 04-616.08	NORCAL GEOPHYSICAL CONSULTANTS INC.	1
DATE: DEC. 2004	DRAWN BY: G.RANDALL — APPROVED BY: WEB	



RESISTIVITY RANGES

- Low (1 - 17 ohm-m)
- Moderate (30 - 80 ohm-m)
- High (105 - 210 ohm-m)

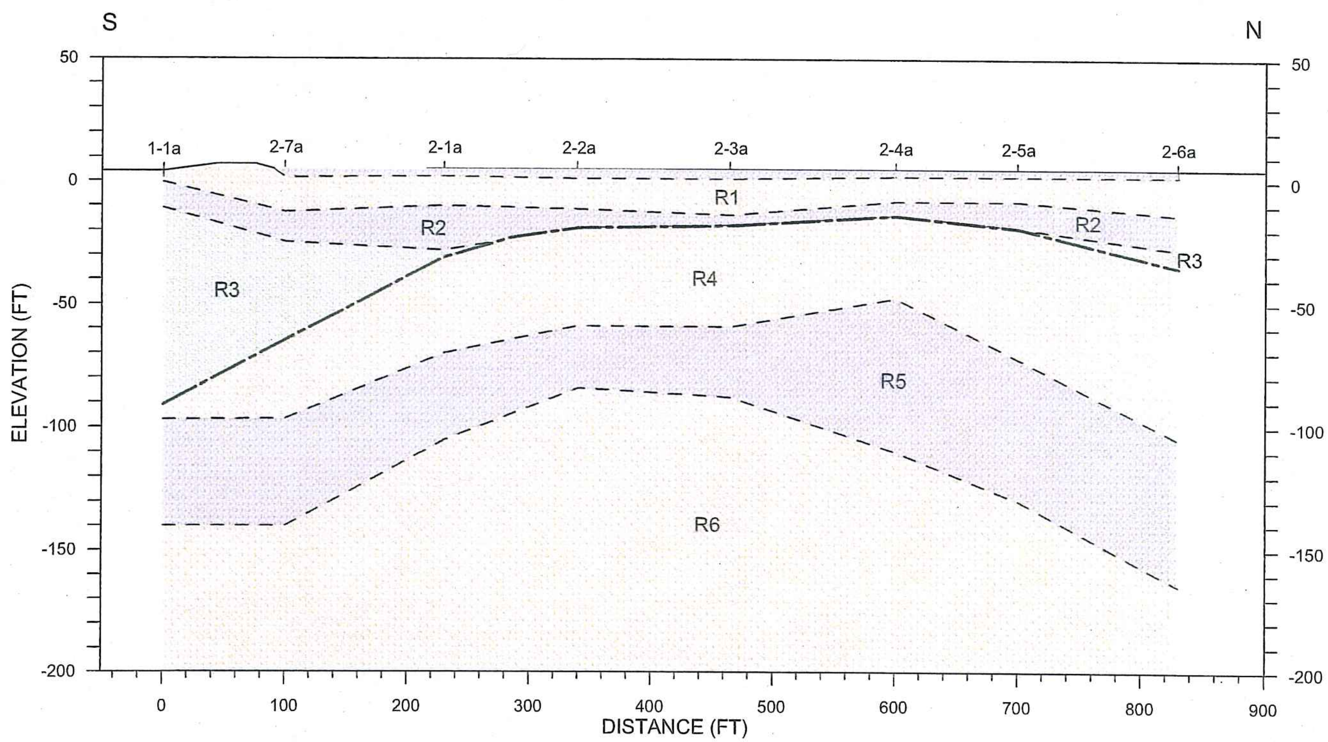
LEGEND

1-1a	TEM Sounding Location
———	Ground Surface
– – – –	Resistivity Interface
—·—·—	Interpreted Bedrock Surface
R1	Resistivity Layer

Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet

NORCAL

LINE 1 - PHASE 1 (Revised) EL SUR TEM SURVEY ANDREW MOLERA STATE PARK	
LOCATION: Big Sur, California	
CLIENT: The Source Group	PLATE 2
JOB #: 04-616.08	NORCAL GEOPHYSICAL CONSULTANTS INC.
DATE: DEC. 2004	DRAWN BY: WEB / APPROVED BY: WEB



RESISTIVITY RANGES

- Low (2 - 11 ohm-m)
- Moderate (70 - 75 ohm-m)
- High (125 - 260 ohm-m)

LEGEND

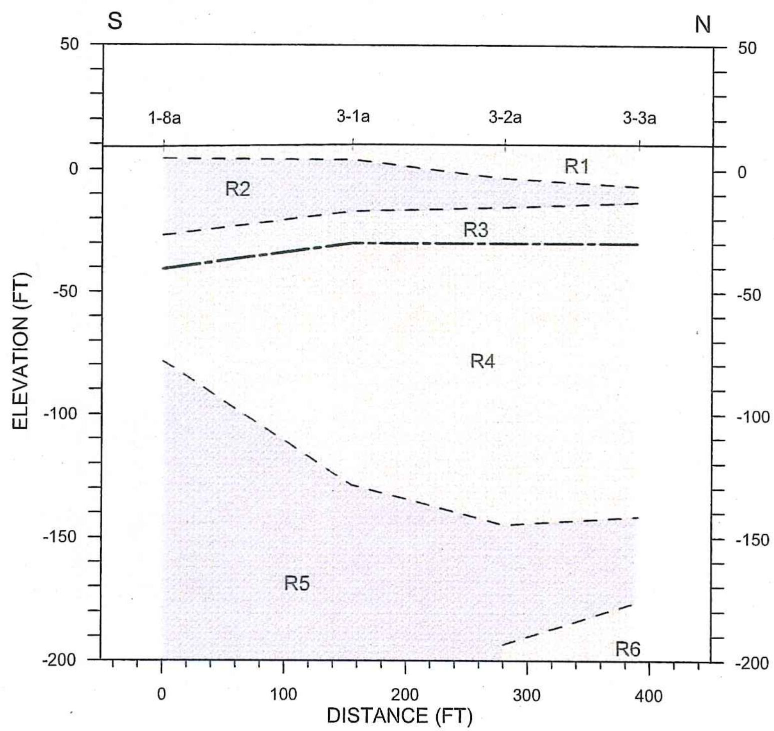
2-1a	TEM Sounding Location
———	Ground Surface
– – –	Resistivity Interface
—·—	Interpreted Bedrock Surface
R1	Resistivity Layer

Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet

NORCAL

LINE 2 - PHASE 1 (Revised)
EL SUR TEM SURVEY
ANDREW MOLERA STATE PARK

LOCATION: Big Sur, California
CLIENT: The Source Group
NORCAL GEOPHYSICAL CONSULTANTS INC.
JOB #: 04-616.08
DATE: DEC. 2004
DRAWN BY: WEB
APPROVED BY: WEB
PLATE 3



RESISTIVITY RANGES
Low (8 - 17 ohm-m)
Moderate (70 - 75 ohm-m)
High (130 - 170 ohm-m)

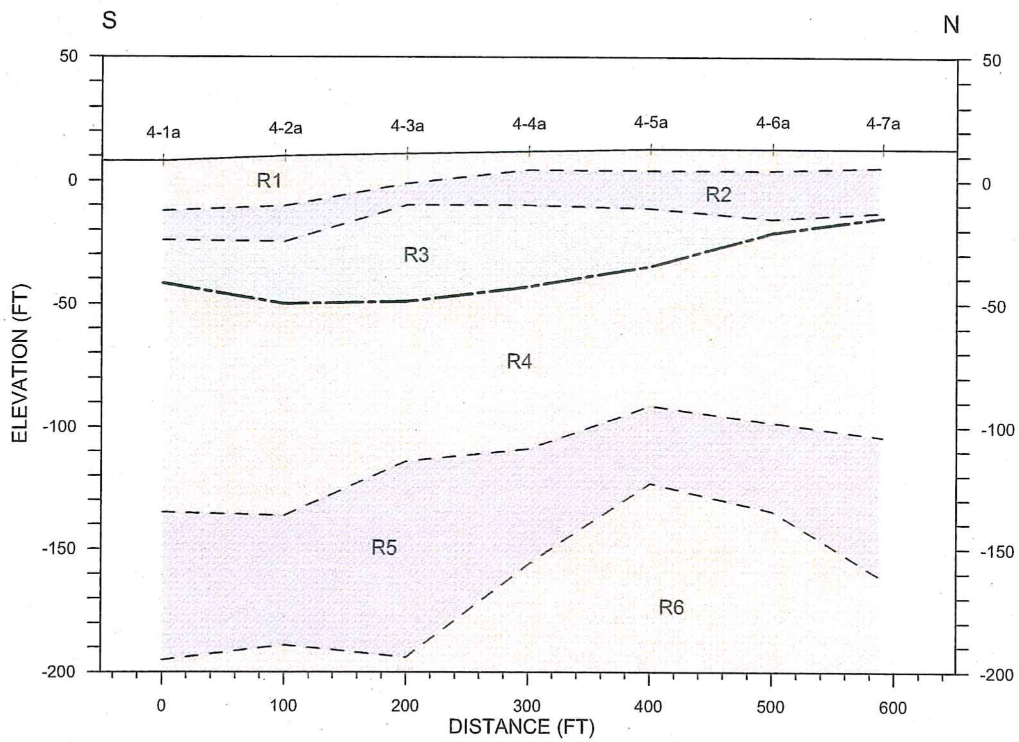
LEGEND	
3-1a	TEM Sounding Location
———	Ground Surface
— — —	Resistivity Interface
—·—	Interpreted Bedrock Surface
R1	Resistivity Layer

Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet

NORCAL

LINE 3 - PHASE 1 (Revised)
EL SUR TEM SURVEY
ANDREW MOLERA STATE PARK

LOCATION: Big Sur, California
CLIENT: The Source Group
NORCAL GEOPHYSICAL CONSULTANTS INC.
JOB #: 04-616.08
DATE: DEC. 2004
DRAWN BY: WEB
APPROVED BY: WEB
PLATE 4



RESISTIVITY RANGES

- Low (7 - 18 ohm-m)
- Moderate (65 - 90 ohm-m)
- High (125 - 175 ohm-m)

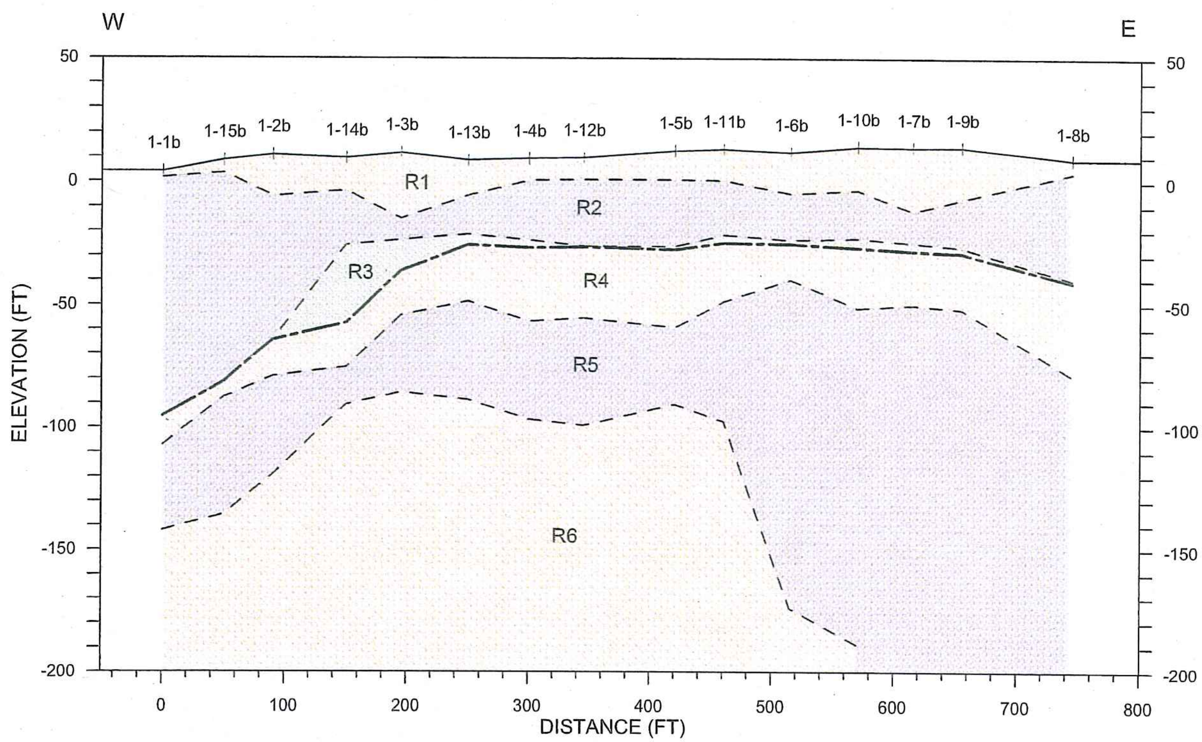
LEGEND

4-1a	TEM Sounding Location
———	Ground Surface
– – –	Resistivity Interface
—·—	Interpreted Bedrock Surface
R1	Resistivity Layer

Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet

NORCAL	LINE 4 - PHASE 1 (Revised) EL SUR TEM SURVEY ANDREW MOLERA STATE PARK
	LOCATION: Big Sur, California
	CLIENT: The Source Group
JOB #: 04-616.08	NORCAL GEOPHYSICAL CONSULTANTS INC.
DATE: DEC. 2004	DRAWN BY: WEB · APPROVED BY: WEB

PLATE 5



RESISTIVITY RANGES

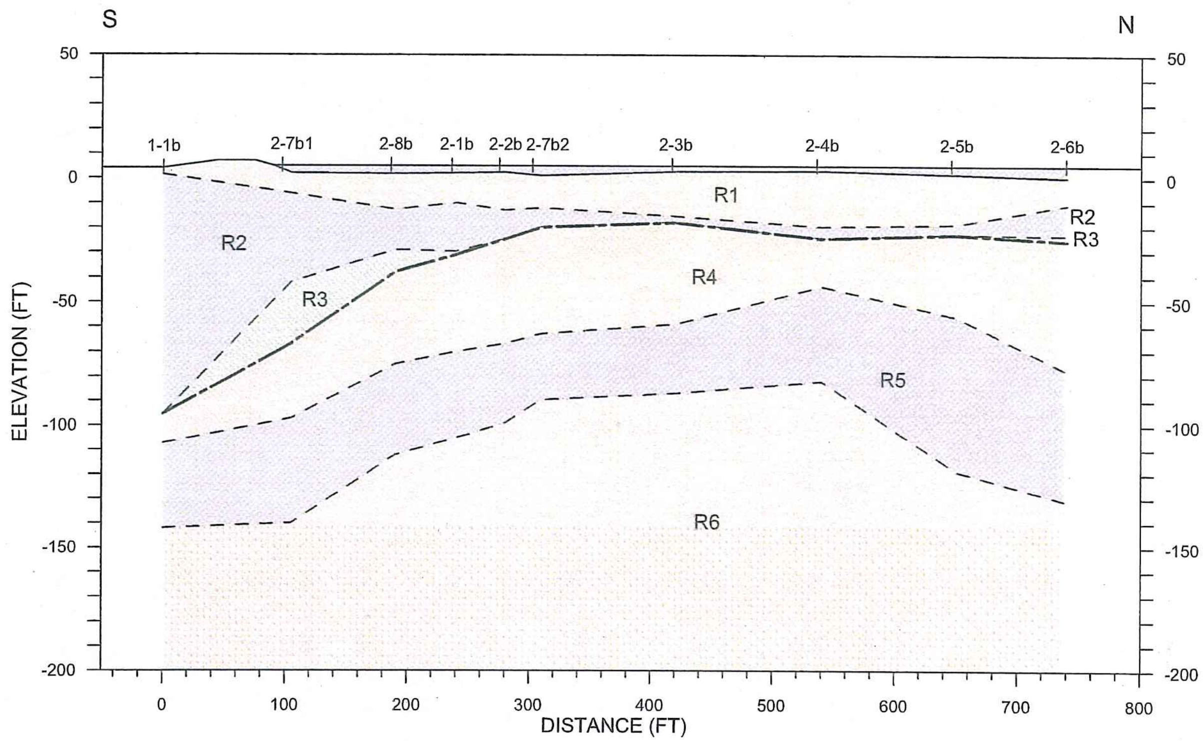
- Low (1 - 25 ohm-m)
- Moderate (50 - 75 ohm-m)
- High (105 - 235 ohm-m)

LEGEND

1-1b	TEM Sounding Location
———	Ground Surface
– – – –	Resistivity Interface
—·—·—	Interpreted Bedrock Surface
R1	Resistivity Layer

Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet

NORCAL	LINE 1 - PHASE 2 EL SUR TEM SURVEY ANDREW MOLERA STATE PARK		PLATE 6
	LOCATION: Big Sur, California		
	CLIENT: The Source Group		
JOB #: 04-616.08	NORCAL GEOPHYSICAL CONSULTANTS INC.		
DATE: DEC. 2004	DRAWN BY: WEB	APPROVED BY: WEB	



RESISTIVITY RANGES

- Low (1 - 15 ohm-m)
- Moderate (35 - 80 ohm-m)
- High (105 - 175 ohm-m)

LEGEND

- 2-1b TEM Sounding Location
- Ground Surface
- Resistivity Interface
- Interpreted Bedrock Surface
- R1 Resistivity Layer

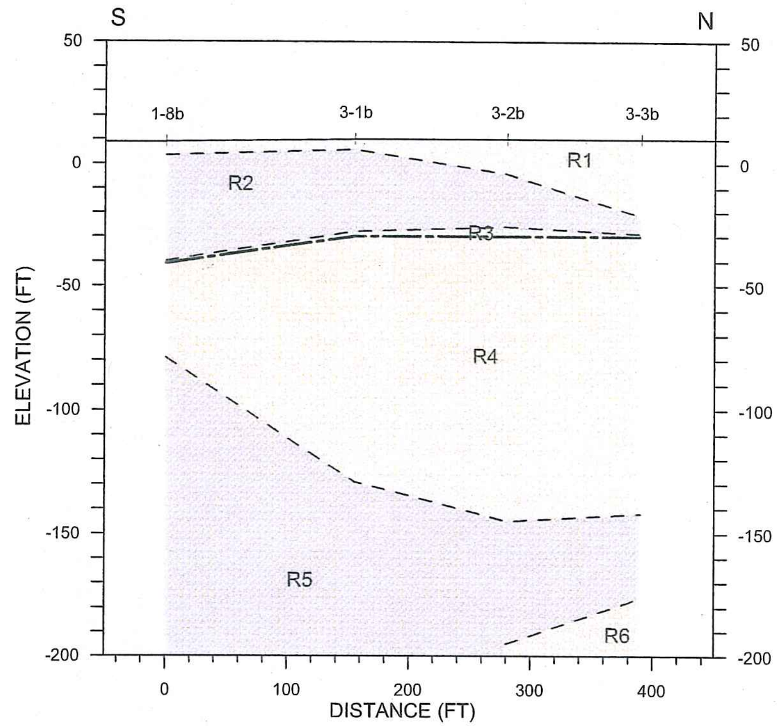
Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet

LINE 2 - PHASE 2
EL SUR TEM SURVEY
ANDREW MOLERA STATE PARK

NORCAL

LOCATION:	Big Sur, California
CLIENT:	The Source Group
	NORCAL GEOPHYSICAL CONSULTANTS INC.
JOB #: 04-616.08	DRAWN BY: WEB
DATE: DEC. 2004	APPROVED BY: WEB

PLATE 7



RESISTIVITY RANGES

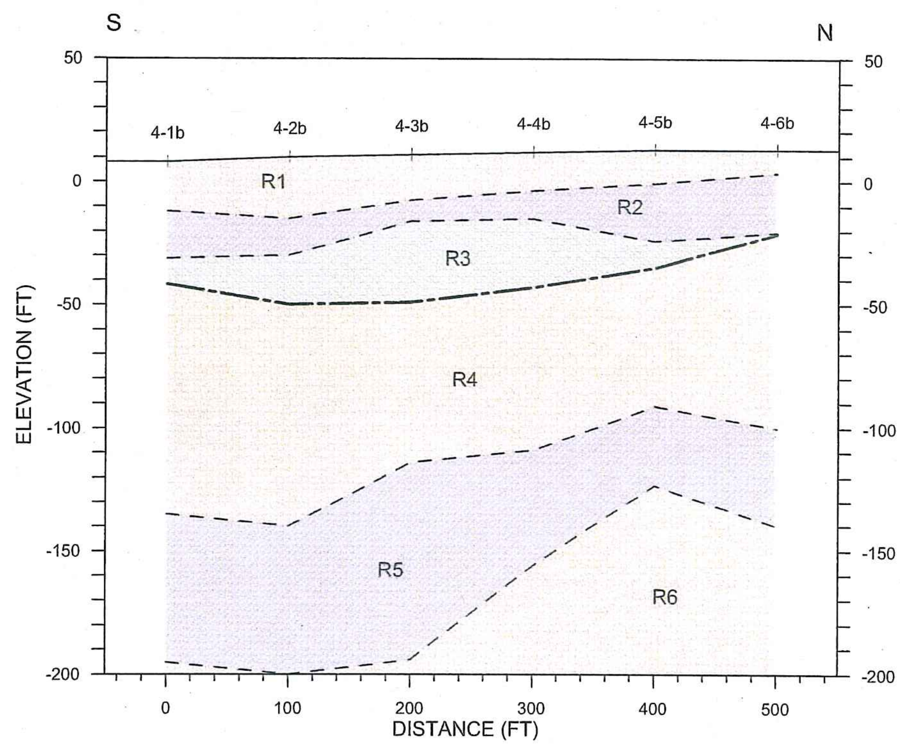
- Low (6 - 25 ohm-m)
- Moderate (35 - 70 ohm-m)
- High (105 - 185 ohm-m)

LEGEND

3-1b	TEM Sounding Location
———	Ground Surface
— — —	Resistivity Interface
—·—	Interpreted Bedrock Surface
R1	Resistivity Layer

Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet

NORCAL	LINE 3 - PHASE 2 EL SUR TEM SURVEY ANDREW MOLERA STATE PARK	
	LOCATION: Big Sur, California	
	CLIENT: The Source Group	PLATE 8
JOB #: 04-616.08	NORCAL GEOPHYSICAL CONSULTANTS INC.	
DATE: DEC. 2004	DRAWN BY: WEB — APPROVED BY: WEB	



RESISTIVITY RANGES

- Low (9 - 23 ohm-m)
- Moderate (20 - 70 ohm-m)
- High (105 - 185 ohm-m)

LEGEND

4-1b	TEM Sounding Location
———	Ground Surface
— — —	Resistivity Interface
—·—	Interpreted Bedrock Surface
R1	Resistivity Layer

Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet

NORCAL

LINE 4 - PHASE 2
EL SUR TEM SURVEY
ANDREW MOLERA STATE PARK

LOCATION: Big Sur, California
CLIENT: The Source Group
NORCAL GEOPHYSICAL CONSULTANTS INC.
JOB #: 04-616.08
DATE: DEC. 2004
DRAWN BY: WEB
APPROVED BY: WEB
PLATE 9

APPENDIX F

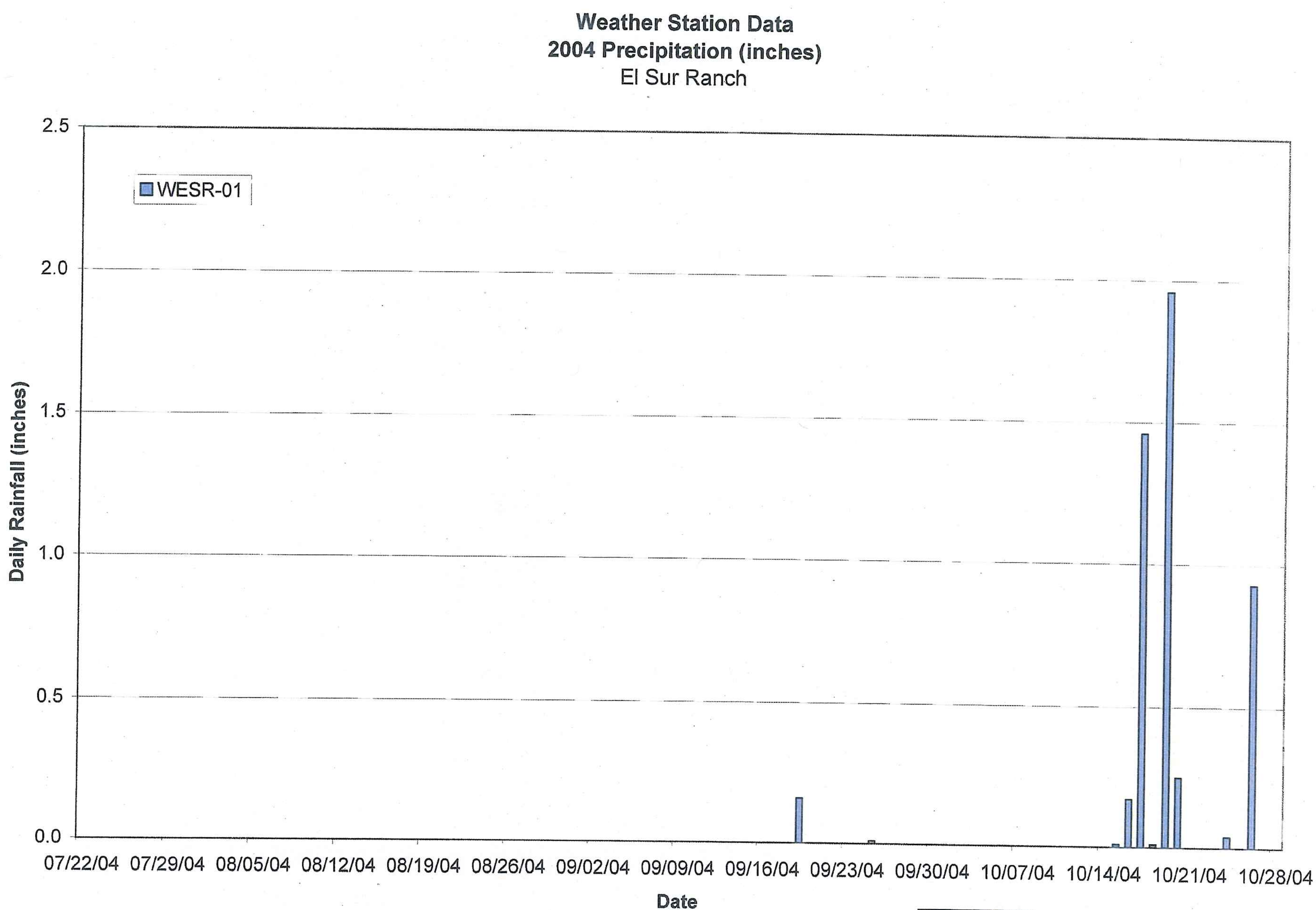
APPENDIX F

ELECTRONIC DATABASE (CD)

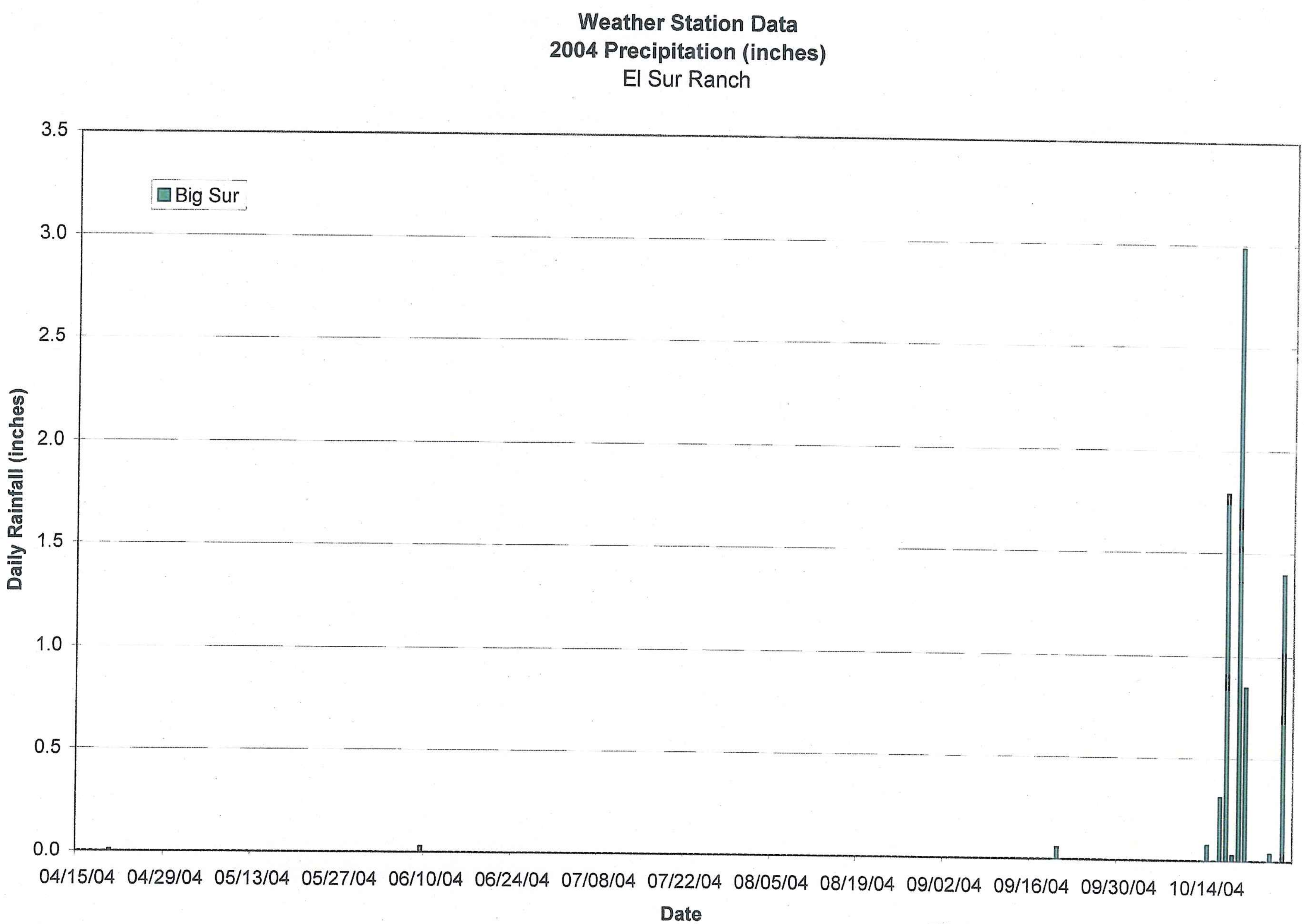
APPENDIX G

APPENDIX G

WEATHER STATION DATA

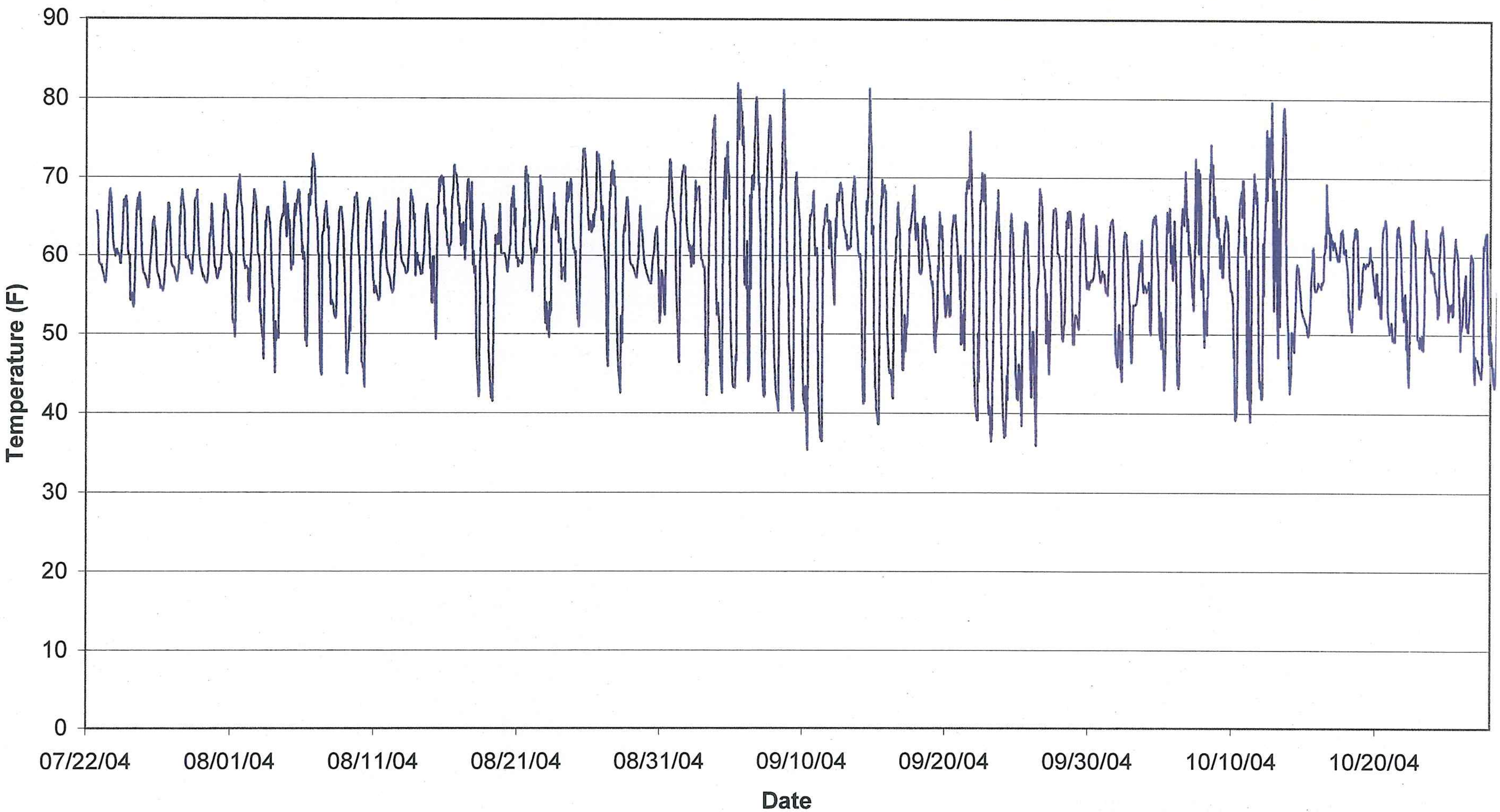


SGI environmental THE SOURCE GROUP, INC.



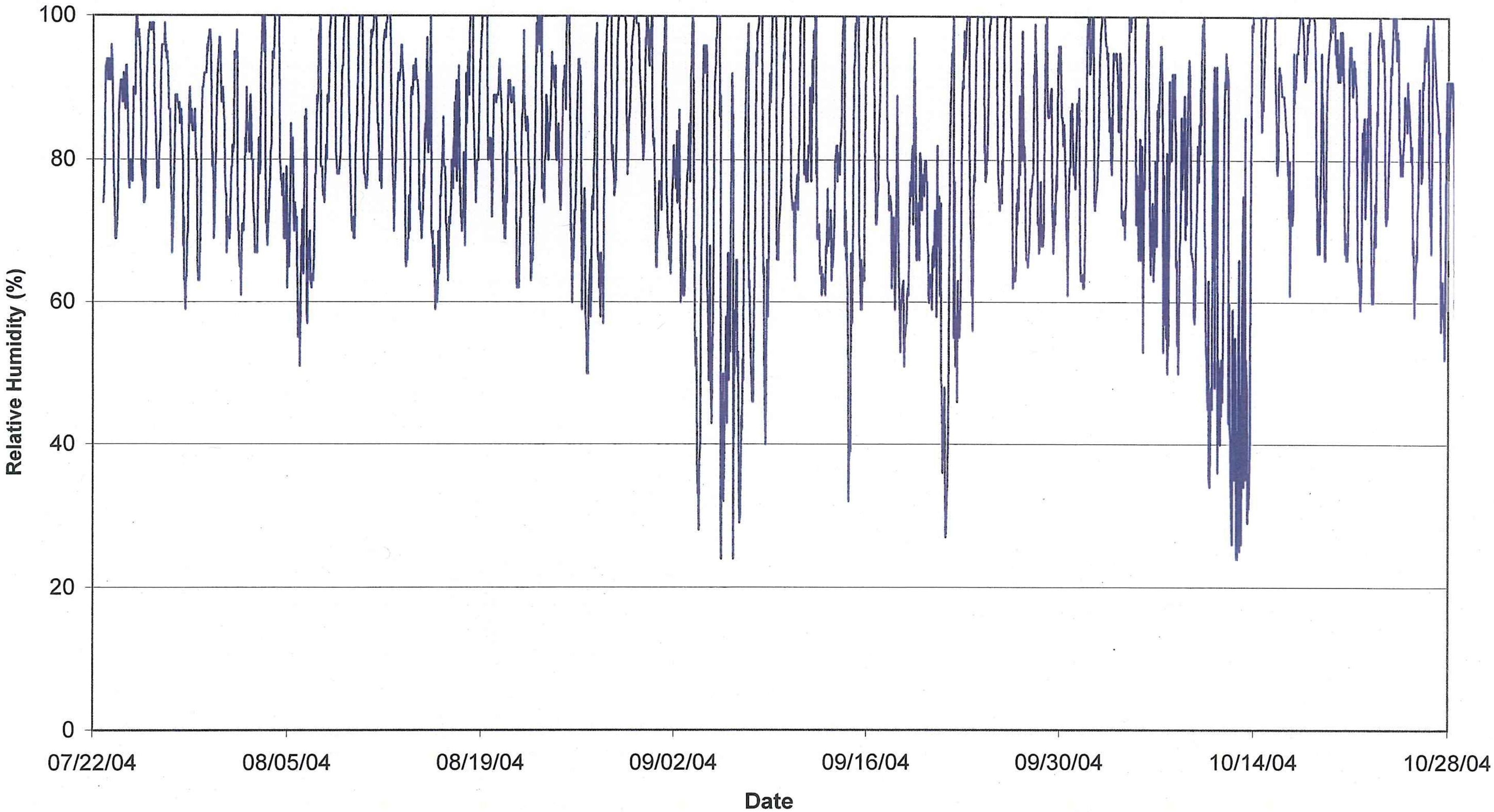
SGI environmental THE SOURCE GROUP, INC.

WESR-02
Weather Station Data
Temperature (F)
El Sur Ranch



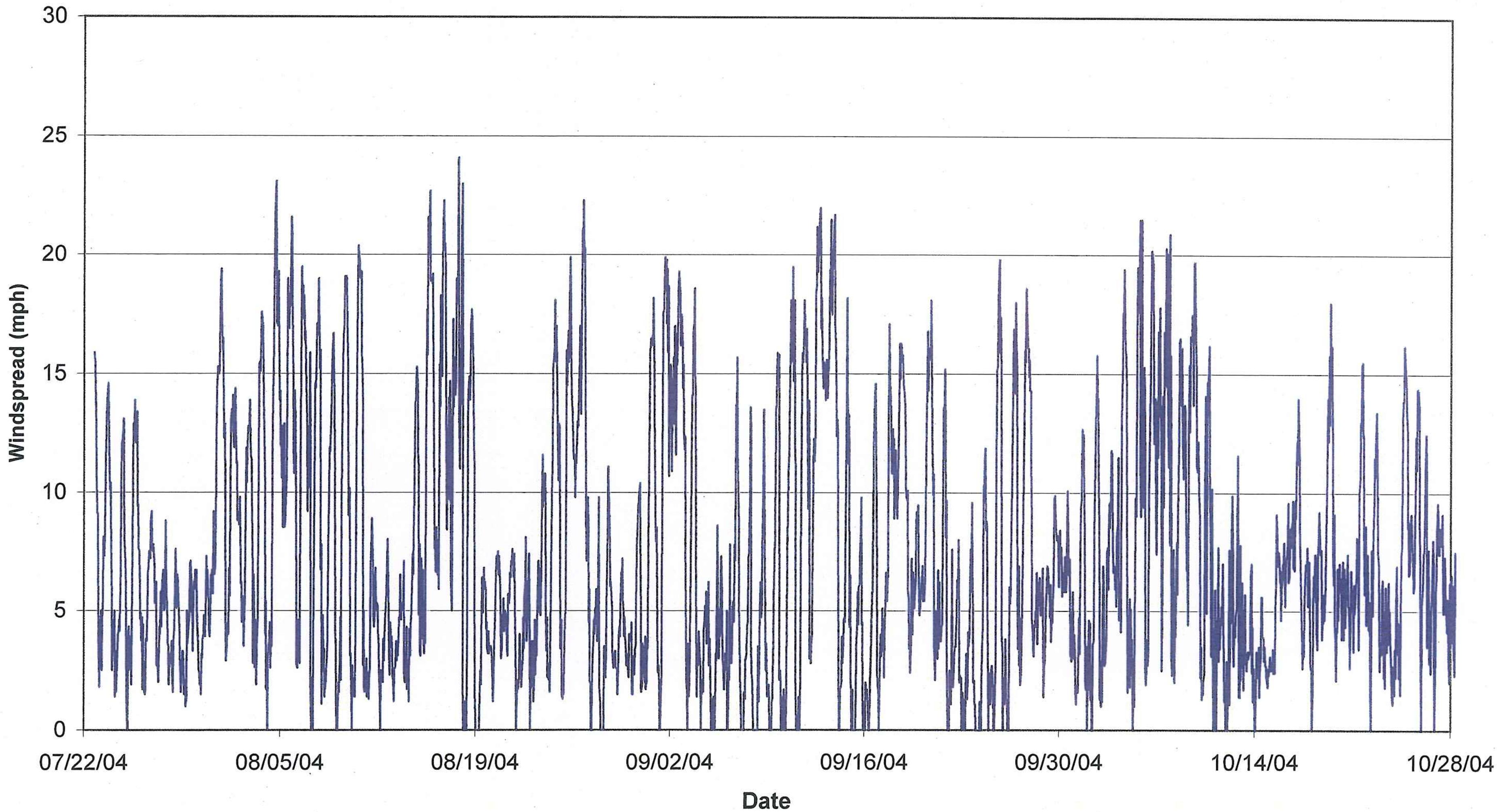
SGI environmental THE SOURCE GROUP, INC.

WESR-02
Weather Station Data
Relative Humidity (%)
El Sur Ranch



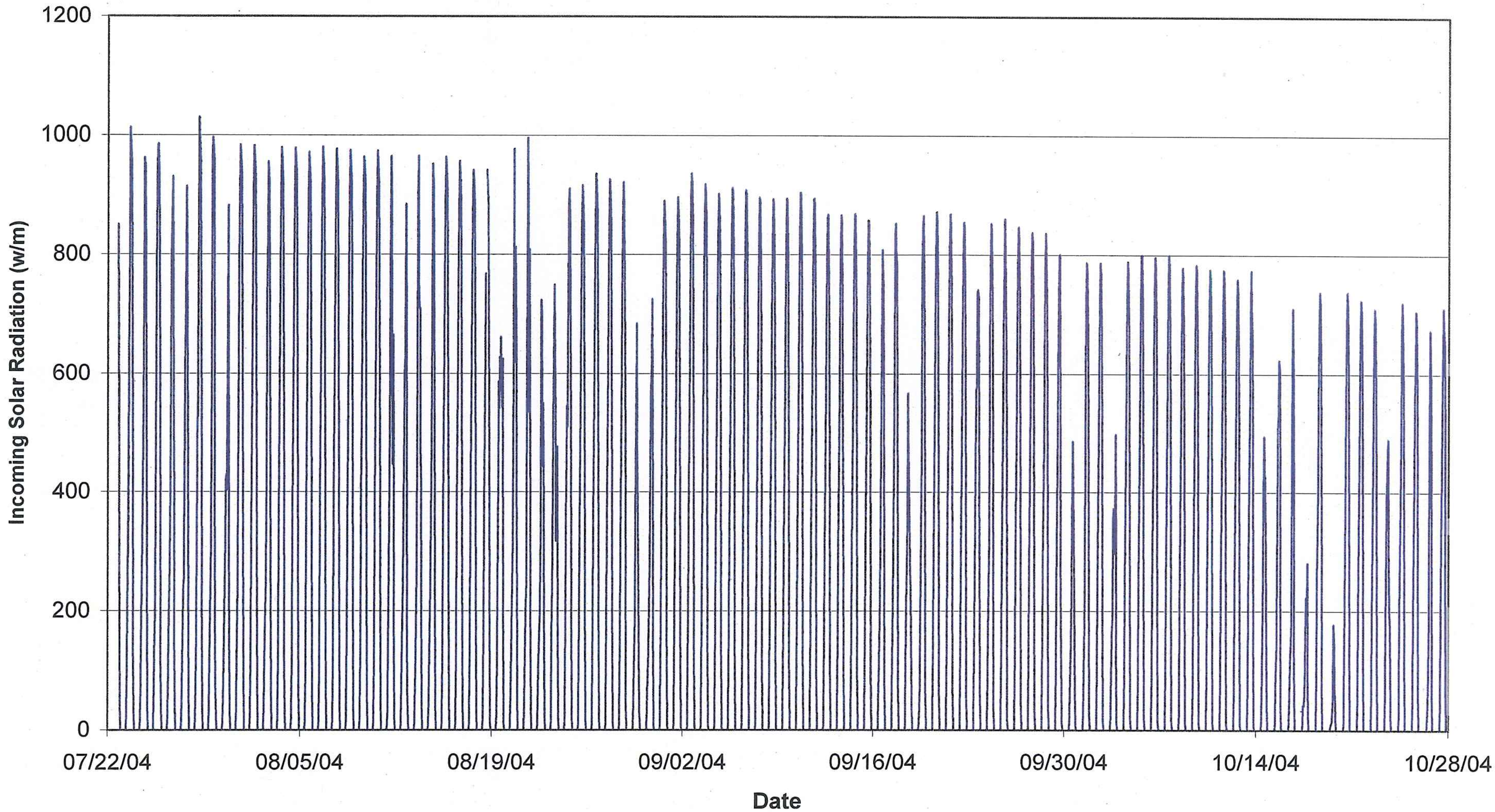
SGI environmental THE SOURCE GROUP, INC.

WESR-02
Weather Station Data
Windspread (mph)
El Sur Ranch



SGI environmental THE SOURCE GROUP, INC.

WESR-02
Weather Station Data
Incoming Solar Radiation (w/m)
El Sur Ranch



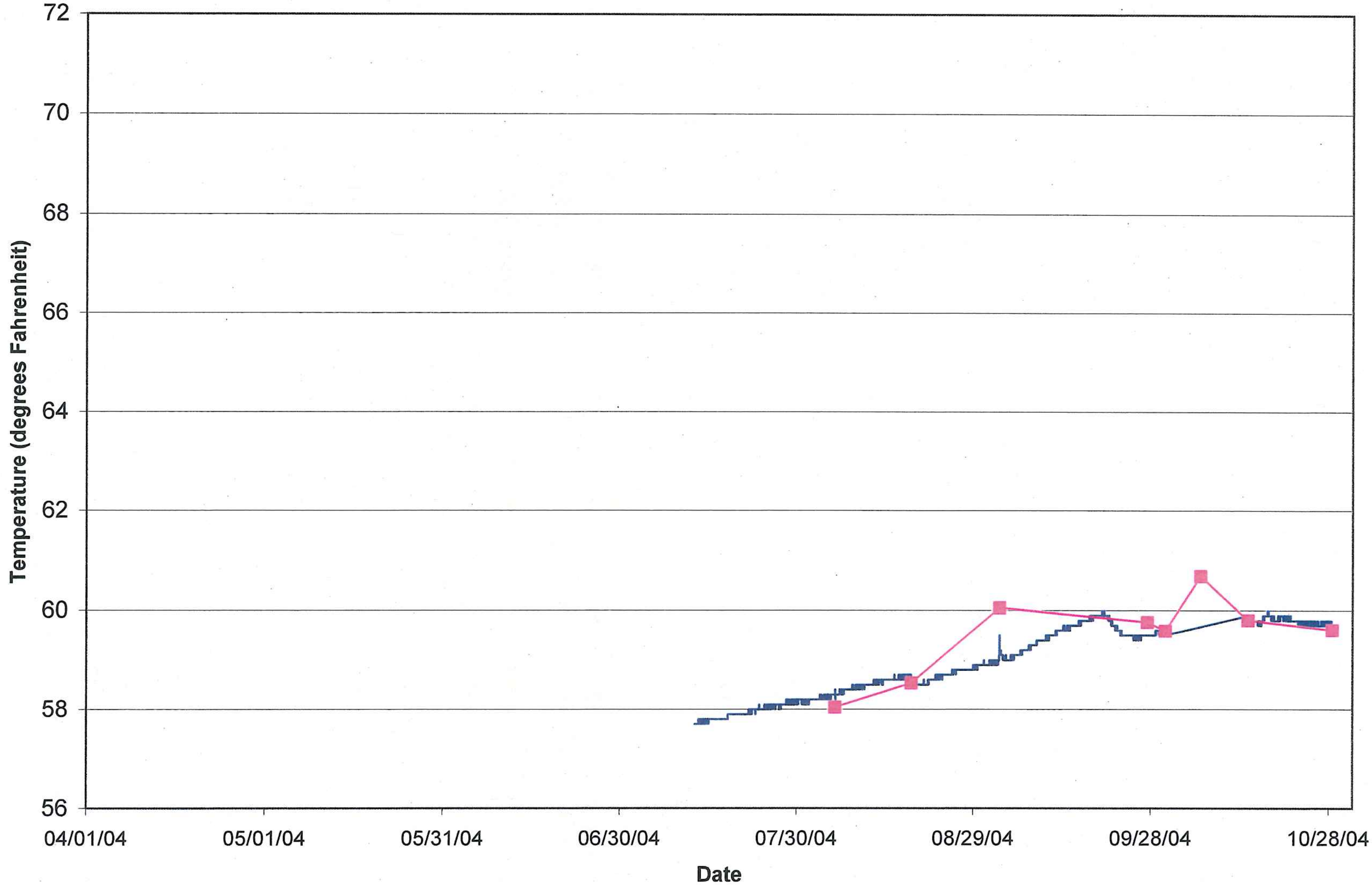
SGI environmental THE SOURCE GROUP, INC.

APPENDIX H

APPENDIX H

TEMPERATURE LOGGER DATA/GRAPHS

Temperature Graph of ESR-02 (Transducer and Manual Measurements)
El Sur Ranch
Big Sur, California

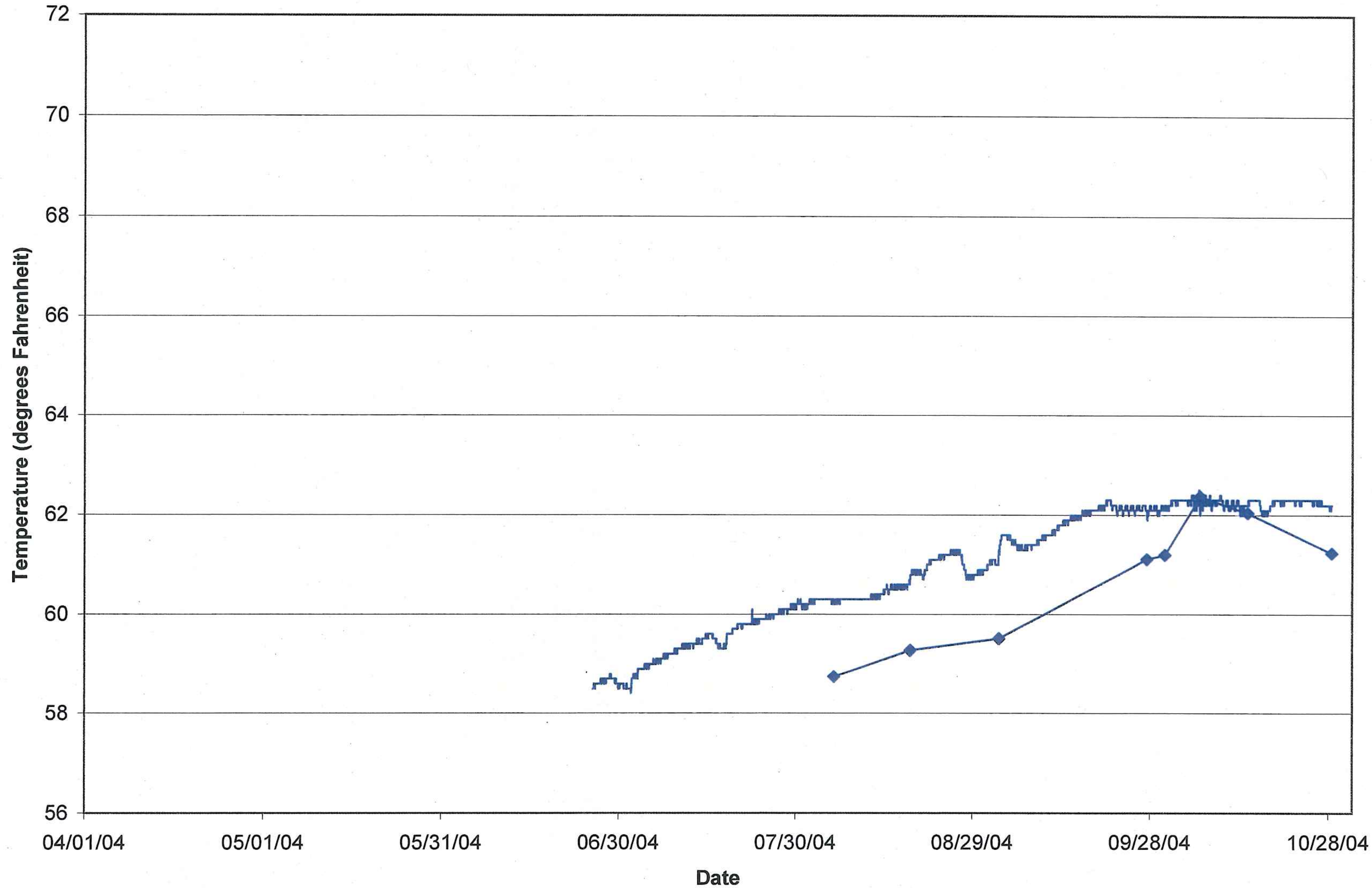


SGI environmental THE SOURCE GROUP, INC.

Temperature Graph of ESR-03 (Transducer and Manual Measurements)

El Sur Ranch

Big Sur, California

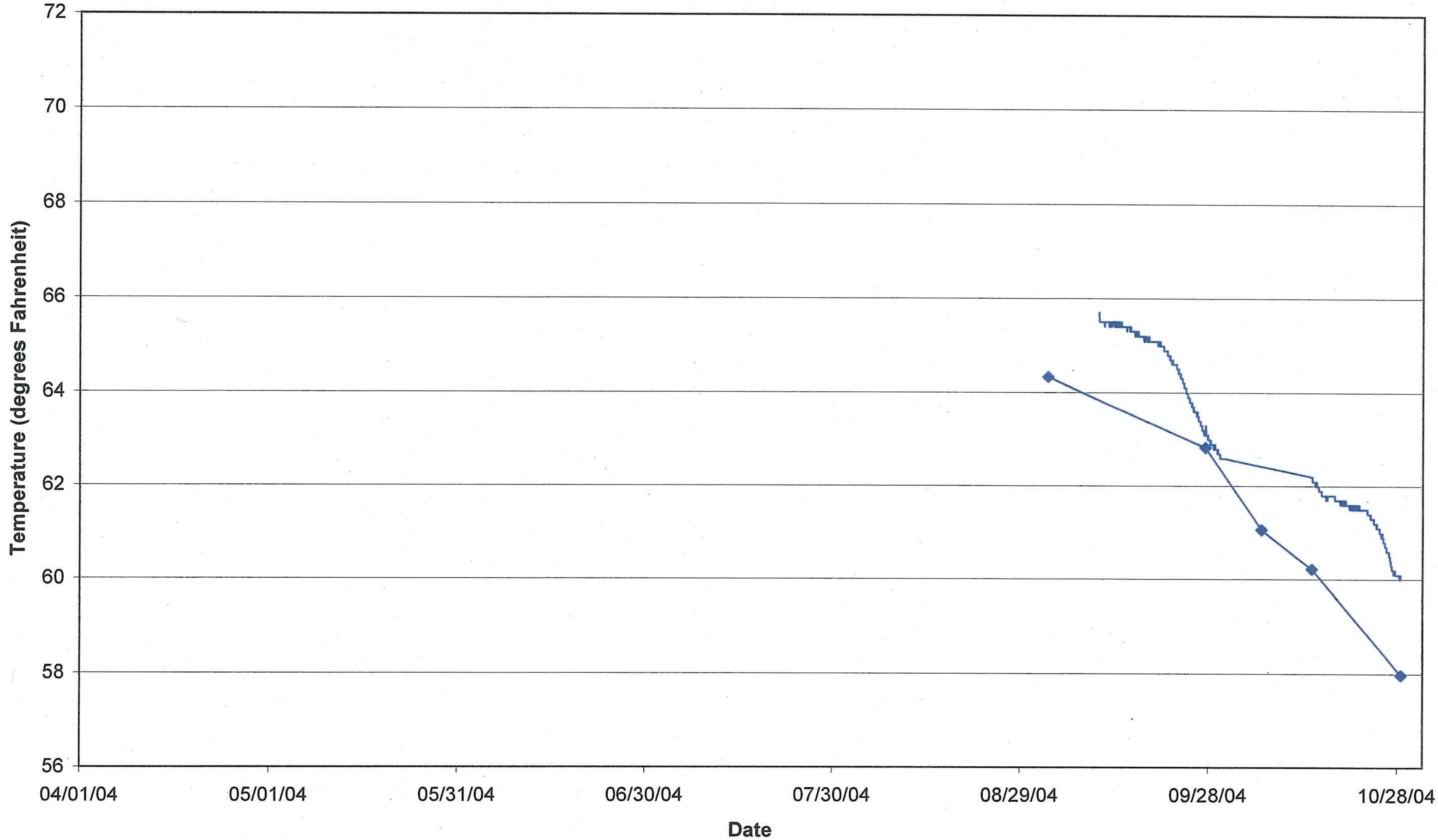


SGI environmental THE SOURCE GROUP, INC.

Temperature Graph of ESR-10A (Transducer and Manual Measurements)

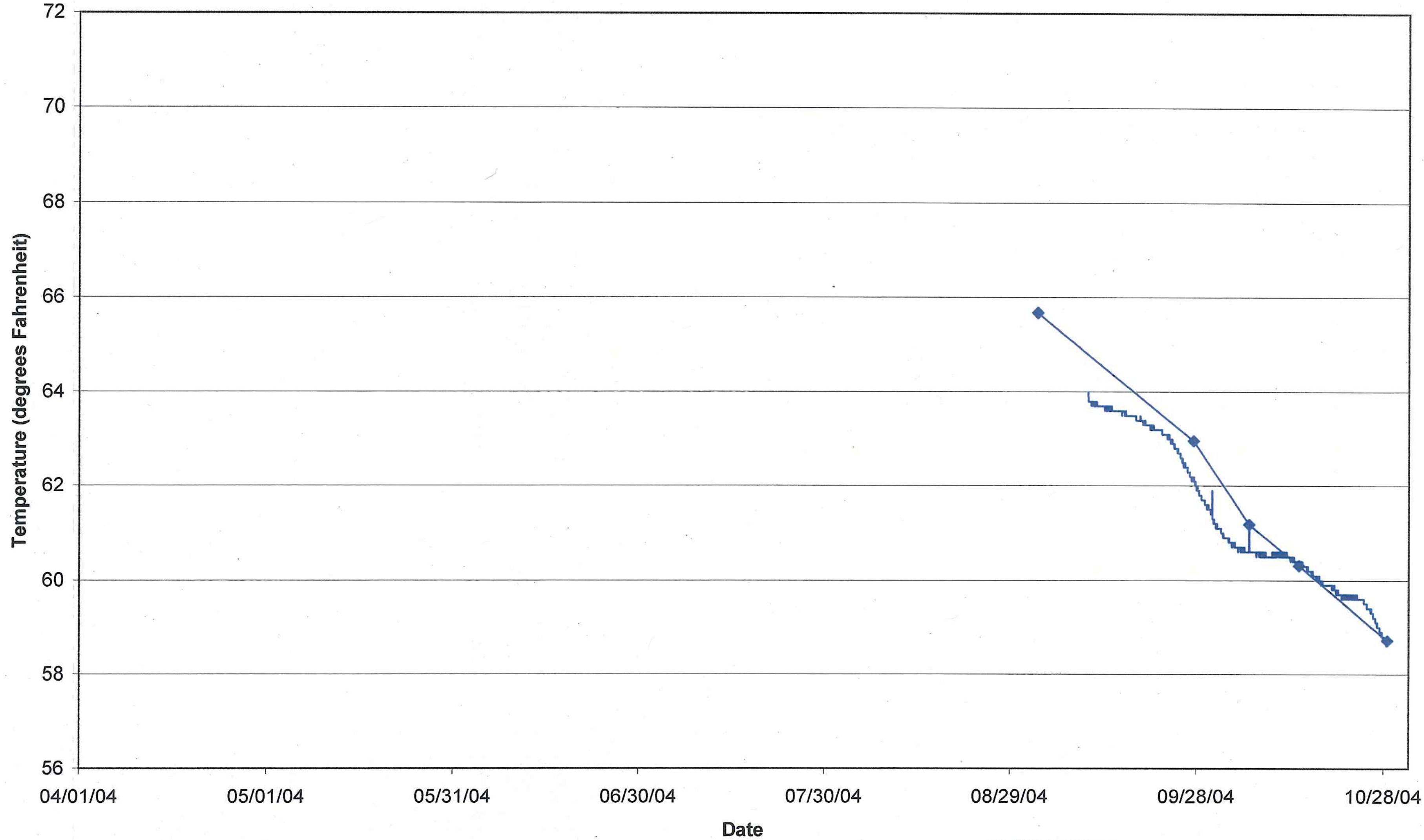
El Sur Ranch

Big Sur, California



THE SOURCE GROUP, INC. SGI environmental

Temperature Graph of ESR-10B (Transducer and Manual Measurements)
El Sur Ranch
Big Sur, California

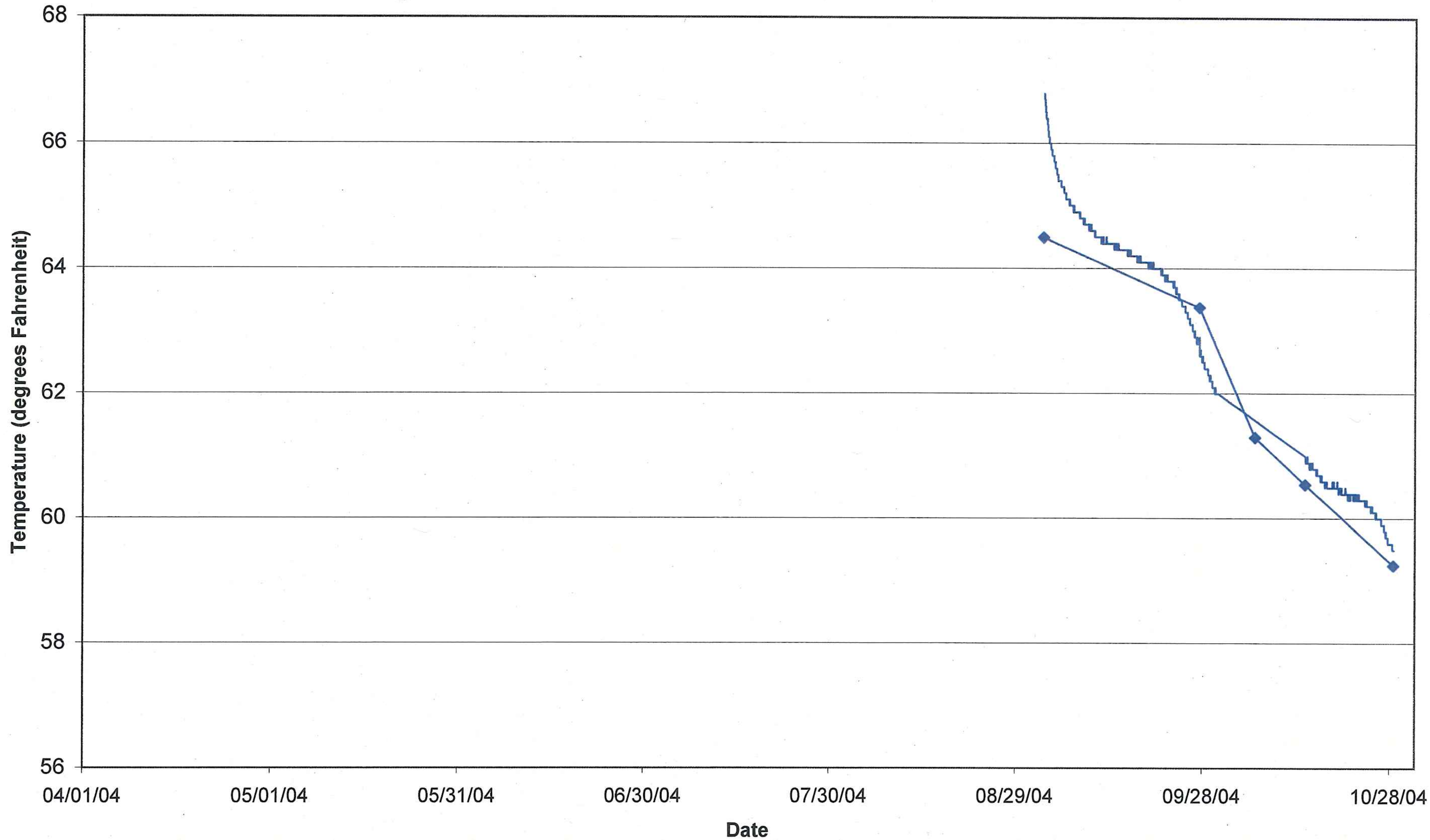


SGI environmental THE SOURCE GROUP, INC.

Temperature Graph of ESR-10C (Transducer and Manual Measurements)

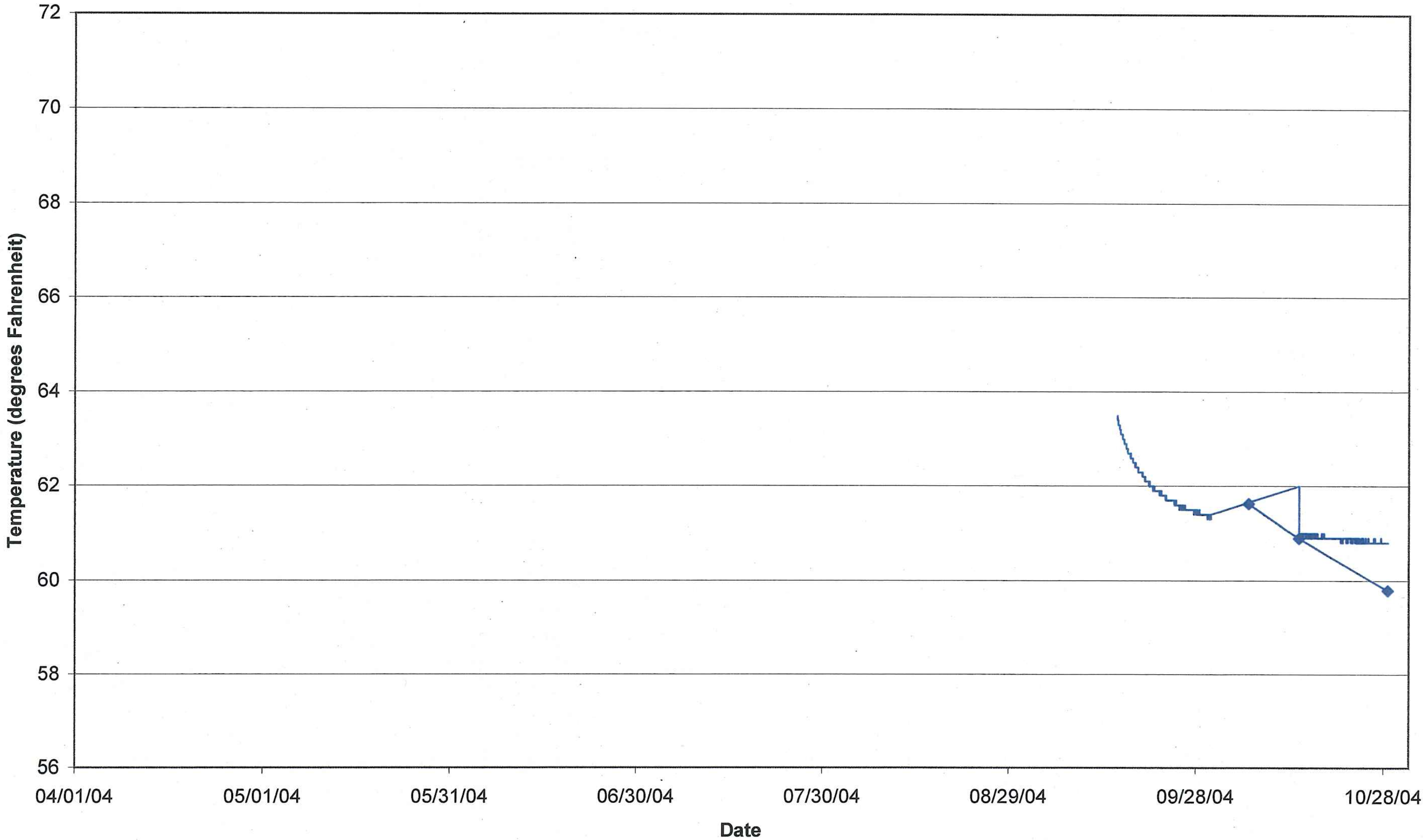
El Sur Ranch

Big Sur, California



SGI environmental THE SOURCE GROUP, INC.

Temperature Graph of ESR-11 (Transducer and Manual Measurements)
El Sur Ranch
Big Sur, California

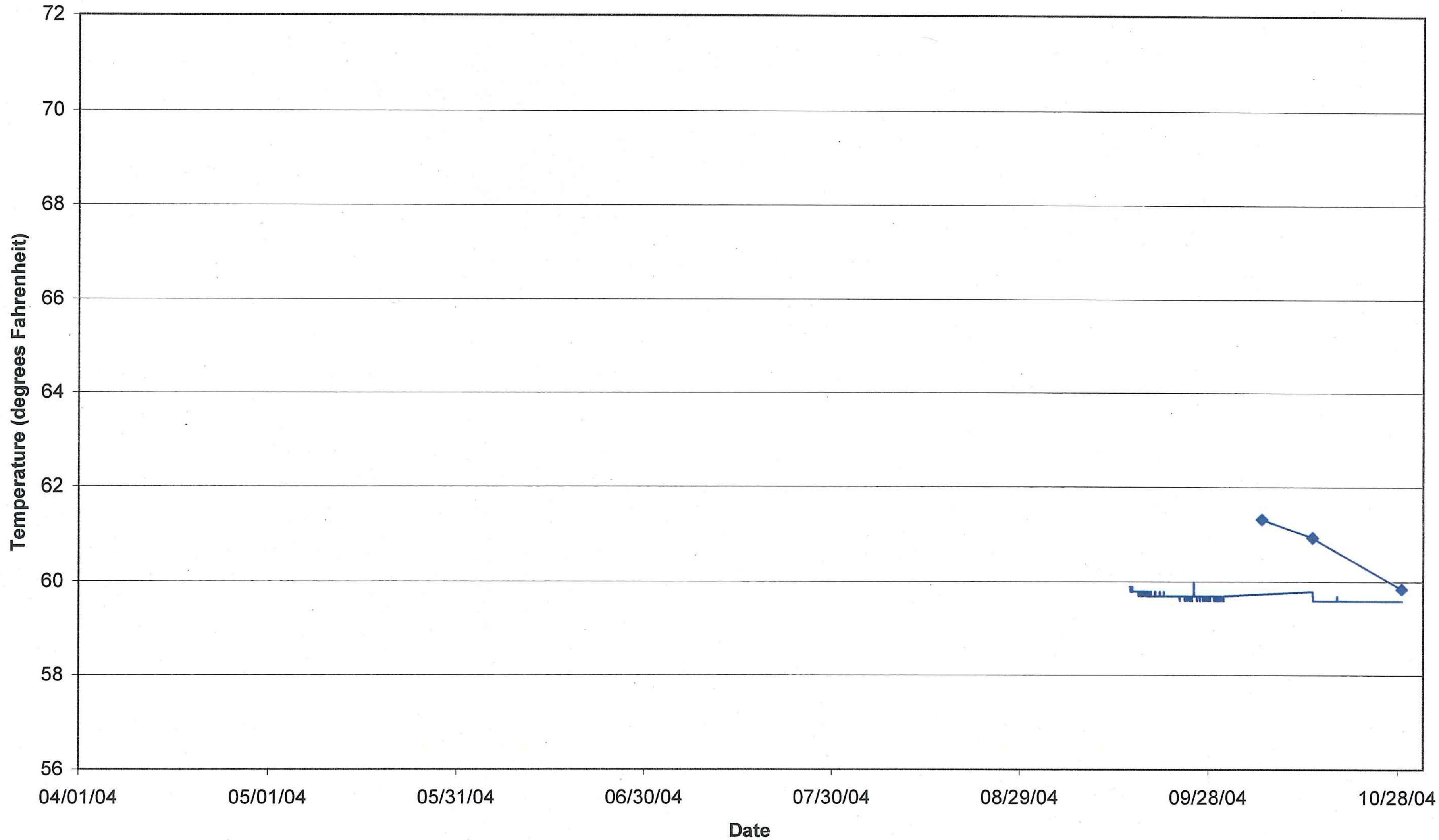


SGI environmental THE SOURCE GROUP, INC.

Temperature Graph of ESR-12 (Transducer and Manual Measurements)

El Sur Ranch

Big Sur, California

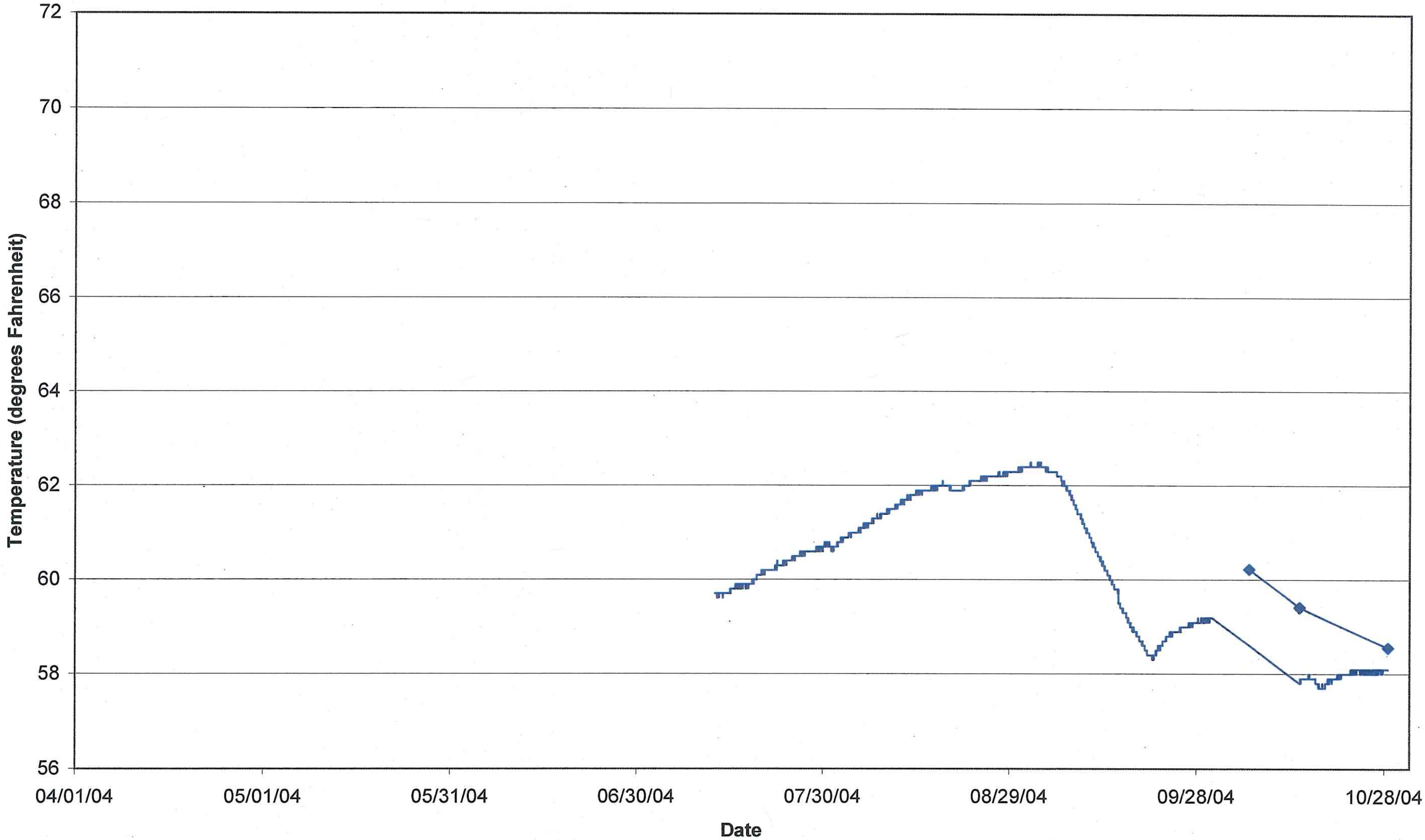


SGI environmental THE SOURCE GROUP, INC.

Temperature Graph of JSA-03 (Transducer and Manual Measurements)

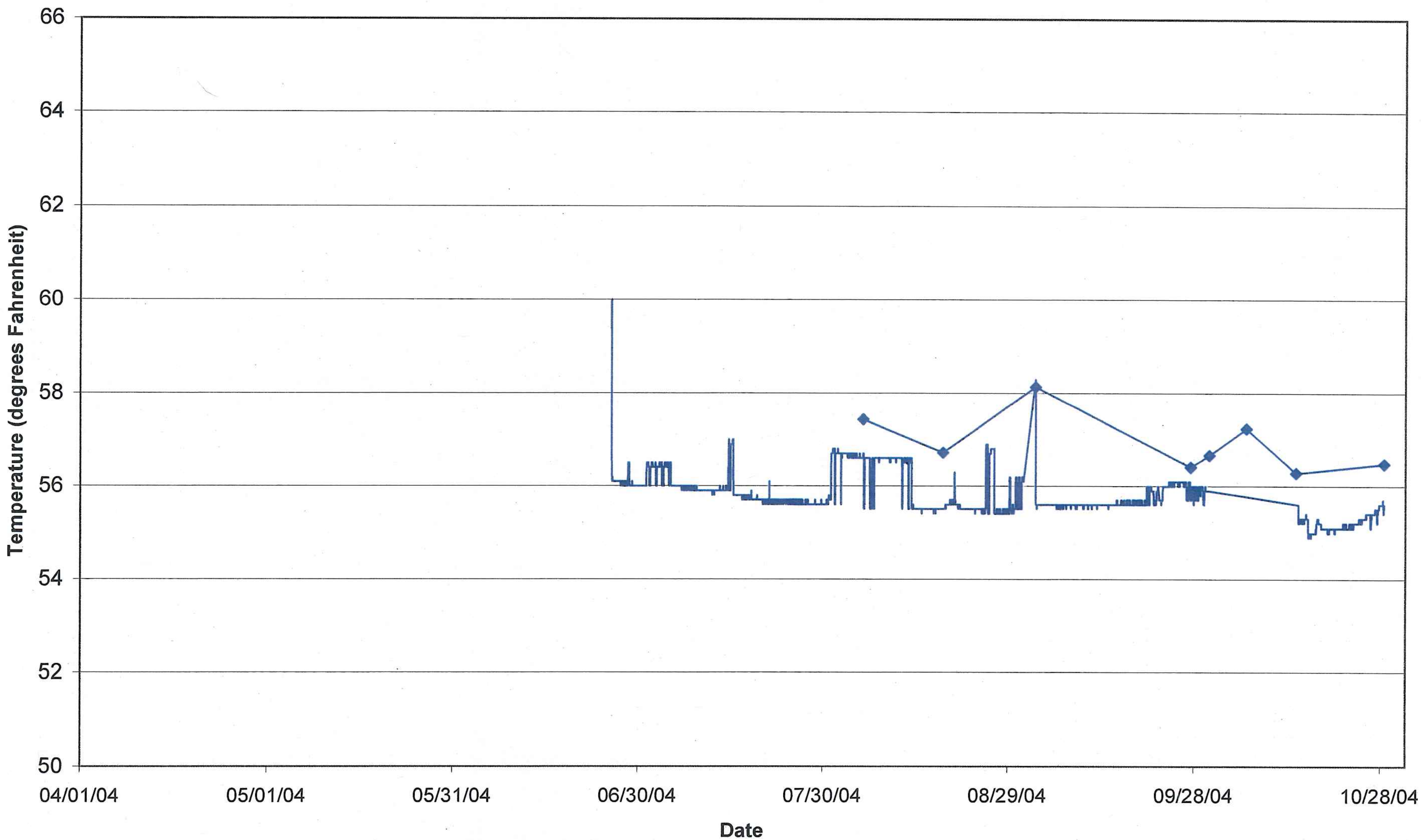
El Sur Ranch

Big Sur, California



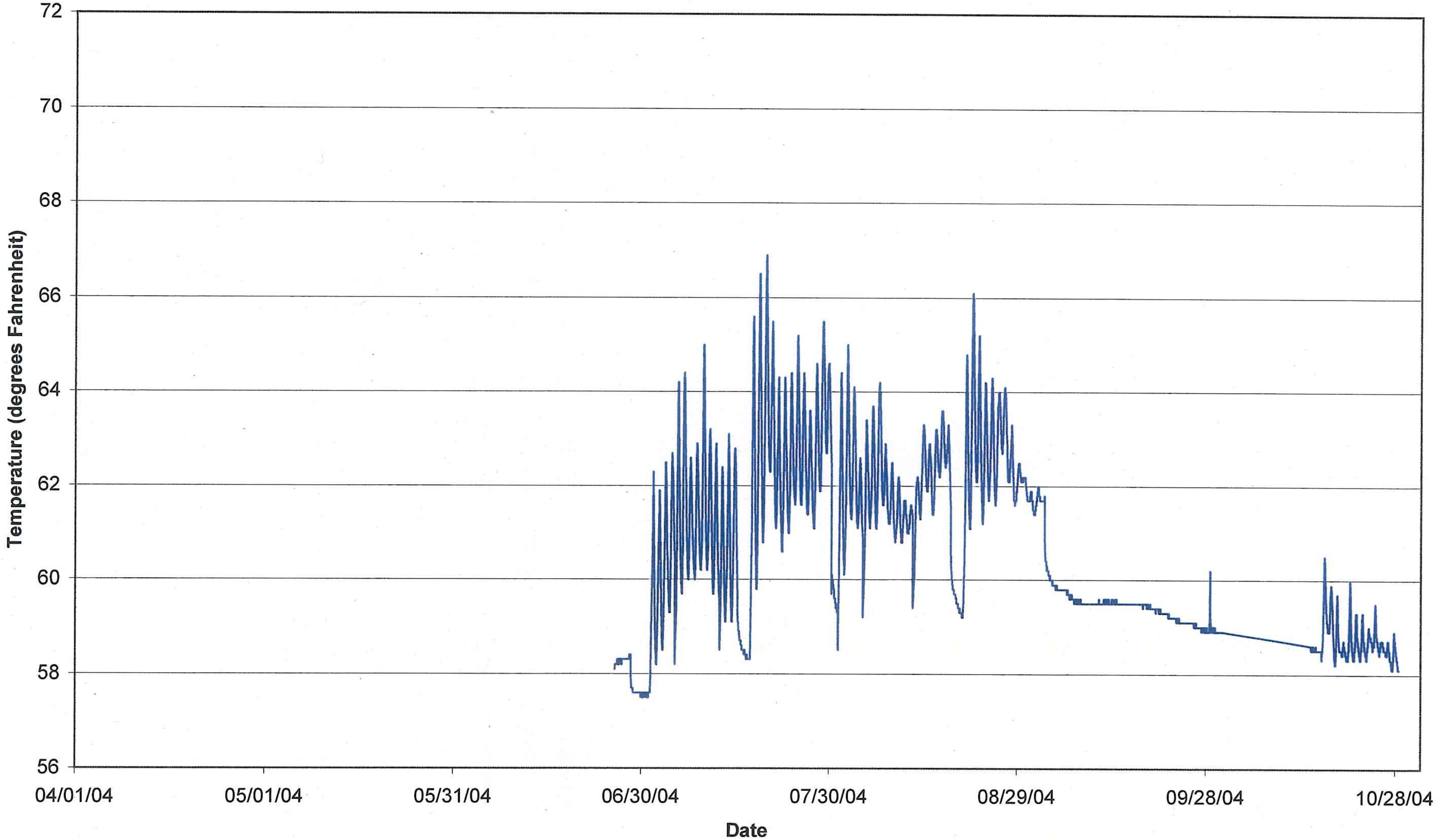
SGI environmental THE SOURCE GROUP, INC.

Temperature Graph of JSA-04 (Transducer and Manual Measurements)
El Sur Ranch
Big Sur, California



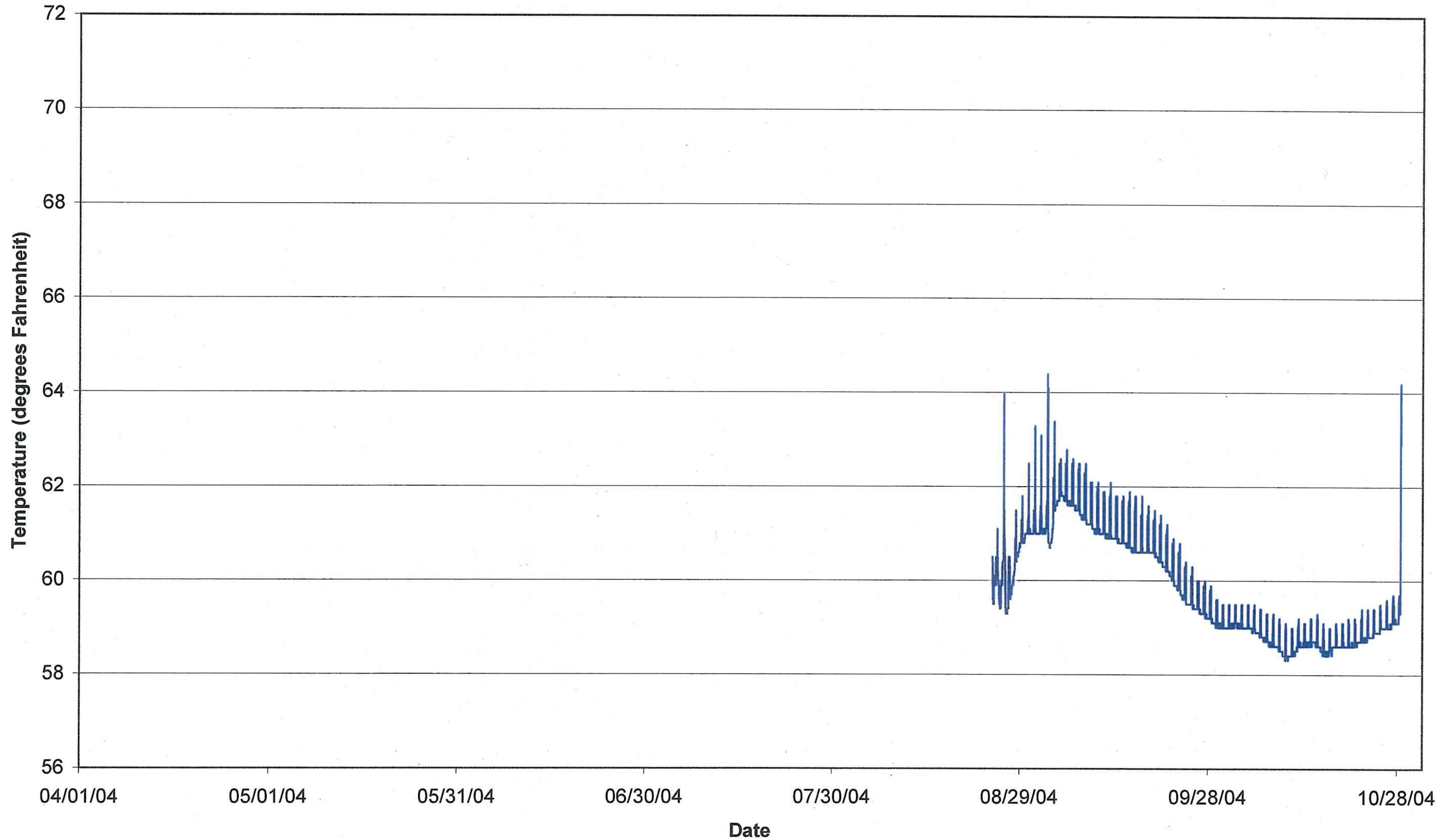
SGI environmental — THE SOURCE GROUP, INC.

Temperature Graph of Old Well
El Sur Ranch
Big Sur, California



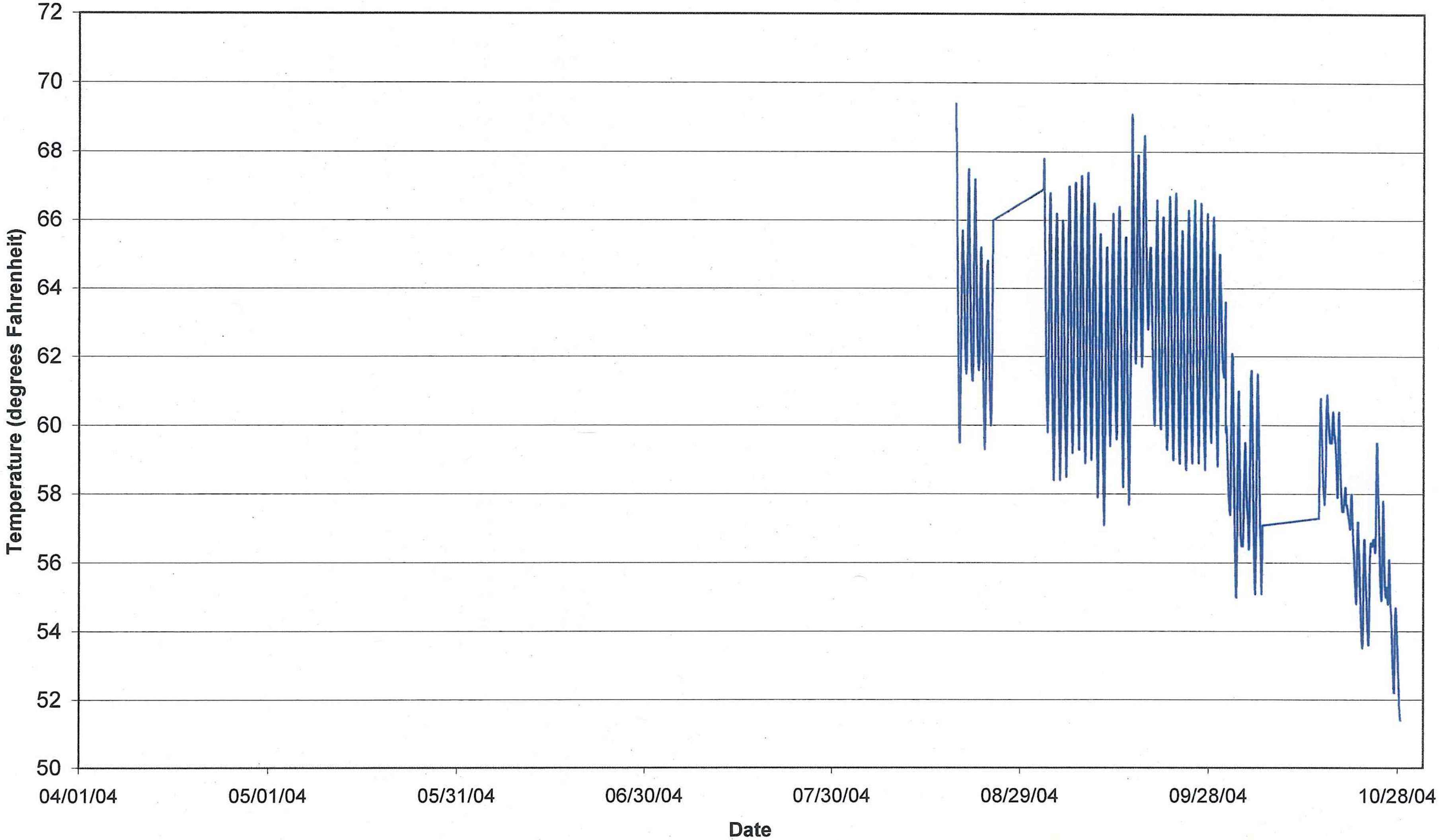
SGI environmental THE SOURCE GROUP, INC.

Temperature Graph of Navy Well
El Sur Ranch
Big Sur, California

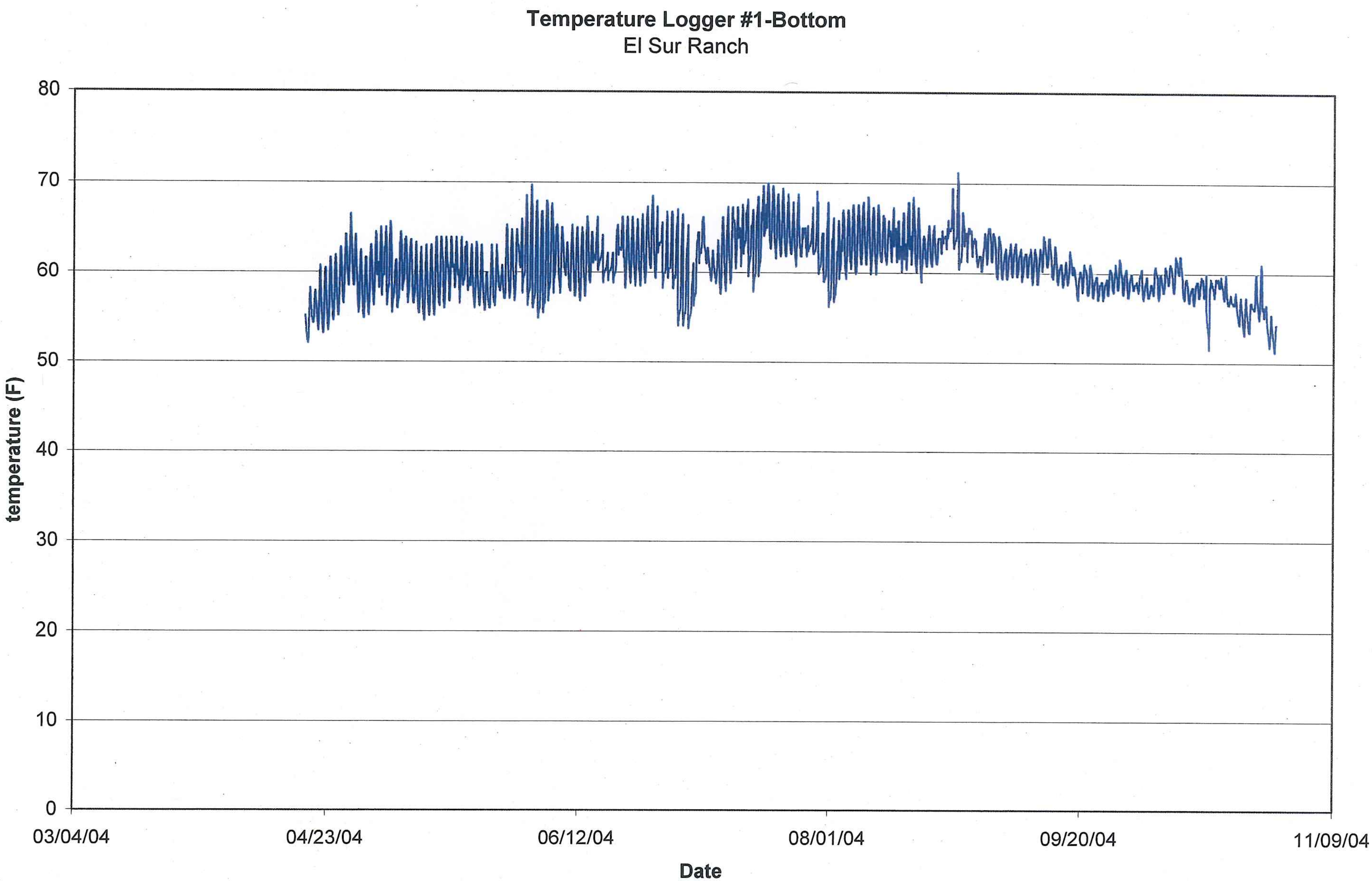


SGI environmental THE SOURCE GROUP, INC.

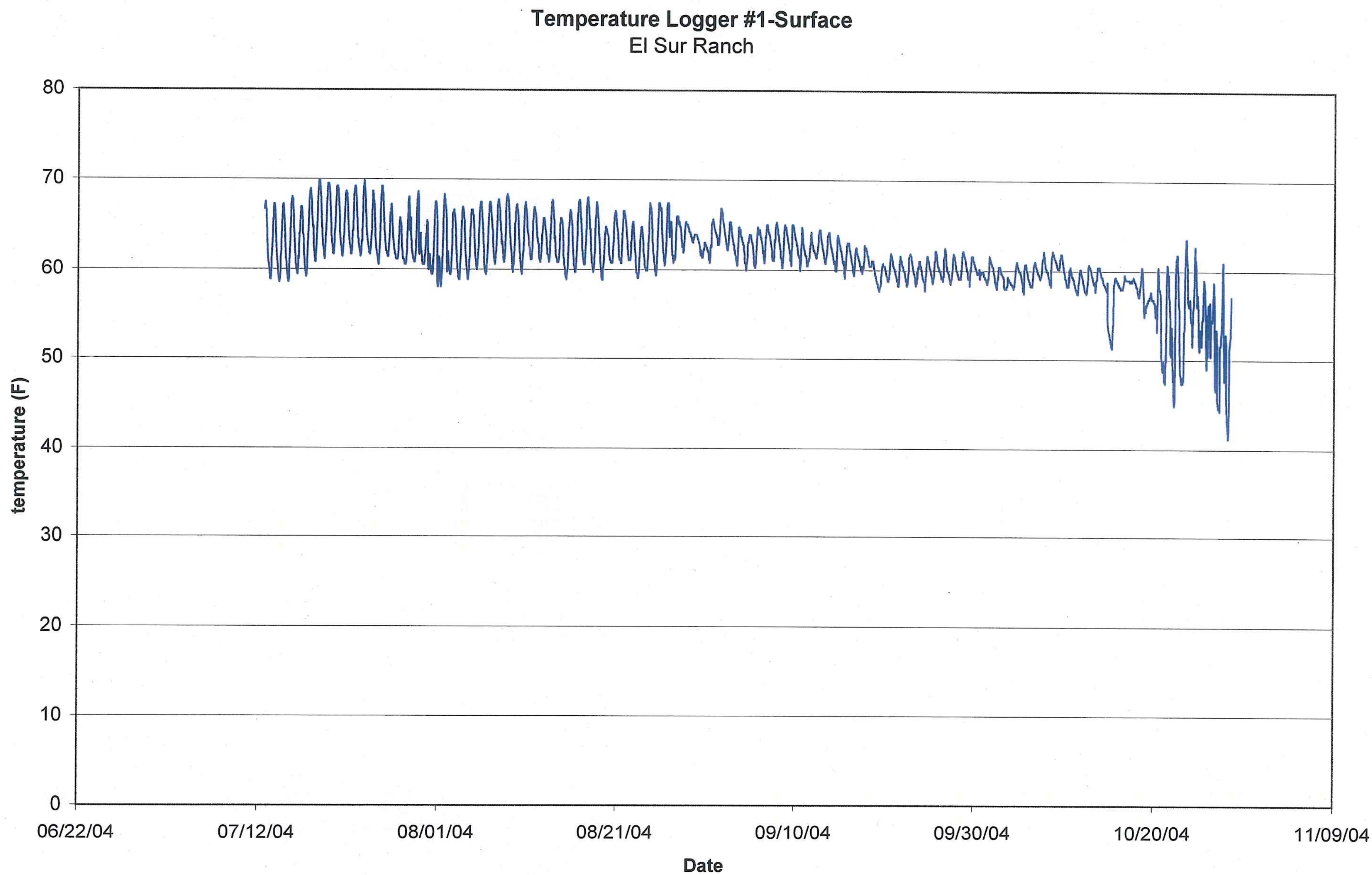
Temperature Graph of Stilling Well
El Sur Ranch
Big Sur, California



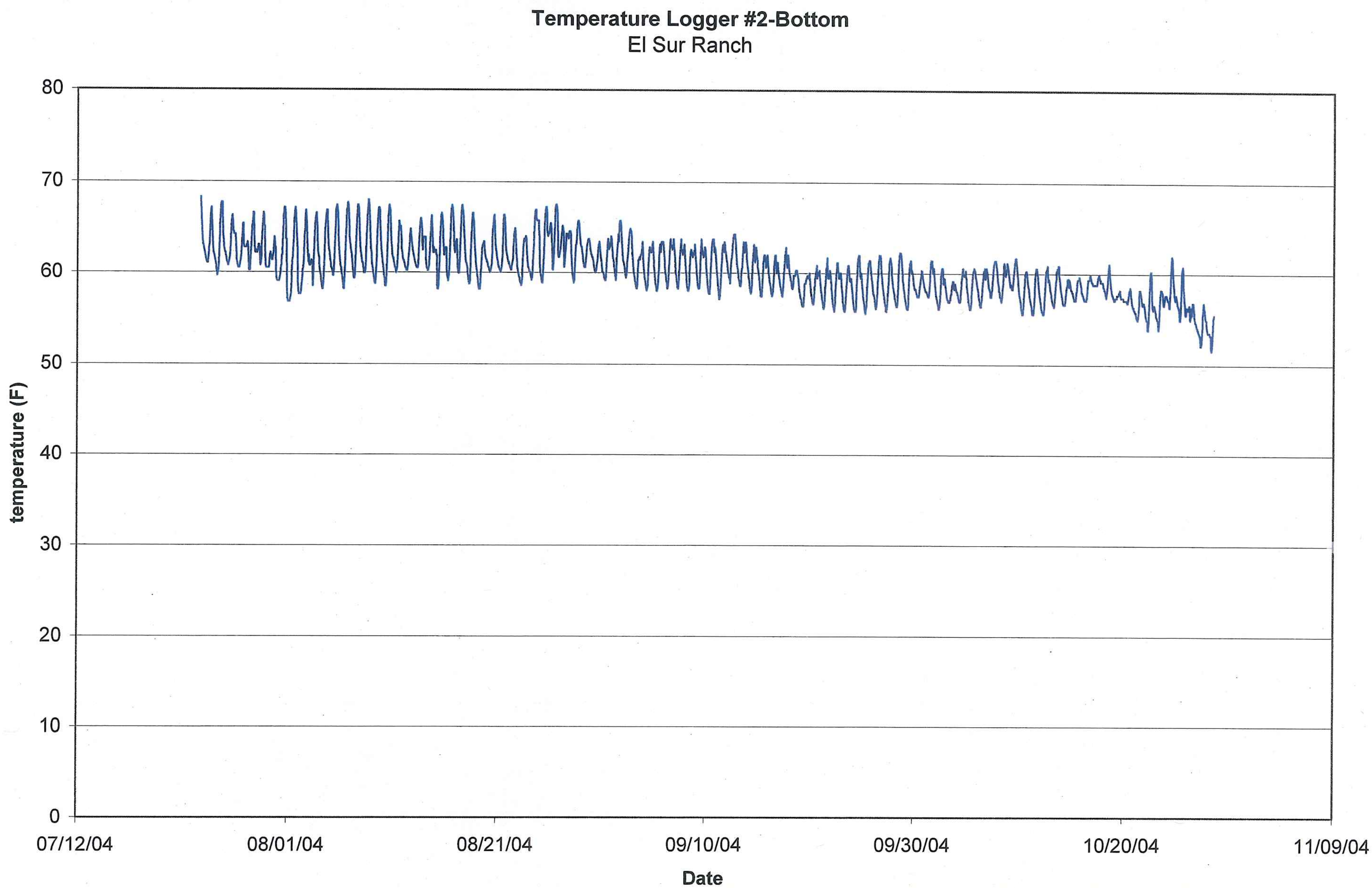
SGI environmental THE SOURCE GROUP, INC.



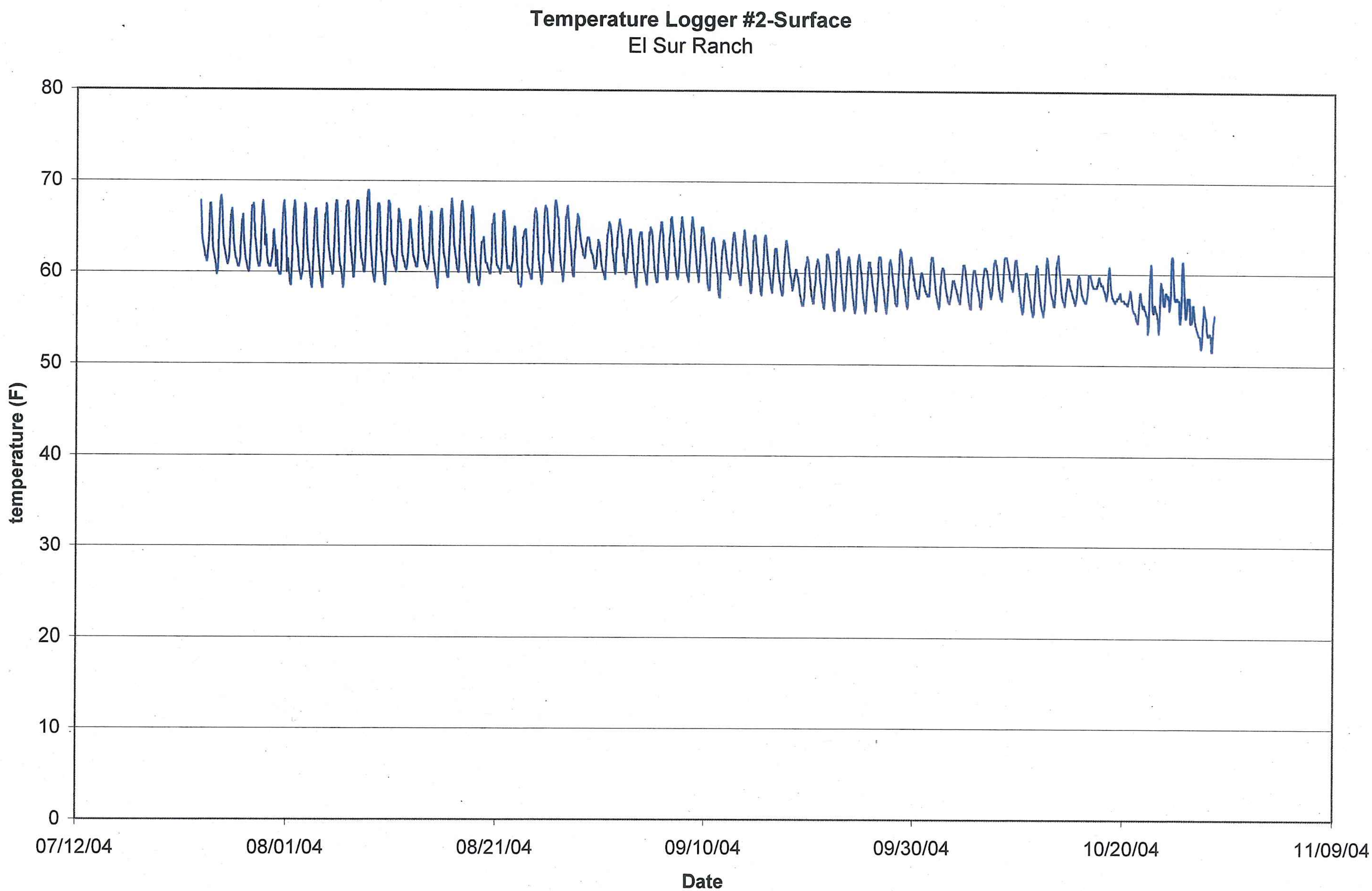
SGI environmental THE SOURCE GROUP, INC.



SGI environmental THE SOURCE GROUP, INC.

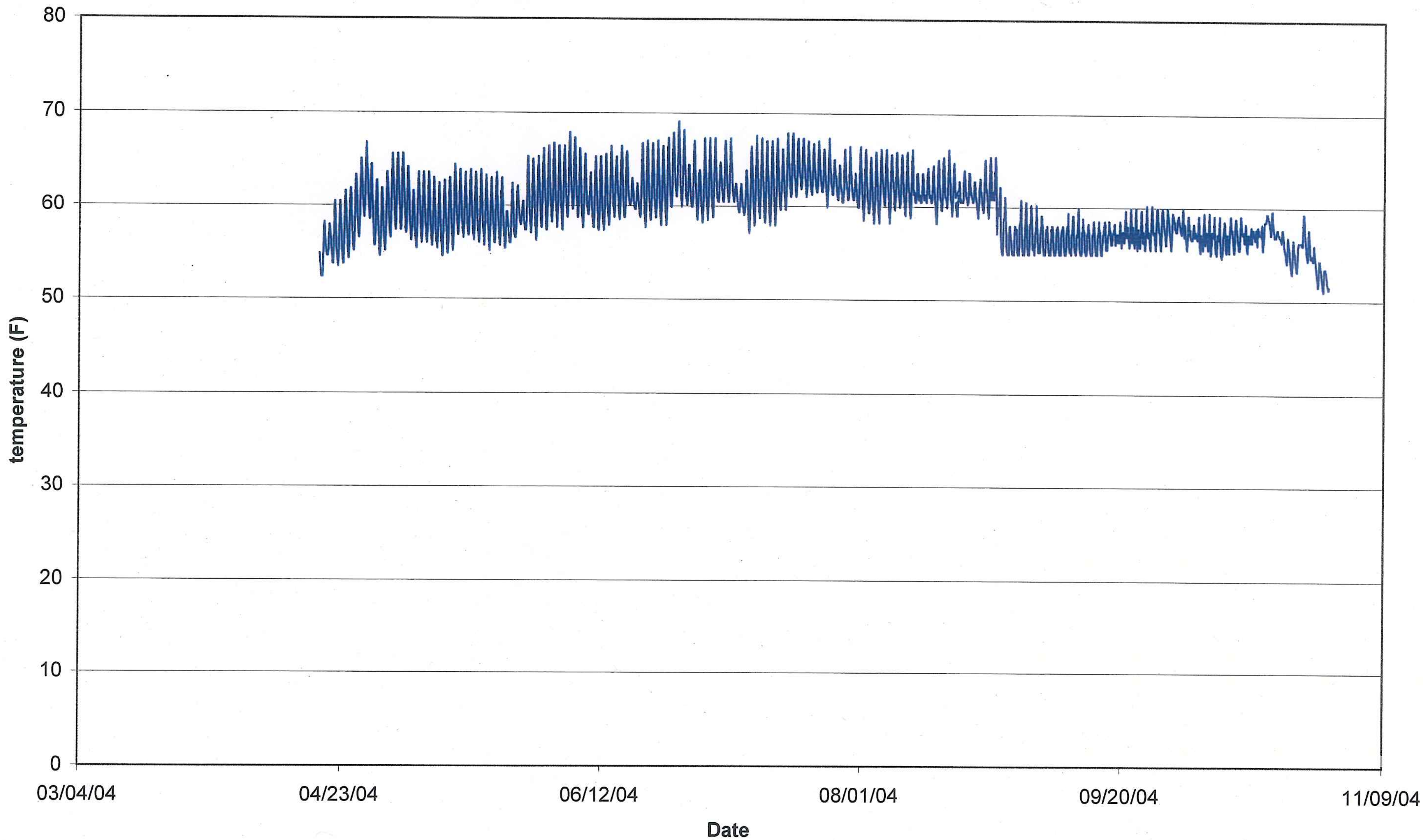


SGI environmental THE SOURCE GROUP, INC.



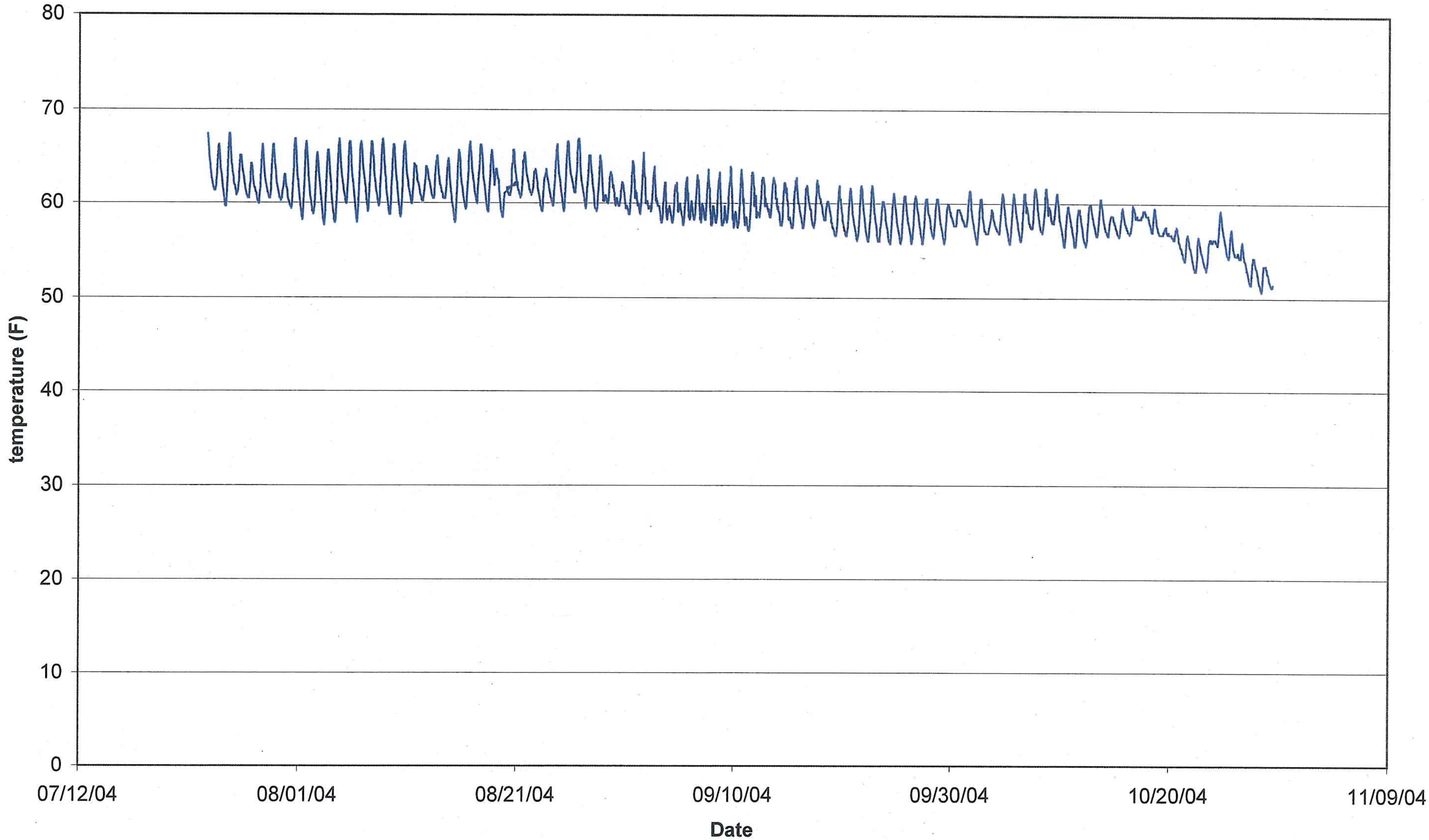
SGI environmental THE SOURCE GROUP, INC.

Temperature Logger #3-Bottom
El Sur Ranch



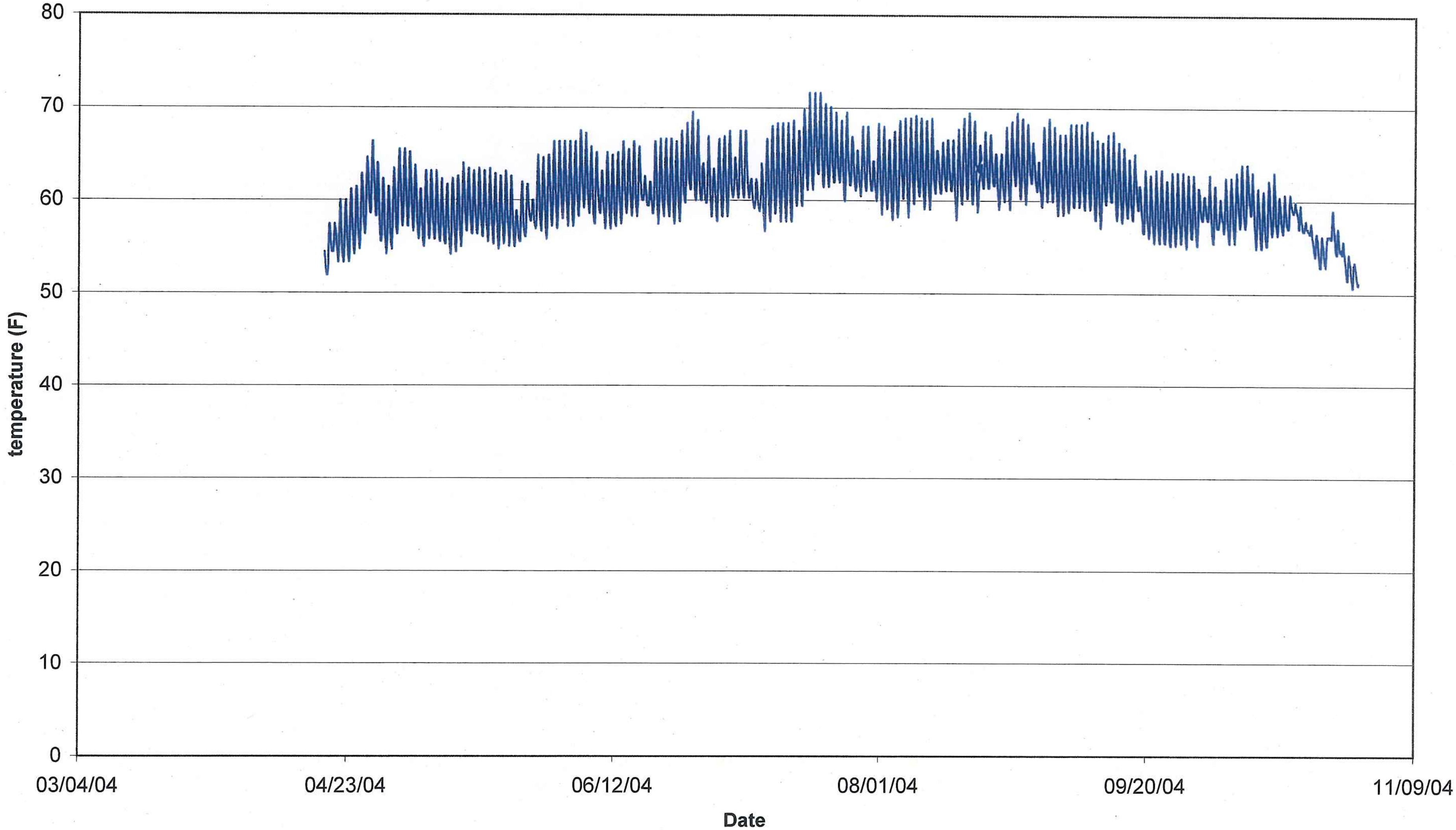
SGI environmental THE SOURCE GROUP, INC.

Temperature Logger #3-Surface
El Sur Ranch

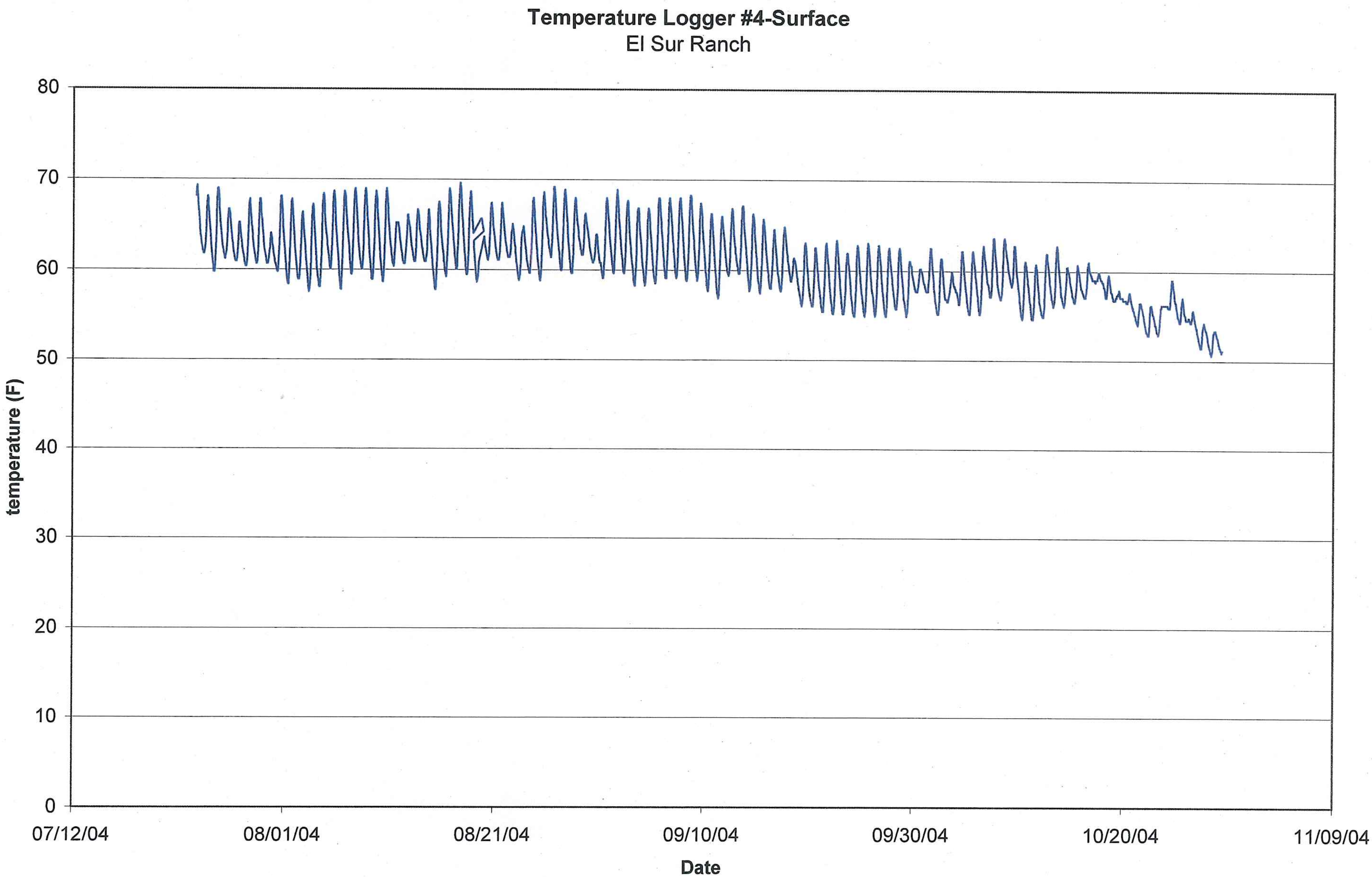


SGI environmental THE SOURCE GROUP, INC.

Temperature Logger #4-Bottom
El Sur Ranch



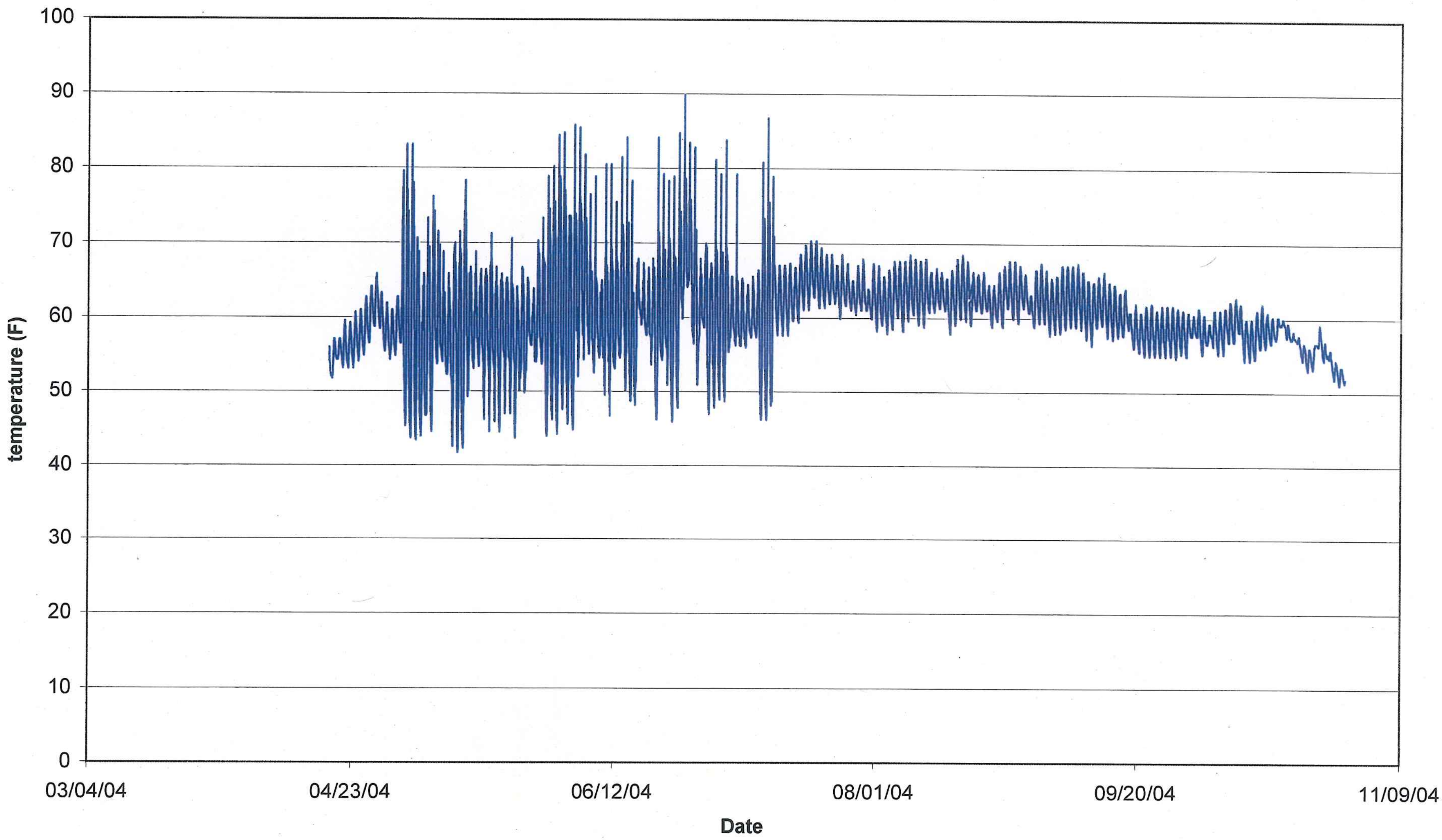
SGI environmental THE SOURCE GROUP, INC.



SGI environmental THE SOURCE GROUP, INC.

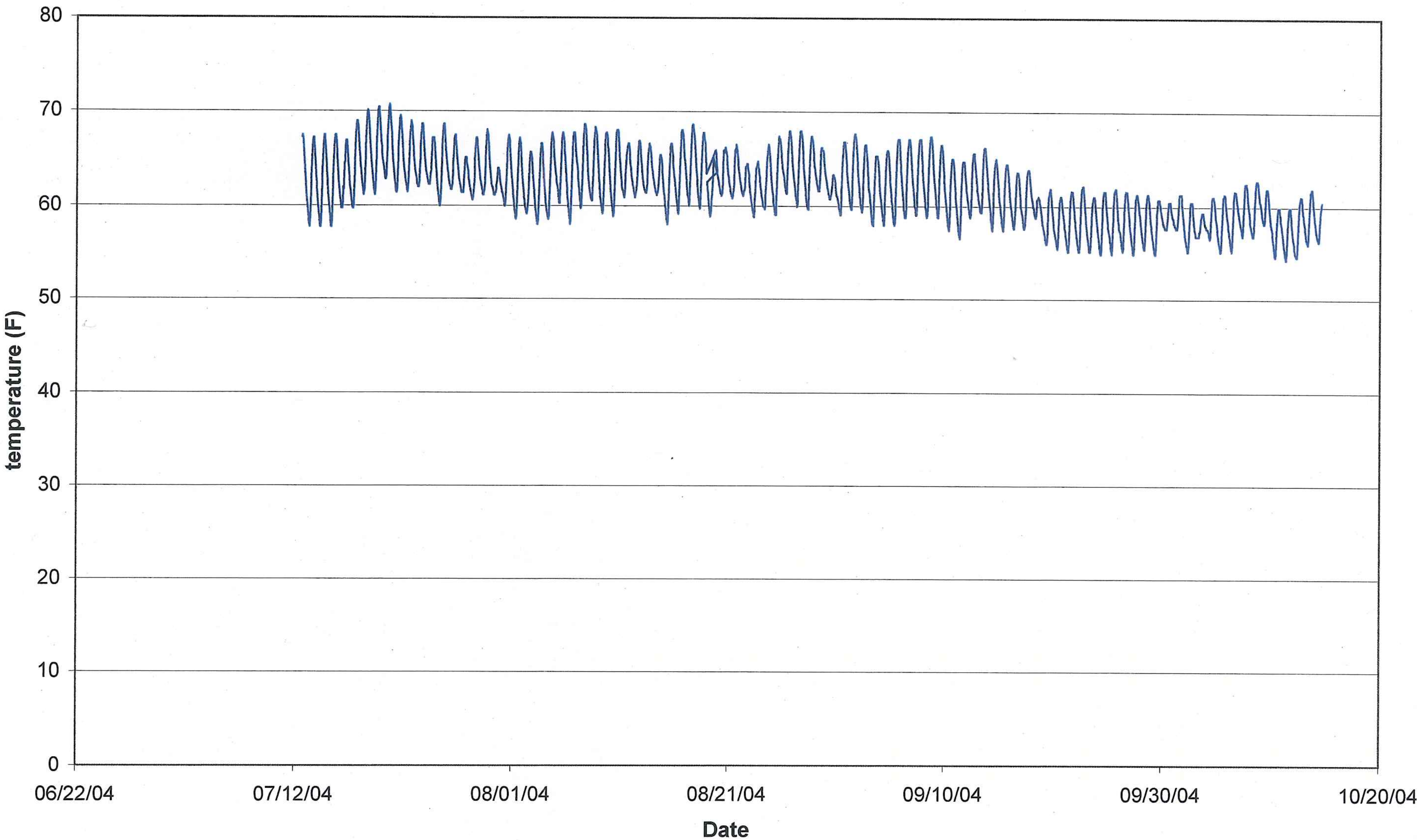
ESR--4

Temperature Logger #5-Bottom
El Sur Ranch



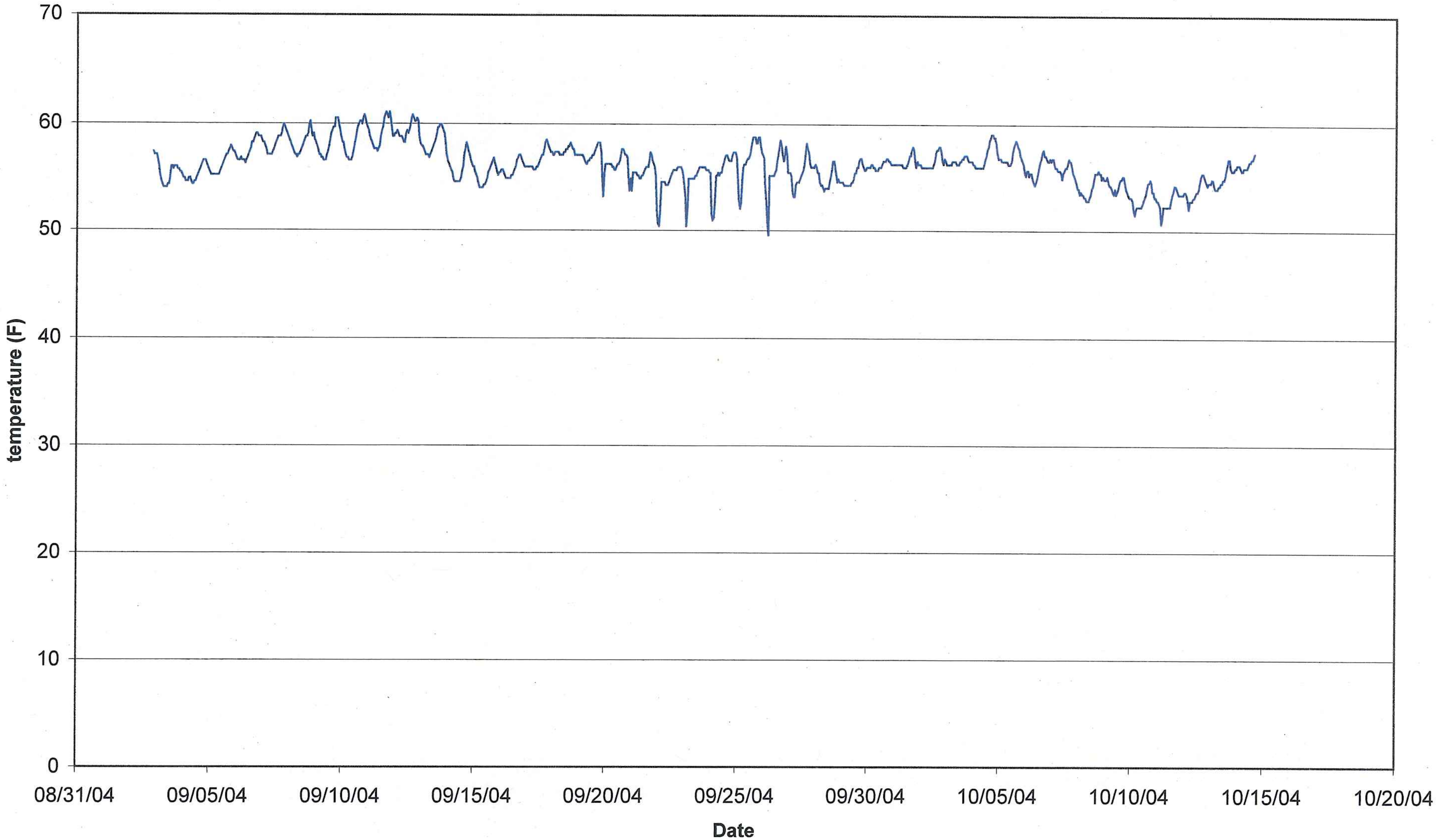
SGI environmental THE SOURCE GROUP, INC.

Temperature Logger #5-Surface
El Sur Ranch



SGI environmental THE SOURCE GROUP, INC.

Temperature Logger #6-Ocean
El Sur Ranch



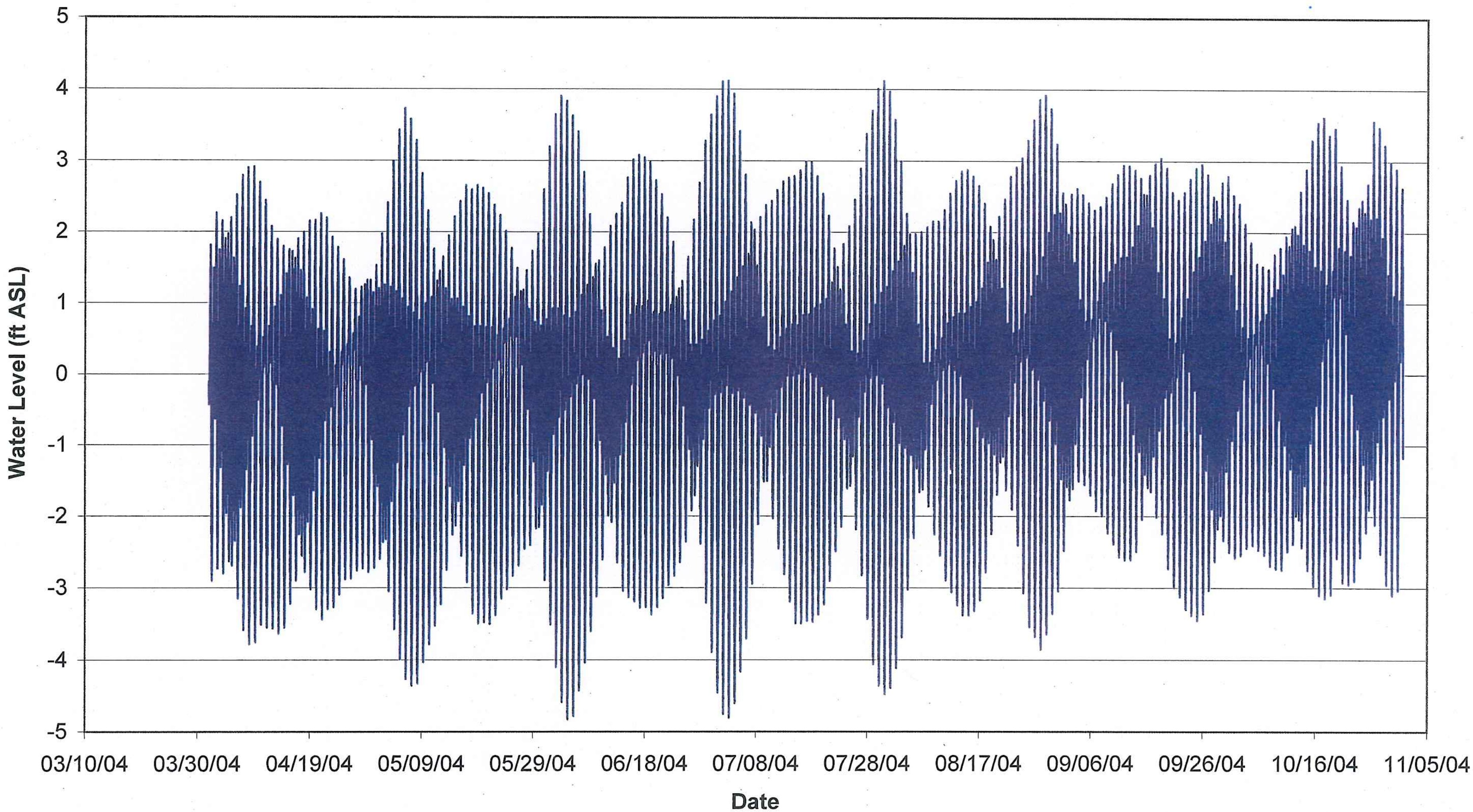
SGI environmental THE SOURCE GROUP, INC.

APPENDIX I

APPENDIX I

TIDAL DATA

Monterey Station 9413450
Tide Data
El Sur Ranch



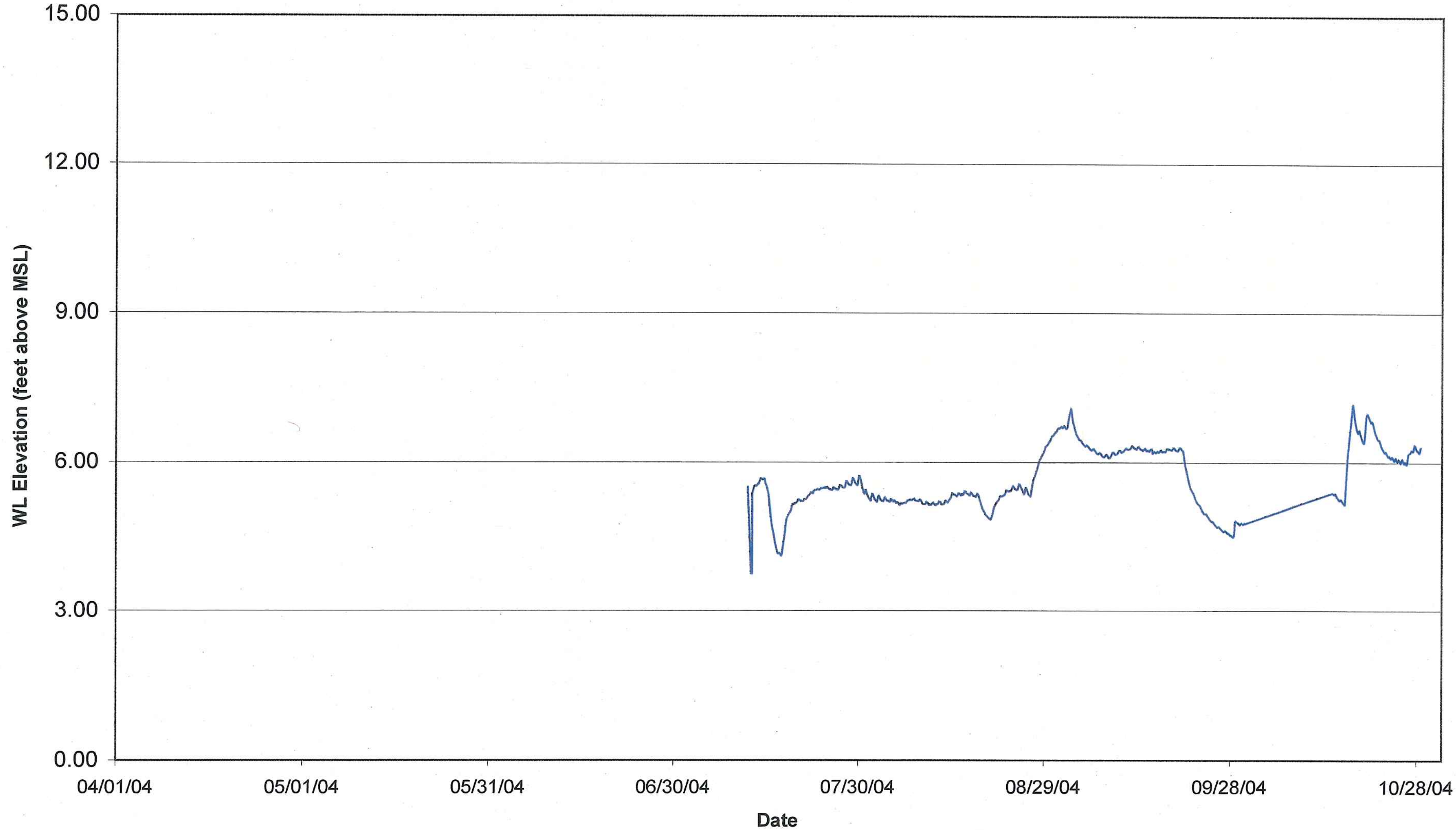
SGI environmental THE SOURCE GROUP, INC.

APPENDIX J

APPENDIX J

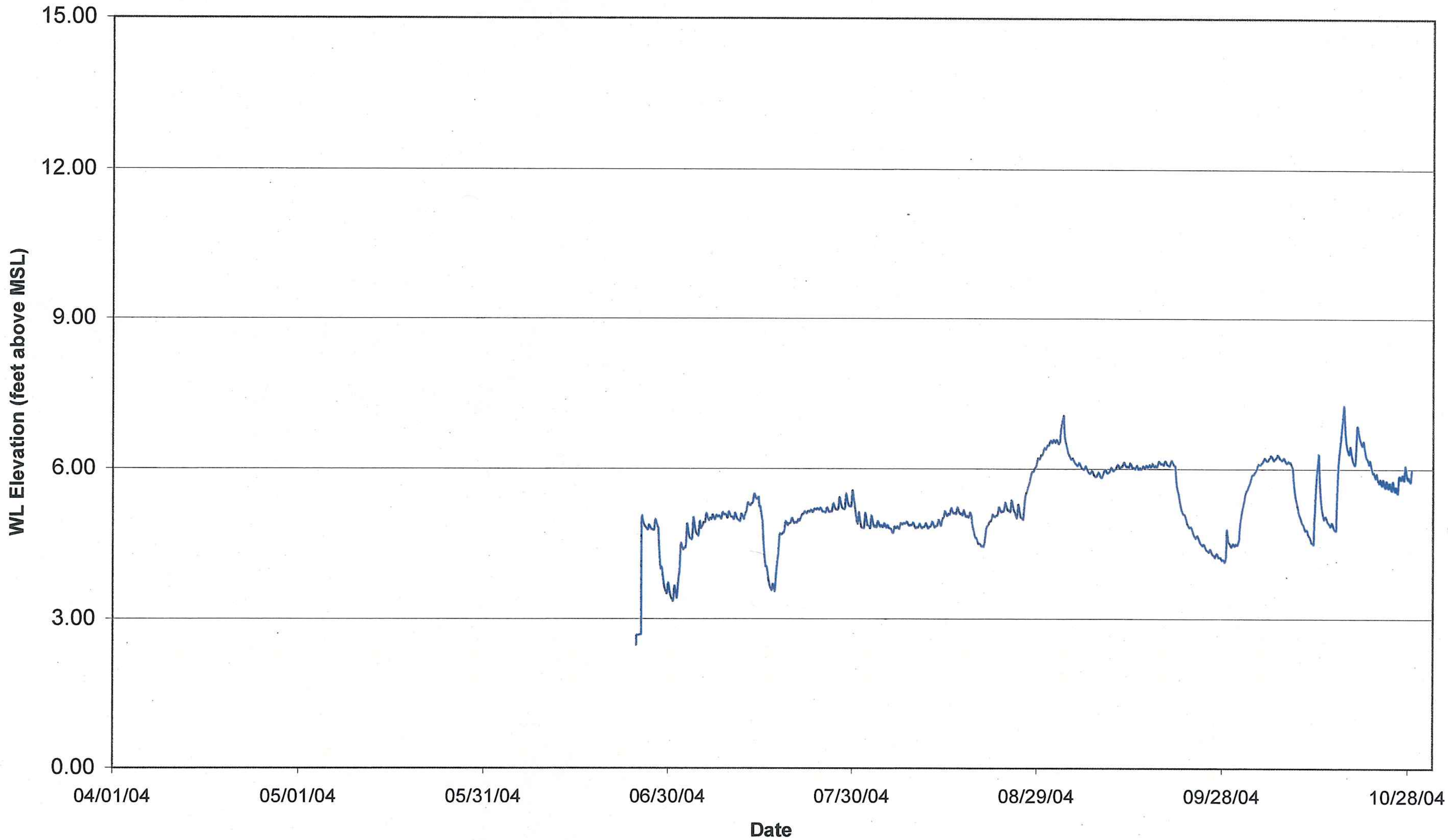
WELL HYDROGRAPHS

Hydrograph of ESR-02
El Sur Ranch
Point Sur, California



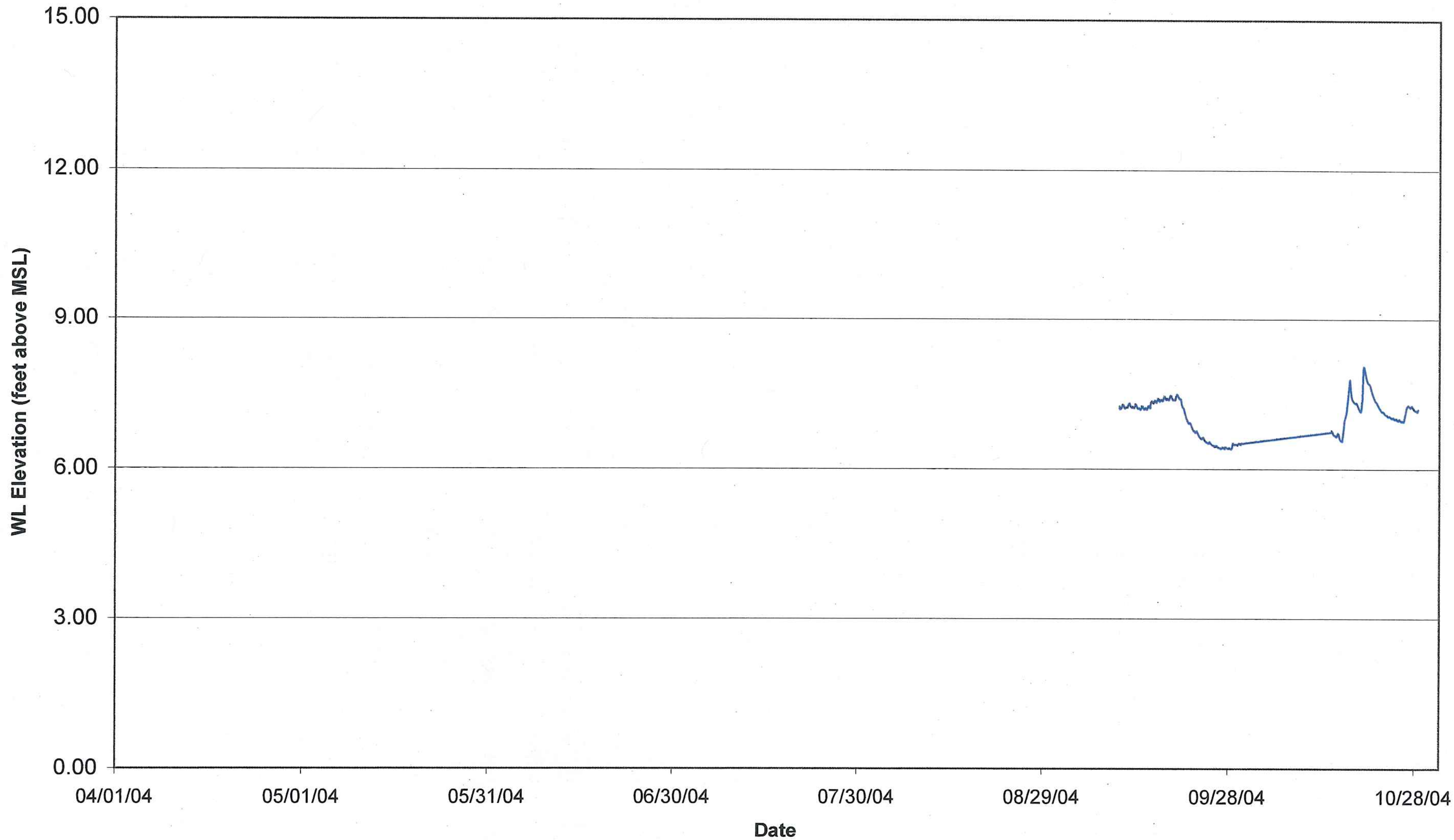
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of ESR-03
El Sur Ranch
Point Sur, California



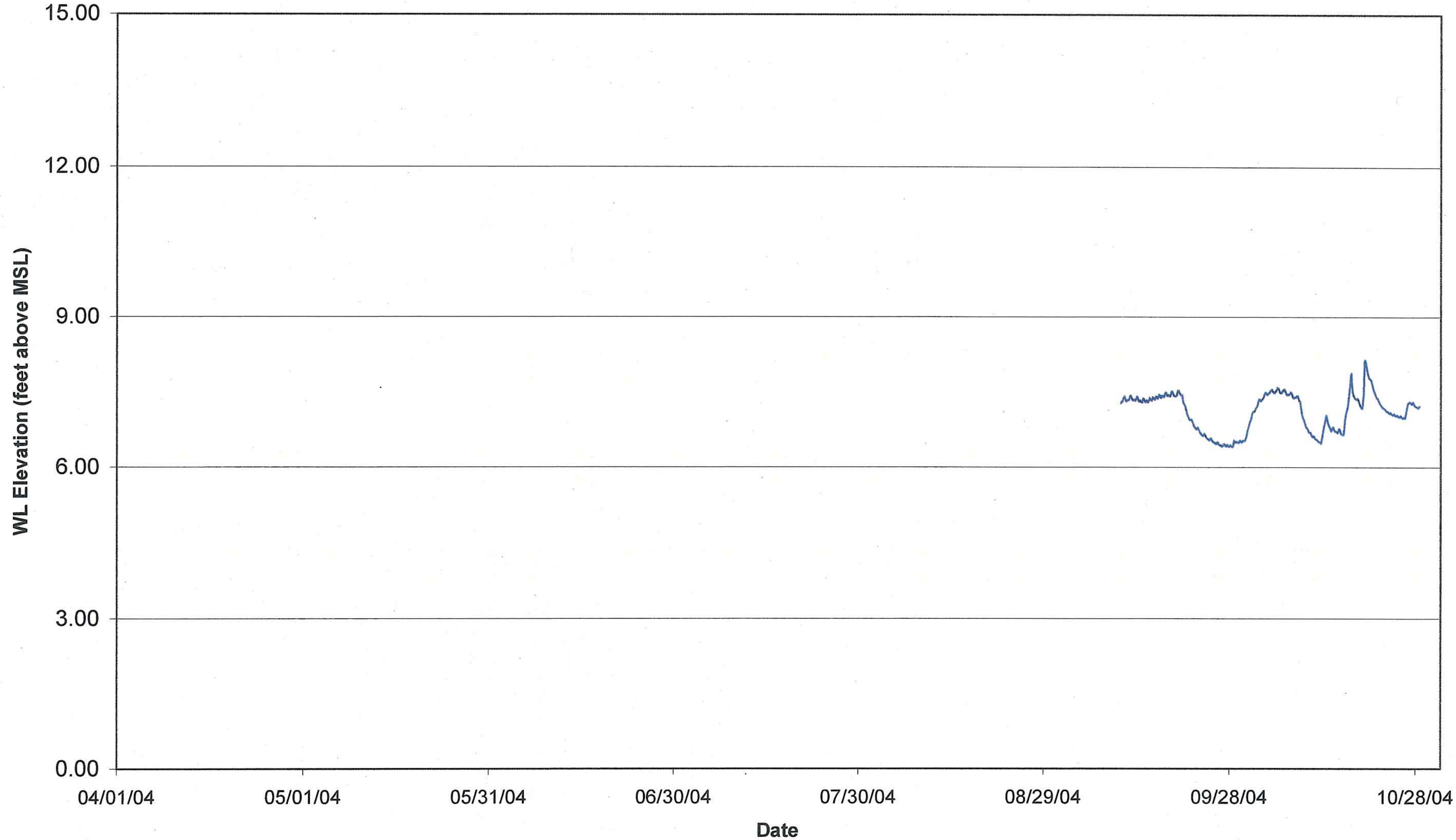
THE SOURCE GROUP, INC.
SGI environmental

Hydrograph of ESR-10A
El Sur Ranch
Point Sur, California



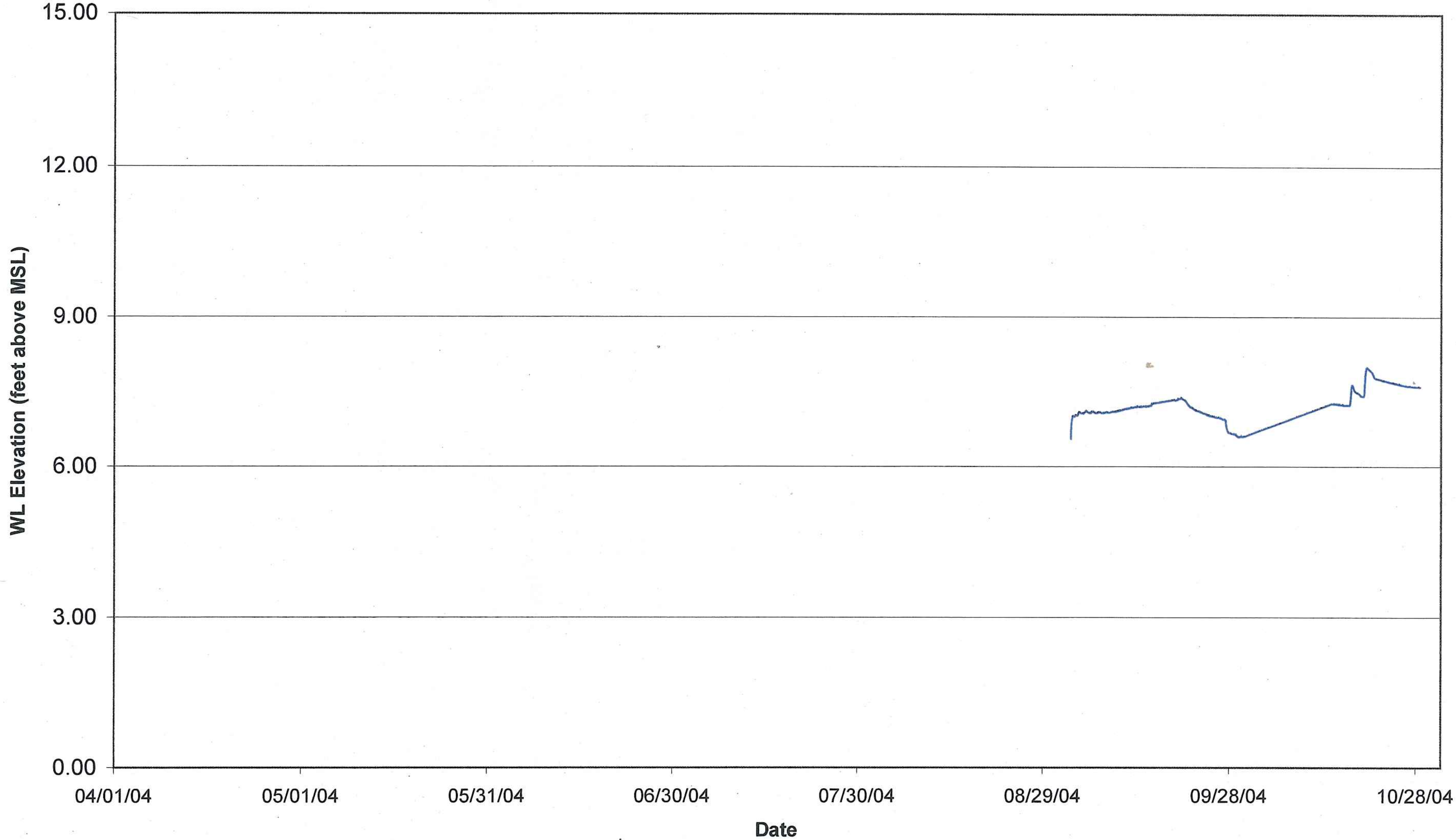
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of ESR-10B
El Sur Ranch
Point Sur, California



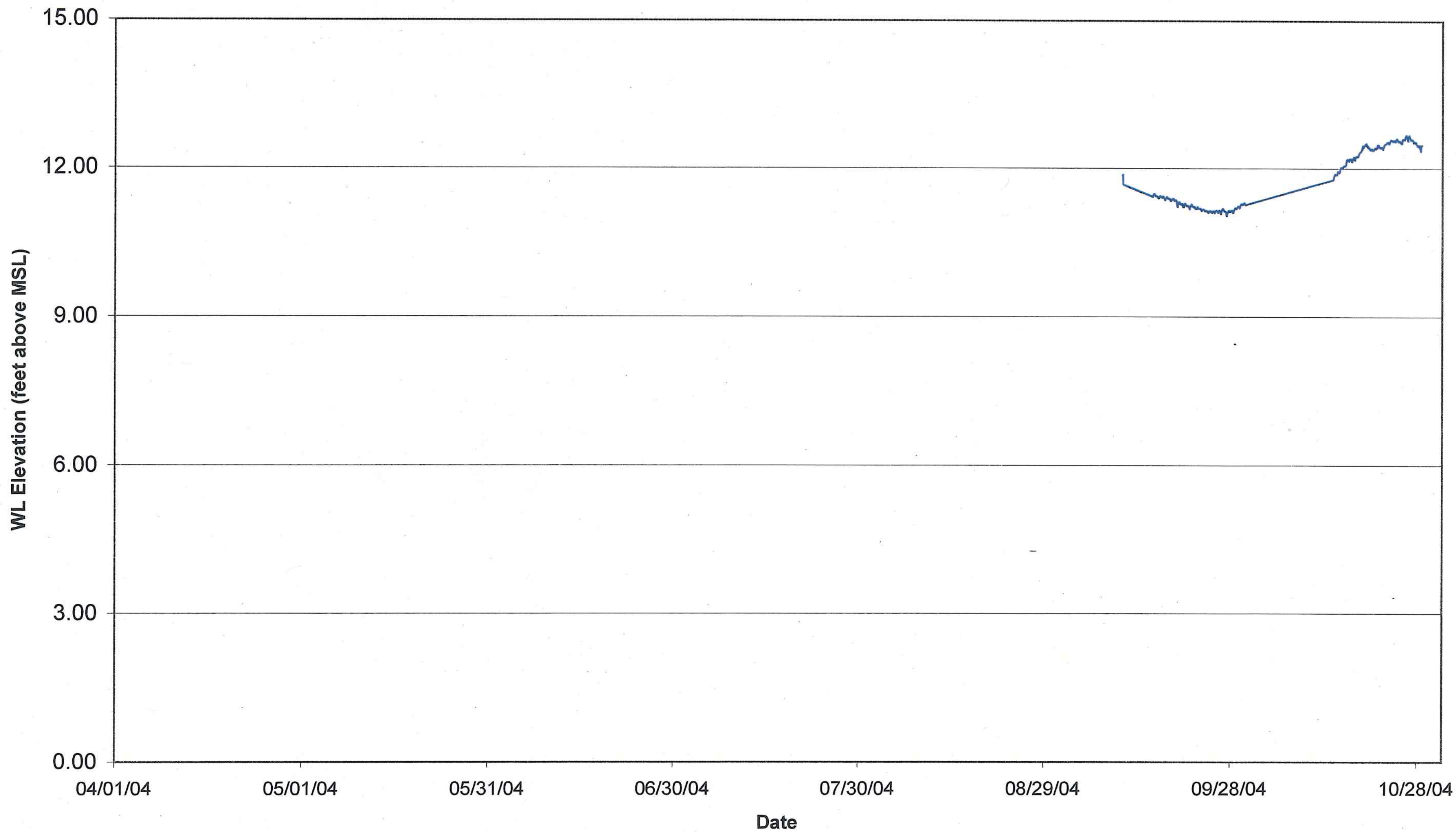
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of ESR-10C
El Sur Ranch
Point Sur, California



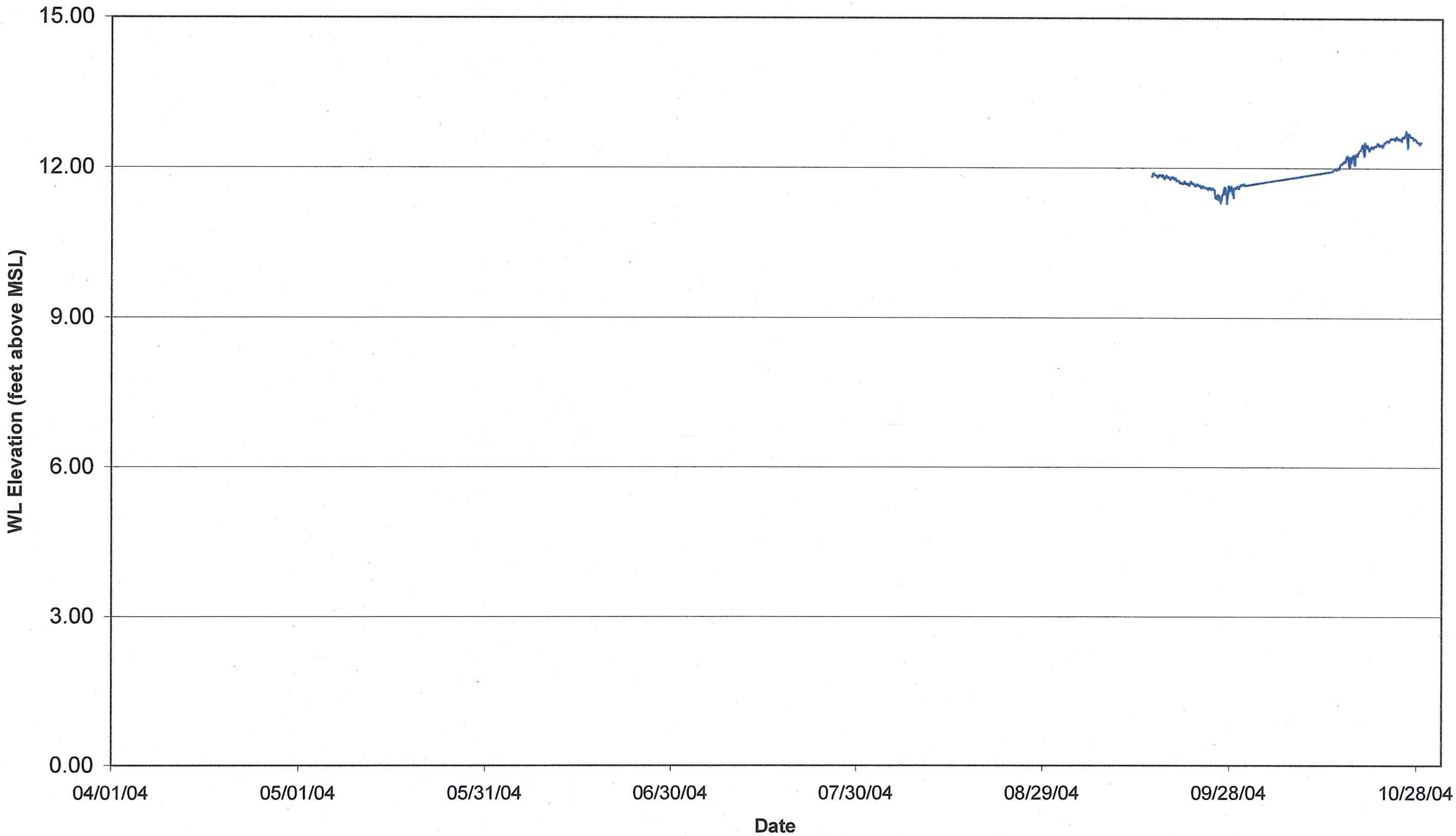
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of ESR-11
El Sur Ranch
Point Sur, California



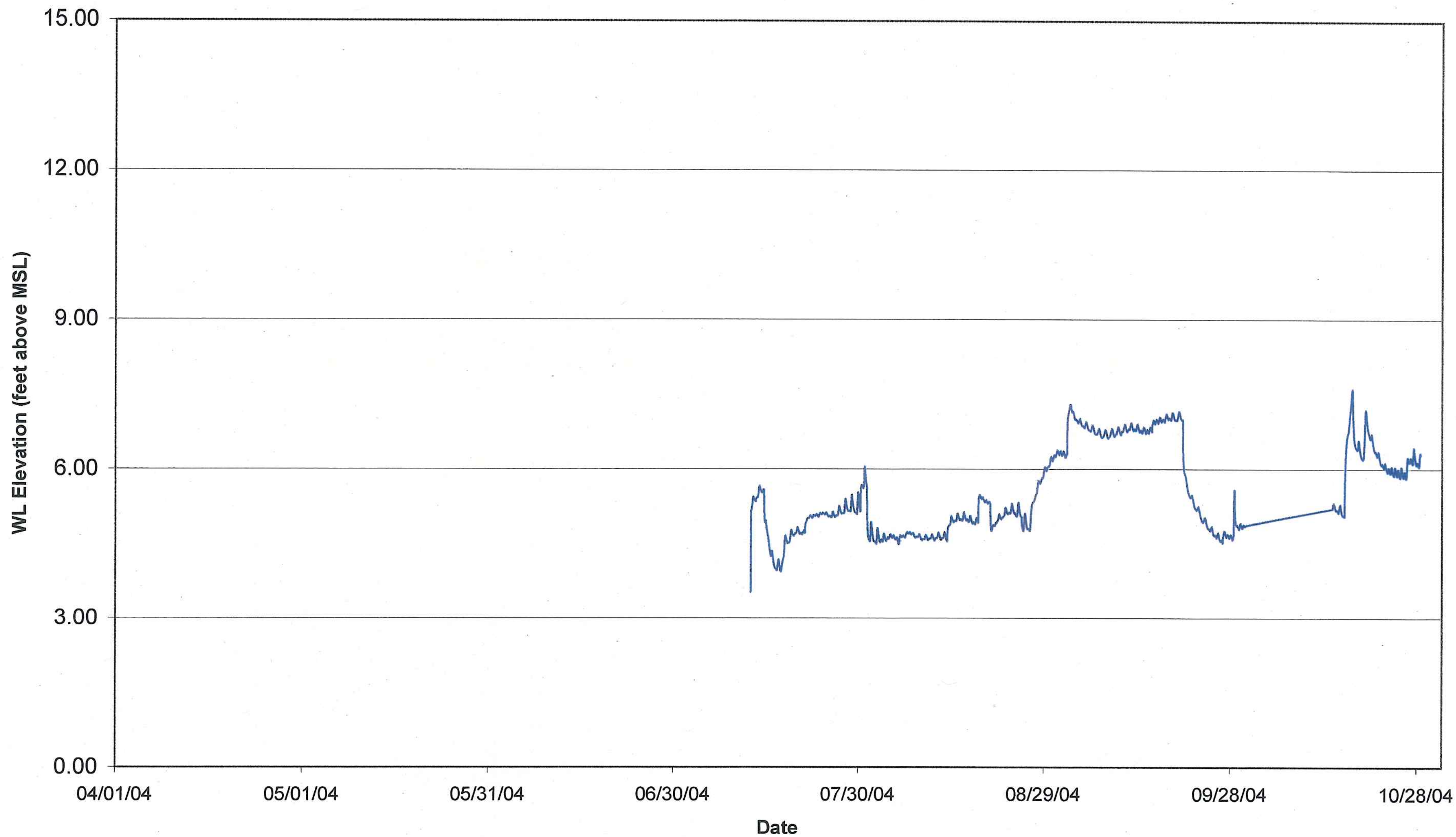
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of ESR-12
El Sur Ranch
Point Sur, California



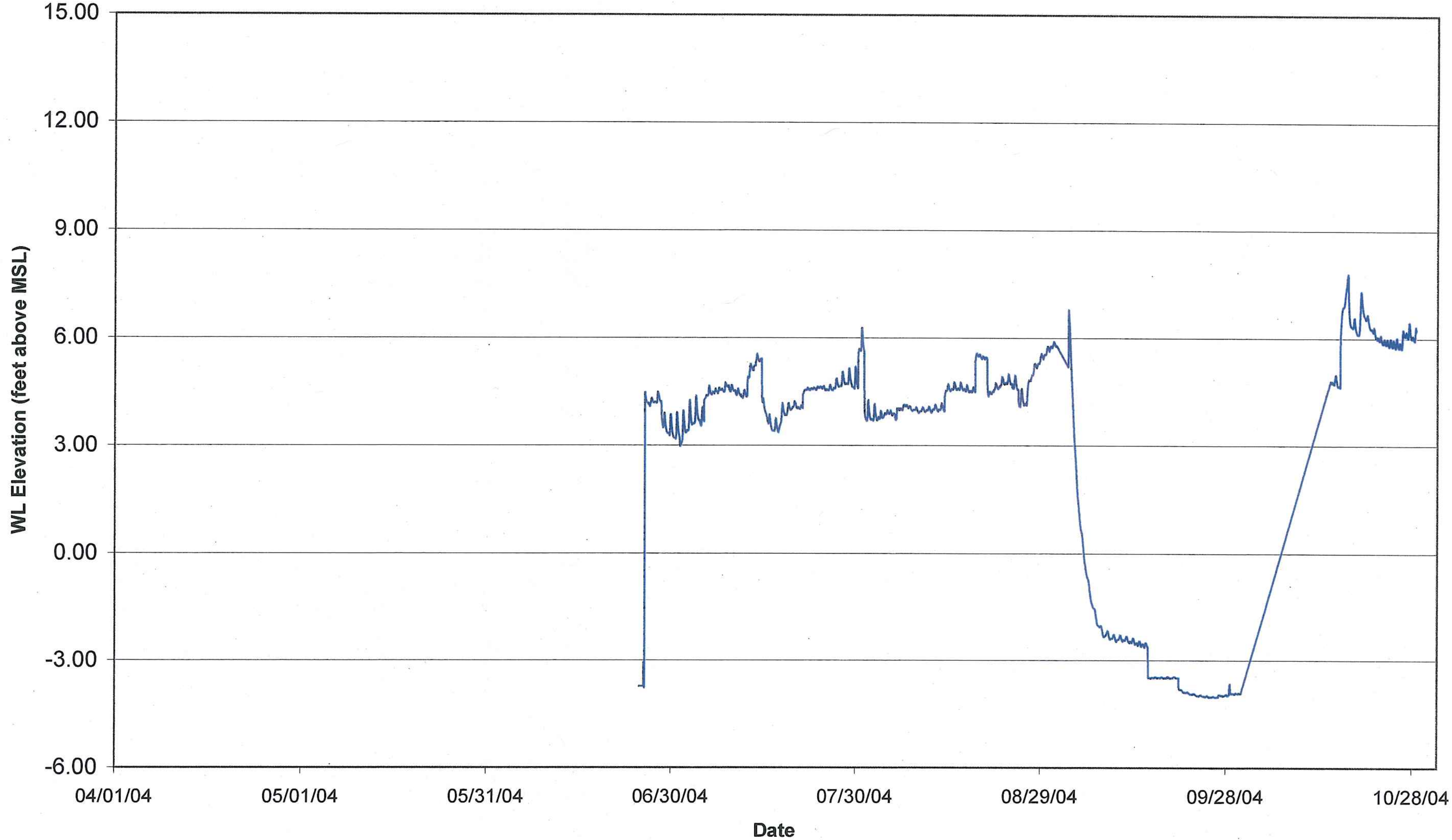
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of JSA-03
El Sur Ranch
Point Sur, California



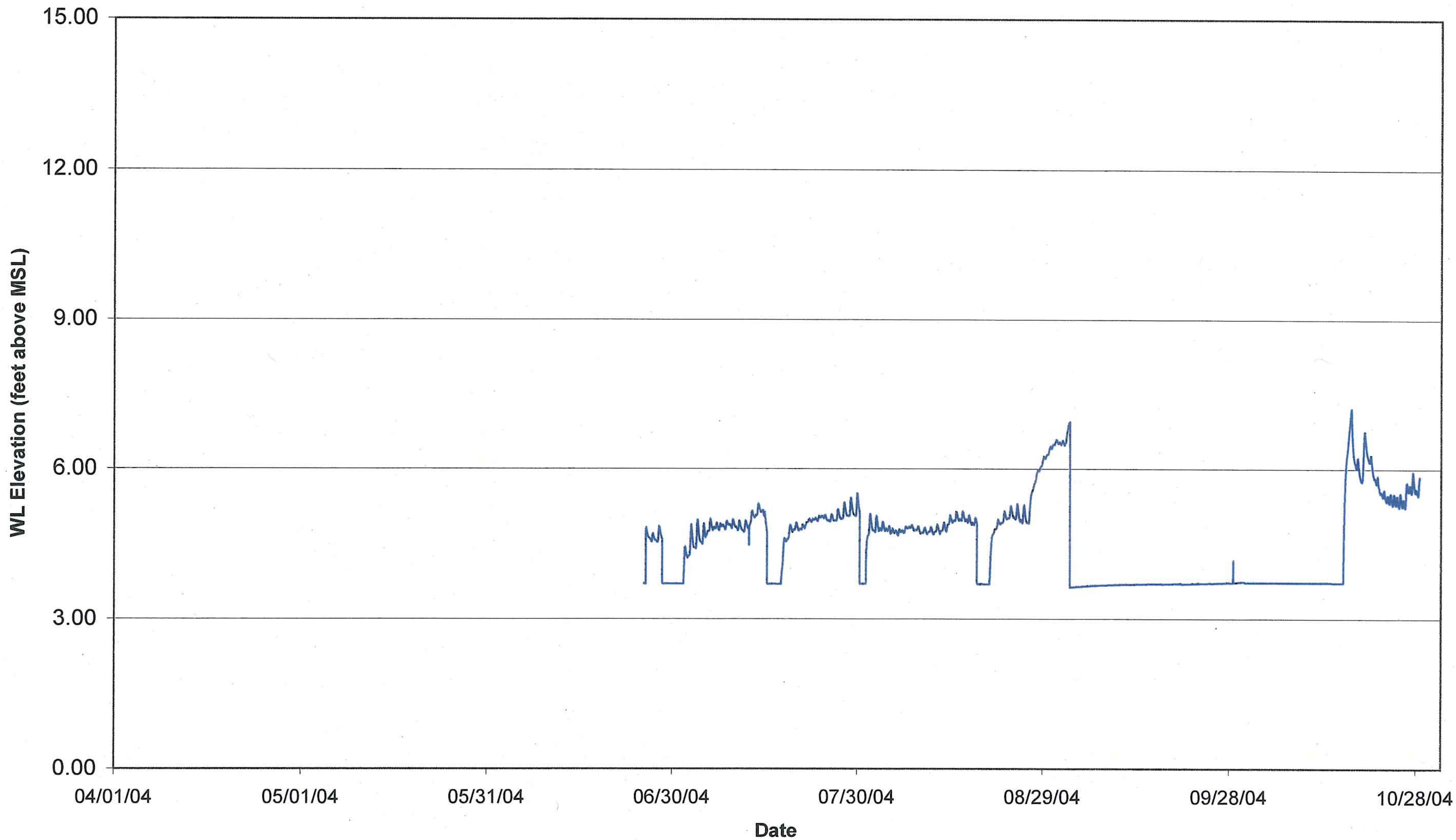
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of JSA-04
El Sur Ranch
Point Sur, California



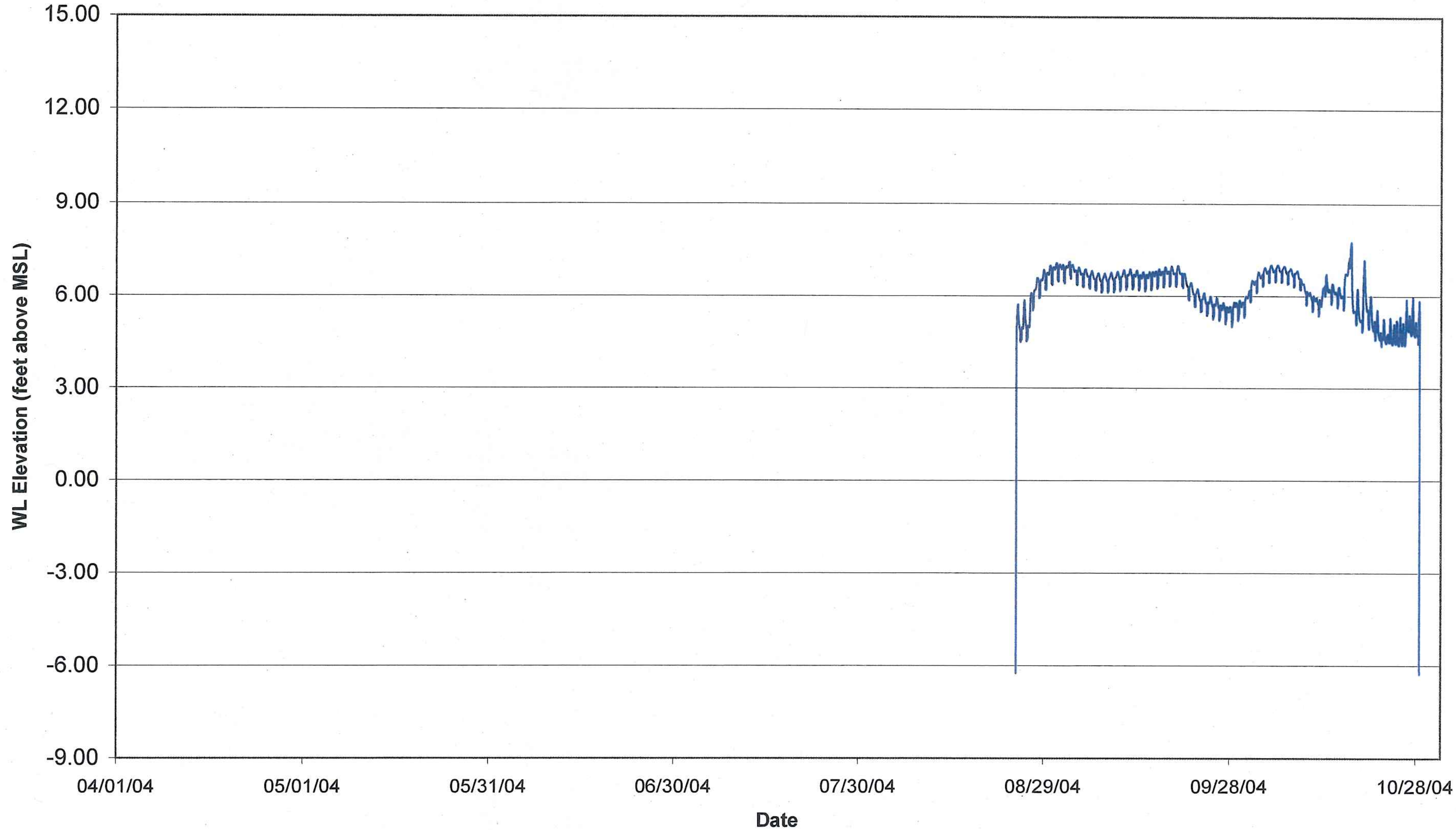
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of Old Well
El Sur Ranch
Point Sur, California



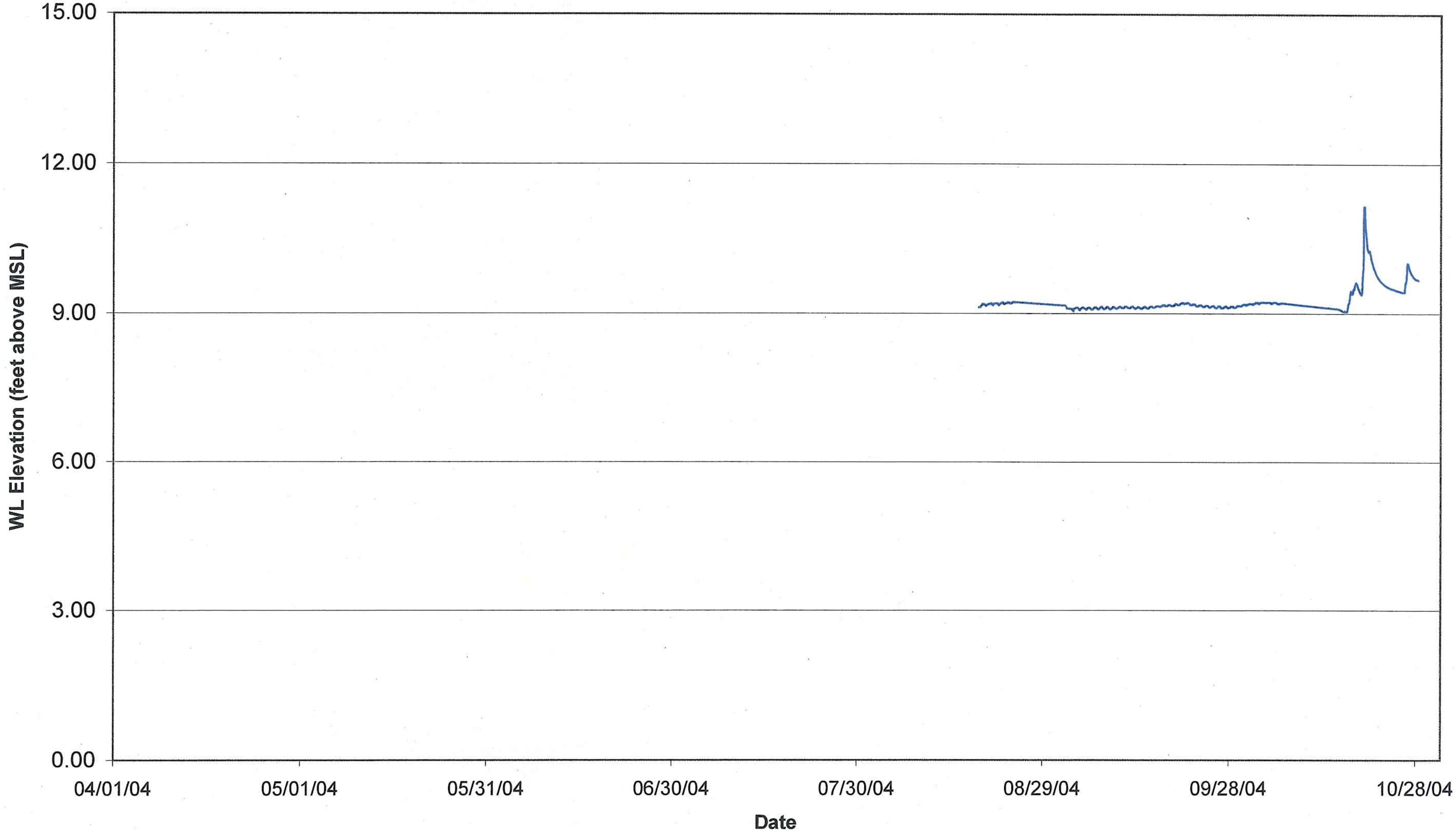
SGI environmental THE SOURCE GROUP, INC.

Hydrograph of Navy Well
El Sur Ranch
Point Sur, California



SGI environmental THE SOURCE GROUP, INC.

Hydrograph of Stilling Well
El Sur Ranch
Point Sur, California



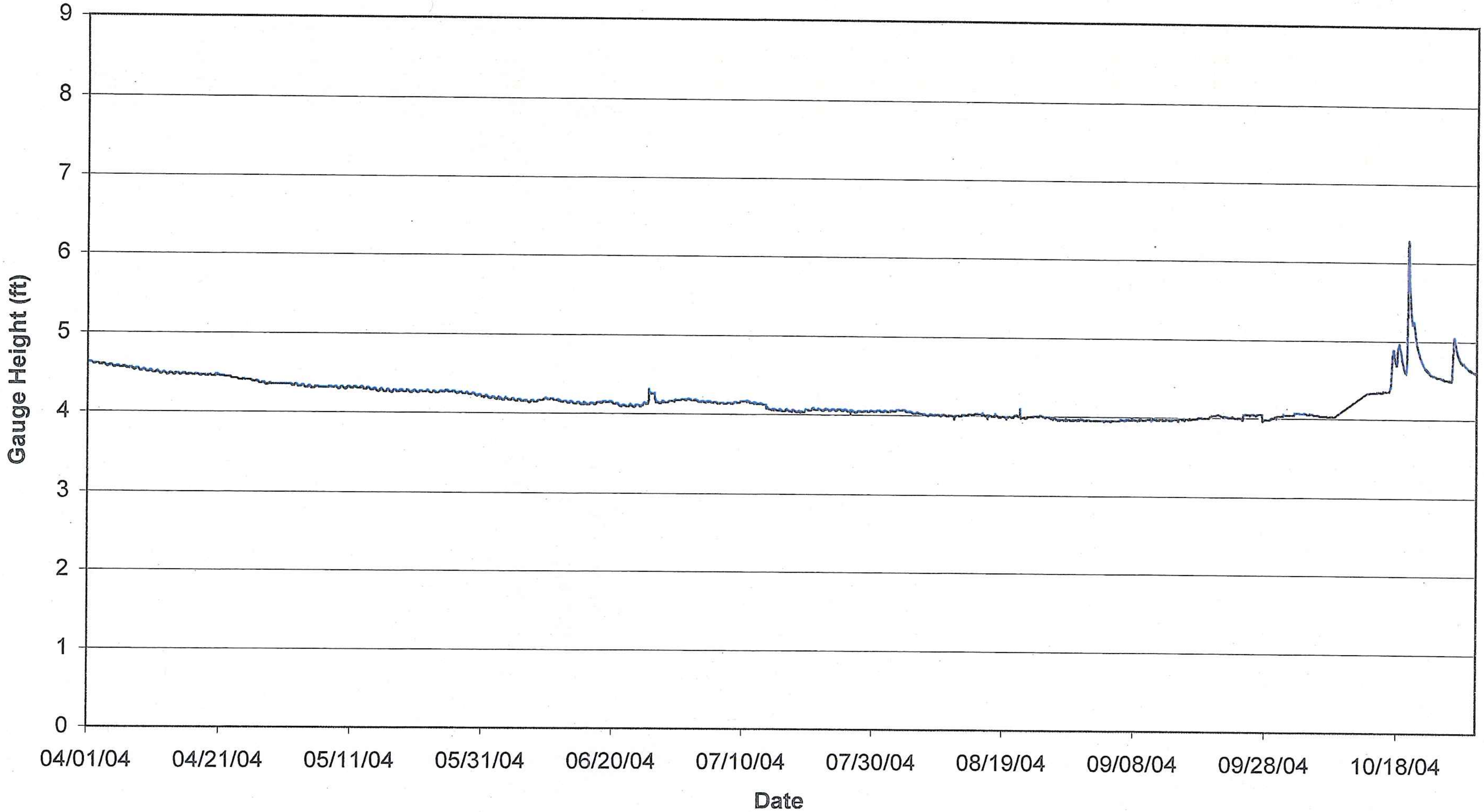
SGI environmental THE SOURCE GROUP, INC.

APPENDIX K

APPENDIX K

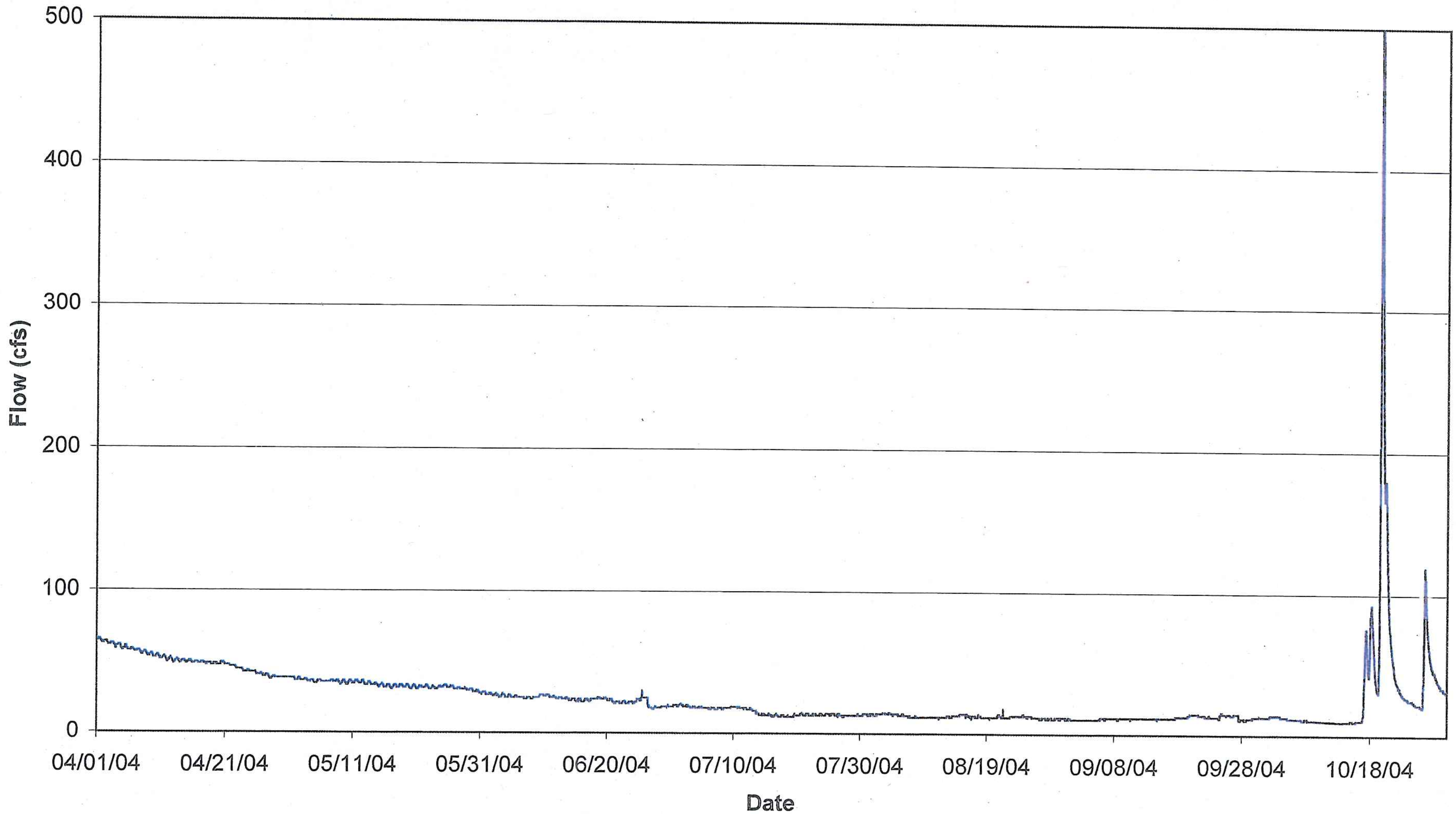
USGS GAUGE DATA

Gauge Height
(Feet)
El Sur Ranch



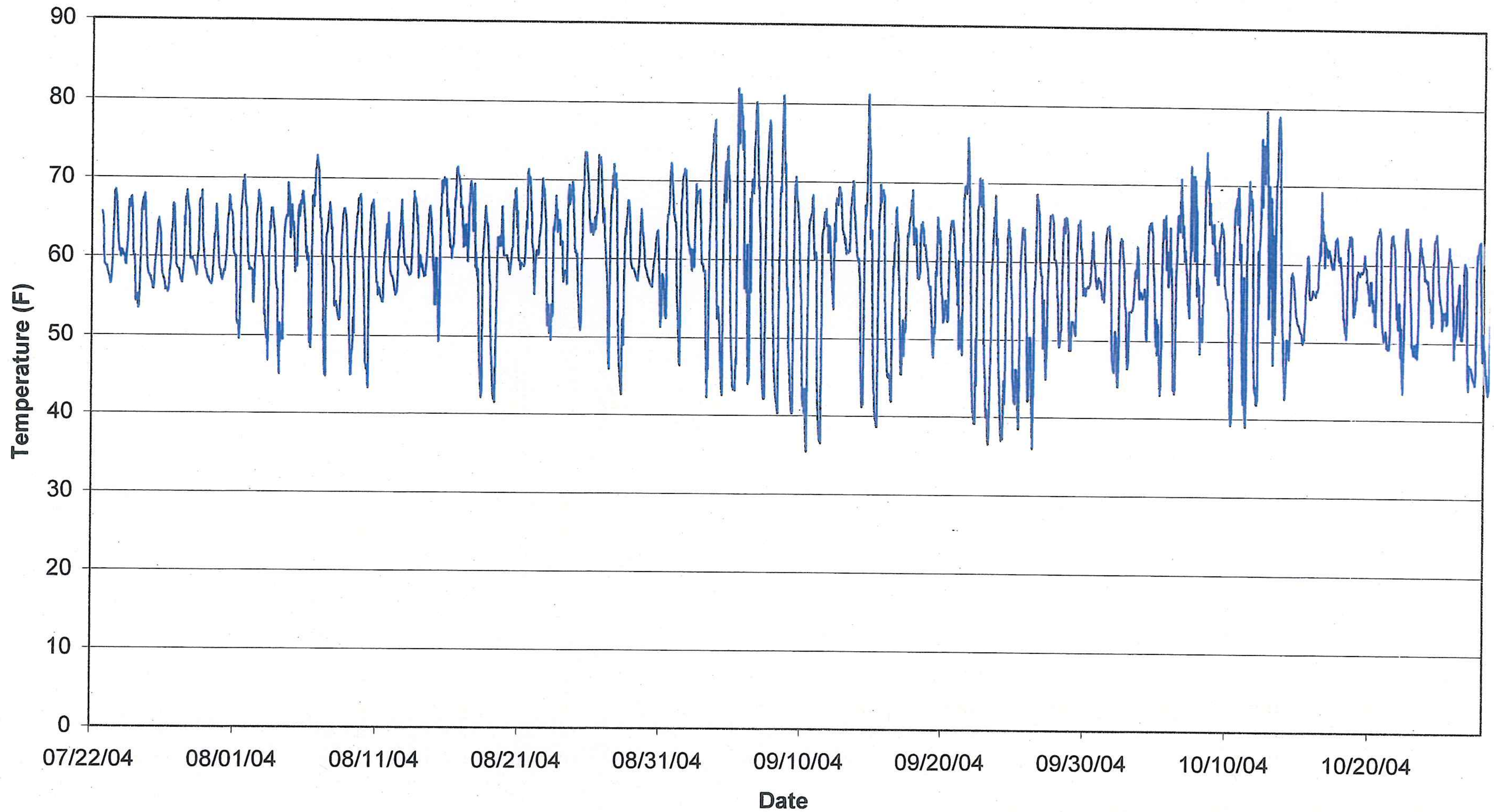
THE SOURCE GROUP, INC.

Stream Flow
(Cubic Feet per Second)
El Sur Ranch



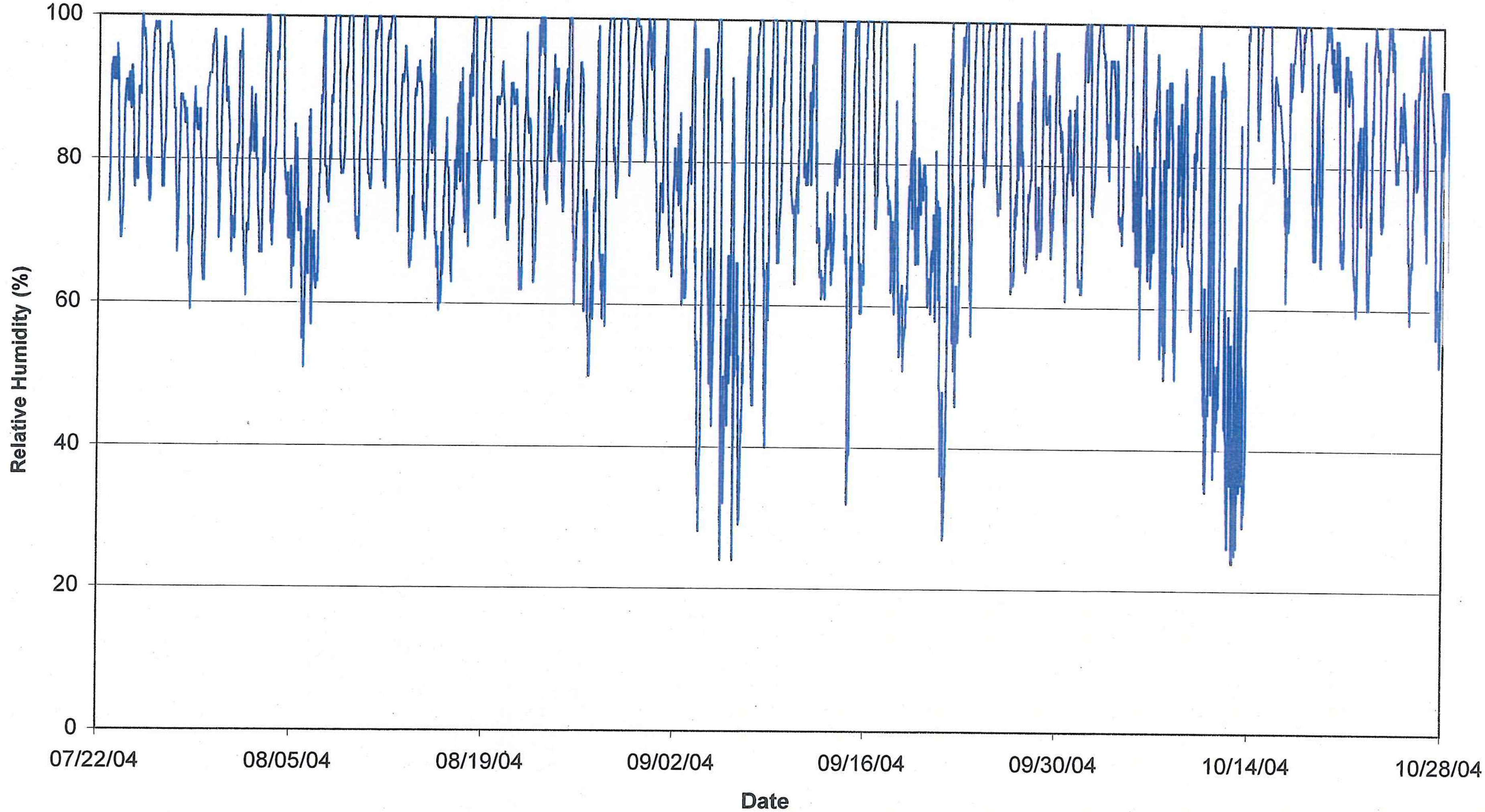
SGI environmental THE SOURCE GROUP, INC.

WESR-02
Weather Station Data
Temperature (F)
El Sur Ranch



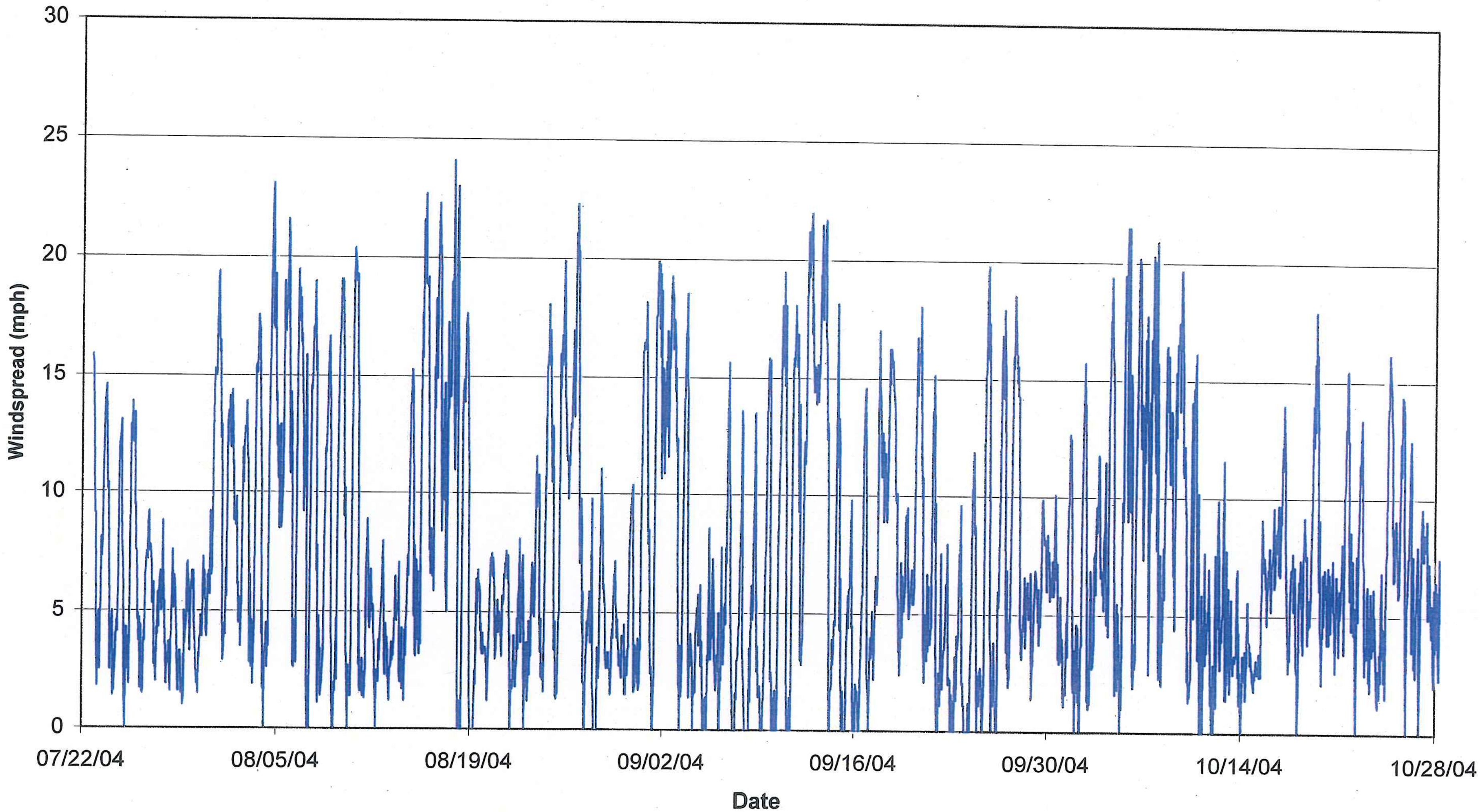
SGI environmental THE SOURCE GROUP, INC.

WESR-02
Weather Station Data
Relative Humidity (%)
El Sur Ranch



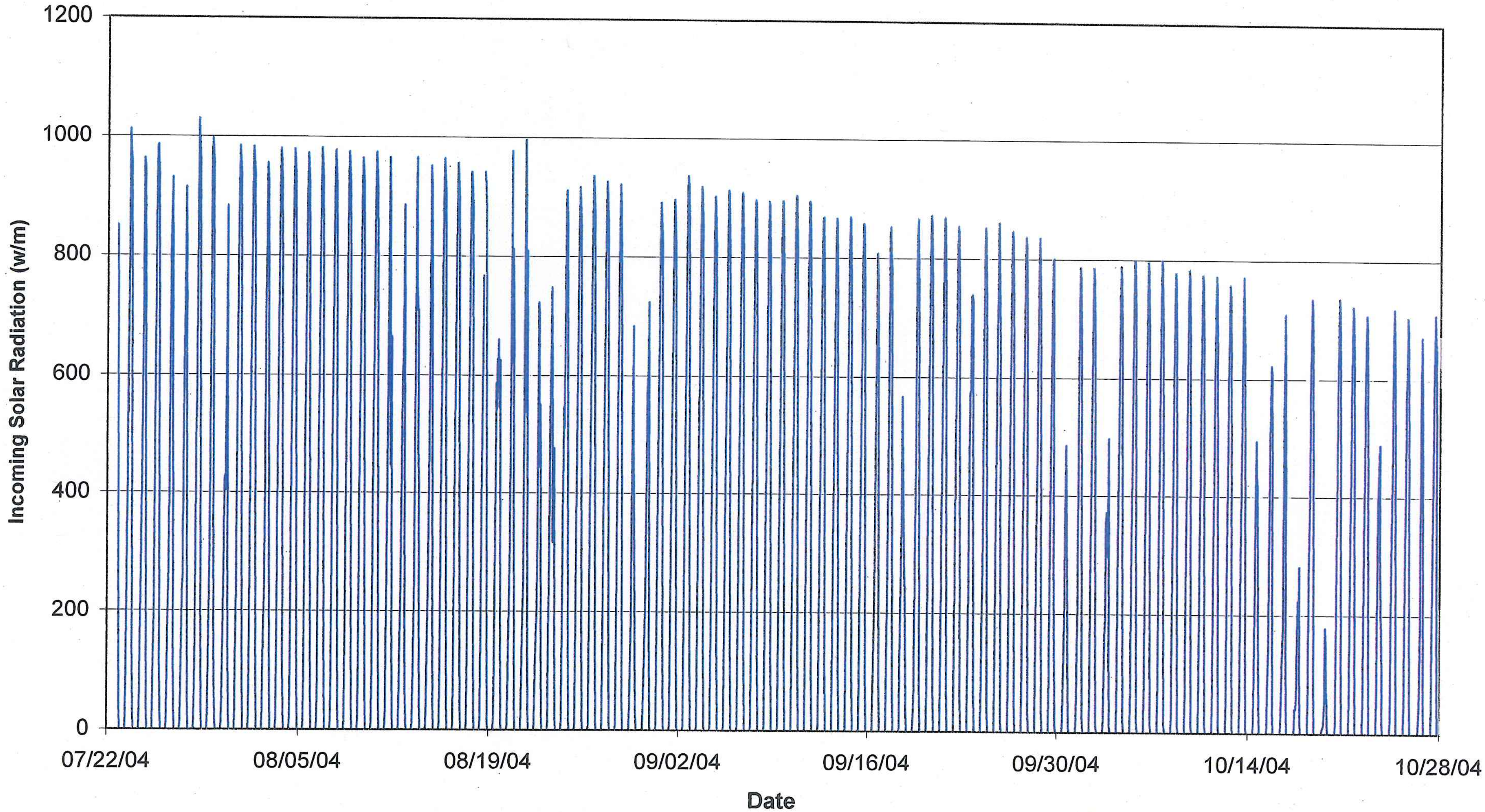
SGI environmental THE SOURCE GROUP, INC.

WESR-02
Weather Station Data
Windspread (mph)
El Sur Ranch



SGI environmental THE SOURCE GROUP, INC.

WESR-02
Weather Station Data
Incoming Solar Radiation (w/m)
El Sur Ranch



SGI environmental THE SOURCE GROUP, INC.

APPENDIX L

APPENDIX L

RIVER STAGE AND FLOW DATA

El Sur Velocity Transect #1

Date:	7/23/2004
Location:	Upstream site - closest to carpark
Pin 1 GPS (Left bank facing upstream):	N 36 17.268 W 121 50.755
Pin 2 GPS (Right bank facing upstream):	N 36 17.261 W 121 50.751
Transect Length Pin to Pin:	43.85
Levelling Notes:	String placed 1ft 2inches down from top of Pin 1 on left bank facing upstream
Depth to water	2ft 3inches and 5/8ths
Start time:	9:40
End time:	10:45

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
LWE	3.4					
	3.9	0.20	0.00	0.50	0.10	0.00
	4.4	0.40	0.00	0.50	0.20	0.00
	4.9	0.55	0.00	0.50	0.28	0.00
	5.4	0.70	0.01	0.50	0.35	0.00
	5.9	0.75	0.01	0.50	0.38	0.00
	6.4	0.75	0.02	0.50	0.38	0.01
	6.9	0.75	0.04	0.50	0.38	0.02
	7.4	0.80	0.08	0.50	0.40	0.03
	7.9	0.90	0.10	0.50	0.45	0.05
	8.4	0.90	0.12	0.50	0.45	0.05
	8.9	1.00	0.13	0.50	0.50	0.07
	9.4	1.10	0.13	0.50	0.55	0.07
	9.9	1.10	0.13	0.50	0.55	0.07
	10.4	1.20	0.15	0.50	0.60	0.09
	10.9	1.25	0.16	0.50	0.63	0.10
	11.4	1.35	0.17	0.50	0.68	0.11
	11.9	1.40	0.17	0.50	0.70	0.12
	12.4	1.40	0.17	0.50	0.70	0.12
	12.9	1.40	0.18	0.50	0.70	0.13
	13.4	1.55	0.19	0.50	0.78	0.15
	13.9	1.60	0.19	0.50	0.80	0.15
	14.4	1.40	0.22	0.50	0.70	0.15
	14.9	1.35	0.30	0.50	0.68	0.20
	15.4	1.45	0.26	0.50	0.73	0.19
	15.9	1.40	0.30	0.50	0.70	0.21
	16.4	1.40	0.35	0.50	0.70	0.25
	16.9	1.50	0.36	0.50	0.75	0.27
	17.4	1.60	0.28	0.50	0.80	0.22
	17.9	1.50	0.32	0.50	0.75	0.24
	18.4	1.55	0.33	0.50	0.78	0.26
	18.9	1.30	0.35	0.50	0.65	0.23
	19.4	1.30	0.37	0.50	0.65	0.24
	19.9	1.25	0.37	0.50	0.63	0.23
	20.4	1.35	0.39	0.50	0.68	0.26
	20.9	1.25	0.37	0.50	0.63	0.23
	21.4	1.30	0.37	0.50	0.65	0.24
	21.9	1.35	0.43	0.50	0.68	0.29
	22.4	1.35	0.45	0.50	0.68	0.30
	22.9	1.40	0.44	0.50	0.70	0.31
	23.4	1.15	0.45	0.50	0.58	0.26
	23.9	0.95	0.49	0.50	0.48	0.23
	24.4	1.00	0.52	0.50	0.50	0.26
	24.9	1.35	0.47	0.50	0.68	0.32
	25.4	1.30	0.49	0.50	0.65	0.32
	25.9	1.35	0.46	0.50	0.68	0.31
	26.4	0.90	0.50	0.50	0.45	0.23
	26.9	1.00	0.53	0.50	0.50	0.27
	27.4	1.15	0.49	0.50	0.58	0.28
	27.9	1.05	0.51	0.50	0.53	0.27
	28.4	1.10	0.50	0.50	0.55	0.28
	28.9	1.00	0.50	0.50	0.50	0.25
	29.4	1.00	0.48	0.50	0.50	0.24
	29.9	1.00	0.45	0.50	0.50	0.23
	30.4	0.90	0.40	0.50	0.45	0.18
	30.9	0.85	0.34	0.50	0.43	0.14
	31.4	0.70	0.38	0.50	0.35	0.13
	31.9	0.70	0.23	0.50	0.35	0.08
	32.4	0.40	0.19	0.50	0.20	0.04
	32.9	0.50	0.22	0.50	0.25	0.06
	33.4	0.50	0.26	0.50	0.25	0.07
	33.9	0.50	0.27	0.50	0.25	0.07
	34.4	0.30	0.27	0.50	0.15	0.04
	34.9	0.40	0.23	0.50	0.20	0.05
	35.4	0.40	0.19	0.50	0.20	0.04
	35.9	0.00	0.00	0.50	0.00	0.00
	36.4	0.25	0.11	0.50	0.13	0.01
	36.9	0.00	0.00	0.50	0.00	0.00
	37.4	0.00	0.00	0.50	0.00	0.00
	37.9	0.00	0.00	0.50	0.00	0.00
	38.4	0.00	0.00	0.43	0.00	0.00
RWE	38.75					
Minimum		0.00	0.00	0.43	0.00	0.00
Maximum		1.60	0.53	0.50	0.80	0.32
Average		0.97	0.26	0.50	0.48	0.15
Sum					33.88	10.29

Wetted Width	35.35
Mean Depth	0.96
Discharge	10.29

El Sur Velocity Transect #2

Date:	7/23/2004
Location:	Mid Point Transect - deep pool with muddy bottom - many large cray fish
Pin 1 GPS (Left bank facing upstream):	N 36 17.096 W 121 51.272
Pin 2 GPS (Right bank facing upstream):	N 36 17.097 W 121 51.271
Transect Length Pin to Pin:	36.5
Levelling Notes:	Left bank Pin has pink 2 zip ties between which string for level should be tied.
Depth to water	2ft 1.5 inches
Start time:	11:50
End time:	12:40

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
LWE	2.7					
	3.2	0.20	0.00	0.50	0.10	0.00
	3.7	0.40	0.00	0.50	0.20	0.00
	4.2	0.60	0.01	0.50	0.30	0.00
	4.7	0.80	0.02	0.50	0.40	0.01
	5.2	0.90	0.03	0.50	0.45	0.01
	5.7	0.90	0.05	0.50	0.45	0.02
	6.2	1.10	0.06	0.50	0.55	0.03
	6.7	1.30	0.06	0.50	0.65	0.04
	7.2	1.45	0.03	0.50	0.73	0.02
	7.7	1.60	0.00	0.50	0.80	0.00
	8.2	1.70	0.00	0.50	0.85	0.00
	8.7	1.80	0.00	0.50	0.90	0.00
	9.2	1.90	0.00	0.50	0.95	0.00
	9.7	2.00	0.03	0.50	1.00	0.03
	10.2	2.30	0.06	0.50	1.15	0.07
	10.7	2.60	0.10	0.50	1.30	0.13
	11.2	2.65	0.13	0.50	1.33	0.17
	11.7	2.80	0.14	0.50	1.40	0.20
	12.2	3.05	0.12	0.50	1.53	0.18
	12.7	3.10	0.10	0.50	1.55	0.16
	13.2	3.10	0.11	0.50	1.55	0.17
	13.7	3.10	0.13	0.50	1.55	0.20
	14.2	3.10	0.16	0.50	1.55	0.25
	14.7	3.10	0.15	0.50	1.55	0.23
	15.2	3.10	0.16	0.50	1.55	0.25
	15.7	3.00	0.21	0.50	1.50	0.32
	16.2	3.00	0.21	0.50	1.50	0.32
	16.7	3.00	0.21	0.50	1.50	0.32
	17.2	3.05	0.21	0.50	1.53	0.32
	17.7	2.90	0.27	0.50	1.45	0.39
	18.2	2.95	0.28	0.50	1.48	0.41
	18.7	2.95	0.34	0.50	1.48	0.50
	19.2	2.80	0.35	0.50	1.40	0.49
	19.7	2.70	0.37	0.50	1.35	0.50
	20.2	2.60	0.37	0.50	1.30	0.48
	20.7	2.50	0.36	0.50	1.25	0.45
	21.2	2.50	0.37	0.50	1.25	0.46
	21.7	2.35	0.37	0.50	1.18	0.43
	22.2	2.05	0.32	0.50	1.03	0.33
	22.7	2.05	0.34	0.50	1.03	0.35
	23.2	2.00	0.31	0.50	1.00	0.31
	23.7	1.75	0.20	0.50	0.88	0.18
	24.2	1.60	0.19	0.50	0.80	0.15
	24.7	1.45	0.16	0.50	0.73	0.12
	25.2	1.30	0.16	0.50	0.65	0.10
	25.7	1.15	0.18	0.50	0.58	0.10
	26.2	1.10	0.16	0.50	0.55	0.09
	26.7	1.00	0.15	0.50	0.50	0.08
	27.2	0.90	0.11	0.50	0.45	0.05
	27.7	0.85	0.09	0.50	0.43	0.04
	28.2	0.80	0.06	0.50	0.40	0.02
	28.7	0.80	0.03	0.50	0.40	0.01
	29.2	0.30	0.00	0.50	0.15	0.00
	29.7	0.40	0.00	0.50	0.20	0.00
	30.2	0.35	0.00	0.50	0.18	0.00
	30.7	0.00	0.00	0.50	0.00	0.00
RWE	31.2					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.50	0.00	0.00
Maximum	3.10	0.37	0.50	1.55	0.50
Average	1.87	0.14	0.50	0.94	0.17
Sum				52.40	9.49

Wetted Width	28.5
Mean Depth	1.84
Discharge	9.49

El Sur Velocity Transect #2

Date:	7/23/2004
Location:	V-Notch
Pin 1 GPS (Left bank facing upstream):	N 36 16.884 W 121 51.598
Pin 2 GPS (Right bank facing upstream):	N 36 16.882 W 121 51.593
Transect Length Pin to Pin:	29.2
Levelling Notes:	String from eye bolt to pin made level - **Pin 2 on a bearing due east of eyebolt.**
Depth to water	1ft 2.5 inches
Start time:	07:40
End time:	08:35

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
LWE	1.4					
	1.9	0.00	0.00	0.50	0.00	0.00
	2.4	0.15	0.00	0.50	0.08	0.00
	2.9	0.10	0.00	0.50	0.05	0.00
	3.4	0.30	0.00	0.50	0.15	0.00
	3.9	0.40	0.00	0.50	0.20	0.00
	4.4	0.42	0.02	0.50	0.21	0.00
	4.9	0.49	0.12	0.50	0.25	0.03
behind rock	5.4	0.45	0.01	0.50	0.23	0.00
on rock	5.9	0.33	0.31	0.50	0.17	0.05
	6.4	0.45	0.44	0.50	0.23	0.10
	6.9	0.65	0.61	0.50	0.33	0.20
	7.4	0.65	0.65	0.50	0.33	0.21
	7.9	0.80	0.65	0.50	0.40	0.26
	8.4	0.95	0.58	0.50	0.48	0.28
	8.9	1.00	0.61	0.50	0.50	0.31
	9.4	1.05	0.65	0.50	0.53	0.34
	9.9	1.15	0.64	0.50	0.58	0.37
	10.4	1.15	0.61	0.50	0.58	0.35
	10.9	1.20	0.56	0.50	0.60	0.34
weeds	11.4	1.35	0.43	0.50	0.68	0.29
weeds: Vel. 0.73 at mid depth	11.9	1.40	0.28	0.50	0.70	0.20
	12.4	1.40	0.55	0.50	0.70	0.39
	12.9	1.40	0.59	0.50	0.70	0.41
	13.4	1.40	0.65	0.50	0.70	0.46
	13.9	1.33	0.67	0.50	0.67	0.45
	14.4	1.30	0.67	0.50	0.65	0.44
	14.9	1.15	0.66	0.50	0.58	0.38
	15.4	1.10	0.66	0.50	0.55	0.36
	15.9	1.00	0.64	0.50	0.50	0.32
	16.4	0.95	0.63	0.50	0.47	0.30
	16.9	0.85	0.61	0.50	0.43	0.26
	17.4	0.80	0.60	0.50	0.40	0.24
	17.9	0.65	0.60	0.50	0.33	0.20
	18.4	0.55	0.60	0.50	0.28	0.17
	18.9	0.45	0.56	0.50	0.23	0.13
	19.4	0.35	0.48	0.50	0.18	0.08
	19.9	0.20	0.45	0.50	0.10	0.05
	20.4	0.10	0.34	0.50	0.05	0.02
	20.9	0.00	0.00	0.50	0.00	0.00
RWE	21.4					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.50	0.00	0.00
Maximum	1.40	0.67	0.50	0.70	0.46
Average	0.75	0.44	0.50	0.38	0.20
Sum				14.71	7.95

Wetted Width	20.00
Mean Depth	0.74
Discharge	7.95

El Sur Velocity Transect #1

Date:	8/5/2004
Location:	Nearest Carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.6
Levelling Notes:	1.82
Depth to water	1.75
Start time:	15:50
End time:	16:23

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	3.4					
	3.9	0.15	0.01	0.50	0.08	0.00
	4.4	0.45	0.00	0.50	0.23	0.00
	4.9	0.50	0.02	0.50	0.25	0.01
	5.4	0.65	0.06	0.50	0.33	0.02
	5.9	0.70	0.07	0.50	0.35	0.02
	6.4	0.70	0.08	0.50	0.35	0.03
	6.9	0.70	0.07	0.50	0.35	0.02
	7.4	0.80	0.08	0.50	0.40	0.03
	7.9	0.85	0.10	0.50	0.43	0.04
	8.4	0.80	0.11	0.50	0.40	0.04
	8.9	0.95	0.12	0.50	0.48	0.06
	9.4	1.00	0.13	0.50	0.50	0.07
	9.9	1.10	0.14	0.50	0.55	0.08
	10.4	1.15	0.14	0.50	0.58	0.08
	10.9	1.20	0.15	0.50	0.60	0.09
	11.4	1.30	0.15	0.50	0.65	0.10
	11.9	1.30	0.15	0.50	0.65	0.10
	12.4	1.30	0.16	0.50	0.65	0.10
	12.9	1.40	0.18	0.50	0.70	0.13
	13.4	1.50	0.17	0.50	0.75	0.13
	13.9	1.45	0.19	0.50	0.73	0.14
	14.4	1.40	0.20	0.50	0.70	0.14
	14.9	1.35	0.23	0.50	0.68	0.16
	15.4	1.40	0.23	0.50	0.70	0.16
	15.9	1.45	0.25	0.50	0.72	0.18
	16.4	1.50	0.27	0.50	0.75	0.20
	16.9	1.50	0.26	0.50	0.75	0.20
	17.4	1.50	0.23	0.50	0.75	0.17
	17.9	1.50	0.28	0.50	0.75	0.21
	18.4	1.50	0.26	0.50	0.75	0.20
	18.9	1.35	0.31	0.50	0.68	0.21
	19.4	1.30	0.32	0.50	0.65	0.21
	19.9	1.30	0.32	0.50	0.65	0.21
	20.4	1.20	0.32	0.50	0.60	0.19
	20.9	1.10	0.35	0.50	0.55	0.19
	21.4	1.25	0.35	0.50	0.63	0.22
	21.9	1.30	0.37	0.50	0.65	0.24
	22.4	1.30	0.38	0.50	0.65	0.25
	22.9	1.40	0.38	0.50	0.70	0.27
	23.4	1.40	0.39	0.50	0.70	0.27
	23.9	0.90	0.45	0.50	0.45	0.20
	24.4	0.90	0.44	0.50	0.45	0.20
	24.9	1.30	0.38	0.50	0.65	0.25
	25.4	1.20	0.42	0.50	0.60	0.25
	25.9	1.30	0.41	0.50	0.65	0.27
	26.4	0.80	0.46	0.50	0.40	0.18
	26.9	1.10	0.47	0.50	0.55	0.26
	27.4	1.10	0.48	0.50	0.55	0.26
	27.9	1.00	0.48	0.50	0.50	0.24
	28.4	1.00	0.46	0.50	0.50	0.23
	28.9	0.95	0.44	0.50	0.48	0.21
	29.4	1.00	0.42	0.50	0.50	0.21
	29.9	0.95	0.42	0.50	0.48	0.20
	30.4	0.90	0.41	0.50	0.45	0.18
	30.9	0.80	0.38	0.50	0.40	0.15
	31.4	0.75	0.32	0.50	0.38	0.12
	31.9	0.75	0.14	0.50	0.38	0.05
	32.4	0.50	0.13	0.50	0.25	0.03
	32.9	0.45	0.18	0.50	0.23	0.04
	33.4	0.40	0.25	0.50	0.20	0.05
	33.9	0.30	0.27	0.50	0.15	0.04
	34.4	0.30	0.27	0.50	0.15	0.04
	34.9	0.35	0.20	0.50	0.18	0.04
	35.4	0.10	0.08	0.50	0.05	0.00
	35.9	0.00	0.00	0.50	0.00	0.00
	36.4	0.15	0.00	0.50	0.08	0.00
	36.9	0.00	0.00	0.50	0.00	0.00
	37.4	0.10	0.00	0.50	0.05	0.00
	37.9	0.00	0.00	0.40	0.00	0.00
RWE	38.2					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.40	0.00	0.00
Maximum	1.50	0.48	0.50	0.75	0.27
Average	0.95	0.24	0.50	0.47	0.13
Sum				32.65	8.86

Wetted Width	34.8	*RWE-LWE*
Mean Depth	0.94	*sum cell area / wetted width*
Discharge	8.86	*sum of discharge*

El Sur Velocity Transect #2

Date:	8/5/2004
Location:	Mid Point
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.1
Levelling Notes:	
Depth to water	2.15
Start time:	16:45
End time:	17:15

*=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.9					
	3.4	0.25	0.00	0.50	0.13	0.00
	3.9	0.55	0.00	0.50	0.28	0.00
	4.4	0.65	0.00	0.50	0.33	0.00
	4.9	0.70	0.00	0.50	0.35	0.00
	5.4	0.75	0.00	0.50	0.38	0.00
	5.9	0.85	0.00	0.50	0.43	0.00
	6.4	1.10	0.00	0.50	0.55	0.00
	6.9	1.30	0.00	0.50	0.65	0.00
	7.4	1.40	0.01	0.50	0.70	0.01
	7.9	1.60	0.01	0.50	0.80	0.01
	8.4	1.70	0.02	0.50	0.85	0.02
	8.9	1.80	0.04	0.50	0.90	0.04
	9.4	2.00	0.03	0.50	1.00	0.03
	9.9	2.20	0.04	0.50	1.10	0.04
	10.4	1.45	0.06	0.50	0.73	0.04
	10.9	2.40	0.11	0.50	1.20	0.13
	11.4	2.80	0.12	0.50	1.40	0.17
	11.9	2.80	0.09	0.50	1.40	0.13
	12.4	3.00	0.09	0.50	1.50	0.14
	12.9	3.00	0.09	0.50	1.50	0.14
	13.4	3.00	0.09	0.50	1.50	0.14
	13.9	3.05	0.11	0.50	1.53	0.17
	14.4	3.10	0.12	0.50	1.55	0.19
	14.9	3.05	0.13	0.50	1.53	0.20
	15.4	3.15	0.14	0.50	1.58	0.22
	15.9	3.15	0.15	0.50	1.58	0.24
	16.4	3.00	0.16	0.50	1.50	0.24
	16.9	2.95	0.17	0.50	1.48	0.25
	17.4	2.95	0.19	0.50	1.48	0.28
	17.9	2.90	0.21	0.50	1.45	0.30
	18.4	2.85	0.23	0.50	1.43	0.33
	18.9	2.85	0.27	0.50	1.43	0.38
	19.4	2.70	0.31	0.50	1.35	0.42
	19.9	2.65	0.34	0.50	1.33	0.45
	20.4	2.50	0.32	0.50	1.25	0.40
	20.9	2.45	0.30	0.50	1.23	0.37
	21.4	2.00	0.29	0.50	1.00	0.29
	21.9	2.10	0.26	0.50	1.05	0.27
	22.4	2.05	0.22	0.50	1.03	0.23
	22.9	1.70	0.15	0.50	0.85	0.13
	23.4	1.70	0.17	0.50	0.85	0.14
	23.9	1.65	0.17	0.50	0.83	0.14
	24.4	1.55	0.15	0.50	0.78	0.12
	24.9	1.40	0.14	0.50	0.70	0.10
	25.4	1.20	0.12	0.50	0.60	0.07
	25.9	1.10	0.11	0.50	0.55	0.06
	26.4	1.00	0.11	0.50	0.50	0.06
	26.9	0.90	0.10	0.50	0.45	0.05
	27.4	0.80	0.07	0.50	0.40	0.03
	27.9	0.80	0.05	0.50	0.40	0.02
	28.4	0.75	0.05	0.50	0.38	0.02
	28.9	0.70	0.04	0.50	0.35	0.01
	29.4	0.20	0.00	0.50	0.10	0.00
	29.9	0.20	0.00	0.50	0.10	0.00
	30.4	0.35	0.00	0.50	0.18	0.00
	30.9	0.15	0.00	0.43	0.06	0.00
RWE	31.25					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.15	0.00	0.43	0.06	0.00
Maximum	3.15	0.34	0.50	1.58	0.45
Average	1.80	0.11	0.50	0.90	0.13
Sum				50.44	7.18

Wetted Width	28.35	*RWE-LWE*
Mean Depth	1.78	*sum cell area / wetted width*
Discharge	7.18	*sum of discharge*

El Sur Velocity Transect #3

Date:	8/5/2004
Location:	V-notch - Mid to high tide with high gusting winds.
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	29.5
Levelling Notes:	
Depth to water	1.2
Start time:	15:00
End time:	15:30

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					depth * width	Vel * Area
LWE	1.4					
	1.9	0.10	0.00	0.50	0.05	0.00
	2.4	0.00	0.00	0.50	0.00	0.00
	2.9	0.15	0.00	0.50	0.08	0.00
	3.4	0.25	0.07	0.50	0.13	0.01
	3.9	0.30	0.07	0.50	0.15	0.01
	4.4	0.50	0.00	0.50	0.25	0.00
	4.9	0.50	0.01	0.50	0.25	0.00
	5.4	0.50	0.07	0.50	0.25	0.02
	5.9	0.60	0.59	0.50	0.30	0.18
	6.4	0.65	0.62	0.50	0.33	0.20
	6.9	0.75	0.87	0.50	0.38	0.33
	7.4	0.90	0.85	0.50	0.45	0.38
	7.9	1.00	0.85	0.50	0.50	0.43
	8.4	1.00	0.87	0.50	0.50	0.44
	8.9	1.00	0.85	0.50	0.50	0.43
	9.4	1.00	0.97	0.50	0.50	0.49
	9.9	1.00	0.72	0.50	0.50	0.36
	10.4	0.90	0.88	0.50	0.45	0.40
	10.9	0.85	0.91	0.50	0.43	0.39
	11.4	0.85	0.84	0.50	0.43	0.36
	11.9	0.80	0.80	0.50	0.40	0.32
	12.4	0.80	0.86	0.50	0.40	0.34
	12.9	0.80	0.86	0.50	0.40	0.34
	13.4	0.75	0.94	0.50	0.38	0.35
	13.9	0.70	0.82	0.50	0.35	0.29
	14.4	0.70	0.94	0.50	0.35	0.33
	14.9	0.65	0.99	0.50	0.33	0.32
	15.4	0.60	0.97	0.50	0.30	0.29
	15.9	0.60	0.84	0.50	0.30	0.25
	16.4	0.55	0.99	0.50	0.28	0.27
	16.9	0.55	0.81	0.50	0.28	0.22
	17.4	0.50	0.89	0.50	0.25	0.22
	17.9	0.50	0.91	0.50	0.25	0.23
	18.4	0.50	0.85	0.50	0.25	0.21
	18.9	0.60	0.89	0.50	0.30	0.27
	19.4	0.60	0.91	0.50	0.30	0.27
	19.9	0.60	0.85	0.50	0.30	0.26
	20.4	0.50	0.88	0.50	0.25	0.22
	20.9	0.50	0.88	0.50	0.25	0.22
	21.4	0.40	0.81	0.50	0.20	0.16
	21.9	0.45	0.40	0.50	0.23	0.09
	22.4	0.35	0.56	0.50	0.18	0.10
	22.9	0.25	0.50	0.50	0.13	0.06
	23.4	0.20	0.44	0.50	0.10	0.04
	23.9	0.10	0.00	0.50	0.05	0.00
	24.4	0.05	0.00	0.40	0.02	0.00
RWE	24.7					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.40	0.00	0.00
Maximum	1.00	0.99	0.50	0.50	0.49
Average	0.57	0.64	0.50	0.29	0.22
Sum				13.20	10.09

Wetted Width	23.3	*RWE-LWE*
Mean Depth	0.57	*sum cell area / wetted width*
Discharge	10.09	*sum of discharge*

El Sur Velocity Transect #1 - NIGHT

Date:	8/6/2004			
Location:	Nearest Carpark			
Pin 1 GPS (Left bank facing upstream):				
Pin 2 GPS (Right bank facing upstream):				
Transect Length Pin to Pin:	43.7			
Levelling Notes:	1.65 down from top of marker	*=((B16-B15)*0.5)+((B15-B14)*0.5)		
Depth to water	1.96			
Start time:	05:30		*depth * width*	*Vel * Area*
End time:	06:30			

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
LWE	3.4					
	3.9	0.20	0.00	0.50	0.00	0.00
	4.4	0.50	0.04	0.50	0.25	0.01
	4.9	0.55	0.01	0.50	0.28	0.00
	5.4	0.70	0.00	0.50	0.35	0.00
	5.9	0.75	0.02	0.50	0.38	0.01
	6.4	0.75	0.02	0.50	0.38	0.01
	6.9	0.75	0.04	0.50	0.38	0.02
	7.4	0.80	0.04	0.50	0.40	0.02
	7.9	0.85	0.06	0.50	0.43	0.03
	8.4	0.90	0.08	0.50	0.45	0.04
	8.9	1.00	0.09	0.50	0.50	0.05
	9.4	1.10	0.09	0.50	0.55	0.05
	9.9	1.15	0.12	0.50	0.58	0.07
	10.4	1.15	0.14	0.50	0.58	0.08
	10.9	1.30	0.13	0.50	0.65	0.08
	11.4	1.40	0.12	0.50	0.70	0.08
	11.9	1.40	0.12	0.50	0.70	0.08
	12.4	1.40	0.14	0.50	0.70	0.10
	12.9	1.45	0.13	0.50	0.73	0.09
	13.4	1.50	0.14	0.50	0.75	0.11
	13.9	1.55	0.17	0.50	0.78	0.13
	14.4	1.35	0.22	0.50	0.68	0.15
	14.9	1.35	0.23	0.50	0.68	0.16
	15.4	1.40	0.26	0.50	0.70	0.18
	15.9	1.40	0.22	0.50	0.70	0.15
	16.4	1.40	0.28	0.50	0.70	0.20
	16.9	1.50	0.30	0.50	0.75	0.23
	17.4	1.30	0.22	0.50	0.65	0.14
	17.9	1.50	0.25	0.50	0.75	0.19
	18.4	1.50	0.32	0.50	0.75	0.24
	18.9	1.05	0.39	0.50	0.53	0.20
	19.4	1.25	0.32	0.50	0.63	0.20
	19.9	1.20	0.33	0.50	0.60	0.20
	20.4	1.30	0.34	0.50	0.65	0.22
	20.9	1.25	0.33	0.50	0.63	0.21
	21.4	1.30	0.35	0.50	0.65	0.23
	21.9	1.30	0.38	0.50	0.65	0.25
	22.4	1.30	0.39	0.50	0.65	0.25
	22.9	1.35	0.40	0.50	0.68	0.27
	23.4	1.15	0.43	0.50	0.58	0.25
	23.9	0.95	0.46	0.50	0.48	0.22
	24.4	0.90	0.51	0.50	0.45	0.23
	24.9	1.30	0.40	0.50	0.65	0.26
	25.4	1.25	0.43	0.50	0.63	0.27
	25.9	1.30	0.44	0.50	0.65	0.29
	26.4	0.85	0.48	0.50	0.43	0.20
	26.9	1.10	0.50	0.50	0.55	0.28
	27.4	1.15	0.48	0.50	0.58	0.28
	27.9	1.00	0.47	0.50	0.50	0.24
	28.4	1.05	0.42	0.50	0.53	0.22
	28.9	1.00	0.42	0.50	0.50	0.21
	29.4	1.00	0.42	0.50	0.50	0.21
	29.9	1.00	0.42	0.50	0.50	0.21
	30.4	0.90	0.39	0.50	0.45	0.18
	30.9	0.80	0.37	0.50	0.40	0.15
	31.4	0.70	0.24	0.50	0.35	0.08
	31.9	0.75	0.09	0.50	0.38	0.03
	32.4	0.40	0.11	0.50	0.20	0.02
	32.9	0.45	0.16	0.50	0.23	0.04
	33.4	0.45	0.23	0.50	0.23	0.05
	33.9	0.30	0.24	0.50	0.15	0.04
	34.4	0.30	0.20	0.50	0.15	0.03
	34.9	0.40	0.13	0.50	0.20	0.03
	35.4	0.35	0.10	0.50	0.18	0.02
	35.9	0.10	0.00	0.50	0.05	0.00
	36.4	0.20	0.00	0.50	0.10	0.00
	36.9	0.10	0.00	0.50	0.05	0.00
	37.4	0.10	0.00	0.50	0.05	0.00
	37.9	0.00	0.00	0.50	0.00	0.00
	38.4	0.00	0.00	0.35	0.00	0.00
RWE	38.6					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.35	0.00	0.00
Maximum	1.55	0.51	0.50	0.78	0.29
Average	0.95	0.23	0.50	0.47	0.12
Sum				33.13	8.72

Wetted Width	35.2	*RWE-LWE*
Mean Depth	0.94	*sum cell area / wetted width*
Discharge	8.72	*sum of discharge*

ESR--4

El Sur Velocity Transect #2 - NIGHT

Date:	8/6/2004
Location:	Midpoint in stream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.3
Levelling Notes:	between two pink zip ties on perm marker
Depth to water	2.05
Start time:	06:40
End time:	07:00

*depth * width* *Vel * Area*
*=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
LWE	2.6					
	3.1	0.25	0.00	0.50	0.13	0.00
	3.6	0.45	0.00	0.50	0.23	0.00
	4.1	0.45	0.02	0.50	0.23	0.00
	4.6	0.70	0.01	0.50	0.35	0.00
	5.1	0.80	0.00	0.50	0.40	0.00
	5.6	0.80	0.00	0.50	0.40	0.00
	6.1	1.00	0.01	0.50	0.50	0.01
	6.6	1.20	0.02	0.50	0.60	0.01
	7.1	1.35	0.02	0.50	0.68	0.01
	7.6	1.50	0.02	0.50	0.75	0.02
	8.1	1.65	0.00	0.50	0.83	0.00
	8.6	1.75	0.00	0.50	0.88	0.00
	9.1	1.85	0.02	0.50	0.93	0.02
	9.6	2.10	0.01	0.50	1.05	0.01
	10.1	2.40	0.02	0.50	1.20	0.02
	10.6	2.55	0.07	0.50	1.28	0.09
	11.1	2.70	0.08	0.50	1.35	0.11
	11.6	2.80	0.11	0.50	1.40	0.15
	12.1	2.75	0.11	0.50	1.38	0.15
	12.6	3.00	0.09	0.50	1.50	0.14
	13.1	3.05	0.08	0.50	1.53	0.12
	13.6	3.05	0.08	0.50	1.53	0.12
	14.1	3.10	0.11	0.50	1.55	0.17
	14.6	3.10	0.12	0.50	1.55	0.19
	15.1	3.10	0.15	0.50	1.55	0.23
	15.6	3.10	0.15	0.50	1.55	0.23
	16.1	3.00	0.16	0.50	1.50	0.24
	16.6	3.20	0.17	0.50	1.60	0.27
	17.1	3.00	0.20	0.50	1.50	0.30
	17.6	3.00	0.20	0.50	1.50	0.30
	18.1	2.90	0.19	0.50	1.45	0.28
	18.6	2.95	0.22	0.50	1.48	0.32
	19.1	2.90	0.26	0.50	1.45	0.38
	19.6	2.80	0.32	0.50	1.40	0.45
	20.1	2.70	0.36	0.50	1.35	0.49
	20.6	2.50	0.39	0.50	1.25	0.49
	21.1	2.50	0.39	0.50	1.25	0.49
	21.6	2.50	0.38	0.50	1.25	0.48
	22.1	2.30	0.35	0.50	1.15	0.40
	22.6	2.15	0.30	0.50	1.08	0.32
	23.1	2.00	0.27	0.50	1.00	0.27
	23.6	1.90	0.19	0.50	0.95	0.18
	24.1	1.70	0.18	0.50	0.85	0.15
	24.6	1.60	0.15	0.50	0.80	0.12
	25.1	1.40	0.13	0.50	0.70	0.09
	25.6	1.35	0.13	0.50	0.68	0.09
	26.1	1.20	0.11	0.50	0.60	0.07
	26.6	1.10	0.10	0.50	0.55	0.06
	27.1	1.00	0.08	0.50	0.50	0.04
	27.6	0.85	0.06	0.50	0.43	0.03
	28.1	0.80	0.05	0.50	0.40	0.02
	28.6	0.80	0.04	0.50	0.40	0.02
	29.1	0.75	0.02	0.50	0.38	0.01
	29.6	0.55	0.01	0.50	0.28	0.00
	30.1	0.30	0.00	0.50	0.15	0.00
	30.6	0.25	0.00	0.50	0.13	0.00
	31.1	0.00	0.00	0.35	0.00	0.00
RWE	31.3					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.35	0.00	0.00
Maximum	3.20	0.39	0.50	1.60	0.49
Average	1.87	0.12	0.50	0.93	0.14
Sum				53.25	8.14

Wetted Width	28.7	*RWE-LWE*
Mean Depth	1.86	*sum cell area / wetted width*
Discharge	8.14	*sum of discharge*

El Sur Velocity Transect #3 - NIGHT

Date:	8/6/2004
Location:	V-Notch
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	30
Levelling Notes:	
Depth to water	1.07
Start time:	04:15
End time:	04:45

*=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	1.4					
	1.9	0.10	0.00	0.50	0.05	0.00
	2.4	0.20	0.00	0.50	0.10	0.00
	2.9	0.20	0.00	0.50	0.10	0.00
	3.4	0.30	0.00	0.50	0.15	0.00
	3.9	0.35	0.00	0.50	0.18	0.00
	4.4	0.40	0.00	0.50	0.20	0.00
	4.9	0.40	0.04	0.50	0.20	0.01
	5.4	0.50	0.11	0.50	0.25	0.03
	5.9	0.50	0.40	0.50	0.25	0.10
	6.4	0.60	0.48	0.50	0.30	0.14
	6.9	0.70	0.77	0.50	0.35	0.27
	7.4	0.80	0.77	0.50	0.40	0.31
	7.9	0.80	0.88	0.50	0.40	0.35
	8.4	0.90	0.94	0.50	0.45	0.42
	8.9	0.95	0.97	0.50	0.48	0.46
	9.4	0.95	0.99	0.50	0.48	0.47
	9.9	0.95	1.01	0.50	0.48	0.48
	10.4	0.85	1.01	0.50	0.43	0.43
	10.9	0.80	0.99	0.50	0.40	0.40
	11.4	0.80	0.90	0.50	0.40	0.36
	11.9	0.80	0.90	0.50	0.40	0.36
	12.4	0.75	0.91	0.50	0.38	0.34
	12.9	0.70	0.89	0.50	0.35	0.31
	13.4	0.65	0.85	0.50	0.33	0.28
	13.9	0.60	0.86	0.50	0.30	0.26
	14.4	0.60	0.89	0.50	0.30	0.27
	14.9	0.60	0.89	0.50	0.30	0.27
	15.4	0.55	0.86	0.50	0.28	0.24
	15.9	0.50	0.86	0.50	0.25	0.22
	16.4	0.50	0.87	0.50	0.25	0.22
	16.9	0.50	0.87	0.50	0.25	0.22
	17.4	0.50	0.87	0.50	0.25	0.22
	17.9	0.50	0.89	0.50	0.25	0.22
	18.4	0.50	0.86	0.50	0.25	0.22
	18.9	0.55	0.83	0.50	0.28	0.23
	19.4	0.50	0.85	0.50	0.25	0.21
	19.9	0.50	0.84	0.50	0.25	0.21
	20.4	0.40	0.80	0.50	0.20	0.16
	20.9	0.35	0.72	0.50	0.18	0.13
	21.4	0.35	0.67	0.50	0.18	0.12
	21.9	0.20	0.47	0.50	0.10	0.05
	22.4	0.20	0.50	0.50	0.10	0.05
	22.9	0.20	0.48	0.50	0.10	0.05
	23.4	0.15	0.26	0.50	0.08	0.02
	23.9	0.10	0.00	0.38	0.04	0.00
RWE	24.15					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.10	0.00	0.38	0.04	0.00
Maximum	0.95	1.01	0.50	0.48	0.48
Average	0.53	0.64	0.50	0.26	0.20
Sum				11.89	9.07

Wetted Width	22.75	*RWE-LWE*
Mean Depth	0.52	*sum cell area / wetted width*
Discharge	9.07	*sum of discharge*

El Sur Velocity Transect #1

Date:	8/19/2004
Location:	Nearest Carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.7ft
Levelling Notes:	string 1.8ft down from top of marker
Depth to water	1.81ft
Stilling Well Depth to Water	1.1ft
Start time:	07:00
End time:	07:30

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	3.4					
	3.9	0.20	0.00	0.50	0.10	0.00
	4.4	0.40	0.03	0.50	0.20	0.01
	4.9	0.50	0.02	0.50	0.25	0.01
	5.4	0.60	0.04	0.50	0.30	0.01
	5.9	0.65	0.05	0.50	0.33	0.02
	6.4	0.70	0.06	0.50	0.35	0.02
	6.9	0.70	0.06	0.50	0.35	0.02
	7.4	0.75	0.07	0.50	0.38	0.03
	7.9	0.85	0.08	0.50	0.43	0.03
	8.4	0.85	0.09	0.50	0.43	0.04
	8.9	0.90	0.10	0.50	0.45	0.05
	9.4	1.00	0.11	0.50	0.50	0.06
	9.9	1.10	0.12	0.50	0.55	0.07
	10.4	1.10	0.12	0.50	0.55	0.07
	10.9	1.20	0.13	0.50	0.60	0.08
	11.4	1.30	0.13	0.50	0.65	0.08
	11.9	1.30	0.12	0.50	0.65	0.08
	12.4	1.30	0.12	0.50	0.65	0.08
	12.9	1.40	0.15	0.50	0.70	0.11
	13.4	1.50	0.13	0.50	0.75	0.10
	13.9	1.50	0.13	0.50	0.75	0.10
	14.4	1.45	0.16	0.50	0.73	0.12
	14.9	1.10	0.18	0.50	0.55	0.10
	15.4	1.30	0.21	0.50	0.65	0.14
	15.9	1.30	0.25	0.50	0.65	0.16
	16.4	1.35	0.26	0.50	0.67	0.18
	16.9	1.50	0.28	0.50	0.75	0.21
	17.4	1.30	0.25	0.50	0.65	0.16
	17.9	1.50	0.27	0.50	0.75	0.20
	18.4	1.50	0.31	0.50	0.75	0.23
	18.9	1.20	0.29	0.50	0.60	0.17
	19.4	1.20	0.27	0.50	0.60	0.16
	19.9	1.15	0.29	0.50	0.58	0.17
	20.4	1.20	0.33	0.50	0.60	0.20
	20.9	1.25	0.30	0.50	0.63	0.19
	21.4	1.20	0.32	0.50	0.60	0.19
	21.9	1.30	0.33	0.50	0.65	0.21
	22.4	1.25	0.34	0.50	0.63	0.21
	22.9	1.30	0.33	0.50	0.65	0.21
	23.4	1.35	0.33	0.50	0.68	0.22
	23.9	1.00	0.38	0.50	0.50	0.19
	24.4	0.90	0.41	0.50	0.45	0.18
	24.9	1.30	0.39	0.50	0.65	0.25
	25.4	1.20	0.38	0.50	0.60	0.23
	25.9	1.20	0.41	0.50	0.60	0.25
	26.4	0.80	0.44	0.50	0.40	0.18
	26.9	1.00	0.41	0.50	0.50	0.21
	27.4	1.10	0.40	0.50	0.55	0.22
	27.9	1.00	0.42	0.50	0.50	0.21
	28.4	1.00	0.40	0.50	0.50	0.20
	28.9	1.00	0.40	0.50	0.50	0.20
	29.4	1.00	0.38	0.50	0.50	0.19
	29.9	0.80	0.39	0.50	0.40	0.16
	30.4	0.90	0.38	0.50	0.45	0.17
	30.9	0.80	0.37	0.50	0.40	0.15
	31.4	0.80	0.33	0.50	0.40	0.13
	31.9	0.70	0.20	0.50	0.35	0.07
	32.4	0.35	0.17	0.50	0.18	0.03
	32.9	0.50	0.16	0.50	0.25	0.04
	33.4	0.45	0.18	0.50	0.23	0.04
	33.9	0.40	0.22	0.50	0.20	0.04
	34.4	0.30	0.25	0.50	0.15	0.04
	34.9	0.40	0.20	0.50	0.20	0.04
	35.4	0.30	0.12	0.50	0.15	0.02
	35.9	0.20	0.06	0.50	0.10	0.01
	36.4	0.10	0.00	0.50	0.05	0.00
	36.9	0.10	0.00	0.50	0.05	0.00
	37.4	0.00	0.00	0.50	0.00	0.00
	37.9	0.00	0.00	0.43	0.00	0.00
RWE	38.25					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.43	0.00	0.00
Maximum	1.50	0.44	0.50	0.75	0.25
Average	0.93	0.22	0.50	0.46	0.11
Sum				32.05	7.91

Wetted Width	34.85	*RWE-LWE*
Mean Depth	0.92	*sum cell area / wetted width*
Discharge	7.91	*sum of discharge*

El Sur Velocity Transect #2

Date:	8/19/2004
Location:	Mid Stream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.4
Levelling Notes:	between pink zip ties.
Depth to water:	2.03
Start time:	05:40
End time:	06:15

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.9					
	3.4	0.35	0.07	0.50	0.18	0.01
	3.9	0.40	0.00	0.50	0.20	0.00
	4.4	0.45	0.01	0.50	0.23	0.00
	4.9	0.75	0.02	0.50	0.38	0.01
	5.4	0.80	0.02	0.50	0.40	0.01
	5.9	0.80	0.02	0.50	0.40	0.01
	6.4	1.00	0.00	0.50	0.50	0.00
	6.9	1.15	0.00	0.50	0.58	0.00
	7.4	1.35	0.01	0.50	0.68	0.01
	7.9	1.50	0.01	0.50	0.75	0.01
	8.4	1.60	0.03	0.50	0.80	0.02
	8.9	1.70	0.05	0.50	0.85	0.04
	9.4	1.80	0.07	0.50	0.90	0.06
	9.9	2.00	0.08	0.50	1.00	0.08
	10.4	2.15	0.07	0.50	1.08	0.08
	10.9	2.45	0.11	0.50	1.23	0.13
	11.4	2.65	0.11	0.50	1.33	0.15
	11.9	2.70	0.11	0.50	1.35	0.15
	12.4	2.90	0.11	0.50	1.45	0.16
	12.9	3.00	0.12	0.50	1.50	0.18
	13.4	3.00	0.11	0.50	1.50	0.17
	13.9	3.00	0.12	0.50	1.50	0.18
	14.4	3.05	0.11	0.50	1.53	0.17
	14.9	3.05	0.12	0.50	1.53	0.18
	15.4	2.90	0.12	0.50	1.45	0.17
	15.9	3.00	0.13	0.50	1.50	0.20
	16.4	3.05	0.15	0.50	1.53	0.23
	16.9	3.00	0.17	0.50	1.50	0.26
	17.4	2.90	0.17	0.50	1.45	0.25
	17.9	3.00	0.18	0.50	1.50	0.27
	18.4	2.90	0.19	0.50	1.45	0.28
	18.9	2.90	0.22	0.50	1.45	0.32
	19.4	2.80	0.27	0.50	1.40	0.38
	19.9	2.55	0.31	0.50	1.28	0.40
	20.4	2.55	0.29	0.50	1.28	0.37
	20.9	2.50	0.29	0.50	1.25	0.36
	21.4	2.35	0.26	0.50	1.18	0.31
	21.9	2.10	0.24	0.50	1.05	0.25
	22.4	2.00	0.22	0.50	1.00	0.22
	22.9	1.90	0.19	0.50	0.95	0.18
	23.4	1.65	0.15	0.50	0.83	0.12
	23.9	1.60	0.14	0.50	0.80	0.11
	24.4	1.40	0.16	0.50	0.70	0.11
	24.9	1.30	0.16	0.50	0.65	0.10
	25.4	1.20	0.14	0.50	0.60	0.08
	25.9	1.10	0.13	0.50	0.55	0.07
	26.4	1.00	0.11	0.50	0.50	0.06
	26.9	0.09	0.11	0.50	0.05	0.00
	27.4	0.85	0.08	0.50	0.43	0.03
	27.9	0.80	0.06	0.50	0.40	0.02
	28.4	0.70	0.02	0.50	0.35	0.01
	28.9	0.70	0.00	0.50	0.35	0.00
	29.4	0.00	0.00	0.50	0.00	0.00
	29.9	0.05	0.00	0.50	0.03	0.00
	30.4	0.10	0.00	0.50	0.05	0.00
	30.9	0.00	0.00	0.33	0.00	0.00
RWE	31.05					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.33	0.00	0.00
Maximum	3.05	0.31	0.50	1.53	0.40
Average	1.76	0.11	0.50	0.88	0.12
Sum				49.27	6.96

Wetted Width	28.15	*RWE-LWE*
Mean Depth	1.75	*sum cell area / wetted width*
Discharge	6.96	*sum of discharge*

El Sur Velocity Transect #1

Date:	8/19/2004
Location:	Nearest Carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.6 ft
Levelling Notes:	1.75 ft down from top of marker
Depth to water	1.77 ft
Start time:	17:30
End time:	17:50

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (*depth * width*)	Cell Discharge (*Vel * Area*)
LWE	3.6					
	4.1	0.20	0.00	0.50	0.10	0.00
	4.6	0.40	0.00	0.50	0.20	0.00
	5.1	0.50	0.01	0.50	0.25	0.00
	5.6	0.60	0.03	0.50	0.30	0.01
	6.1	0.60	0.04	0.50	0.30	0.01
	6.6	0.65	0.07	0.50	0.33	0.02
	7.1	0.70	0.07	0.50	0.35	0.02
	7.6	0.75	0.09	0.50	0.38	0.03
	8.1	0.80	0.10	0.50	0.40	0.04
	8.6	0.80	0.10	0.50	0.40	0.04
	9.1	0.90	0.12	0.50	0.45	0.05
	9.6	1.00	0.12	0.50	0.50	0.06
	10.1	1.10	0.13	0.50	0.55	0.07
	10.6	1.10	0.13	0.50	0.55	0.07
	11.1	1.20	0.11	0.50	0.60	0.07
	11.6	1.30	0.11	0.50	0.65	0.07
	12.1	1.30	0.12	0.50	0.65	0.08
	12.6	1.30	0.14	0.50	0.65	0.09
	13.1	1.45	0.15	0.50	0.73	0.11
	13.6	1.50	0.17	0.50	0.75	0.13
	14.1	1.40	0.19	0.50	0.70	0.13
	14.6	1.25	0.20	0.50	0.63	0.13
	15.1	1.30	0.22	0.50	0.65	0.14
	15.6	1.35	0.24	0.50	0.68	0.16
	16.1	1.35	0.24	0.50	0.68	0.16
	16.6	1.35	0.26	0.50	0.68	0.18
	17.1	1.50	0.24	0.50	0.75	0.18
	17.6	1.30	0.23	0.50	0.65	0.15
	18.1	1.50	0.23	0.50	0.75	0.17
	18.6	1.20	0.27	0.50	0.60	0.16
	19.1	1.20	0.28	0.50	0.60	0.17
	19.6	1.15	0.27	0.50	0.58	0.16
	20.1	1.10	0.30	0.50	0.55	0.17
	20.6	1.20	0.32	0.50	0.60	0.19
	21.1	1.10	0.32	0.50	0.55	0.18
	21.6	1.25	0.32	0.50	0.63	0.20
	22.1	1.20	0.35	0.50	0.60	0.21
	22.6	1.30	0.34	0.50	0.65	0.22
	23.1	1.30	0.35	0.50	0.65	0.23
	23.6	1.10	0.36	0.50	0.55	0.20
	24.1	0.80	0.39	0.50	0.40	0.16
	24.6	1.25	0.35	0.50	0.63	0.22
	25.1	1.20	0.37	0.50	0.60	0.22
	25.6	1.20	0.38	0.50	0.60	0.23
	26.1	0.80	0.42	0.50	0.40	0.17
	26.6	0.80	0.41	0.50	0.40	0.16
	27.1	1.00	0.38	0.50	0.50	0.19
	27.6	1.00	0.38	0.50	0.50	0.19
	28.1	0.95	0.40	0.50	0.48	0.19
	28.6	0.90	0.37	0.50	0.45	0.17
	29.1	0.90	0.37	0.50	0.45	0.17
	29.6	0.90	0.37	0.50	0.45	0.17
	30.1	0.85	0.34	0.50	0.43	0.14
	30.6	0.80	0.31	0.50	0.40	0.12
	31.1	0.60	0.21	0.50	0.30	0.06
	31.6	0.60	0.13	0.50	0.30	0.04
	32.1	0.30	0.11	0.50	0.15	0.02
	32.6	0.30	0.12	0.50	0.15	0.02
	33.1	0.40	0.16	0.50	0.20	0.03
	33.6	0.30	0.21	0.50	0.15	0.03
	34.1	0.20	0.21	0.50	0.10	0.02
	34.6	0.25	0.14	0.50	0.13	0.02
	35.1	0.20	0.08	0.50	0.10	0.01
	35.6	0.10	0.00	0.50	0.05	0.00
	36.1	0.10	0.00	0.50	0.05	0.00
	36.6	0.10	0.00	0.50	0.05	0.00
	37.1	0.10	0.00	0.50	0.05	0.00
	37.6	0.05	0.00	0.50	0.03	0.00
	38.1	0.00	0.00	0.32	0.00	0.00
RWE	38.25					
Minimum		0.00	0.00	0.32	0.00	0.00
Maximum		1.50	0.42	0.50	0.75	0.23
Average		0.88	0.20	0.50	0.44	0.10
Sum					30.25	7.20

Wetted Width	34.65	*RWE-LWE*
Mean Depth	0.87	*sum cell area / wetted width*
Discharge	7.20	*sum of discharge*

El Sur Velocity Transect #2

Date:	8/19/2004
Location:	Mid Stream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.4
Levelling Notes:	between pink zip ties.
Depth to water:	2.03
Start time:	16:30
End time:	

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.20	0.00	0.50	0.10	0.00
	3.8	0.45	0.00	0.50	0.23	0.00
	4.3	0.65	0.00	0.50	0.33	0.00
	4.8	0.70	0.00	0.50	0.35	0.00
	5.3	0.75	0.00	0.50	0.38	0.00
	5.8	0.80	0.00	0.50	0.40	0.00
	6.3	1.00	0.00	0.50	0.50	0.00
	6.8	1.20	0.00	0.50	0.60	0.00
	7.3	1.35	0.01	0.50	0.68	0.01
	7.8	1.60	0.02	0.50	0.80	0.02
	8.3	1.60	0.02	0.50	0.80	0.02
	8.8	1.70	0.01	0.50	0.85	0.01
	9.3	1.80	0.02	0.50	0.90	0.02
	9.8	2.00	0.02	0.50	1.00	0.02
	10.3	2.40	0.03	0.50	1.20	0.04
	10.8	2.45	0.07	0.50	1.23	0.09
	11.3	2.60	0.06	0.50	1.30	0.08
	11.8	2.90	0.07	0.50	1.45	0.10
	12.3	2.95	0.08	0.50	1.48	0.12
	12.8	3.00	0.07	0.50	1.50	0.11
	13.3	3.10	0.07	0.50	1.55	0.11
	13.8	3.00	0.08	0.50	1.50	0.12
	14.3	3.05	0.09	0.50	1.53	0.14
	14.8	3.00	0.09	0.50	1.50	0.14
	15.3	3.00	0.10	0.50	1.50	0.15
	15.8	3.00	0.11	0.50	1.50	0.17
	16.3	3.15	0.14	0.50	1.58	0.22
	16.8	3.00	0.15	0.50	1.50	0.23
	17.3	3.00	0.14	0.50	1.50	0.21
	17.8	2.85	0.14	0.50	1.43	0.20
	18.3	2.90	0.15	0.50	1.45	0.22
	18.8	2.90	0.18	0.50	1.45	0.26
	19.3	2.60	0.23	0.50	1.30	0.30
	19.8	2.60	0.28	0.50	1.30	0.36
	20.3	2.50	0.32	0.50	1.25	0.40
	20.8	2.40	0.30	0.50	1.20	0.36
	21.3	2.40	0.29	0.50	1.20	0.35
	21.8	2.30	0.28	0.50	1.15	0.32
	22.3	2.15	0.22	0.50	1.08	0.24
	22.8	1.95	0.18	0.50	0.98	0.18
	23.3	1.85	0.15	0.50	0.93	0.14
	23.8	1.70	0.11	0.50	0.85	0.09
	24.3	1.50	0.11	0.50	0.75	0.08
	24.8	1.40	0.11	0.50	0.70	0.08
	25.3	1.30	0.08	0.50	0.65	0.05
	25.8	1.15	0.08	0.50	0.58	0.05
	26.3	1.00	0.07	0.50	0.50	0.04
	26.8	0.90	0.06	0.50	0.45	0.03
	27.3	0.90	0.05	0.50	0.45	0.02
	27.8	0.80	0.01	0.50	0.40	0.00
	28.3	0.80	0.00	0.50	0.40	0.00
	28.8	0.70	0.00	0.50	0.35	0.00
	29.3	0.60	0.00	0.50	0.30	0.00
	29.8	0.10	0.00	0.50	0.05	0.00
	30.3	0.10	0.00	0.50	0.05	0.00
	30.8	0.00	0.00	0.48	0.00	0.00
RWE	31.25					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.48	0.00	0.00
Maximum	3.15	0.32	0.50	1.58	0.40
Average	1.82	0.09	0.50	0.91	0.10
Sum				50.88	5.84

Wetted Width	28.45	*RWE-LWE*
Mean Depth	1.79	*sum cell area / wetted width*
Discharge	5.84	*sum of discharge*

El Sur Velocity Transect #2

Date:	8/19/2004
Location:	Mid Stream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.4
Levelling Notes:	between pink zip ties.
Depth to water:	2.03
Start time:	05:40
End time:	06:15

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.9					
	3.4	0.35	0.07	0.50	0.18	0.01
	3.9	0.40	0.00	0.50	0.20	0.00
	4.4	0.45	0.01	0.50	0.23	0.00
	4.9	0.75	0.02	0.50	0.38	0.01
	5.4	0.80	0.02	0.50	0.40	0.01
	5.9	0.80	0.02	0.50	0.40	0.01
	6.4	1.00	0.00	0.50	0.50	0.00
	6.9	1.15	0.00	0.50	0.58	0.00
	7.4	1.35	0.01	0.50	0.68	0.01
	7.9	1.50	0.01	0.50	0.75	0.01
	8.4	1.60	0.03	0.50	0.80	0.02
	8.9	1.70	0.05	0.50	0.85	0.04
	9.4	1.80	0.07	0.50	0.90	0.06
	9.9	2.00	0.08	0.50	1.00	0.08
	10.4	2.15	0.07	0.50	1.08	0.08
	10.9	2.45	0.11	0.50	1.23	0.13
	11.4	2.65	0.11	0.50	1.33	0.15
	11.9	2.70	0.11	0.50	1.35	0.15
	12.4	2.90	0.11	0.50	1.45	0.16
	12.9	3.00	0.12	0.50	1.50	0.18
	13.4	3.00	0.11	0.50	1.50	0.17
	13.9	3.00	0.12	0.50	1.50	0.18
	14.4	3.05	0.11	0.50	1.53	0.17
	14.9	3.05	0.12	0.50	1.53	0.18
	15.4	2.90	0.12	0.50	1.45	0.17
	15.9	3.00	0.13	0.50	1.50	0.20
	16.4	3.05	0.15	0.50	1.53	0.23
	16.9	3.00	0.17	0.50	1.50	0.26
	17.4	2.90	0.17	0.50	1.45	0.25
	17.9	3.00	0.18	0.50	1.50	0.27
	18.4	2.90	0.19	0.50	1.45	0.28
	18.9	2.90	0.22	0.50	1.45	0.32
	19.4	2.80	0.27	0.50	1.40	0.38
	19.9	2.55	0.31	0.50	1.28	0.40
	20.4	2.55	0.29	0.50	1.28	0.37
	20.9	2.50	0.29	0.50	1.25	0.36
	21.4	2.35	0.26	0.50	1.18	0.31
	21.9	2.10	0.24	0.50	1.05	0.25
	22.4	2.00	0.22	0.50	1.00	0.22
	22.9	1.90	0.19	0.50	0.95	0.18
	23.4	1.65	0.15	0.50	0.83	0.12
	23.9	1.60	0.14	0.50	0.80	0.11
	24.4	1.40	0.16	0.50	0.70	0.11
	24.9	1.30	0.16	0.50	0.65	0.10
	25.4	1.20	0.14	0.50	0.60	0.08
	25.9	1.10	0.13	0.50	0.55	0.07
	26.4	1.00	0.11	0.50	0.50	0.06
	26.9	0.09	0.11	0.50	0.05	0.00
	27.4	0.85	0.08	0.50	0.43	0.03
	27.9	0.80	0.06	0.50	0.40	0.02
	28.4	0.70	0.02	0.50	0.35	0.01
	28.9	0.70	0.00	0.50	0.35	0.00
	29.4	0.00	0.00	0.50	0.00	0.00
	29.9	0.05	0.00	0.50	0.03	0.00
	30.4	0.10	0.00	0.50	0.05	0.00
	30.9	0.00	0.00	0.33	0.00	0.00
RWE	31.05					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.33	0.00	0.00
Maximum	3.05	0.31	0.50	1.53	0.40
Average	1.76	0.11	0.50	0.88	0.12
Sum				49.27	6.96

Wetted Width	28.15	*RWE-LWE*
Mean Depth	1.75	*sum cell area / wetted width*
Discharge	6.96	*sum of discharge*

El Sur Velocity Transect #3

Date:	8/19/2004
Location:	V-Notch
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	27.7 ft
Levelling Notes:	
Depth to water:	1.11 ft
Start time:	04:10
End time:	04:50

**=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area *depth * width*	Cell Discharge *Vel * Area*
LWE	1.5					
	2	0.10	0.00	0.50	0.05	0.00
	2.5	0.10	0.00	0.50	0.05	0.00
	3	0.15	0.00	0.50	0.08	0.00
	3.5	0.20	0.00	0.50	0.10	0.00
	4	0.30	0.00	0.50	0.15	0.00
	4.5	0.20	0.00	0.50	0.10	0.00
	5	0.40	0.05	0.50	0.20	0.01
	5.5	0.30	0.10	0.50	0.15	0.02
	6	0.20	0.57	0.50	0.10	0.06
	6.5	0.40	0.42	0.50	0.20	0.08
	7	0.50	0.75	0.50	0.25	0.19
	7.5	0.60	0.73	0.50	0.30	0.22
	8	0.90	0.78	0.50	0.45	0.35
	8.5	0.90	0.86	0.50	0.45	0.39
	9	1.00	0.92	0.50	0.50	0.46
	9.5	0.90	0.95	0.50	0.45	0.43
	10	0.80	0.99	0.50	0.40	0.40
	10.5	0.85	0.98	0.50	0.43	0.42
	11	0.80	0.99	0.50	0.40	0.40
	11.5	0.80	0.89	0.50	0.40	0.36
	12	0.80	0.93	0.50	0.40	0.37
	12.5	0.80	0.95	0.50	0.40	0.38
	13	0.80	0.93	0.50	0.40	0.37
	13.5	0.80	0.93	0.50	0.40	0.37
	14	0.70	0.96	0.50	0.35	0.34
	14.5	0.70	0.94	0.50	0.35	0.33
	15	0.65	0.93	0.50	0.33	0.30
	15.5	0.60	0.91	0.50	0.30	0.27
	16	0.60	0.91	0.50	0.30	0.27
	16.5	0.60	0.90	0.50	0.30	0.27
	17	0.50	0.89	0.50	0.25	0.22
	17.5	0.50	0.89	0.50	0.25	0.22
	18	0.45	0.89	0.50	0.23	0.20
	18.5	0.50	0.87	0.50	0.25	0.22
	19	0.40	0.86	0.50	0.20	0.17
	19.5	0.40	0.78	0.50	0.20	0.16
	20	0.40	0.77	0.50	0.20	0.15
	20.5	0.30	0.77	0.50	0.15	0.12
	21	0.25	0.71	0.50	0.13	0.09
	21.5	0.20	0.67	0.50	0.10	0.07
	22	0.20	0.44	0.50	0.10	0.04
	22.5	0.10	0.31	0.50	0.05	0.02
	23	0.00	0.00	0.50	0.00	0.00
	23.5	0.00	0.00	0.30	0.00	0.00
RWE	23.6					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.30	0.00	0.00
Maximum	1.00	0.99	0.50	0.50	0.46
Average	0.49	0.64	0.50	0.25	0.20
Sum				10.83	8.72

Wetted Width	22.1	*RWE-LWE*
Mean Depth	0.49	*sum cell area / wetted width*
Discharge	8.72	*sum of discharge*

El Sur Velocity Transect #3

Date:	8/19/2004
Location:	V-Notch
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	27.4
Levelling Notes:	
Depth to water	0.97
Start time:	15:50
End time:	16:20

**=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	1.4					
	1.9	0.10	0.00	0.50	0.05	0.00
	2.4	0.15	0.00	0.50	0.08	0.00
	2.9	0.15	0.00	0.50	0.08	0.00
	3.4	0.30	0.00	0.50	0.15	0.00
	3.9	0.25	0.00	0.50	0.13	0.00
	4.4	0.20	0.01	0.50	0.10	0.00
	4.9	0.15	0.06	0.50	0.08	0.00
	5.4	0.30	0.11	0.50	0.15	0.02
	5.9	0.25	0.61	0.50	0.13	0.08
	6.4	0.45	0.58	0.50	0.23	0.13
	6.9	0.55	0.65	0.50	0.28	0.18
	7.4	0.60	0.73	0.50	0.30	0.22
	7.9	0.85	0.89	0.50	0.43	0.38
	8.4	0.95	0.87	0.50	0.48	0.41
	8.9	1.00	0.85	0.50	0.50	0.43
	9.4	1.00	0.92	0.50	0.50	0.46
	9.9	0.85	0.99	0.50	0.43	0.42
	10.4	0.95	0.99	0.50	0.48	0.47
	10.9	0.90	0.99	0.50	0.45	0.45
	11.4	0.90	0.96	0.50	0.45	0.43
	11.9	0.85	0.99	0.50	0.43	0.42
	12.4	0.80	0.98	0.50	0.40	0.39
	12.9	0.80	0.98	0.50	0.40	0.39
	13.4	0.80	1.01	0.50	0.40	0.40
	13.9	0.75	1.03	0.50	0.38	0.39
	14.4	0.75	1.01	0.50	0.38	0.38
	14.9	0.70	1.00	0.50	0.35	0.35
	15.4	0.70	1.00	0.50	0.35	0.35
	15.9	0.65	0.96	0.50	0.32	0.31
	16.4	0.65	0.95	0.50	0.32	0.31
	16.9	0.55	0.96	0.50	0.28	0.26
	17.4	0.55	0.95	0.50	0.28	0.26
	17.9	0.50	0.94	0.50	0.25	0.24
	18.4	0.50	0.92	0.50	0.25	0.23
	18.9	0.50	0.87	0.50	0.25	0.22
	19.4	0.50	0.84	0.50	0.25	0.21
	19.9	0.45	0.79	0.50	0.23	0.18
	20.4	0.35	0.72	0.50	0.18	0.13
	20.9	0.30	0.77	0.50	0.15	0.12
	21.4	0.30	0.76	0.50	0.15	0.11
	21.9	0.25	0.75	0.50	0.13	0.09
	22.4	0.20	0.48	0.50	0.10	0.05
	22.9	0.15	0.43	0.50	0.08	0.03
	23.4	0.10	0.00	0.50	0.05	0.00
	23.9	0.10	0.00	0.43	0.04	0.00
RWE	24.25					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.10	0.00	0.43	0.04	0.00
Maximum	1.00	1.03	0.50	0.50	0.47
Average	0.52	0.67	0.50	0.26	0.22
Sum				11.79	9.89

Wetted Width	22.85	*RWE-LWE*
Mean Depth	0.52	*sum cell area / wetted width*
Discharge	9.89	*sum of discharge*

El Sur Velocity Transect # 1

Date:	8/30/2004
Location:	Near parking lot
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.6
Levelling Notes:	1.6
Depth to water	2.15
Start time:	18:15
End time:	18:45

*=((B16-B15)*0.5)+((B15-B14)*0.5)

*depth * width* *Vel * Area*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
LWE	3.3					
	3.8	0.10	0.00	0.50	0.05	0.00
	4.3	0.25	0.01	0.50	0.13	0.00
	4.8	0.50	0.01	0.50	0.25	0.00
	5.3	0.50	0.04	0.50	0.25	0.01
	5.8	0.50	0.04	0.50	0.25	0.01
	6.3	0.70	0.06	0.50	0.35	0.02
	6.8	0.70	0.08	0.50	0.35	0.03
	7.3	0.75	0.10	0.50	0.38	0.04
	7.8	0.80	0.10	0.50	0.40	0.04
	8.3	0.85	0.11	0.50	0.43	0.05
	8.8	0.90	0.12	0.50	0.45	0.05
	9.3	1.00	0.13	0.50	0.50	0.07
	9.8	1.10	0.14	0.50	0.55	0.08
	10.3	1.10	0.15	0.50	0.55	0.08
	10.8	1.20	0.14	0.50	0.60	0.08
	11.3	1.25	0.15	0.50	0.63	0.09
	11.8	1.30	0.14	0.50	0.65	0.09
	12.3	1.30	0.14	0.50	0.65	0.09
	12.8	1.30	0.17	0.50	0.65	0.11
	13.3	1.25	0.17	0.50	0.63	0.11
	13.8	1.50	0.22	0.50	0.75	0.17
	14.3	1.10	0.23	0.50	0.55	0.13
	14.8	1.05	0.26	0.50	0.53	0.14
	15.3	1.30	0.27	0.50	0.65	0.18
	15.8	1.30	0.28	0.50	0.65	0.18
	16.3	1.40	0.30	0.50	0.70	0.21
	16.8	1.50	0.25	0.50	0.75	0.19
	17.3	1.50	0.24	0.50	0.75	0.18
	17.8	1.35	0.32	0.50	0.68	0.22
	18.3	1.40	0.32	0.50	0.70	0.22
	18.8	1.00	0.32	0.50	0.50	0.16
	19.3	1.20	0.32	0.50	0.60	0.19
	19.8	1.00	0.36	0.50	0.50	0.18
	20.3	1.20	0.32	0.50	0.60	0.19
	20.8	1.10	0.35	0.50	0.55	0.19
	21.3	1.20	0.34	0.50	0.60	0.20
	21.8	1.10	0.35	0.50	0.55	0.19
	22.3	1.25	0.37	0.50	0.63	0.23
	22.8	1.25	0.39	0.50	0.63	0.24
	23.3	1.30	0.39	0.50	0.65	0.25
	23.8	1.10	0.38	0.50	0.55	0.21
	24.3	1.20	0.39	0.50	0.60	0.23
	24.8	1.25	0.37	0.50	0.63	0.23
	25.3	1.30	0.36	0.50	0.65	0.23
	25.8	1.20	0.37	0.50	0.60	0.22
	26.3	0.90	0.44	0.50	0.45	0.20
	26.8	0.95	0.44	0.50	0.48	0.21
	27.3	1.00	0.40	0.50	0.50	0.20
	27.8	1.00	0.39	0.50	0.50	0.20
	28.3	0.85	0.43	0.50	0.43	0.18
	28.8	1.05	0.41	0.50	0.53	0.22
	29.3	1.00	0.37	0.50	0.50	0.19
	29.8	0.80	0.37	0.50	0.40	0.15
	30.3	0.90	0.37	0.50	0.45	0.17
	30.8	0.80	0.36	0.50	0.40	0.14
	31.3	0.70	0.32	0.50	0.35	0.11
	31.8	0.65	0.08	0.50	0.32	0.03
	32.3	0.45	0.16	0.50	0.22	0.04
	32.8	0.50	0.15	0.50	0.25	0.04
	33.3	0.40	0.25	0.50	0.20	0.05
	33.8	0.40	0.24	0.50	0.20	0.05
	34.3	0.25	0.24	0.50	0.13	0.03
	34.8	0.25	0.14	0.50	0.13	0.02
	35.3	0.30	0.09	0.50	0.15	0.01
	35.8	0.00	0.00	0.50	0.00	0.00
	36.3	0.10	0.00	0.50	0.05	0.00
	36.8	0.10	0.00	0.50	0.05	0.00
	37.3	0.00	0.00	0.50	0.00	0.00
	37.8	0.00	0.00	0.40	0.00	0.00
RWE	38.1					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.40	0.00	0.00
Maximum	1.50	0.44	0.50	0.75	0.25
Average	0.89	0.23	0.50	0.45	0.12
Sum				30.88	8.24

Wetted Width	34.8 *RWE-LWE*
Mean Depth	0.89 *sum cell area / wetted width*
Discharge	8.24 *sum of discharge*

El Sur Velocity Transect #2

Date:	8/30/2004
Location:	mid point
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.35
Levelling Notes:	
Depth to water	2.3
Start time:	16:45
End time:	17:15

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (depth * width)	Cell Discharge (Vel * Area)
LWE	2.8					
	3.3	0.40	0.05	0.50	0.20	0.01
	3.8	0.45	0.02	0.50	0.23	0.00
	4.3	0.45	0.04	0.50	0.23	0.01
	4.8	0.80	0.07	0.50	0.40	0.03
	5.3	0.80	0.07	0.50	0.40	0.03
	5.8	0.80	0.08	0.50	0.40	0.03
	6.3	1.00	0.07	0.50	0.50	0.04
	6.8	1.20	0.08	0.50	0.60	0.05
	7.3	1.30	0.08	0.50	0.65	0.05
	7.8	1.50	0.07	0.50	0.75	0.05
	8.3	1.65	0.04	0.50	0.83	0.03
	8.8	1.75	0.03	0.50	0.88	0.03
	9.3	1.85	0.03	0.50	0.93	0.03
	9.8	2.05	0.07	0.50	1.03	0.07
	10.3	2.35	0.12	0.50	1.18	0.14
	10.8	2.50	0.16	0.50	1.25	0.20
	11.3	2.60	0.16	0.50	1.30	0.21
	11.8	2.70	0.15	0.50	1.35	0.20
	12.3	2.90	0.14	0.50	1.45	0.20
	12.8	3.05	0.12	0.50	1.53	0.18
	13.3	3.10	0.12	0.50	1.55	0.19
	13.8	3.05	0.13	0.50	1.53	0.20
	14.3	3.10	0.15	0.50	1.55	0.23
	14.8	3.10	0.16	0.50	1.55	0.25
	15.3	3.05	0.17	0.50	1.53	0.26
	15.8	3.10	0.16	0.50	1.55	0.25
	16.3	3.15	0.17	0.50	1.58	0.27
	16.8	3.00	0.19	0.50	1.50	0.29
	17.3	2.80	0.20	0.50	1.40	0.28
	17.8	2.90	0.20	0.50	1.45	0.29
	18.3	2.95	0.21	0.50	1.48	0.31
	18.8	2.85	0.24	0.50	1.43	0.34
	19.3	2.60	0.29	0.50	1.30	0.38
	19.8	2.65	0.32	0.50	1.33	0.42
	20.3	2.40	0.36	0.50	1.20	0.43
	20.8	2.50	0.37	0.50	1.25	0.46
	21.3	2.40	0.38	0.50	1.20	0.46
	21.8	2.30	0.38	0.50	1.15	0.44
	22.3	2.15	0.38	0.50	1.08	0.41
	22.8	1.95	0.34	0.50	0.98	0.33
	23.3	1.80	0.28	0.50	0.90	0.25
	23.8	1.60	0.24	0.50	0.80	0.19
	24.3	1.50	0.23	0.50	0.75	0.17
	24.8	1.40	0.22	0.50	0.70	0.15
	25.3	1.25	0.21	0.50	0.63	0.13
	25.8	1.15	0.19	0.50	0.58	0.11
	26.3	1.00	0.17	0.50	0.50	0.09
	26.8	0.95	0.15	0.50	0.48	0.07
	27.3	0.90	0.13	0.50	0.45	0.06
	27.8	0.80	0.09	0.50	0.40	0.04
	28.3	0.75	0.08	0.50	0.38	0.03
	28.8	0.50	0.07	0.50	0.25	0.02
	29.3	0.50	0.05	0.50	0.25	0.01
	29.8	0.00	0.00	0.50	0.00	0.00
	30.3	0.05	0.00	0.50	0.03	0.00
	30.8	0.00	0.00	0.45	0.00	0.00
RWE	31.2					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	3.15	0.38	0.50	1.58	0.46
Average	1.81	0.16	0.50	0.90	0.17
Sum				50.68	9.39

Wetted Width	28.4	*RWE-LWE*
Mean Depth	1.78	*sum cell area / wetted width*
Discharge	9.39	*sum of discharge*

El Sur Velocity Transect #1

Date:	8/31/2004
Location:	near carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.6
Levelling Notes:	1.65
Depth to water	1.98
Start time:	4:50
End time:	5:13

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	3.3					
	3.8	0.10	0.00	0.50	0.05	0.00
	4.3	0.20	0.00	0.50	0.10	0.00
	4.8	0.45	0.00	0.50	0.23	0.00
	5.3	0.60	0.03	0.50	0.30	0.01
	5.8	0.65	0.02	0.50	0.33	0.01
	6.3	0.70	0.04	0.50	0.35	0.01
	6.8	0.75	0.06	0.50	0.38	0.02
	7.3	0.80	0.08	0.50	0.40	0.03
	7.8	0.80	0.09	0.50	0.40	0.04
	8.3	0.85	0.10	0.50	0.43	0.04
	8.8	1.00	0.11	0.50	0.50	0.06
	9.3	1.05	0.11	0.50	0.53	0.06
	9.8	1.10	0.12	0.50	0.55	0.07
	10.3	1.15	0.13	0.50	0.58	0.07
	10.8	1.20	0.12	0.50	0.60	0.07
	11.3	1.20	0.12	0.50	0.60	0.07
	11.8	1.35	0.13	0.50	0.68	0.09
	12.3	1.35	0.14	0.50	0.68	0.09
	12.8	1.35	0.15	0.50	0.68	0.10
	13.3	1.35	0.16	0.50	0.68	0.11
	13.8	1.50	0.18	0.50	0.75	0.14
	14.3	1.10	0.23	0.50	0.55	0.13
	14.8	1.10	0.23	0.50	0.55	0.13
	15.3	1.35	0.27	0.50	0.68	0.18
	15.8	1.35	0.27	0.50	0.68	0.18
	16.3	1.40	0.26	0.50	0.70	0.18
	16.8	1.55	0.23	0.50	0.78	0.18
	17.3	1.55	0.24	0.50	0.78	0.19
	17.8	1.40	0.28	0.50	0.70	0.20
	18.3	1.45	0.28	0.50	0.73	0.20
	18.8	1.05	0.33	0.50	0.53	0.17
	19.3	1.30	0.35	0.50	0.65	0.23
	19.8	1.10	0.33	0.50	0.55	0.18
	20.3	1.25	0.32	0.50	0.63	0.20
	20.8	1.25	0.34	0.50	0.63	0.21
	21.3	1.25	0.35	0.50	0.63	0.22
	21.8	1.15	0.39	0.50	0.58	0.22
	22.3	1.40	0.36	0.50	0.70	0.25
	22.8	1.25	0.40	0.50	0.63	0.25
	23.3	1.25	0.40	0.50	0.63	0.25
	23.8	1.25	0.38	0.50	0.63	0.24
	24.3	1.05	0.40	0.50	0.53	0.21
	24.8	1.00	0.39	0.50	0.50	0.20
	25.3	1.25	0.40	0.50	0.63	0.25
	25.8	1.25	0.43	0.50	0.63	0.27
	26.3	0.90	0.42	0.50	0.45	0.19
	26.8	1.00	0.42	0.50	0.50	0.21
	27.3	1.10	0.40	0.50	0.55	0.22
	27.8	1.05	0.42	0.50	0.53	0.22
	28.3	0.85	0.42	0.50	0.43	0.18
	28.8	1.10	0.37	0.50	0.55	0.20
	29.3	1.05	0.36	0.50	0.53	0.19
	29.8	0.80	0.36	0.50	0.40	0.14
	30.3	0.90	0.36	0.50	0.45	0.16
	30.8	0.80	0.37	0.50	0.40	0.15
	31.3	0.75	0.26	0.50	0.38	0.10
	31.8	0.70	0.08	0.50	0.35	0.03
	32.3	0.35	0.20	0.50	0.17	0.03
	32.8	0.40	0.20	0.50	0.20	0.04
	33.3	0.45	0.21	0.50	0.23	0.05
	33.8	0.30	0.23	0.50	0.15	0.03
	34.3	0.25	0.17	0.50	0.13	0.02
	34.8	0.35	0.11	0.50	0.18	0.02
	35.3	0.30	0.08	0.50	0.15	0.01
	35.8	0.10	0.00	0.50	0.05	0.00
	36.3	0.20	0.01	0.50	0.10	0.00
	36.8	0.00	0.00	0.50	0.00	0.00
	37.3	0.00	0.00	0.50	0.00	0.00
	37.8	0.10	0.00	0.45	0.05	0.00
RWE	38.2					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	1.55	0.43	0.50	0.78	0.27
Average	0.92	0.22	0.50	0.46	0.12
Sum				31.80	8.20

Wetted Width	34.9	*RWE-LWE*
Mean Depth	0.91	*sum cell area / wetted width*
Discharge	8.20	*sum of discharge*

El Sur Velocity Transect # 1

Date:	8/31/2004
Location:	Near Carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.55
Levelling Notes:	1.3
Depth to water	2.2
Still Well:	1.4
Start time:	18:15
End time:	18:45

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area *depth * width*	Cell Discharge *Vel * Area*
LWE	3.5					
	4	0.20	0.00	0.50	0.10	0.00
	4.5	0.35	0.07	0.50	0.18	0.01
	5	0.50	0.09	0.50	0.25	0.02
	5.5	0.55	0.10	0.50	0.28	0.03
	6	0.60	0.11	0.50	0.30	0.03
	6.5	0.65	0.13	0.50	0.33	0.04
	7	0.70	0.13	0.50	0.35	0.05
	7.5	0.75	0.14	0.50	0.38	0.05
	8	0.80	0.14	0.50	0.40	0.06
	8.5	0.80	0.15	0.50	0.40	0.06
	9	0.95	0.15	0.50	0.48	0.07
	9.5	1.00	0.17	0.50	0.50	0.09
	10	1.00	0.17	0.50	0.50	0.09
	10.5	1.10	0.18	0.50	0.55	0.10
	11	1.20	0.17	0.50	0.60	0.10
	11.5	1.05	0.18	0.50	0.53	0.09
	12	1.30	0.18	0.50	0.65	0.12
	12.5	1.30	0.17	0.50	0.65	0.11
	13	1.25	0.19	0.50	0.63	0.12
	13.5	1.40	0.21	0.50	0.70	0.15
	14	1.50	0.19	0.50	0.75	0.14
	14.5	1.05	0.24	0.50	0.53	0.13
	15	1.05	0.27	0.50	0.53	0.14
	15.5	1.10	0.27	0.50	0.55	0.15
	16	1.10	0.28	0.50	0.55	0.15
	16.5	1.40	0.29	0.50	0.70	0.20
	17	1.50	0.25	0.50	0.75	0.19
	17.5	1.50	0.24	0.50	0.75	0.18
	18	1.40	0.26	0.50	0.70	0.18
	18.5	1.00	0.30	0.50	0.50	0.15
	19	1.20	0.33	0.50	0.60	0.20
	19.5	1.05	0.34	0.50	0.53	0.18
	20	1.00	0.35	0.50	0.50	0.18
	20.5	1.20	0.35	0.50	0.60	0.21
	21	1.10	0.32	0.50	0.55	0.18
	21.5	1.10	0.34	0.50	0.55	0.19
	22	1.10	0.37	0.50	0.55	0.20
	22.5	1.25	0.41	0.50	0.63	0.26
	23	1.30	0.38	0.50	0.65	0.25
	23.5	1.10	0.40	0.50	0.55	0.22
	24	0.85	0.40	0.50	0.43	0.17
	24.5	0.95	0.41	0.50	0.48	0.19
	25	1.25	0.41	0.50	0.63	0.26
	25.5	1.25	0.42	0.50	0.63	0.26
	26	0.80	0.44	0.50	0.40	0.18
	26.5	0.90	0.44	0.50	0.45	0.20
	27	1.00	0.43	0.50	0.50	0.22
	27.5	1.00	0.43	0.50	0.50	0.22
	28	1.00	0.43	0.50	0.50	0.22
	28.5	0.90	0.42	0.50	0.45	0.19
	29	0.90	0.40	0.50	0.45	0.18
	29.5	0.95	0.39	0.50	0.48	0.19
	30	0.85	0.37	0.50	0.43	0.16
	30.5	0.75	0.37	0.50	0.38	0.14
	31	0.75	0.34	0.50	0.38	0.13
	31.5	0.70	0.25	0.50	0.35	0.09
	32	0.40	0.21	0.50	0.20	0.04
	32.5	0.40	0.23	0.50	0.20	0.05
	33	0.40	0.24	0.50	0.20	0.05
	33.5	0.30	0.27	0.50	0.15	0.04
	34	0.25	0.21	0.50	0.13	0.03
	34.5	0.25	0.15	0.50	0.13	0.02
	35	0.20	0.13	0.50	0.10	0.01
	35.5	0.05	0.00	0.50	0.03	0.00
	36	0.10	0.00	0.50	0.05	0.00
	36.5	0.05	0.00	0.50	0.03	0.00
	37	0.10	0.00	0.50	0.05	0.00
	37.5	0.00	0.00	0.50	0.00	0.00
RWE	38					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.50	0.00	0.00
Maximum	1.50	0.44	0.50	0.75	0.26
Average	0.86	0.25	0.50	0.43	0.12
Sum				29.38	8.25

Wetted Width	34.5	*RWE-LWE*
Mean Depth	0.85	*sum cell area / wetted width*
Discharge	8.25	*sum of discharge*

El Sur Velocity Transect #1

Date: 8/31/2004
Location: Near carpark
Pin 1 GPS (Left bank facing upstream):
Pin 2 GPS (Right bank facing upstream):
Transect Length Pin to Pin:
Levelling Notes: *=((B16-B15)*0.5)+((B15-B14)*0.5)
Depth to water
Start time: 18:45
End time: 19:05

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	3.5					
	4	0.20	0.00	0.50	0.10	0.00
	4.5	0.35	0.04	0.50	0.18	0.01
	5	0.50	0.08	0.50	0.25	0.02
	5.5	0.60	0.11	0.50	0.30	0.03
	6	0.65	0.12	0.50	0.33	0.04
	6.5	0.70	0.13	0.50	0.35	0.05
	7	0.70	0.13	0.50	0.35	0.05
	7.5	0.75	0.13	0.50	0.38	0.05
	8	0.80	0.15	0.50	0.40	0.06
	8.5	0.85	0.15	0.50	0.43	0.06
	9	0.90	0.15	0.50	0.45	0.07
	9.5	1.00	0.16	0.50	0.50	0.08
	10	1.05	0.17	0.50	0.53	0.09
	10.5	1.10	0.18	0.50	0.55	0.10
	11	1.20	0.20	0.50	0.60	0.12
	11.5	1.25	0.21	0.50	0.63	0.13
	12	1.30	0.20	0.50	0.65	0.13
	12.5	1.30	0.22	0.50	0.65	0.14
	13	1.35	0.22	0.50	0.68	0.15
	13.5	1.50	0.24	0.50	0.75	0.18
	14	1.40	0.27	0.50	0.70	0.19
	14.5	1.25	0.27	0.50	0.63	0.17
	15	1.25	0.29	0.50	0.63	0.18
	15.5	1.30	0.28	0.50	0.65	0.18
	16	1.30	0.31	0.50	0.65	0.20
	16.5	1.35	0.30	0.50	0.68	0.20
	17	1.45	0.28	0.50	0.73	0.20
	17.5	1.30	0.30	0.50	0.65	0.20
	18	1.40	0.30	0.50	0.70	0.21
	18.5	1.20	0.31	0.50	0.60	0.19
	19	1.20	0.35	0.50	0.60	0.21
	19.5	1.10	0.35	0.50	0.55	0.19
	20	1.10	0.34	0.50	0.55	0.19
	20.5	1.20	0.36	0.50	0.60	0.22
	21	1.20	0.36	0.50	0.60	0.22
	21.5	1.20	0.37	0.50	0.60	0.22
	22	1.20	0.39	0.50	0.60	0.23
	22.5	1.20	0.40	0.50	0.60	0.24
	23	1.30	0.40	0.50	0.65	0.26
	23.5	0.90	0.41	0.50	0.45	0.18
	24	0.85	0.44	0.50	0.43	0.19
	24.5	0.95	0.46	0.50	0.48	0.22
	25	1.25	0.43	0.50	0.63	0.27
	25.5	1.25	0.42	0.50	0.63	0.26
	26	0.80	0.44	0.50	0.40	0.18
	26.5	0.90	0.47	0.50	0.45	0.21
	27	1.00	0.45	0.50	0.50	0.23
	27.5	1.00	0.43	0.50	0.50	0.22
	28	1.00	0.41	0.50	0.50	0.21
	28.5	0.90	0.41	0.50	0.45	0.18
	29	0.90	0.41	0.50	0.45	0.18
	29.5	0.95	0.40	0.50	0.48	0.19
	30	0.85	0.38	0.50	0.43	0.16
	30.5	0.80	0.38	0.50	0.40	0.15
	31	0.60	0.32	0.50	0.30	0.10
	31.5	0.60	0.15	0.50	0.30	0.05
	32	0.30	0.19	0.50	0.15	0.03
	32.5	0.30	0.19	0.50	0.15	0.03
	33	0.40	0.18	0.50	0.20	0.04
	33.5	0.30	0.19	0.50	0.15	0.03
	34	0.20	0.18	0.50	0.10	0.02
	34.5	0.20	0.16	0.50	0.10	0.02
	35	0.30	0.11	0.50	0.15	0.02
	35.5	0.05	0.00	0.50	0.03	0.00
	36	0.10	0.00	0.50	0.05	0.00
	36.5	0.15	0.00	0.50	0.08	0.00
	37	0.00	0.00	0.50	0.00	0.00
	37.5	0.00	0.00	0.50	0.00	0.00
RWE	38					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.50	0.00	0.00
Maximum	1.50	0.47	0.50	0.75	0.27
Average	0.88	0.25	0.50	0.44	0.13
Sum				29.88	8.79

Wetted Width 34.5 *RWE-LWE*
Mean Depth 0.87 *sum cell area / wetted width*
Discharge 8.79 *sum of discharge*

El Sur Velocity Transect # 2

Date:	8/31/2004
Location:	Mid Point
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.3
Levelling Notes:	
Depth to water	2.05
Start time:	16:50
End time:	17:14

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (depth * width)	Cell Discharge (Vel * Area)
LWE	2.8					
	3.3	0.45	0.05	0.50	0.23	0.01
	3.8	0.60	0.04	0.50	0.30	0.01
	4.3	0.60	0.05	0.50	0.30	0.02
	4.8	0.65	0.07	0.50	0.33	0.02
	5.3	0.80	0.09	0.50	0.40	0.04
	5.8	0.90	0.10	0.50	0.45	0.05
	6.3	1.00	0.10	0.50	0.50	0.05
	6.8	1.20	0.09	0.50	0.60	0.05
	7.3	1.30	0.09	0.50	0.65	0.06
	7.8	1.50	0.09	0.50	0.75	0.07
	8.3	1.60	0.09	0.50	0.80	0.07
	8.8	1.70	0.10	0.50	0.85	0.09
	9.3	1.80	0.09	0.50	0.90	0.08
	9.8	1.90	0.09	0.50	0.95	0.09
	10.3	2.25	0.13	0.50	1.13	0.15
	10.8	2.35	0.18	0.50	1.18	0.21
	11.3	2.55	0.18	0.50	1.28	0.23
	11.8	2.65	0.16	0.50	1.33	0.21
	12.3	2.90	0.13	0.50	1.45	0.19
	12.8	3.00	0.13	0.50	1.50	0.20
	13.3	3.00	0.13	0.50	1.50	0.20
	13.8	3.05	0.16	0.50	1.53	0.24
	14.3	3.05	0.19	0.50	1.53	0.29
	14.8	3.05	0.19	0.50	1.53	0.29
	15.3	3.00	0.19	0.50	1.50	0.29
	15.8	3.15	0.19	0.50	1.58	0.30
	16.3	3.15	0.20	0.50	1.58	0.32
	16.8	2.95	0.21	0.50	1.48	0.31
	17.3	3.00	0.24	0.50	1.50	0.36
	17.8	2.90	0.24	0.50	1.45	0.35
	18.3	2.85	0.24	0.50	1.43	0.34
	18.8	2.85	0.25	0.50	1.43	0.36
	19.3	2.70	0.28	0.50	1.35	0.38
	19.8	2.65	0.34	0.50	1.33	0.45
	20.3	2.50	0.38	0.50	1.25	0.48
	20.8	2.50	0.42	0.50	1.25	0.53
	21.3	2.40	0.44	0.50	1.20	0.53
	21.8	2.30	0.39	0.50	1.15	0.45
	22.3	2.10	0.33	0.50	1.05	0.35
	22.8	1.80	0.27	0.50	0.90	0.24
	23.3	1.80	0.27	0.50	0.90	0.24
	23.8	1.55	0.28	0.50	0.78	0.22
	24.3	1.45	0.29	0.50	0.73	0.21
	24.8	1.40	0.26	0.50	0.70	0.18
	25.3	1.30	0.25	0.50	0.65	0.16
	25.8	1.10	0.22	0.50	0.55	0.12
	26.3	1.00	0.19	0.50	0.50	0.10
	26.8	1.00	0.16	0.50	0.50	0.08
	27.3	0.90	0.14	0.50	0.45	0.06
	27.8	0.80	0.12	0.50	0.40	0.05
	28.3	0.75	0.07	0.50	0.38	0.03
	28.8	0.65	0.03	0.50	0.33	0.01
	29.3	0.10	0.00	0.50	0.05	0.00
	29.8	0.15	0.00	0.50	0.08	0.00
	30.3	0.15	0.00	0.50	0.08	0.00
	30.8	0.00	0.00	0.45	0.00	0.00
RWE	31.2					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	3.15	0.44	0.50	1.58	0.53
Average	1.80	0.17	0.50	0.90	0.19
Sum				50.38	10.36

Wetted Width	28.4	*RWE-LWE*
Mean Depth	1.77	*sum cell area / wetted width*
Discharge	10.36	*sum of discharge*

El Sur Velocity Transect #2

Date:	8/31/2004
Location:	midpoint
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	
Levelling Notes:	
Depth to water	
Start time:	17:15
End time:	17:35

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.40	0.04	0.50	0.20	0.01
	3.8	0.55	0.05	0.50	0.28	0.01
	4.3	0.65	0.05	0.50	0.33	0.02
	4.8	0.70	0.06	0.50	0.35	0.02
	5.3	0.80	0.05	0.50	0.40	0.02
	5.8	0.85	0.06	0.50	0.43	0.03
	6.3	1.00	0.06	0.50	0.50	0.03
	6.8	1.15	0.07	0.50	0.58	0.04
	7.3	1.30	0.06	0.50	0.65	0.04
	7.8	1.50	0.07	0.50	0.75	0.05
	8.3	1.60	0.08	0.50	0.80	0.06
	8.8	1.65	0.09	0.50	0.83	0.07
	9.3	1.80	0.09	0.50	0.90	0.08
	9.8	1.90	0.10	0.50	0.95	0.10
	10.3	2.20	0.10	0.50	1.10	0.11
	10.8	2.40	0.10	0.50	1.20	0.12
	11.3	2.50	0.11	0.50	1.25	0.14
	11.8	2.65	0.12	0.50	1.33	0.16
	12.3	2.90	0.13	0.50	1.45	0.19
	12.8	3.00	0.14	0.50	1.50	0.21
	13.3	3.00	0.14	0.50	1.50	0.21
	13.8	3.05	0.15	0.50	1.53	0.23
	14.3	3.00	0.16	0.50	1.50	0.24
	14.8	3.05	0.16	0.50	1.53	0.24
	15.3	3.05	0.16	0.50	1.53	0.24
	15.8	3.05	0.16	0.50	1.53	0.24
	16.3	2.95	0.17	0.50	1.48	0.25
	16.8	3.00	0.19	0.50	1.50	0.29
	17.3	3.00	0.20	0.50	1.50	0.30
	17.8	2.90	0.22	0.50	1.45	0.32
	18.3	2.90	0.22	0.50	1.45	0.32
	18.8	2.85	0.28	0.50	1.43	0.40
	19.3	2.60	0.28	0.50	1.30	0.36
	19.8	2.50	0.30	0.50	1.25	0.38
	20.3	2.55	0.40	0.50	1.28	0.51
	20.8	2.50	0.39	0.50	1.25	0.49
	21.3	2.30	0.36	0.50	1.15	0.41
	21.8	2.10	0.31	0.50	1.05	0.33
	22.3	2.00	0.29	0.50	1.00	0.29
	22.8	1.90	0.27	0.50	0.95	0.26
	23.3	1.70	0.25	0.50	0.85	0.21
	23.8	1.55	0.24	0.50	0.78	0.19
	24.3	1.50	0.20	0.50	0.75	0.15
	24.8	1.20	0.17	0.50	0.60	0.10
	25.3	1.10	0.14	0.50	0.55	0.08
	25.8	1.00	0.12	0.50	0.50	0.06
	26.3	0.95	0.11	0.50	0.48	0.05
	26.8	0.90	0.09	0.50	0.45	0.04
	27.3	0.80	0.07	0.50	0.40	0.03
	27.8	0.70	0.05	0.50	0.35	0.02
	28.3	0.75	0.12	0.50	0.38	0.05
	28.8	0.85	0.11	0.50	0.43	0.05
	29.3	0.75	0.10	0.50	0.38	0.04
	29.8	0.65	0.11	0.50	0.33	0.04
	30.3	0.10	0.00	0.50	0.05	0.00
	30.8	0.20	0.00	0.50	0.10	0.00
	31.3	0.10	0.00	0.50	0.05	0.00
RWE	31.8					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.10	0.00	0.50	0.05	0.00
Maximum	3.05	0.40	0.50	1.53	0.51
Average	1.76	0.15	0.50	0.88	0.16
Sum				50.28	8.90

Wetted Width	29	*RWE-LWE*
Mean Depth	1.73	*sum cell area / wetted width*
Discharge	8.90	*sum of discharge*

El Sur Velocity Transect #2

Date:	8/31/2004
Location:	mid point
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.2
Levelling Notes:	
Depth to water	2.13
Start time:	6:02
End time:	6:21

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (*depth * width*)	Cell Discharge (*Vel * Area*)
LWE	2.8					
	3.3	0.45	0.00	0.50	0.23	0.00
	3.8	0.55	0.00	0.50	0.28	0.00
	4.3	0.70	0.00	0.50	0.35	0.00
	4.8	0.75	0.00	0.50	0.38	0.00
	5.3	0.90	0.00	0.50	0.45	0.00
	5.8	0.90	0.02	0.50	0.45	0.01
	6.3	1.05	0.04	0.50	0.53	0.02
	6.8	1.20	0.04	0.50	0.60	0.02
	7.3	1.40	0.04	0.50	0.70	0.03
	7.8	1.50	0.02	0.50	0.75	0.02
	8.3	1.70	0.02	0.50	0.85	0.02
	8.8	1.75	0.02	0.50	0.88	0.02
	9.3	1.90	0.03	0.50	0.95	0.03
	9.8	2.00	0.04	0.50	1.00	0.04
	10.3	2.05	0.04	0.50	1.03	0.04
	10.8	2.40	0.07	0.50	1.20	0.08
	11.3	2.75	0.12	0.50	1.38	0.17
	11.8	2.70	0.13	0.50	1.35	0.18
	12.3	2.95	0.12	0.50	1.48	0.18
	12.8	3.05	0.12	0.50	1.53	0.18
	13.3	3.10	0.13	0.50	1.55	0.20
	13.8	3.05	0.13	0.50	1.53	0.20
	14.3	3.05	0.14	0.50	1.53	0.21
	14.8	3.05	0.15	0.50	1.53	0.23
	15.3	3.10	0.15	0.50	1.55	0.23
	15.8	3.05	0.17	0.50	1.53	0.26
	16.3	3.05	0.17	0.50	1.53	0.26
	16.8	3.00	0.17	0.50	1.50	0.26
	17.3	3.10	0.19	0.50	1.55	0.29
	17.8	2.95	0.22	0.50	1.48	0.32
	18.3	2.90	0.22	0.50	1.45	0.32
	18.8	2.90	0.26	0.50	1.45	0.38
	19.3	2.60	0.33	0.50	1.30	0.43
	19.8	2.65	0.37	0.50	1.33	0.49
	20.3	2.40	0.38	0.50	1.20	0.46
	20.8	2.50	0.37	0.50	1.25	0.46
	21.3	2.40	0.36	0.50	1.20	0.43
	21.8	2.35	0.36	0.50	1.18	0.42
	22.3	2.20	0.32	0.50	1.10	0.35
	22.8	2.00	0.30	0.50	1.00	0.30
	23.3	1.85	0.22	0.50	0.93	0.20
	23.8	1.70	0.20	0.50	0.85	0.17
	24.3	1.60	0.21	0.50	0.80	0.17
	24.8	1.40	0.20	0.50	0.70	0.14
	25.3	1.30	0.18	0.50	0.65	0.12
	25.8	1.15	0.15	0.50	0.58	0.09
	26.3	1.05	0.14	0.50	0.53	0.07
	26.8	0.95	0.10	0.50	0.48	0.05
	27.3	0.90	0.08	0.50	0.45	0.04
	27.8	0.80	0.06	0.50	0.40	0.02
	28.3	0.75	0.04	0.50	0.38	0.02
	28.8	0.70	0.01	0.50	0.35	0.00
	29.3	0.50	0.00	0.50	0.25	0.00
	29.8	0.15	0.00	0.50	0.08	0.00
	30.3	0.10	0.00	0.50	0.05	0.00
	30.8	0.10	0.00	0.50	0.05	0.00
	31.3	0.00	0.00	0.32	0.00	0.00
RWE	31.45					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.32	0.00	0.00
Maximum	3.10	0.38	0.50	1.55	0.49
Average	1.81	0.13	0.50	0.90	0.15
Sum				51.53	8.62

Wetted Width	28.65	*RWE-LWE*
Mean Depth	1.80	*sum cell area / wetted width*
Discharge	8.62	*sum of discharge*

El Sur Velocity Transect #1

Date:	9/1/2004
Location:	near car park
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.35
Levelling Notes:	0.95
Depth to water	2.5
Still Well:	1.14
Start time:	16:15
End time:	16:39

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area *depth * width*	Cell Discharge *Vel * Area*
LWE	3.3					
	3.8	0.20	0.06	0.50	0.10	0.01
	4.3	0.40	0.12	0.50	0.20	0.02
	4.8	0.40	0.15	0.50	0.20	0.03
	5.3	0.50	0.18	0.50	0.25	0.05
	5.8	0.60	0.19	0.50	0.30	0.06
	6.3	0.65	0.20	0.50	0.33	0.07
	6.8	0.70	0.20	0.50	0.35	0.07
	7.3	0.70	0.21	0.50	0.35	0.07
	7.8	0.80	0.20	0.50	0.40	0.08
	8.3	0.90	0.22	0.50	0.45	0.10
	8.8	0.90	0.23	0.50	0.45	0.10
	9.3	1.00	0.23	0.50	0.50	0.12
	9.8	1.00	0.23	0.50	0.50	0.12
	10.3	1.10	0.23	0.50	0.55	0.13
	10.8	1.20	0.24	0.50	0.60	0.14
	11.3	1.10	0.25	0.50	0.55	0.14
	11.8	1.30	0.25	0.50	0.65	0.16
	12.3	1.30	0.24	0.50	0.65	0.16
	12.8	1.35	0.24	0.50	0.68	0.16
	13.3	1.45	0.27	0.50	0.73	0.20
	13.8	1.50	0.27	0.50	0.75	0.20
	14.3	1.25	0.29	0.50	0.63	0.18
	14.8	1.05	0.31	0.50	0.53	0.16
	15.3	1.35	0.33	0.50	0.68	0.22
	15.8	1.30	0.35	0.50	0.65	0.23
	16.3	1.35	0.37	0.50	0.68	0.25
	16.8	1.50	0.33	0.50	0.75	0.25
	17.3	1.35	0.33	0.50	0.68	0.22
	17.8	1.40	0.37	0.50	0.70	0.26
	18.3	1.30	0.38	0.50	0.65	0.25
	18.8	1.20	0.38	0.50	0.60	0.23
	19.3	1.10	0.41	0.50	0.55	0.23
	19.8	1.15	0.38	0.50	0.58	0.22
	20.3	1.15	0.39	0.50	0.58	0.22
	20.8	1.10	0.40	0.50	0.55	0.22
	21.3	1.10	0.43	0.50	0.55	0.24
	21.8	1.20	0.41	0.50	0.60	0.25
	22.3	1.20	0.44	0.50	0.60	0.26
	22.8	1.20	0.45	0.50	0.60	0.27
	23.3	1.10	0.45	0.50	0.55	0.25
	23.8	0.80	0.46	0.50	0.40	0.18
	24.3	0.90	0.45	0.50	0.45	0.20
	24.8	1.20	0.47	0.50	0.60	0.28
	25.3	1.20	0.47	0.50	0.60	0.28
	25.8	1.10	0.48	0.50	0.55	0.26
	26.3	0.90	0.49	0.50	0.45	0.22
	26.8	1.00	0.46	0.50	0.50	0.23
	27.3	1.00	0.46	0.50	0.50	0.23
	27.8	1.00	0.46	0.50	0.50	0.23
	28.3	0.80	0.49	0.50	0.40	0.20
	28.8	1.00	0.47	0.50	0.50	0.24
	29.3	0.80	0.48	0.50	0.40	0.19
	29.8	0.75	0.48	0.50	0.38	0.18
	30.3	0.80	0.49	0.50	0.40	0.20
	30.8	0.60	0.44	0.50	0.30	0.13
	31.3	0.65	0.16	0.50	0.33	0.05
	31.8	0.40	0.13	0.50	0.20	0.03
	32.3	0.50	0.24	0.50	0.25	0.06
	32.8	0.35	0.32	0.50	0.18	0.06
	33.3	0.40	0.33	0.50	0.20	0.07
	33.8	0.30	0.30	0.50	0.15	0.05
	34.3	0.20	0.25	0.50	0.10	0.03
	34.8	0.20	0.11	0.50	0.10	0.01
	35.3	0.00	0.00	0.50	0.00	0.00
	35.8	0.00	0.00	0.50	0.00	0.00
	36.3	0.05	0.00	0.50	0.03	0.00
	36.8	0.00	0.00	0.50	0.00	0.00
	37.3	0.00	0.00	0.40	0.00	0.00
RWE	37.6					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.40	0.00	0.00
Maximum	1.50	0.49	0.50	0.75	0.28
Average	0.87	0.30	0.50	0.44	0.15
Sum				29.65	10.17

Wetted Width	34.3	*RWE-LWE*
Mean Depth	0.86	*sum cell area / wetted width*
Discharge	10.17	*sum of discharge*

El Sur Velocity Transect #1

Date:	9/1/2004
Location:	near carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	
Levelling Notes:	
Depth to water	
Start time:	16:40
End time:	16:55

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	3.3					
	3.8	0.20	0.04	0.50	0.10	0.00
	4.3	0.25	0.09	0.50	0.13	0.01
	4.8	0.40	0.11	0.50	0.20	0.02
	5.3	0.50	0.15	0.50	0.25	0.04
	5.8	0.60	0.17	0.50	0.30	0.05
	6.3	0.60	0.19	0.50	0.30	0.06
	6.8	0.70	0.21	0.50	0.35	0.07
	7.3	0.70	0.21	0.50	0.35	0.07
	7.8	0.75	0.20	0.50	0.38	0.08
	8.3	0.90	0.20	0.50	0.45	0.09
	8.8	0.90	0.20	0.50	0.45	0.09
	9.3	1.00	0.21	0.50	0.50	0.11
	9.8	1.00	0.22	0.50	0.50	0.11
	10.3	1.10	0.21	0.50	0.55	0.12
	10.8	1.20	0.22	0.50	0.60	0.13
	11.3	1.00	0.23	0.50	0.50	0.12
	11.8	1.30	0.24	0.50	0.65	0.16
	12.3	1.30	0.24	0.50	0.65	0.16
	12.8	1.40	0.23	0.50	0.70	0.16
	13.3	1.45	0.27	0.50	0.73	0.20
	13.8	1.50	0.27	0.50	0.75	0.20
	14.3	1.00	0.28	0.50	0.50	0.14
	14.8	1.00	0.29	0.50	0.50	0.15
	15.3	1.40	0.27	0.50	0.70	0.19
	15.8	1.30	0.30	0.50	0.65	0.20
	16.3	1.40	0.34	0.50	0.70	0.24
	16.8	1.45	0.32	0.50	0.73	0.23
	17.3	1.30	0.33	0.50	0.65	0.21
	17.8	1.40	0.34	0.50	0.70	0.24
	18.3	1.20	0.36	0.50	0.60	0.22
	18.8	1.20	0.37	0.50	0.60	0.22
	19.3	1.10	0.38	0.50	0.55	0.21
	19.8	1.00	0.37	0.50	0.50	0.19
	20.3	1.15	0.38	0.50	0.58	0.22
	20.8	1.00	0.40	0.50	0.50	0.20
	21.3	1.10	0.41	0.50	0.55	0.23
	21.8	1.20	0.45	0.50	0.60	0.27
	22.3	1.20	0.43	0.50	0.60	0.26
	22.8	1.20	0.44	0.50	0.60	0.26
	23.3	1.30	0.44	0.50	0.65	0.29
	23.8	1.20	0.44	0.50	0.60	0.26
	24.3	0.90	0.46	0.50	0.45	0.21
	24.8	1.20	0.42	0.50	0.60	0.25
	25.3	1.05	0.44	0.50	0.53	0.23
	25.8	1.15	0.47	0.50	0.58	0.27
	26.3	0.90	0.48	0.50	0.45	0.22
	26.8	1.05	0.49	0.50	0.53	0.26
	27.3	1.00	0.49	0.50	0.50	0.25
	27.8	1.10	0.47	0.50	0.55	0.26
	28.3	1.05	0.47	0.50	0.53	0.25
	28.8	1.00	0.46	0.50	0.50	0.23
	29.3	0.90	0.47	0.50	0.45	0.21
	29.8	0.70	0.46	0.50	0.35	0.16
	30.3	0.80	0.45	0.50	0.40	0.18
	30.8	0.60	0.43	0.50	0.30	0.13
	31.3	0.60	0.17	0.50	0.30	0.05
	31.8	0.40	0.18	0.50	0.20	0.04
	32.3	0.30	0.24	0.50	0.15	0.04
	32.8	0.45	0.32	0.50	0.23	0.07
	33.3	0.30	0.34	0.50	0.15	0.05
	33.8	0.20	0.28	0.50	0.10	0.03
	34.3	0.20	0.18	0.50	0.10	0.02
	34.8	0.30	0.15	0.50	0.15	0.02
	35.3	0.05	0.00	0.50	0.03	0.00
	35.8	0.05	0.00	0.50	0.03	0.00
	36.3	0.00	0.00	0.50	0.00	0.00
	36.8	0.00	0.00	0.50	0.00	0.00
	37.3	0.00	0.00	0.40	0.00	0.00
RWE	37.6					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.40	0.00	0.00
Maximum	1.50	0.49	0.50	0.75	0.29
Average	0.87	0.29	0.50	0.43	0.14
Sum				29.55	9.85

Wetted Width	34.3	*RWE-LWE*
Mean Depth	0.86	*sum cell area / wetted width*
Discharge	9.85	*sum of discharge*

El Sur Velocity Transect #1

Date:	9/1/2004
Location:	carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.55
Levelling Notes:	1.6
Depth to water	2
Still Well:	1.01
Start time:	5:50
End time:	6:15

*=((B16-B15)*0.5)+((B15-B14)*0.5)

Distance	Depth	Velocity	Cell Width	Cell Area (depth * width)	Cell Discharge (Vel * Area)	
3.5						LWE
4	0.20	0.00	0.50	0.10	0.00	
4.5	0.40	0.05	0.50	0.20	0.01	
5	0.50	0.08	0.50	0.25	0.02	
5.5	0.60	0.09	0.50	0.30	0.03	
6	0.70	0.11	0.50	0.35	0.04	
6.5	0.70	0.10	0.50	0.35	0.04	
7	0.70	0.11	0.50	0.35	0.04	
7.5	0.80	0.12	0.50	0.40	0.05	
8	0.80	0.13	0.50	0.40	0.05	
8.5	0.90	0.14	0.50	0.45	0.06	
9	0.95	0.13	0.50	0.48	0.06	
9.5	1.00	0.14	0.50	0.50	0.07	
10	1.10	0.15	0.50	0.55	0.08	
10.5	1.15	0.15	0.50	0.58	0.09	
11	1.20	0.16	0.50	0.60	0.10	
11.5	1.30	0.14	0.50	0.65	0.09	
12	1.30	0.15	0.50	0.65	0.10	
12.5	1.40	0.15	0.50	0.70	0.11	
13	1.45	0.17	0.50	0.73	0.12	
13.5	1.50	0.17	0.50	0.75	0.13	
14	1.50	0.18	0.50	0.75	0.14	
14.5	1.25	0.21	0.50	0.63	0.13	
15	1.30	0.23	0.50	0.65	0.15	
15.5	1.35	0.29	0.50	0.68	0.20	
16	1.40	0.30	0.50	0.70	0.21	
16.5	1.50	0.28	0.50	0.75	0.21	
17	1.30	0.27	0.50	0.65	0.18	
17.5	1.50	0.29	0.50	0.75	0.22	
18	1.50	0.29	0.50	0.75	0.22	
18.5	1.20	0.34	0.50	0.60	0.20	
19	1.10	0.33	0.50	0.55	0.18	
19.5	1.15	0.33	0.50	0.58	0.19	
20	1.20	0.32	0.50	0.60	0.19	
20.5	1.20	0.35	0.50	0.60	0.21	
21	1.25	0.30	0.50	0.63	0.19	
21.5	1.30	0.30	0.50	0.65	0.20	
22	1.25	0.34	0.50	0.63	0.21	
22.5	1.30	0.41	0.50	0.65	0.27	
23	1.30	0.36	0.50	0.65	0.23	
23.5	0.90	0.41	0.50	0.45	0.18	
24	0.85	0.44	0.50	0.43	0.19	
24.5	1.00	0.46	0.50	0.50	0.23	
25	1.20	0.42	0.50	0.60	0.25	
25.5	1.20	0.38	0.50	0.60	0.23	
26	0.80	0.41	0.50	0.40	0.16	
26.5	0.90	0.40	0.50	0.45	0.18	
27	1.00	0.39	0.50	0.50	0.20	
27.5	1.00	0.38	0.50	0.50	0.19	
28	1.00	0.37	0.50	0.50	0.19	
28.5	0.95	0.39	0.50	0.48	0.19	
29	0.90	0.41	0.50	0.45	0.18	
29.5	1.00	0.39	0.50	0.50	0.20	
30	0.90	0.37	0.50	0.45	0.17	
30.5	0.80	0.36	0.50	0.40	0.14	
31	0.60	0.38	0.50	0.30	0.11	
31.5	0.60	0.21	0.50	0.30	0.06	
32	0.70	0.20	0.50	0.35	0.07	
32.5	0.45	0.27	0.50	0.23	0.06	
33	0.35	0.27	0.50	0.18	0.05	
33.5	0.40	0.26	0.50	0.20	0.05	
34	0.20	0.28	0.50	0.10	0.03	
34.5	0.30	0.27	0.50	0.15	0.04	
35	0.30	0.18	0.50	0.15	0.03	
35.5	0.10	0.00	0.50	0.05	0.00	
36	0.20	0.00	0.50	0.10	0.00	
36.5	0.10	0.00	0.50	0.05	0.00	
37	0.00	0.00	0.50	0.00	0.00	
37.5	0.00	0.00	0.50	0.00	0.00	
38	0.00	0.00	0.35	0.00	0.00	
38.2						RWE

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.35	0.00	0.00
Maximum	1.50	0.46	0.50	0.75	0.27
Average	0.90	0.24	0.50	0.45	0.12
Sum				31.10	8.36

Wetted Width	34.7	*RWE-LWE*
Mean Depth	0.90	*sum cell area / wetted width*
Discharge	8.36	*sum of discharge*

El Sur Velocity Transect #2

Date: 9/1/2004
Location: midstream
Pin 1 GPS (Left bank facing upstream):
Pin 2 GPS (Right bank facing upstream):
Transect Length Pin to Pin: 36.25
Levelling Notes:
Depth to water 2.1
Start time: 15:00
End time: 15:34

*=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.40	0.10	0.50	0.20	0.02
	3.8	0.60	0.13	0.50	0.30	0.04
	4.3	0.65	0.15	0.50	0.33	0.05
	4.8	0.70	0.16	0.50	0.35	0.06
	5.3	0.80	0.17	0.50	0.40	0.07
	5.8	0.85	0.19	0.50	0.43	0.08
	6.3	1.10	0.17	0.50	0.55	0.09
	6.8	1.30	0.17	0.50	0.65	0.11
	7.3	1.40	0.16	0.50	0.70	0.11
	7.8	1.60	0.17	0.50	0.80	0.14
	8.3	1.70	0.18	0.50	0.85	0.15
	8.8	1.80	0.19	0.50	0.90	0.17
	9.3	1.95	0.21	0.50	0.98	0.20
	9.8	2.10	0.24	0.50	1.05	0.25
	10.3	2.40	0.27	0.50	1.20	0.32
	10.8	2.70	0.28	0.50	1.35	0.38
	11.3	2.80	0.25	0.50	1.40	0.35
	11.8	2.90	0.24	0.50	1.45	0.35
	12.3	3.00	0.24	0.50	1.50	0.36
	12.8	3.00	0.25	0.50	1.50	0.38
	13.3	3.00	0.26	0.50	1.50	0.39
	13.8	3.05	0.26	0.50	1.53	0.40
	14.3	3.05	0.26	0.50	1.53	0.40
	14.8	3.00	0.26	0.50	1.50	0.39
	15.3	2.95	0.28	0.50	1.48	0.41
	15.8	3.00	0.29	0.50	1.50	0.44
	16.3	3.05	0.31	0.50	1.53	0.47
	16.8	3.00	0.31	0.50	1.50	0.47
	17.3	3.10	0.32	0.50	1.55	0.50
	17.8	3.00	0.32	0.50	1.50	0.48
	18.3	2.85	0.31	0.50	1.43	0.44
	18.8	2.60	0.34	0.50	1.30	0.44
	19.3	2.60	0.38	0.50	1.30	0.49
	19.8	2.60	0.44	0.50	1.30	0.57
	20.3	2.35	0.46	0.50	1.18	0.54
	20.8	2.50	0.45	0.50	1.25	0.56
	21.3	2.20	0.44	0.50	1.10	0.48
	21.8	2.30	0.41	0.50	1.15	0.47
	22.3	2.10	0.39	0.50	1.05	0.41
	22.8	1.80	0.36	0.50	0.90	0.32
	23.3	1.70	0.34	0.50	0.85	0.29
	23.8	1.55	0.32	0.50	0.78	0.25
	24.3	1.40	0.32	0.50	0.70	0.22
	24.8	1.30	0.32	0.50	0.65	0.21
	25.3	1.20	0.32	0.50	0.60	0.19
	25.8	1.10	0.30	0.50	0.55	0.17
	26.3	1.05	0.27	0.50	0.53	0.14
	26.8	0.90	0.26	0.50	0.45	0.12
	27.3	0.80	0.25	0.50	0.40	0.10
	27.8	0.75	0.21	0.50	0.38	0.08
	28.3	0.70	0.19	0.50	0.35	0.07
	28.8	0.60	0.16	0.50	0.30	0.05
	29.3	0.20	0.05	0.50	0.10	0.01
	29.8	0.20	0.02	0.50	0.10	0.00
	30.3	0.15	0.04	0.50	0.08	0.00
	30.8	0.00	0.00	0.48	0.00	0.00
RWE	31.25					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.48	0.00	0.00
Maximum	3.10	0.46	0.50	1.55	0.57
Average	1.81	0.25	0.50	0.91	0.26
Sum				50.73	14.64

Wetted Width 28.45 *RWE-LWE*
Mean Depth 1.78 *sum cell area / wetted width*
Discharge 14.64 *sum of discharge*

El Sur Velocity Transect #2

Date: 9/1/2004
Location:
Pin 1 GPS (Left bank facing upstream):
Pin 2 GPS (Right bank facing upstream):
Transect Length Pin to Pin:
Levelling Notes: *=((B16-B15)*0.5)+((B15-B14)*0.5)
Depth to water
Start time: 15:35
End time: 16:00

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.45	0.06	0.50	0.23	0.01
	3.8	0.50	0.09	0.50	0.25	0.02
	4.3	0.60	0.14	0.50	0.30	0.04
	4.8	0.70	0.16	0.50	0.35	0.06
	5.3	0.75	0.18	0.50	0.38	0.07
	5.8	0.80	0.19	0.50	0.40	0.08
	6.3	1.00	0.18	0.50	0.50	0.09
	6.8	1.10	0.18	0.50	0.55	0.10
	7.3	1.35	0.19	0.50	0.68	0.13
	7.8	1.50	0.18	0.50	0.75	0.14
	8.3	1.60	0.17	0.50	0.80	0.14
	8.8	1.65	0.15	0.50	0.83	0.12
	9.3	1.80	0.15	0.50	0.90	0.14
	9.8	1.90	0.16	0.50	0.95	0.15
	10.3	2.20	0.23	0.50	1.10	0.25
	10.8	2.50	0.25	0.50	1.25	0.31
	11.3	2.60	0.25	0.50	1.30	0.33
	11.8	2.90	0.24	0.50	1.45	0.35
	12.3	2.90	0.24	0.50	1.45	0.35
	12.8	3.00	0.22	0.50	1.50	0.33
	13.3	3.00	0.22	0.50	1.50	0.33
	13.8	3.00	0.22	0.50	1.50	0.33
	14.3	3.10	0.24	0.50	1.55	0.37
	14.8	3.10	0.25	0.50	1.55	0.39
	15.3	2.95	0.24	0.50	1.48	0.35
	15.8	3.00	0.25	0.50	1.50	0.38
	16.3	3.05	0.28	0.50	1.53	0.43
	16.8	3.00	0.27	0.50	1.50	0.41
	17.3	3.00	0.28	0.50	1.50	0.42
	17.8	2.85	0.29	0.50	1.43	0.41
	18.3	2.90	0.29	0.50	1.45	0.42
	18.8	2.65	0.31	0.50	1.33	0.41
	19.3	2.60	0.38	0.50	1.30	0.49
	19.8	2.60	0.44	0.50	1.30	0.57
	20.3	2.44	0.44	0.50	1.22	0.54
	20.8	2.45	0.45	0.50	1.23	0.55
	21.3	2.35	0.46	0.50	1.18	0.54
	21.8	2.30	0.45	0.50	1.15	0.52
	22.3	2.10	0.40	0.50	1.05	0.42
	22.8	2.00	0.38	0.50	1.00	0.38
	23.3	1.80	0.34	0.50	0.90	0.31
	23.8	1.60	0.32	0.50	0.80	0.26
	24.3	1.50	0.33	0.50	0.75	0.25
	24.8	1.40	0.33	0.50	0.70	0.23
	25.3	1.20	0.33	0.50	0.60	0.20
	25.8	1.10	0.30	0.50	0.55	0.17
	26.3	1.05	0.28	0.50	0.53	0.15
	26.8	0.90	0.24	0.50	0.45	0.11
	27.3	0.85	0.22	0.50	0.43	0.09
	27.8	0.80	0.19	0.50	0.40	0.08
	28.3	0.70	0.16	0.50	0.35	0.06
	28.8	0.60	0.13	0.50	0.30	0.04
	29.3	0.50	0.08	0.50	0.25	0.02
	29.8	0.20	0.00	0.50	0.10	0.00
	30.3	0.10	0.00	0.50	0.05	0.00
	30.8	0.00	0.00	0.48	0.00	0.00
RWE	31.25					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.48	0.00	0.00
Maximum	3.10	0.46	0.50	1.55	0.57
Average	1.80	0.24	0.50	0.90	0.25
Sum				50.27	13.79

Wetted Width 28.45 *RWE-LWE*
Mean Depth 1.77 *sum cell area / wetted width*
Discharge 13.79 *sum of discharge*

El Sur Velocity Transect #2

Date:	9/1/2004
Location:	midpoint
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36
Levelling Notes:	
Depth to water	2.15
Start time:	4:50
End time:	5:22

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (*depth * width*)	Cell Discharge (*Vel * Area*)
LWE	2.8					
	3.3	0.50	0.02	0.50	0.25	0.01
	3.8	0.50	0.05	0.50	0.25	0.01
	4.3	0.50	0.06	0.50	0.25	0.02
	4.8	0.80	0.06	0.50	0.40	0.02
	5.3	0.90	0.07	0.50	0.45	0.03
	5.8	0.90	0.08	0.50	0.45	0.04
	6.3	1.00	0.07	0.50	0.50	0.04
	6.8	1.20	0.08	0.50	0.60	0.05
	7.3	1.30	0.07	0.50	0.65	0.05
	7.8	1.50	0.07	0.50	0.75	0.05
	8.3	1.60	0.06	0.50	0.80	0.05
	8.8	1.75	0.05	0.50	0.88	0.04
	9.3	1.90	0.04	0.50	0.95	0.04
	9.8	1.90	0.04	0.50	0.95	0.04
	10.3	1.80	0.04	0.50	0.90	0.04
	10.8	1.90	0.11	0.50	0.95	0.10
	11.3	2.50	0.13	0.50	1.25	0.16
	11.8	2.70	0.12	0.50	1.35	0.16
	12.3	2.80	0.12	0.50	1.40	0.17
	12.8	3.00	0.10	0.50	1.50	0.15
	13.3	3.10	0.12	0.50	1.55	0.19
	13.8	3.00	0.13	0.50	1.50	0.20
	14.3	3.05	0.15	0.50	1.53	0.23
	14.8	3.05	0.16	0.50	1.53	0.24
	15.3	3.10	0.17	0.50	1.55	0.26
	15.8	3.00	0.19	0.50	1.50	0.29
	16.3	3.10	0.17	0.50	1.55	0.26
	16.8	3.05	0.18	0.50	1.53	0.27
	17.3	3.05	0.19	0.50	1.53	0.29
	17.8	2.80	0.19	0.50	1.40	0.27
	18.3	2.90	0.19	0.50	1.45	0.28
	18.8	2.65	0.26	0.50	1.33	0.34
	19.3	2.60	0.30	0.50	1.30	0.39
	19.8	2.50	0.33	0.50	1.25	0.41
	20.3	2.40	0.39	0.50	1.20	0.47
	20.8	2.50	0.39	0.50	1.25	0.49
	21.3	2.40	0.40	0.50	1.20	0.48
	21.8	2.30	0.32	0.50	1.15	0.37
	22.3	2.10	0.31	0.50	1.05	0.33
	22.8	2.00	0.27	0.50	1.00	0.27
	23.3	1.80	0.22	0.50	0.90	0.20
	23.8	1.70	0.20	0.50	0.85	0.17
	24.3	1.50	0.20	0.50	0.75	0.15
	24.8	1.50	0.21	0.50	0.75	0.16
	25.3	1.20	0.21	0.50	0.60	0.13
	25.8	1.20	0.20	0.50	0.60	0.12
	26.3	1.05	0.17	0.50	0.53	0.09
	26.8	0.90	0.12	0.50	0.45	0.05
	27.3	0.90	0.11	0.50	0.45	0.05
	27.8	0.80	0.09	0.50	0.40	0.04
	28.3	0.70	0.08	0.50	0.35	0.03
	28.8	0.70	0.07	0.50	0.35	0.02
	29.3	0.20	0.00	0.50	0.10	0.00
	29.8	0.20	0.00	0.50	0.10	0.00
	30.3	0.10	0.00	0.50	0.05	0.00
	30.8	0.05	0.00	0.50	0.03	0.00
	31.3	0.05	0.00	0.32	0.02	0.00
RWE	31.45					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.05	0.00	0.32	0.02	0.00
Maximum	3.10	0.40	0.50	1.55	0.49
Average	1.76	0.14	0.50	0.88	0.15
Sum				50.07	8.78

Wetted Width	28.65	*RWE-LWE*
Mean Depth	1.75	*sum cell area / wetted width*
Discharge	8.78	*sum of discharge*

El Sur Velocity Transect #1

Date:	9/2/2004
Location:	carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.25
Levelling Notes:	1.325
Depth to water	2.15
still well:	1.02
Start time:	5:30
End time:	6:00

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	3					
	3.5	0.20	0.00	0.50	0.10	0.00
	4	0.40	0.00	0.50	0.20	0.00
	4.5	0.50	0.01	0.50	0.25	0.00
	5	0.50	0.05	0.50	0.25	0.01
	5.5	0.60	0.05	0.50	0.30	0.02
	6	0.70	0.07	0.50	0.35	0.02
	6.5	0.75	0.06	0.50	0.38	0.02
	7	0.75	0.08	0.50	0.38	0.03
	7.5	0.90	0.09	0.50	0.45	0.04
	8	0.90	0.07	0.50	0.45	0.03
	8.5	0.90	0.09	0.50	0.45	0.04
	9	1.00	0.09	0.50	0.50	0.05
	9.5	1.05	0.11	0.50	0.53	0.06
	10	1.10	0.09	0.50	0.55	0.05
	10.5	1.20	0.10	0.50	0.60	0.06
	11	1.30	0.11	0.50	0.65	0.07
	11.5	1.30	0.11	0.50	0.65	0.07
	12	1.35	0.11	0.50	0.68	0.07
	12.5	1.20	0.12	0.50	0.60	0.07
	13	1.50	0.16	0.50	0.75	0.12
	13.5	1.10	0.18	0.50	0.55	0.10
	14	1.05	0.20	0.50	0.53	0.11
	14.5	1.40	0.20	0.50	0.70	0.14
	15	1.35	0.25	0.50	0.68	0.17
	15.5	1.25	0.26	0.50	0.63	0.16
	16	1.50	0.24	0.50	0.75	0.18
	16.5	1.50	0.19	0.50	0.75	0.14
	17	1.40	0.22	0.50	0.70	0.15
	17.5	1.40	0.31	0.50	0.70	0.22
	18	1.40	0.28	0.50	0.70	0.20
	18.5	1.60	0.30	0.50	0.80	0.24
	19	1.20	0.29	0.50	0.60	0.17
	19.5	1.00	0.30	0.50	0.50	0.15
	20	1.20	0.30	0.50	0.60	0.18
	20.5	1.20	0.29	0.50	0.60	0.17
	21	1.10	0.29	0.50	0.55	0.16
	21.5	1.20	0.32	0.50	0.60	0.19
	22	1.40	0.33	0.50	0.70	0.23
	22.5	1.20	0.35	0.50	0.60	0.21
	23	1.20	0.34	0.50	0.60	0.20
	23.5	1.20	0.36	0.50	0.60	0.22
	24	1.00	0.40	0.50	0.50	0.20
	24.5	1.00	0.36	0.50	0.50	0.18
	25	1.25	0.37	0.50	0.63	0.23
	25.5	1.15	0.38	0.50	0.58	0.22
	26	1.15	0.34	0.50	0.58	0.20
	26.5	1.00	0.36	0.50	0.50	0.18
	27	1.00	0.40	0.50	0.50	0.20
	27.5	1.05	0.40	0.50	0.53	0.21
	28	1.10	0.33	0.50	0.55	0.18
	28.5	1.00	0.31	0.50	0.50	0.16
	29	1.00	0.34	0.50	0.50	0.17
	29.5	0.80	0.37	0.50	0.40	0.15
	30	0.80	0.38	0.50	0.40	0.15
	30.5	0.70	0.27	0.50	0.35	0.09
	31	0.60	0.18	0.50	0.30	0.05
	31.5	0.60	0.01	0.50	0.30	0.00
	32	0.30	0.11	0.50	0.15	0.02
	32.5	0.50	0.11	0.50	0.25	0.03
	33	0.50	0.17	0.50	0.25	0.04
	33.5	0.40	0.00	0.50	0.20	0.00
	34	0.20	0.00	0.50	0.10	0.00
	34.5	0.30	0.14	0.50	0.15	0.02
	35	0.30	0.13	0.50	0.15	0.02
	35.5	0.10	0.00	0.50	0.05	0.00
	36	0.10	0.00	0.50	0.05	0.00
	36.5	0.00	0.00	0.50	0.00	0.00
	37	0.00	0.00	0.50	0.00	0.00
	37.5	0.00	0.00	0.45	0.00	0.00
RWE	37.9					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	1.60	0.40	0.50	0.80	0.24
Average	0.91	0.19	0.50	0.46	0.10
Sum				31.43	7.24

Wetted Width	34.9	*RWE-LWE*
Mean Depth	0.90	*sum cell area / wetted width*
Discharge	7.24	*sum of discharge*

El Sur Velocity Transect #1

Date:	9/2/2004
Location:	carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.6
Levelling Notes:	1.49
Depth to water	2.09
Start time:	16:24
End time:	16:50

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	3.5					
	4	0.20	0.00	0.50	0.10	0.00
	4.5	0.30	0.06	0.50	0.15	0.01
	5	0.40	0.11	0.50	0.20	0.02
	5.5	0.50	0.14	0.50	0.25	0.04
	6	0.60	0.21	0.50	0.30	0.06
	6.5	0.70	0.23	0.50	0.35	0.08
	7	0.70	0.24	0.50	0.35	0.08
	7.5	0.70	0.25	0.50	0.35	0.09
	8	0.80	0.25	0.50	0.40	0.10
	8.5	0.85	0.26	0.50	0.43	0.11
	9	0.90	0.26	0.50	0.45	0.12
	9.5	1.00	0.26	0.50	0.50	0.13
	10	1.00	0.26	0.50	0.50	0.13
	10.5	1.10	0.27	0.50	0.55	0.15
	11	1.20	0.27	0.50	0.60	0.16
	11.5	1.20	0.27	0.50	0.60	0.16
	12	1.25	0.28	0.50	0.63	0.18
	12.5	1.25	0.29	0.50	0.63	0.18
	13	1.30	0.30	0.50	0.65	0.20
	13.5	1.45	0.32	0.50	0.73	0.23
	14	1.50	0.33	0.50	0.75	0.25
	14.5	1.00	0.35	0.50	0.50	0.18
	15	1.00	0.36	0.50	0.50	0.18
	15.5	1.35	0.35	0.50	0.68	0.24
	16	1.25	0.37	0.50	0.63	0.23
	16.5	1.30	0.40	0.50	0.65	0.26
	17	1.45	0.38	0.50	0.73	0.28
	17.5	1.45	0.36	0.50	0.73	0.26
	18	1.30	0.38	0.50	0.65	0.25
	18.5	1.15	0.39	0.50	0.58	0.22
	19	1.10	0.42	0.50	0.55	0.23
	19.5	1.10	0.44	0.50	0.55	0.24
	20	1.00	0.46	0.50	0.50	0.23
	20.5	1.20	0.42	0.50	0.60	0.25
	21	1.05	0.42	0.50	0.53	0.22
	21.5	1.15	0.45	0.50	0.58	0.26
	22	1.20	0.45	0.50	0.60	0.27
	22.5	1.20	0.45	0.50	0.60	0.27
	23	1.20	0.45	0.50	0.60	0.27
	23.5	1.30	0.45	0.50	0.65	0.29
	24	1.10	0.47	0.50	0.55	0.26
	24.5	0.95	0.48	0.50	0.48	0.23
	25	1.20	0.50	0.50	0.60	0.30
	25.5	1.20	0.48	0.50	0.60	0.29
	26	1.00	0.50	0.50	0.50	0.25
	26.5	0.80	0.51	0.50	0.40	0.20
	27	0.90	0.51	0.50	0.45	0.23
	27.5	1.00	0.51	0.50	0.50	0.26
	28	0.90	0.51	0.50	0.45	0.23
	28.5	0.95	0.51	0.50	0.48	0.24
	29	0.95	0.51	0.50	0.48	0.24
	29.5	0.95	0.49	0.50	0.48	0.23
	30	0.90	0.48	0.50	0.45	0.22
	30.5	0.80	0.44	0.50	0.40	0.18
	31	0.70	0.26	0.50	0.35	0.09
	31.5	0.65	0.19	0.50	0.33	0.06
	32	0.40	0.20	0.50	0.20	0.04
	32.5	0.30	0.25	0.50	0.15	0.04
	33	0.40	0.27	0.50	0.20	0.05
	33.5	0.40	0.29	0.50	0.20	0.06
	34	0.20	0.23	0.50	0.10	0.02
	34.5	0.20	0.19	0.50	0.10	0.02
	35	0.30	0.21	0.50	0.15	0.03
	35.5	0.00	0.00	0.50	0.00	0.00
	36	0.00	0.00	0.50	0.00	0.00
	36.5	0.05	0.00	0.50	0.03	0.00
	37	0.00	0.00	0.50	0.00	0.00
	37.5	0.00	0.00	0.45	0.00	0.00
RWE	37.9					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	1.50	0.51	0.50	0.75	0.30
Average	0.87	0.32	0.50	0.43	0.16
Sum				29.43	10.87

Wetted Width	34.4	*RWE-LWE*
Mean Depth	0.86	*sum cell area / wetted width*
Discharge	10.87	*sum of discharge*

El Sur Velocity Transect #2

Date:	9/2/2004
Location:	midpoint
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36
Levelling Notes:	
Depth to water	2.05
Start time:	4:30
End time:	5:00

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (depth * width)	Cell Discharge (Vel * Area)
LWE	2.8					
	3.3	0.45	0.00	0.50	0.23	0.00
	3.8	0.45	0.00	0.50	0.23	0.00
	4.3	0.50	0.00	0.50	0.25	0.00
	4.8	0.90	0.02	0.50	0.45	0.01
	5.3	0.90	0.00	0.50	0.45	0.00
	5.8	0.95	0.00	0.50	0.48	0.00
	6.3	1.00	0.01	0.50	0.50	0.01
	6.8	1.10	0.00	0.50	0.55	0.00
	7.3	1.30	0.02	0.50	0.65	0.01
	7.8	1.50	0.03	0.50	0.75	0.02
	8.3	1.60	0.04	0.50	0.80	0.03
	8.8	1.70	0.03	0.50	0.85	0.03
	9.3	1.85	0.02	0.50	0.93	0.02
	9.8	1.95	0.02	0.50	0.98	0.02
	10.3	2.25	0.06	0.50	1.13	0.07
	10.8	2.40	0.09	0.50	1.20	0.11
	11.3	2.60	0.10	0.50	1.30	0.13
	11.8	2.70	0.12	0.50	1.35	0.16
	12.3	2.90	0.11	0.50	1.45	0.16
	12.8	3.00	0.10	0.50	1.50	0.15
	13.3	3.05	0.09	0.50	1.53	0.14
	13.8	3.05	0.12	0.50	1.53	0.18
	14.3	3.05	0.12	0.50	1.53	0.18
	14.8	3.05	0.13	0.50	1.53	0.20
	15.3	3.00	0.13	0.50	1.50	0.20
	15.8	3.10	0.14	0.50	1.55	0.22
	16.3	2.95	0.17	0.50	1.48	0.25
	16.8	3.00	0.18	0.50	1.50	0.27
	17.3	2.80	0.17	0.50	1.40	0.24
	17.8	2.90	0.17	0.50	1.45	0.25
	18.3	2.90	0.18	0.50	1.45	0.26
	18.8	2.60	0.27	0.50	1.30	0.35
	19.3	1.60	0.28	0.50	0.80	0.22
	19.8	1.60	0.29	0.50	0.80	0.23
	20.3	2.35	0.34	0.50	1.18	0.40
	20.8	2.15	0.31	0.50	1.08	0.33
	21.3	2.40	0.31	0.50	1.20	0.37
	21.8	2.30	0.32	0.50	1.15	0.37
	22.3	2.05	0.25	0.50	1.03	0.26
	22.8	1.90	0.24	0.50	0.95	0.23
	23.3	1.80	0.23	0.50	0.90	0.21
	23.8	1.65	0.21	0.50	0.83	0.17
	24.3	1.50	0.21	0.50	0.75	0.16
	24.8	1.50	0.22	0.50	0.75	0.17
	25.3	1.20	0.18	0.50	0.60	0.11
	25.8	1.20	0.16	0.50	0.60	0.10
	26.3	1.00	0.15	0.50	0.50	0.08
	26.8	0.95	0.12	0.50	0.48	0.06
	27.3	0.90	0.10	0.50	0.45	0.05
	27.8	0.80	0.09	0.50	0.40	0.04
	28.3	0.75	0.08	0.50	0.38	0.03
	28.8	0.65	0.06	0.50	0.33	0.02
	29.3	0.20	0.00	0.50	0.10	0.00
	29.8	0.20	0.00	0.50	0.10	0.00
	30.3	0.00	0.00	0.50	0.00	0.00
	30.8	0.00	0.00	0.50	0.00	0.00
	31.3	0.00	0.00	0.30	0.00	0.00
RWE	31.4					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.30	0.00	0.00
Maximum	3.10	0.34	0.50	1.55	0.40
Average	1.72	0.12	0.50	0.86	0.13
Sum				49.05	7.24

Wetted Width	28.6	*RWE-LWE*
Mean Depth	1.72	*sum cell area / wetted width*
Discharge	7.24	*sum of discharge*

El Sur Velocity Transect #2

Date: 9/2/2004
Location: midpoint
Pin 1 GPS (Left bank facing upstream):
Pin 2 GPS (Right bank facing upstream):
Transect Length Pin to Pin: 36.15
Levelling Notes:
Depth to water 2.18
Start time: 15:10
End time: 15:40

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (*depth * width*)	Cell Discharge (*Vel * Area*)
LWE	2.8					
	3.3	0.40	0.07	0.50	0.20	0.01
	3.8	0.60	0.09	0.50	0.30	0.03
	4.3	0.55	0.09	0.50	0.28	0.02
	4.8	0.80	0.08	0.50	0.40	0.03
	5.3	0.90	0.07	0.50	0.45	0.03
	5.8	0.90	0.07	0.50	0.45	0.03
	6.3	1.00	0.07	0.50	0.50	0.04
	6.8	1.20	0.05	0.50	0.60	0.03
	7.3	1.30	0.08	0.50	0.65	0.05
	7.8	1.50	0.07	0.50	0.75	0.05
	8.3	1.60	0.06	0.50	0.80	0.05
	8.8	1.70	0.10	0.50	0.85	0.09
	9.3	1.80	0.11	0.50	0.90	0.10
	9.8	2.00	0.13	0.50	1.00	0.13
	10.3	2.30	0.15	0.50	1.15	0.17
	10.8	2.50	0.15	0.50	1.25	0.19
	11.3	2.60	0.15	0.50	1.30	0.20
	11.8	2.70	0.16	0.50	1.35	0.22
	12.3	2.90	0.16	0.50	1.45	0.23
	12.8	3.00	0.17	0.50	1.50	0.26
	13.3	3.00	0.17	0.50	1.50	0.26
	13.8	3.00	0.19	0.50	1.50	0.29
	14.3	3.00	0.20	0.50	1.50	0.30
	14.8	3.00	0.19	0.50	1.50	0.29
	15.3	3.00	0.19	0.50	1.50	0.29
	15.8	3.10	0.21	0.50	1.55	0.33
	16.3	2.90	0.21	0.50	1.45	0.30
	16.8	2.95	0.22	0.50	1.48	0.32
	17.3	2.80	0.22	0.50	1.40	0.31
	17.8	2.90	0.22	0.50	1.45	0.32
	18.3	2.90	0.24	0.50	1.45	0.35
	18.8	2.80	0.27	0.50	1.40	0.38
	19.3	2.65	0.30	0.50	1.33	0.40
	19.8	2.55	0.33	0.50	1.28	0.42
	20.3	2.60	0.34	0.50	1.30	0.44
	20.8	2.40	0.34	0.50	1.20	0.41
	21.3	2.30	0.35	0.50	1.15	0.40
	21.8	2.20	0.34	0.50	1.10	0.37
	22.3	2.15	0.34	0.50	1.08	0.37
	22.8	2.00	0.31	0.50	1.00	0.31
	23.3	1.60	0.24	0.50	0.80	0.19
	23.8	1.70	0.26	0.50	0.85	0.22
	24.3	1.60	0.25	0.50	0.80	0.20
	24.8	1.40	0.23	0.50	0.70	0.16
	25.3	1.20	0.24	0.50	0.60	0.14
	25.8	1.10	0.23	0.50	0.55	0.13
	26.3	1.10	0.20	0.50	0.55	0.11
	26.8	0.90	0.18	0.50	0.45	0.08
	27.3	0.85	0.16	0.50	0.43	0.07
	27.8	0.80	0.14	0.50	0.40	0.06
	28.3	0.70	0.15	0.50	0.35	0.05
	28.8	0.60	0.11	0.50	0.30	0.03
	29.3	0.20	0.00	0.50	0.10	0.00
	29.8	0.20	0.00	0.50	0.10	0.00
	30.3	0.10	0.00	0.50	0.05	0.00
	30.8	0.00	0.00	0.48	0.00	0.00
RWE	31.25					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.48	0.00	0.00
Maximum	3.10	0.35	0.50	1.55	0.44
Average	1.79	0.17	0.50	0.90	0.18
Sum				50.25	10.23

Wetted Width	28.45	*RWE-LWE*
Mean Depth	1.77	*sum cell area / wetted width*
Discharge	10.23	*sum of discharge*

El Sur Velocity Transect #1

Date:	9/15/2004
Location:	carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.58
Levelling Notes:	0.98
Depth to water	2.72
still well:	1.13
Start time:	14:10
End time:	14:40

*=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area *(depth * width)*	Cell Discharge *(Vel * Area)*
LWE	3.4					
	3.9	0.20	0.00	0.50	0.10	0.00
	4.4	0.35	0.00	0.50	0.18	0.00
	4.9	0.40	0.00	0.50	0.20	0.00
	5.4	0.45	0.02	0.50	0.23	0.00
	5.9	0.55	0.02	0.50	0.28	0.01
	6.4	0.65	0.05	0.50	0.33	0.02
	6.9	0.65	0.06	0.50	0.33	0.02
	7.4	0.70	0.07	0.50	0.35	0.02
	7.9	0.80	0.09	0.50	0.40	0.04
	8.4	0.80	0.09	0.50	0.40	0.04
	8.9	0.90	0.09	0.50	0.45	0.04
	9.4	0.90	0.09	0.50	0.45	0.04
	9.9	1.00	0.10	0.50	0.50	0.05
	10.4	1.10	0.11	0.50	0.55	0.06
	10.9	1.15	0.11	0.50	0.58	0.06
	11.4	1.20	0.12	0.50	0.60	0.07
	11.9	1.25	0.13	0.50	0.63	0.08
	12.4	1.25	0.11	0.50	0.63	0.07
	12.9	1.30	0.11	0.50	0.65	0.07
	13.4	1.40	0.14	0.50	0.70	0.10
	13.9	1.50	0.16	0.50	0.75	0.12
	14.4	1.20	0.18	0.50	0.60	0.11
	14.9	1.00	0.20	0.50	0.50	0.10
	15.4	1.40	0.20	0.50	0.70	0.14
	15.9	1.25	0.22	0.50	0.62	0.14
	16.4	1.30	0.22	0.50	0.65	0.14
	16.9	1.45	0.19	0.50	0.73	0.14
	17.4	1.25	0.20	0.50	0.63	0.13
	17.9	1.40	0.17	0.50	0.70	0.12
	18.4	1.15	0.19	0.50	0.58	0.11
	18.9	1.05	0.24	0.50	0.53	0.13
	19.4	1.10	0.26	0.50	0.55	0.14
	19.9	1.10	0.28	0.50	0.55	0.15
	20.4	1.20	0.29	0.50	0.60	0.17
	20.9	1.20	0.28	0.50	0.60	0.17
	21.4	1.20	0.30	0.50	0.60	0.18
	21.9	1.10	0.31	0.50	0.55	0.17
	22.4	1.20	0.34	0.50	0.60	0.20
	22.9	1.30	0.33	0.50	0.65	0.21
	23.4	1.10	0.32	0.50	0.55	0.18
	23.9	0.80	0.35	0.50	0.40	0.14
	24.4	0.85	0.35	0.50	0.43	0.15
	24.9	1.20	0.37	0.50	0.60	0.22
	25.4	1.20	0.33	0.50	0.60	0.20
	25.9	1.20	0.34	0.50	0.60	0.20
	26.4	0.80	0.36	0.50	0.40	0.14
	26.9	0.90	0.37	0.50	0.45	0.17
	27.4	1.00	0.35	0.50	0.50	0.18
	27.9	0.90	0.34	0.50	0.45	0.15
	28.4	1.00	0.35	0.50	0.50	0.18
	28.9	1.00	0.35	0.50	0.50	0.18
	29.4	1.00	0.35	0.50	0.50	0.18
	29.9	0.70	0.34	0.50	0.35	0.12
	30.4	0.75	0.34	0.50	0.38	0.13
	30.9	0.70	0.12	0.50	0.35	0.04
	31.4	0.70	0.13	0.50	0.35	0.05
	31.9	0.65	0.07	0.50	0.33	0.02
	32.4	0.30	0.17	0.50	0.15	0.03
	32.9	0.45	0.16	0.50	0.23	0.04
	33.4	0.40	0.20	0.50	0.20	0.04
	33.9	0.20	0.00	0.50	0.10	0.00
	34.4	0.20	0.13	0.50	0.10	0.01
	34.9	0.30	0.09	0.50	0.15	0.01
	35.4	0.30	0.03	0.50	0.15	0.00
	35.9	0.00	0.00	0.50	0.00	0.00
	36.4	0.10	0.00	0.50	0.05	0.00
	36.9	0.00	0.00	0.50	0.00	0.00
	37.4	0.00	0.00	0.50	0.00	0.00
RWE	37.9					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.50	0.00	0.00
Maximum	1.50	0.37	0.50	0.75	0.22
Average	0.87	0.18	0.50	0.43	0.09
Sum				29.53	6.30

Wetted Width	34.5	*RWE-LWE*
Mean Depth	0.86	*sum cell area / wetted width*
Discharge	6.30	*sum of discharge*

El Sur Velocity Transect #2

Date:	9/15/2004
Location:	midpoint
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.04
Levelling Notes:	
Depth to water	2.06
Start time:	17:10
End time:	17:40

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.40	0.01	0.50	0.20	0.00
	3.8	0.40	0.00	0.50	0.20	0.00
	4.3	0.50	0.02	0.50	0.25	0.01
	4.8	0.75	0.00	0.50	0.38	0.00
	5.3	0.80	0.00	0.50	0.40	0.00
	5.8	0.95	0.00	0.50	0.48	0.00
	6.3	1.00	0.00	0.50	0.50	0.00
	6.8	1.10	0.01	0.50	0.55	0.01
	7.3	1.30	0.04	0.50	0.65	0.03
	7.8	1.50	0.04	0.50	0.75	0.03
	8.3	1.50	0.04	0.50	0.75	0.03
	8.8	1.65	0.04	0.50	0.83	0.03
	9.3	1.80	0.05	0.50	0.90	0.05
	9.8	2.00	0.05	0.50	1.00	0.05
	10.3	2.30	0.08	0.50	1.15	0.09
	10.8	2.40	0.10	0.50	1.20	0.12
	11.3	2.50	0.12	0.50	1.25	0.15
	11.8	2.65	0.12	0.50	1.33	0.16
	12.3	2.40	0.09	0.50	1.20	0.11
	12.8	3.00	0.07	0.50	1.50	0.11
	13.3	3.00	0.06	0.50	1.50	0.09
	13.8	3.00	0.07	0.50	1.50	0.11
	14.3	3.00	0.10	0.50	1.50	0.15
	14.8	3.00	0.11	0.50	1.50	0.17
	15.3	3.00	0.10	0.50	1.50	0.15
	15.8	3.10	0.10	0.50	1.55	0.16
	16.3	3.00	0.12	0.50	1.50	0.18
	16.8	3.00	0.12	0.50	1.50	0.18
	17.3	3.00	0.14	0.50	1.50	0.21
	17.8	2.85	0.16	0.50	1.43	0.23
	18.3	2.80	0.14	0.50	1.40	0.20
	18.8	2.60	0.16	0.50	1.30	0.21
	19.3	2.50	0.19	0.50	1.25	0.24
	19.8	2.60	0.25	0.50	1.30	0.33
	20.3	2.30	0.32	0.50	1.15	0.37
	20.8	2.05	0.32	0.50	1.03	0.33
	21.3	2.35	0.32	0.50	1.18	0.38
	21.8	2.25	0.28	0.50	1.13	0.32
	22.3	2.10	0.24	0.50	1.05	0.25
	22.8	2.00	0.18	0.50	1.00	0.18
	23.3	1.70	0.17	0.50	0.85	0.14
	23.8	1.50	0.14	0.50	0.75	0.11
	24.3	1.45	0.14	0.50	0.73	0.10
	24.8	1.30	0.15	0.50	0.65	0.10
	25.3	1.10	0.15	0.50	0.55	0.08
	25.8	1.10	0.14	0.50	0.55	0.08
	26.3	1.00	0.12	0.50	0.50	0.06
	26.8	1.00	0.09	0.50	0.50	0.05
	27.3	0.80	0.06	0.50	0.40	0.02
	27.8	0.75	0.04	0.50	0.38	0.02
	28.3	0.65	0.00	0.50	0.33	0.00
	28.8	0.60	0.00	0.50	0.30	0.00
	29.3	0.25	0.00	0.50	0.13	0.00
	29.8	0.35	0.00	0.50	0.18	0.00
	30.3	0.00	0.00	0.50	0.00	0.00
	30.8	0.00	0.00	0.50	0.00	0.00
RWE	31.3					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.50	0.00	0.00
Maximum	3.10	0.32	0.50	1.55	0.38
Average	1.75	0.10	0.50	0.87	0.11
Sum				48.98	6.11

Wetted Width	28.5	*RWE-LWE*
Mean Depth	1.72	*sum cell area / wetted width*
Discharge	6.11	*sum of discharge*

El Sur Velocity Transect #1

Date:	9/16/2004
Location:	Carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.66
Levelling Notes:	1.13
Still Well	1.12
Depth to water	2.56
Start time:	6:45
End time:	7:10

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (depth * width)	Cell Discharge (Vel * Area)
LWE	3.4					
	3.9	0.20	0.00	0.50	0.10	0.00
	4.4	0.40	0.00	0.50	0.20	0.00
	4.9	0.40	0.01	0.50	0.20	0.00
	5.4	0.50	0.03	0.50	0.25	0.01
	5.9	0.60	0.01	0.50	0.30	0.00
	6.4	0.70	0.07	0.50	0.35	0.02
	6.9	0.70	0.06	0.50	0.35	0.02
	7.4	0.70	0.08	0.50	0.35	0.03
	7.9	0.80	0.08	0.50	0.40	0.03
	8.4	0.80	0.09	0.50	0.40	0.04
	8.9	0.90	0.11	0.50	0.45	0.05
	9.4	0.95	0.12	0.50	0.48	0.06
	9.9	1.00	0.11	0.50	0.50	0.06
	10.4	1.10	0.12	0.50	0.55	0.07
	10.9	1.10	0.12	0.50	0.55	0.07
	11.4	1.20	0.12	0.50	0.60	0.07
	11.9	1.30	0.12	0.50	0.65	0.08
	12.4	1.15	0.12	0.50	0.58	0.07
	12.9	1.30	0.14	0.50	0.65	0.09
	13.4	1.45	0.16	0.50	0.73	0.12
	13.9	1.50	0.17	0.50	0.75	0.13
	14.4	1.40	0.18	0.50	0.70	0.13
	14.9	1.00	0.20	0.50	0.50	0.10
	15.4	1.25	0.23	0.50	0.63	0.14
	15.9	1.40	0.24	0.50	0.70	0.17
	16.4	1.30	0.26	0.50	0.65	0.17
	16.9	1.40	0.26	0.50	0.70	0.18
	17.4	1.30	0.25	0.50	0.65	0.16
	17.9	1.40	0.29	0.50	0.70	0.20
	18.4	1.40	0.27	0.50	0.70	0.19
	18.9	1.20	0.27	0.50	0.60	0.16
	19.4	1.10	0.31	0.50	0.55	0.17
	19.9	1.10	0.32	0.50	0.55	0.18
	20.4	1.20	0.32	0.50	0.60	0.19
	20.9	1.20	0.31	0.50	0.60	0.19
	21.4	1.20	0.31	0.50	0.60	0.19
	21.9	1.20	0.30	0.50	0.60	0.18
	22.4	1.20	0.31	0.50	0.60	0.19
	22.9	1.25	0.30	0.50	0.63	0.19
	23.4	1.20	0.30	0.50	0.60	0.18
	23.9	1.00	0.34	0.50	0.50	0.17
	24.4	1.25	0.34	0.50	0.63	0.21
	24.9	1.25	0.37	0.50	0.63	0.23
	25.4	1.20	0.37	0.50	0.60	0.22
	25.9	1.20	0.38	0.50	0.60	0.23
	26.4	1.00	0.37	0.50	0.50	0.19
	26.9	1.00	0.38	0.50	0.50	0.19
	27.4	1.00	0.36	0.50	0.50	0.18
	27.9	1.00	0.35	0.50	0.50	0.18
	28.4	1.00	0.35	0.50	0.50	0.18
	28.9	0.90	0.37	0.50	0.45	0.17
	29.4	0.90	0.37	0.50	0.45	0.17
	29.9	0.90	0.36	0.50	0.45	0.16
	30.4	0.80	0.33	0.50	0.40	0.13
	30.9	0.70	0.24	0.50	0.35	0.08
	31.4	0.70	0.19	0.50	0.35	0.07
	31.9	0.70	0.11	0.50	0.35	0.04
	32.4	0.50	0.10	0.50	0.25	0.03
	32.9	0.40	0.17	0.50	0.20	0.03
	33.4	0.40	0.21	0.50	0.20	0.04
	33.9	0.20	0.22	0.50	0.10	0.02
	34.4	0.30	0.20	0.50	0.15	0.03
	34.9	0.40	0.15	0.50	0.20	0.03
	35.4	0.10	0.00	0.50	0.05	0.00
	35.9	0.05	0.00	0.50	0.03	0.00
	36.4	0.00	0.00	0.50	0.00	0.00
	36.9	0.00	0.00	0.50	0.00	0.00
	37.4	0.00	0.00	0.45	0.00	0.00
RWE	37.8					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	1.50	0.38	0.50	0.75	0.23
Average	0.90	0.20	0.50	0.45	0.11
Sum				30.65	7.22

Wetted Width	34.4	*RWE-LWE*
Mean Depth	0.89	*sum cell area / wetted width*
Discharge	7.22	*sum of discharge*

El Sur Velocity Transect #2

Date:	9/16/2004
Location:	midpoint
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	35.83
Levelling Notes:	
Depth to water	2.23
Start time:	5:45
End time:	6:20

**=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.45	0.01	0.50	0.23	0.00
	3.8	0.45	0.00	0.50	0.23	0.00
	4.3	0.45	0.00	0.50	0.23	0.00
	4.8	0.80	0.00	0.50	0.40	0.00
	5.3	0.90	0.00	0.50	0.45	0.00
	5.8	1.00	0.00	0.50	0.50	0.00
	6.3	1.10	0.00	0.50	0.55	0.00
	6.8	1.20	0.00	0.50	0.60	0.00
	7.3	1.35	0.01	0.50	0.68	0.01
	7.8	1.50	0.01	0.50	0.75	0.01
	8.3	1.60	0.02	0.50	0.80	0.02
	8.8	1.70	0.02	0.50	0.85	0.02
	9.3	1.80	0.02	0.50	0.90	0.02
	9.8	2.00	0.00	0.50	1.00	0.00
	10.3	2.30	0.03	0.50	1.15	0.03
	10.8	2.50	0.05	0.50	1.25	0.06
	11.3	2.60	0.07	0.50	1.30	0.09
	11.8	2.70	0.07	0.50	1.35	0.09
	12.3	2.90	0.06	0.50	1.45	0.09
	12.8	3.00	0.07	0.50	1.50	0.11
	13.3	3.00	0.08	0.50	1.50	0.12
	13.8	3.00	0.09	0.50	1.50	0.14
	14.3	3.00	0.10	0.50	1.50	0.15
	14.8	3.00	0.09	0.50	1.50	0.14
	15.3	3.05	0.09	0.50	1.53	0.14
	15.8	3.10	0.09	0.50	1.55	0.14
	16.3	3.10	0.09	0.50	1.55	0.14
	16.8	3.00	0.12	0.50	1.50	0.18
	17.3	2.80	0.14	0.50	1.40	0.20
	17.8	2.80	0.15	0.50	1.40	0.21
	18.3	2.90	0.17	0.50	1.45	0.25
	18.8	2.80	0.19	0.50	1.40	0.27
	19.3	2.60	0.20	0.50	1.30	0.26
	19.8	2.55	0.28	0.50	1.28	0.36
	20.3	2.50	0.31	0.50	1.25	0.39
	20.8	2.40	0.34	0.50	1.20	0.41
	21.3	2.30	0.30	0.50	1.15	0.35
	21.8	2.10	0.24	0.50	1.05	0.25
	22.3	2.00	0.25	0.50	1.00	0.25
	22.8	1.90	0.21	0.50	0.95	0.20
	23.3	1.80	0.19	0.50	0.90	0.17
	23.8	1.65	0.16	0.50	0.83	0.13
	24.3	1.50	0.15	0.50	0.75	0.11
	24.8	1.40	0.17	0.50	0.70	0.12
	25.3	1.20	0.15	0.50	0.60	0.09
	25.8	1.10	0.13	0.50	0.55	0.07
	26.3	1.00	0.12	0.50	0.50	0.06
	26.8	0.95	0.09	0.50	0.48	0.04
	27.3	0.90	0.08	0.50	0.45	0.04
	27.8	0.80	0.05	0.50	0.40	0.02
	28.3	0.70	0.02	0.50	0.35	0.01
	28.8	0.40	0.00	0.50	0.20	0.00
	29.3	0.50	0.01	0.50	0.25	0.00
	29.8	0.40	0.00	0.50	0.20	0.00
	30.3	0.00	0.00	0.50	0.00	0.00
	30.8	0.10	0.00	0.45	0.04	0.00
RWE	31.2					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	3.10	0.34	0.50	1.55	0.41
Average	1.80	0.09	0.50	0.90	0.11
Sum				50.30	5.92

Wetted Width	28.4	*RWE-LWE*
Mean Depth	1.77	*sum cell area / wetted width*
Discharge	5.92	*sum of discharge*

El Sur Velocity Transect # 1

Date:	9/30/2004
Location:	Upstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.5
Levelling Notes:	1.28
Depth to water	2.33
Still well:	1.1
Start time:	16:38
End time:	17:05

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area *depth * width*	Cell Discharge *Vel * Area*
LWE	3.5					
	4	0.30	0.02	0.50	0.15	0.00
	4.5	0.40	0.00	0.50	0.20	0.00
	5	0.45	0.02	0.50	0.23	0.00
	5.5	0.60	0.05	0.50	0.30	0.02
	6	0.60	0.05	0.50	0.30	0.02
	6.5	0.70	0.07	0.50	0.35	0.02
	7	0.70	0.08	0.50	0.35	0.03
	7.5	0.80	0.10	0.50	0.40	0.04
	8	0.80	0.10	0.50	0.40	0.04
	8.5	0.90	0.11	0.50	0.45	0.05
	9	1.00	0.13	0.50	0.50	0.07
	9.5	1.00	0.12	0.50	0.50	0.06
	10	1.05	0.12	0.50	0.53	0.06
	10.5	1.15	0.11	0.50	0.58	0.06
	11	1.15	0.10	0.50	0.58	0.06
	11.5	1.30	0.11	0.50	0.65	0.07
	12	1.30	0.13	0.50	0.65	0.08
	12.5	1.30	0.15	0.50	0.65	0.10
	13	1.30	0.15	0.50	0.65	0.10
	13.5	1.30	0.16	0.50	0.65	0.10
	14	1.50	0.17	0.50	0.75	0.13
	14.5	1.10	0.19	0.50	0.55	0.10
	15	1.10	0.23	0.50	0.55	0.13
	15.5	1.40	0.25	0.50	0.70	0.18
	16	1.35	0.26	0.50	0.68	0.18
	16.5	1.35	0.27	0.50	0.68	0.18
	17	1.50	0.26	0.50	0.75	0.20
	17.5	1.50	0.24	0.50	0.75	0.18
	18	1.40	0.29	0.50	0.70	0.20
	18.5	1.50	0.29	0.50	0.75	0.22
	19	1.00	0.29	0.50	0.50	0.15
	19.5	1.25	0.32	0.50	0.63	0.20
	20	1.00	0.31	0.50	0.50	0.16
	20.5	1.25	0.31	0.50	0.63	0.19
	21	1.10	0.35	0.50	0.55	0.19
	21.5	1.10	0.35	0.50	0.55	0.19
	22	1.15	0.34	0.50	0.58	0.20
	22.5	1.25	0.33	0.50	0.63	0.21
	23	1.25	0.40	0.50	0.63	0.25
	23.5	1.35	0.38	0.50	0.68	0.26
	24	0.90	0.41	0.50	0.45	0.18
	24.5	1.00	0.41	0.50	0.50	0.21
	25	1.30	0.40	0.50	0.65	0.26
	25.5	1.30	0.41	0.50	0.65	0.27
	26	1.20	0.42	0.50	0.60	0.25
	26.5	0.90	0.44	0.50	0.45	0.20
	27	1.10	0.44	0.50	0.55	0.24
	27.5	1.00	0.45	0.50	0.50	0.23
	28	1.00	0.45	0.50	0.50	0.23
	28.5	1.10	0.43	0.50	0.55	0.24
	29	1.00	0.40	0.50	0.50	0.20
	29.5	1.00	0.37	0.50	0.50	0.19
	30	0.90	0.36	0.50	0.45	0.16
	30.5	0.85	0.37	0.50	0.43	0.16
	31	0.80	0.29	0.50	0.40	0.12
	31.5	0.70	0.28	0.50	0.35	0.10
	32	0.50	0.19	0.50	0.25	0.05
	32.5	0.40	0.19	0.50	0.20	0.04
	33	0.40	0.19	0.50	0.20	0.04
	33.5	0.35	0.23	0.50	0.18	0.04
	34	0.30	0.18	0.50	0.15	0.03
	34.5	0.30	0.19	0.50	0.15	0.03
	35	0.30	0.18	0.50	0.15	0.03
	35.5	0.10	0.00	0.50	0.05	0.00
	36	0.20	0.00	0.50	0.10	0.00
	36.5	0.10	0.00	0.50	0.05	0.00
	37	0.00	0.00	0.50	0.00	0.00
	37.5	0.00	0.00	0.45	0.00	0.00
RWE	37.9					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	1.50	0.45	0.50	0.75	0.27
Average	0.92	0.23	0.50	0.46	0.12
Sum				31.25	8.12

Wetted Width	34.4	*RWE-LWE*
Mean Depth	0.91	*sum cell area / wetted width*
Discharge	8.12	*sum of discharge*

El Sur Velocity Transect # 2

Still well logger calibration off

Date:	9/30/2004
Location:	Mid-point
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.25
Levelling Notes:	
Depth to water	2.1
Start time:	15:35
End time:	15:55

*=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.50	0.02	0.50	0.25	0.01
	3.8	0.50	0.00	0.50	0.25	0.00
	4.3	0.50	0.00	0.50	0.25	0.00
	4.8	0.75	0.01	0.50	0.38	0.00
	5.3	0.90	0.01	0.50	0.45	0.00
	5.8	1.00	0.02	0.50	0.50	0.01
	6.3	1.10	0.03	0.50	0.55	0.02
	6.8	1.20	0.01	0.50	0.60	0.01
	7.3	1.30	0.01	0.50	0.65	0.01
	7.8	1.45	0.02	0.50	0.73	0.01
	8.3	1.60	0.02	0.50	0.80	0.02
	8.8	1.75	0.04	0.50	0.88	0.04
	9.3	1.80	0.04	0.50	0.90	0.04
	9.8	2.00	0.05	0.50	1.00	0.05
	10.3	2.30	0.05	0.50	1.15	0.06
	10.8	2.50	0.06	0.50	1.25	0.08
	11.3	2.60	0.10	0.50	1.30	0.13
	11.8	2.70	0.12	0.50	1.35	0.16
	12.3	2.90	0.11	0.50	1.45	0.16
	12.8	3.00	0.10	0.50	1.50	0.15
	13.3	3.00	0.10	0.50	1.50	0.15
	13.8	3.00	0.09	0.50	1.50	0.14
	14.3	3.00	0.11	0.50	1.50	0.17
	14.8	3.00	0.12	0.50	1.50	0.18
	15.3	3.00	0.12	0.50	1.50	0.18
	15.8	3.05	0.12	0.50	1.53	0.18
	16.3	3.00	0.13	0.50	1.50	0.20
	16.8	3.00	0.15	0.50	1.50	0.23
	17.3	2.90	0.16	0.50	1.45	0.23
	17.8	2.90	0.17	0.50	1.45	0.25
	18.3	2.90	0.20	0.50	1.45	0.29
	18.8	2.90	0.24	0.50	1.45	0.35
	19.3	2.60	0.24	0.50	1.30	0.31
	19.8	2.60	0.25	0.50	1.30	0.33
	20.3	2.50	0.31	0.50	1.25	0.39
	20.8	2.50	0.32	0.50	1.25	0.40
	21.3	2.40	0.34	0.50	1.20	0.41
	21.8	2.00	0.32	0.50	1.00	0.32
	22.3	2.05	0.30	0.50	1.03	0.31
	22.8	2.00	0.29	0.50	1.00	0.29
	23.3	1.75	0.22	0.50	0.88	0.19
	23.8	1.70	0.19	0.50	0.85	0.16
	24.3	1.60	0.19	0.50	0.80	0.15
	24.8	1.50	0.19	0.50	0.75	0.14
	25.3	1.35	0.19	0.50	0.68	0.13
	25.8	1.20	0.19	0.50	0.60	0.11
	26.3	1.10	0.17	0.50	0.55	0.09
	26.8	1.00	0.15	0.50	0.50	0.08
	27.3	0.90	0.14	0.50	0.45	0.06
	27.8	0.80	0.12	0.50	0.40	0.05
	28.3	0.70	0.08	0.50	0.35	0.03
	28.8	0.60	0.01	0.50	0.30	0.00
	29.3	0.20	0.00	0.50	0.10	0.00
	29.8	0.10	0.00	0.50	0.05	0.00
	30.3	0.15	0.00	0.50	0.08	0.00
	30.8	0.00	0.00	0.50	0.00	0.00
	31.3	0.00	0.00	0.30	0.00	0.00
RWE	31.4					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.30	0.00	0.00
Maximum	3.05	0.34	0.50	1.53	0.41
Average	1.78	0.12	0.50	0.89	0.13
Sum				50.65	7.42

Wetted Width	28.6	*RWE-LWE*
Mean Depth	1.77	*sum cell area / wetted width*
Discharge	7.42	*sum of discharge*

El Sur Velocity Transect # 1

Date:	10/1/2004
Location:	upstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.4
Levelling Notes:	1.24
Depth to water	2.41
Still Well:	1.08
Start time:	7:35
End time:	8:00

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	3.2					
	3.7	0.20	0.00	0.50	0.10	0.00
	4.2	0.40	0.06	0.50	0.20	0.01
	4.7	0.50	0.06	0.50	0.25	0.02
	5.2	0.60	0.06	0.50	0.30	0.02
	5.7	0.70	0.07	0.50	0.35	0.02
	6.2	0.70	0.08	0.50	0.35	0.03
	6.7	0.70	0.08	0.50	0.35	0.03
	7.2	0.80	0.10	0.50	0.40	0.04
	7.7	0.80	0.11	0.50	0.40	0.04
	8.2	0.90	0.11	0.50	0.45	0.05
	8.7	1.00	0.11	0.50	0.50	0.06
	9.2	1.00	0.13	0.50	0.50	0.07
	9.7	1.00	0.13	0.50	0.50	0.07
	10.2	1.20	0.14	0.50	0.60	0.08
	10.7	1.20	0.14	0.50	0.60	0.08
	11.2	1.30	0.15	0.50	0.65	0.10
	11.7	1.30	0.15	0.50	0.65	0.10
	12.2	1.35	0.16	0.50	0.68	0.11
	12.7	1.35	0.17	0.50	0.68	0.11
	13.2	1.30	0.19	0.50	0.65	0.12
	13.7	1.50	0.22	0.50	0.75	0.17
	14.2	1.10	0.26	0.50	0.55	0.14
	14.7	1.10	0.27	0.50	0.55	0.15
	15.2	1.45	0.24	0.50	0.73	0.17
	15.7	1.40	0.25	0.50	0.70	0.18
	16.2	1.50	0.27	0.50	0.75	0.20
	16.7	1.50	0.26	0.50	0.75	0.20
	17.2	1.50	0.25	0.50	0.75	0.19
	17.7	1.40	0.29	0.50	0.70	0.20
	18.2	1.50	0.32	0.50	0.75	0.24
	18.7	1.25	0.32	0.50	0.63	0.20
	19.2	1.30	0.35	0.50	0.65	0.23
	19.7	1.00	0.35	0.50	0.50	0.18
	20.2	1.30	0.32	0.50	0.65	0.21
	20.7	1.10	0.35	0.50	0.55	0.19
	21.2	1.30	0.33	0.50	0.65	0.21
	21.7	1.20	0.35	0.50	0.60	0.21
	22.2	1.30	0.39	0.50	0.65	0.25
	22.7	1.30	0.40	0.50	0.65	0.26
	23.2	1.40	0.43	0.50	0.70	0.30
	23.7	0.90	0.44	0.50	0.45	0.20
	24.2	1.20	0.44	0.50	0.60	0.26
	24.7	1.30	0.42	0.50	0.65	0.27
	25.2	1.30	0.46	0.50	0.65	0.30
	25.7	1.20	0.46	0.50	0.60	0.28
	26.2	0.90	0.46	0.50	0.45	0.21
	26.7	1.10	0.44	0.50	0.55	0.24
	27.2	1.10	0.44	0.50	0.55	0.24
	27.7	1.00	0.44	0.50	0.50	0.22
	28.2	1.10	0.45	0.50	0.55	0.25
	28.7	1.00	0.43	0.50	0.50	0.22
	29.2	1.00	0.43	0.50	0.50	0.22
	29.7	1.00	0.46	0.50	0.50	0.23
	30.2	0.90	0.44	0.50	0.45	0.20
	30.7	0.85	0.32	0.50	0.43	0.14
	31.2	0.70	0.27	0.50	0.35	0.09
	31.7	0.50	0.15	0.50	0.25	0.04
	32.2	0.40	0.17	0.50	0.20	0.03
	32.7	0.50	0.19	0.50	0.25	0.05
	33.2	0.40	0.26	0.50	0.20	0.05
	33.7	0.20	0.27	0.50	0.10	0.03
	34.2	0.30	0.21	0.50	0.15	0.03
	34.7	0.40	0.13	0.50	0.20	0.03
	35.2	0.10	0.00	0.50	0.05	0.00
	35.7	0.10	0.00	0.50	0.05	0.00
	36.2	0.10	0.00	0.50	0.05	0.00
	36.7	0.00	0.00	0.50	0.00	0.00
	37.2	0.00	0.00	0.50	0.00	0.00
	37.7	0.00	0.00	0.45	0.00	0.00
RWE	38.1					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	1.50	0.46	0.50	0.75	0.30
Average	0.93	0.24	0.50	0.47	0.13
Sum				32.13	9.04

Wetted Width	34.9 *RWE-LWE*
Mean Depth	0.92 *sum cell area / wetted width*
Discharge	9.04 *sum of discharge*

El Sur Velocity Transect # 2

Date:	10/1/2004
Location:	midstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.2
Levelling Notes:	
Depth to water	2.01
Start time:	6:40
End time:	7:10

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (depth * width)	Cell Discharge (Vel * Area)
LWE	2.8					
	3.3	0.40	0.04	0.50	0.20	0.01
	3.8	0.60	0.02	0.50	0.30	0.01
	4.3	0.60	0.03	0.50	0.30	0.01
	4.8	0.75	0.01	0.50	0.38	0.00
	5.3	0.85	0.00	0.50	0.43	0.00
	5.8	0.90	0.00	0.50	0.45	0.00
	6.3	1.00	0.00	0.50	0.50	0.00
	6.8	1.10	0.00	0.50	0.55	0.00
	7.3	1.20	0.00	0.50	0.60	0.00
	7.8	1.40	0.00	0.50	0.70	0.00
	8.3	1.50	0.00	0.50	0.75	0.00
	8.8	1.70	0.00	0.50	0.85	0.00
	9.3	1.80	0.03	0.50	0.90	0.03
	9.8	1.90	0.05	0.50	0.95	0.05
	10.3	2.00	0.05	0.50	1.00	0.05
	10.8	2.40	0.06	0.50	1.20	0.07
	11.3	2.60	0.12	0.50	1.30	0.16
	11.8	2.70	0.14	0.50	1.35	0.19
	12.3	2.90	0.11	0.50	1.45	0.16
	12.8	3.00	0.10	0.50	1.50	0.15
	13.3	3.00	0.10	0.50	1.50	0.15
	13.8	3.00	0.11	0.50	1.50	0.17
	14.3	3.00	0.13	0.50	1.50	0.20
	14.8	3.10	0.14	0.50	1.55	0.22
	15.3	3.10	0.13	0.50	1.55	0.20
	15.8	3.00	0.13	0.50	1.50	0.20
	16.3	3.05	0.15	0.50	1.53	0.23
	16.8	3.10	0.19	0.50	1.55	0.29
	17.3	3.05	0.20	0.50	1.53	0.31
	17.8	3.00	0.20	0.50	1.50	0.30
	18.3	2.90	0.20	0.50	1.45	0.29
	18.8	2.80	0.21	0.50	1.40	0.29
	19.3	2.90	0.29	0.50	1.45	0.42
	19.8	2.55	0.36	0.50	1.28	0.46
	20.3	2.60	0.36	0.50	1.30	0.47
	20.8	2.60	0.35	0.50	1.30	0.46
	21.3	2.10	0.34	0.50	1.05	0.36
	21.8	2.30	0.35	0.50	1.15	0.40
	22.3	2.20	0.31	0.50	1.10	0.34
	22.8	2.10	0.29	0.50	1.05	0.30
	23.3	1.85	0.21	0.50	0.93	0.19
	23.8	1.65	0.17	0.50	0.83	0.14
	24.3	1.60	0.19	0.50	0.80	0.15
	24.8	1.50	0.19	0.50	0.75	0.14
	25.3	1.30	0.17	0.50	0.65	0.11
	25.8	1.20	0.16	0.50	0.60	0.10
	26.3	1.10	0.15	0.50	0.55	0.08
	26.8	1.00	0.13	0.50	0.50	0.07
	27.3	0.90	0.07	0.50	0.45	0.03
	27.8	0.90	0.06	0.50	0.45	0.03
	28.3	0.80	0.04	0.50	0.40	0.02
	28.8	0.50	0.02	0.50	0.25	0.01
	29.3	0.30	0.00	0.50	0.15	0.00
	29.8	0.30	0.00	0.50	0.15	0.00
	30.3	0.10	0.00	0.50	0.05	0.00
	30.8	0.05	0.00	0.50	0.03	0.00
	31.3	0.00	0.00	0.38	0.00	0.00
RWE	31.55					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.38	0.00	0.00
Maximum	3.10	0.36	0.50	1.55	0.47
Average	1.79	0.12	0.50	0.89	0.14
Sum				50.90	7.98

Wetted Width	28.75	*RWE-LWE*
Mean Depth	1.77	*sum cell area / wetted width*
Discharge	7.98	*sum of discharge*

El Sur Velocity Transect # 1

Date:	10/14/2004
Location:	Carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.6
Levelling Notes:	1.19
Depth to water	2.5
Still Well:	1.11
Start time:	15:55
End time:	16:15

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (depth * width)	Cell Discharge (Vel * Area)
LWE	3.5					
	4	0.20	0.04	0.50	0.10	0.00
	4.5	0.40	0.08	0.50	0.20	0.02
	5	0.50	0.12	0.50	0.25	0.03
	5.5	0.50	0.13	0.50	0.25	0.03
	6	0.60	0.15	0.50	0.30	0.05
	6.5	0.70	0.19	0.50	0.35	0.07
	7	0.70	0.19	0.50	0.35	0.07
	7.5	0.70	0.18	0.50	0.35	0.06
	8	0.80	0.18	0.50	0.40	0.07
	8.5	0.90	0.18	0.50	0.45	0.08
	9	0.90	0.19	0.50	0.45	0.09
	9.5	1.00	0.20	0.50	0.50	0.10
	10	1.00	0.20	0.50	0.50	0.10
	10.5	1.10	0.20	0.50	0.55	0.11
	11	1.15	0.20	0.50	0.58	0.12
	11.5	1.20	0.21	0.50	0.60	0.13
	12	1.25	0.22	0.50	0.63	0.14
	12.5	1.30	0.23	0.50	0.65	0.15
	13	1.35	0.22	0.50	0.68	0.15
	13.5	1.45	0.24	0.50	0.73	0.17
	14	1.40	0.25	0.50	0.70	0.18
	14.5	1.25	0.26	0.50	0.63	0.16
	15	1.30	0.28	0.50	0.65	0.18
	15.5	1.30	0.31	0.50	0.65	0.20
	16	1.30	0.32	0.50	0.65	0.21
	16.5	1.30	0.33	0.50	0.65	0.21
	17	1.50	0.32	0.50	0.75	0.24
	17.5	1.30	0.34	0.50	0.65	0.22
	18	1.40	0.33	0.50	0.70	0.23
	18.5	1.20	0.34	0.50	0.60	0.20
	19	1.20	0.38	0.50	0.60	0.23
	19.5	1.15	0.40	0.50	0.58	0.23
	20	1.20	0.38	0.50	0.60	0.23
	20.5	1.20	0.37	0.50	0.60	0.22
	21	1.20	0.37	0.50	0.60	0.22
	21.5	1.20	0.38	0.50	0.60	0.23
	22	1.25	0.41	0.50	0.63	0.26
	22.5	1.30	0.41	0.50	0.65	0.27
	23	1.30	0.42	0.50	0.65	0.27
	23.5	1.10	0.43	0.50	0.55	0.24
	24	0.80	0.44	0.50	0.40	0.18
	24.5	0.90	0.44	0.50	0.45	0.20
	25	1.30	0.46	0.50	0.65	0.30
	25.5	1.30	0.43	0.50	0.65	0.28
	26	1.20	0.45	0.50	0.60	0.27
	26.5	0.90	0.45	0.50	0.45	0.20
	27	1.10	0.47	0.50	0.55	0.26
	27.5	1.00	0.47	0.50	0.50	0.24
	28	1.00	0.48	0.50	0.50	0.24
	28.5	1.00	0.47	0.50	0.50	0.24
	29	1.00	0.48	0.50	0.50	0.24
	29.5	1.00	0.46	0.50	0.50	0.23
	30	0.90	0.43	0.50	0.45	0.19
	30.5	0.80	0.41	0.50	0.40	0.16
	31	0.80	0.35	0.50	0.40	0.14
	31.5	0.60	0.20	0.50	0.30	0.06
	32	0.40	0.15	0.50	0.20	0.03
	32.5	0.30	0.22	0.50	0.15	0.03
	33	0.50	0.24	0.50	0.25	0.06
	33.5	0.35	0.26	0.50	0.18	0.05
	34	0.20	0.20	0.50	0.10	0.02
	34.5	0.20	0.24	0.50	0.10	0.02
	35	0.30	0.16	0.50	0.15	0.02
	35.5	0.00	0.00	0.50	0.00	0.00
	36	0.10	0.00	0.50	0.05	0.00
	36.5	0.10	0.00	0.50	0.05	0.00
	37	0.00	0.00	0.50	0.00	0.00
	37.5	0.00	0.00	0.45	0.00	0.00
RWE	37.9					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	1.50	0.48	0.50	0.75	0.30
Average	0.90	0.28	0.50	0.45	0.14
Sum				30.55	9.81

Wetted Width	34.4	*RWE-LWE*
Mean Depth	0.89	*sum cell area / wetted width*
Discharge	9.81	*sum of discharge*

El Sur Velocity Transect # 2

Date:	10/14/2004
Location:	Midstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.2
Levelling Notes:	
Depth to water	2.19
Start time:	14:50
End time:	15:15

*=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.40	0.09	0.50	0.20	0.02
	3.8	0.50	0.10	0.50	0.25	0.03
	4.3	0.50	0.14	0.50	0.25	0.04
	4.8	0.80	0.14	0.50	0.40	0.06
	5.3	0.90	0.13	0.50	0.45	0.06
	5.8	1.00	0.14	0.50	0.50	0.07
	6.3	1.00	0.14	0.50	0.50	0.07
	6.8	1.15	0.14	0.50	0.58	0.08
	7.3	1.25	0.14	0.50	0.63	0.09
	7.8	1.40	0.13	0.50	0.70	0.09
	8.3	1.50	0.13	0.50	0.75	0.10
	8.8	1.70	0.14	0.50	0.85	0.12
	9.3	1.70	0.14	0.50	0.85	0.12
	9.8	1.90	0.15	0.50	0.95	0.14
	10.3	2.30	0.19	0.50	1.15	0.22
	10.8	2.40	0.23	0.50	1.20	0.28
	11.3	2.50	0.23	0.50	1.25	0.29
	11.8	2.80	0.22	0.50	1.40	0.31
	12.3	2.90	0.22	0.50	1.45	0.32
	12.8	2.90	0.20	0.50	1.45	0.29
	13.3	3.00	0.20	0.50	1.50	0.30
	13.8	3.00	0.21	0.50	1.50	0.32
	14.3	3.00	0.22	0.50	1.50	0.33
	14.8	3.00	0.23	0.50	1.50	0.35
	15.3	3.00	0.23	0.50	1.50	0.35
	15.8	3.00	0.23	0.50	1.50	0.35
	16.3	3.10	0.24	0.50	1.55	0.37
	16.8	3.00	0.24	0.50	1.50	0.36
	17.3	2.80	0.25	0.50	1.40	0.35
	17.8	2.80	0.27	0.50	1.40	0.38
	18.3	2.90	0.28	0.50	1.45	0.41
	18.8	2.80	0.29	0.50	1.40	0.41
	19.3	2.60	0.33	0.50	1.30	0.43
	19.8	2.60	0.39	0.50	1.30	0.51
	20.3	2.50	0.40	0.50	1.25	0.50
	20.8	2.50	0.40	0.50	1.25	0.50
	21.3	2.40	0.38	0.50	1.20	0.46
	21.8	2.30	0.36	0.50	1.15	0.41
	22.3	2.10	0.30	0.50	1.05	0.32
	22.8	1.90	0.29	0.50	0.95	0.28
	23.3	1.80	0.29	0.50	0.90	0.26
	23.8	1.60	0.28	0.50	0.80	0.22
	24.3	1.50	0.28	0.50	0.75	0.21
	24.8	1.40	0.28	0.50	0.70	0.20
	25.3	1.25	0.26	0.50	0.63	0.16
	25.8	1.15	0.24	0.50	0.58	0.14
	26.3	1.00	0.23	0.50	0.50	0.12
	26.8	1.00	0.23	0.50	0.50	0.12
	27.3	0.90	0.20	0.50	0.45	0.09
	27.8	0.80	0.19	0.50	0.40	0.08
	28.3	0.70	0.12	0.50	0.35	0.04
	28.8	0.40	0.10	0.50	0.20	0.02
	29.3	0.30	0.08	0.50	0.15	0.01
	29.8	0.00	0.00	0.50	0.00	0.00
	30.3	0.20	0.00	0.50	0.10	0.00
	30.8	0.10	0.00	0.50	0.05	0.00
	31.3	0.00	0.00	0.30	0.00	0.00
RWE	31.4					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.30	0.00	0.00
Maximum	3.10	0.40	0.50	1.55	0.51
Average	1.75	0.20	0.50	0.88	0.21
Sum				49.95	12.08

Wetted Width	28.6	*RWE-LWE*
Mean Depth	1.75	*sum cell area / wetted width*
Discharge	12.08	*sum of discharge*

El Sur Velocity Transect # 1

Date:	10/15/2004
Location:	Carpark
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.37
Levelling Notes:	1.55
Depth to water	2.12
Still well:	1.10
Start time:	9:33
End time:	10:00

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (*depth * width*)	Cell Discharge (*Vel * Area*)
LWE	3.3					
	3.8	0.20	0.10	0.50	0.10	0.01
	4.3	0.40	0.09	0.50	0.20	0.02
	4.8	0.50	0.18	0.50	0.25	0.05
	5.3	0.55	0.19	0.50	0.28	0.05
	5.8	0.60	0.22	0.50	0.30	0.07
	6.3	0.70	0.23	0.50	0.35	0.08
	6.8	0.70	0.24	0.50	0.35	0.08
	7.3	0.75	0.23	0.50	0.38	0.09
	7.8	0.85	0.25	0.50	0.43	0.11
	8.3	0.90	0.25	0.50	0.45	0.11
	8.8	1.00	0.25	0.50	0.50	0.13
	9.3	1.00	0.25	0.50	0.50	0.13
	9.8	1.00	0.27	0.50	0.50	0.14
	10.3	1.10	0.26	0.50	0.55	0.14
	10.8	1.20	0.26	0.50	0.60	0.16
	11.3	1.30	0.26	0.50	0.65	0.17
	11.8	1.30	0.27	0.50	0.65	0.18
	12.3	1.30	0.28	0.50	0.65	0.18
	12.8	1.30	0.29	0.50	0.65	0.19
	13.3	1.50	0.30	0.50	0.75	0.23
	13.8	1.50	0.30	0.50	0.75	0.23
	14.3	1.30	0.31	0.50	0.65	0.20
	14.8	1.10	0.34	0.50	0.55	0.19
	15.3	1.40	0.34	0.50	0.70	0.24
	15.8	1.30	0.35	0.50	0.65	0.23
	16.3	1.35	0.38	0.50	0.68	0.26
	16.8	1.50	0.38	0.50	0.75	0.29
	17.3	1.50	0.37	0.50	0.75	0.28
	17.8	1.40	0.39	0.50	0.70	0.27
	18.3	1.40	0.43	0.50	0.70	0.30
	18.8	1.10	0.42	0.50	0.55	0.23
	19.3	1.20	0.44	0.50	0.60	0.26
	19.8	1.20	0.44	0.50	0.60	0.26
	20.3	1.25	0.46	0.50	0.63	0.29
	20.8	1.20	0.43	0.50	0.60	0.26
	21.3	1.20	0.46	0.50	0.60	0.28
	21.8	1.30	0.46	0.50	0.65	0.30
	22.3	1.30	0.46	0.50	0.65	0.30
	22.8	1.30	0.49	0.50	0.65	0.32
	23.3	1.15	0.48	0.50	0.58	0.28
	23.8	0.85	0.51	0.50	0.43	0.22
	24.3	1.00	0.50	0.50	0.50	0.25
	24.8	1.20	0.52	0.50	0.60	0.31
	25.3	1.20	0.50	0.50	0.60	0.30
	25.8	1.20	0.51	0.50	0.60	0.31
	26.3	0.80	0.52	0.50	0.40	0.21
	26.8	1.10	0.53	0.50	0.55	0.29
	27.3	1.05	0.52	0.50	0.53	0.27
	27.8	1.00	0.53	0.50	0.50	0.27
	28.3	1.00	0.50	0.50	0.50	0.25
	28.8	1.00	0.50	0.50	0.50	0.25
	29.3	1.00	0.50	0.50	0.50	0.25
	29.8	0.90	0.45	0.50	0.45	0.20
	30.3	0.80	0.37	0.50	0.40	0.15
	30.8	0.80	0.36	0.50	0.40	0.14
	31.3	0.70	0.33	0.50	0.35	0.12
	31.8	0.50	0.25	0.50	0.25	0.06
	32.3	0.40	0.32	0.50	0.20	0.06
	32.8	0.50	0.33	0.50	0.25	0.08
	33.3	0.40	0.29	0.50	0.20	0.06
	33.8	0.20	0.25	0.50	0.10	0.03
	34.3	0.20	0.26	0.50	0.10	0.03
	34.8	0.35	0.27	0.50	0.18	0.05
	35.3	0.05	0.00	0.50	0.03	0.00
	35.8	0.10	0.00	0.50	0.05	0.00
	36.3	0.05	0.00	0.50	0.03	0.00
	36.8	0.00	0.00	0.50	0.00	0.00
	37.3	0.00	0.00	0.45	0.00	0.00
RWE	37.7					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.45	0.00	0.00
Maximum	1.50	0.53	0.50	0.75	0.32
Average	0.92	0.33	0.50	0.46	0.17
Sum				31.23	11.68

Wetted Width	34.4	*RWE-LWE*
Mean Depth	0.91	*sum cell area / wetted width*
Discharge	11.68	*sum of discharge*

El Sur Velocity Transect # 2

Date:	10/15/2004
Location:	midstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.2
Levelling Notes:	
Depth to water	2.16
Start time:	8:30
End time:	8:55

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.8					
	3.3	0.40	0.08	0.50	0.20	0.02
	3.8	0.50	0.06	0.50	0.25	0.02
	4.3	0.50	0.06	0.50	0.25	0.02
	4.8	0.80	0.08	0.50	0.40	0.03
	5.3	1.00	0.10	0.50	0.50	0.05
	5.8	1.10	0.12	0.50	0.55	0.07
	6.3	1.10	0.13	0.50	0.55	0.07
	6.8	1.20	0.13	0.50	0.60	0.08
	7.3	1.30	0.13	0.50	0.65	0.08
	7.8	1.50	0.09	0.50	0.75	0.07
	8.3	1.60	0.09	0.50	0.80	0.07
	8.8	1.70	0.13	0.50	0.85	0.11
	9.3	1.80	0.14	0.50	0.90	0.13
	9.8	2.00	0.14	0.50	1.00	0.14
	10.3	2.30	0.15	0.50	1.15	0.17
	10.8	2.40	0.14	0.50	1.20	0.17
	11.3	2.55	0.15	0.50	1.28	0.19
	11.8	2.70	0.19	0.50	1.35	0.26
	12.3	2.90	0.21	0.50	1.45	0.30
	12.8	3.00	0.21	0.50	1.50	0.32
	13.3	3.00	0.21	0.50	1.50	0.32
	13.8	2.70	0.23	0.50	1.35	0.31
	14.3	3.05	0.21	0.50	1.53	0.32
	14.8	3.00	0.20	0.50	1.50	0.30
	15.3	2.90	0.17	0.50	1.45	0.25
	15.8	3.10	0.17	0.50	1.55	0.26
	16.3	3.00	0.19	0.50	1.50	0.29
	16.8	3.10	0.21	0.50	1.55	0.33
	17.3	2.90	0.23	0.50	1.45	0.33
	17.8	2.90	0.25	0.50	1.45	0.36
	18.3	2.90	0.26	0.50	1.45	0.38
	18.8	2.80	0.28	0.50	1.40	0.39
	19.3	2.60	0.35	0.50	1.30	0.46
	19.8	2.60	0.39	0.50	1.30	0.51
	20.3	2.50	0.41	0.50	1.25	0.51
	20.8	2.45	0.42	0.50	1.23	0.51
	21.3	2.35	0.40	0.50	1.18	0.47
	21.8	2.25	0.38	0.50	1.13	0.43
	22.3	2.10	0.38	0.50	1.05	0.40
	22.8	1.90	0.37	0.50	0.95	0.35
	23.3	1.80	0.33	0.50	0.90	0.30
	23.8	1.65	0.32	0.50	0.83	0.26
	24.3	1.55	0.32	0.50	0.78	0.25
	24.8	1.40	0.32	0.50	0.70	0.22
	25.3	1.30	0.29	0.50	0.65	0.19
	25.8	1.20	0.28	0.50	0.60	0.17
	26.3	1.00	0.28	0.50	0.50	0.14
	26.8	0.90	0.27	0.50	0.45	0.12
	27.3	0.90	0.25	0.50	0.45	0.11
	27.8	0.80	0.22	0.50	0.40	0.09
	28.3	0.70	0.20	0.50	0.35	0.07
	28.8	0.50	0.16	0.50	0.25	0.04
	29.3	0.20	0.07	0.50	0.10	0.01
	29.8	0.40	0.12	0.50	0.20	0.02
	30.3	0.10	0.00	0.50	0.05	0.00
	30.8	0.15	0.00	0.50	0.08	0.00
	31.3	0.00	0.00	0.30	0.00	0.00
RWE	31.4					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.00	0.00	0.30	0.00	0.00
Maximum	3.10	0.42	0.50	1.55	0.51
Average	1.77	0.20	0.50	0.89	0.21
Sum				50.50	11.81

Wetted Width	28.6	*RWE-LWE*
Mean Depth	1.77	*sum cell area / wetted width*
Discharge	11.81	*sum of discharge*

El Sur Velocity Transect # 1

Date:	10/28/2004
Location:	Upstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.5
Levelling Notes:	1.58
Depth to water	1.57
Start time:	11:24
End time:	11:44

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (*depth * width*)	Cell Discharge (*Vel * Area*)
LWE	2.6					
	3.1	0.25	0.02	0.50	0.13	0.00
	3.6	0.60	0.04	0.50	0.30	0.01
	4.1	0.90	0.02	0.50	0.45	0.01
	4.6	0.95	0.04	0.50	0.48	0.02
	5.1	1.10	0.08	0.50	0.55	0.04
	5.6	1.20	0.11	0.50	0.60	0.07
	6.1	1.20	0.24	0.50	0.60	0.14
	6.6	1.30	0.22	0.50	0.65	0.14
	7.1	1.30	0.22	0.50	0.65	0.14
	7.6	1.30	0.31	0.50	0.65	0.20
	8.1	1.40	0.46	0.50	0.70	0.32
	8.6	1.50	0.50	0.50	0.75	0.38
	9.1	1.65	0.52	0.50	0.83	0.43
	9.6	1.70	0.55	0.50	0.85	0.47
	10.1	1.70	0.63	0.50	0.85	0.54
	10.6	1.80	0.60	0.50	0.90	0.54
	11.1	1.80	0.62	0.50	0.90	0.56
	11.6	1.90	0.61	0.50	0.95	0.58
	12.1	1.90	0.66	0.50	0.95	0.63
	12.6	1.90	0.68	0.50	0.95	0.65
	13.1	1.95	0.70	0.50	0.98	0.68
	13.6	2.05	0.71	0.50	1.03	0.73
	14.1	2.15	0.75	0.50	1.08	0.81
	14.6	1.60	0.75	0.50	0.80	0.60
	15.1	1.90	0.83	0.50	0.95	0.79
	15.6	2.00	0.88	0.50	1.00	0.88
	16.1	2.00	0.95	0.50	1.00	0.95
	16.6	2.00	1.00	0.50	1.00	1.00
	17.1	2.00	1.03	0.50	1.00	1.03
	17.6	2.00	1.06	0.50	1.00	1.06
	18.1	2.00	1.10	0.50	1.00	1.10
	18.6	1.70	1.22	0.50	0.85	1.04
	19.1	1.80	1.22	0.50	0.90	1.10
	19.6	1.70	1.26	0.50	0.85	1.07
	20.1	1.60	1.29	0.50	0.80	1.03
	20.6	1.80	1.32	0.50	0.90	1.19
	21.1	1.80	1.31	0.50	0.90	1.18
	21.6	1.80	1.27	0.50	0.90	1.14
	22.1	1.80	1.35	0.50	0.90	1.22
	22.6	1.80	1.39	0.50	0.90	1.25
	23.1	1.80	1.31	0.50	0.90	1.18
	23.6	1.90	1.22	0.50	0.95	1.16
	24.1	1.80	1.19	0.50	0.90	1.07
	24.6	1.60	1.24	0.50	0.80	0.99
	25.1	1.80	1.18	0.50	0.90	1.06
	25.6	1.70	1.29	0.50	0.85	1.10
	26.1	1.80	1.21	0.50	0.90	1.09
	26.6	1.60	1.13	0.50	0.80	0.90
	27.1	1.60	1.13	0.50	0.80	0.90
	27.6	1.70	1.10	0.50	0.85	0.94
	28.1	1.70	1.05	0.50	0.85	0.89
	28.6	1.70	0.99	0.50	0.85	0.84
	29.1	1.60	0.95	0.50	0.80	0.76
	29.6	1.55	0.81	0.50	0.78	0.63
	30.1	1.50	0.83	0.50	0.75	0.62
	30.6	1.40	0.74	0.50	0.70	0.52
	31.1	1.30	0.72	0.50	0.65	0.47
	31.6	1.30	0.64	0.50	0.65	0.42
	32.1	1.00	0.55	0.50	0.50	0.28
	32.6	1.00	0.53	0.50	0.50	0.27
	33.1	1.05	0.54	0.50	0.53	0.28
	33.6	0.90	0.54	0.50	0.45	0.24
	34.1	0.80	0.53	0.50	0.40	0.21
	34.6	0.85	0.51	0.50	0.43	0.22
	35.1	0.90	0.53	0.50	0.45	0.24
	35.6	0.90	0.46	0.50	0.45	0.21
	36.1	0.80	0.45	0.50	0.40	0.18
	36.6	0.60	0.43	0.50	0.30	0.13
	37.1	0.60	0.41	0.50	0.30	0.12
	37.6	0.60	0.41	0.50	0.30	0.12
	38.1	0.50	0.36	0.50	0.25	0.09
	38.6	0.40	0.35	0.50	0.20	0.07
	39.1	0.30	0.31	0.50	0.15	0.05
	39.6	0.20	0.30	0.50	0.10	0.03
	40.1	0.10	0.00	0.50	0.05	0.00
	40.6	0.05	0.00	0.35	0.02	0.00
RWE	40.8					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.05	0.00	0.35	0.02	0.00
Maximum	2.15	1.39	0.50	1.08	1.25
Average	1.39	0.72	0.50	0.70	0.58
Sum				52.84	43.97

Wetted Width	38.2	*RWE-LWE*
Mean Depth	1.38	*sum cell area / wetted width*
Discharge	43.97	*sum of discharge*

El Sur Velocity Transect # 1

Date:	10/28/2004
Location:	Upstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	43.5
Levelling Notes:	1.53
Depth to water	1.65
Still Well:	0.55
Start time:	20:52
End time:	21:12

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
					*depth * width*	*Vel * Area*
LWE	2.7					
	3.2	0.30	0.02	0.50	0.15	0.00
	3.7	0.60	0.10	0.50	0.30	0.03
	4.2	0.90	0.06	0.50	0.45	0.03
	4.7	0.95	0.06	0.50	0.48	0.03
	5.2	1.10	0.11	0.50	0.55	0.06
	5.7	1.10	0.15	0.50	0.55	0.08
	6.2	1.20	0.21	0.50	0.60	0.13
	6.7	1.20	0.25	0.50	0.60	0.15
	7.2	1.30	0.25	0.50	0.65	0.16
	7.7	1.30	0.31	0.50	0.65	0.20
	8.2	1.40	0.35	0.50	0.70	0.25
	8.7	1.45	0.38	0.50	0.73	0.28
	9.2	1.60	0.46	0.50	0.80	0.37
	9.7	1.70	0.45	0.50	0.85	0.38
	10.2	1.60	0.44	0.50	0.80	0.35
	10.7	1.80	0.55	0.50	0.90	0.50
	11.2	1.80	0.59	0.50	0.90	0.53
	11.7	1.90	0.62	0.50	0.95	0.59
	12.2	1.90	0.63	0.50	0.95	0.60
	12.7	1.80	0.64	0.50	0.90	0.58
	13.2	2.00	0.59	0.50	1.00	0.59
	13.7	2.00	0.61	0.50	1.00	0.61
	14.2	2.00	0.62	0.50	1.00	0.62
	14.7	1.60	0.76	0.50	0.80	0.61
	15.2	1.90	0.78	0.50	0.95	0.74
	15.7	1.90	0.87	0.50	0.95	0.83
	16.2	1.90	0.89	0.50	0.95	0.85
	16.7	2.00	0.88	0.50	1.00	0.88
	17.2	2.00	0.90	0.50	1.00	0.90
	17.7	1.90	0.87	0.50	0.95	0.83
	18.2	2.00	0.89	0.50	1.00	0.89
	18.7	1.60	1.04	0.50	0.80	0.83
	19.2	1.70	1.10	0.50	0.85	0.94
	19.7	1.70	1.20	0.50	0.85	1.02
	20.2	1.80	1.26	0.50	0.90	1.13
	20.7	1.70	1.23	0.50	0.85	1.05
	21.2	1.80	1.19	0.50	0.90	1.07
	21.7	1.80	1.28	0.50	0.90	1.15
	22.2	1.90	1.31	0.50	0.95	1.24
	22.7	1.80	1.35	0.50	0.90	1.22
	23.2	2.00	1.33	0.50	1.00	1.33
	23.7	1.80	1.29	0.50	0.90	1.16
	24.2	1.70	1.18	0.50	0.85	1.00
	24.7	1.50	1.19	0.50	0.75	0.89
	25.2	1.80	1.17	0.50	0.90	1.05
	25.7	1.70	1.25	0.50	0.85	1.06
	26.2	1.70	1.24	0.50	0.85	1.05
	26.7	1.60	1.18	0.50	0.80	0.94
	27.2	1.60	1.16	0.50	0.80	0.93
	27.7	1.60	1.05	0.50	0.80	0.84
	28.2	1.60	1.00	0.50	0.80	0.80
	28.7	1.60	0.95	0.50	0.80	0.76
	29.2	1.50	0.93	0.50	0.75	0.70
	29.7	1.40	0.87	0.50	0.70	0.61
	30.2	1.50	0.79	0.50	0.75	0.59
	30.7	1.30	0.73	0.50	0.65	0.47
	31.2	1.30	0.68	0.50	0.65	0.44
	31.7	1.30	0.54	0.50	0.65	0.35
	32.2	1.00	0.50	0.50	0.50	0.25
	32.7	1.00	0.51	0.50	0.50	0.26
	33.2	0.90	0.49	0.50	0.45	0.22
	33.7	0.80	0.50	0.50	0.40	0.20
	34.2	0.80	0.49	0.50	0.40	0.20
	34.7	0.80	0.52	0.50	0.40	0.21
	35.2	0.90	0.50	0.50	0.45	0.23
	35.7	0.60	0.51	0.50	0.30	0.15
	36.2	0.60	0.49	0.50	0.30	0.15
	36.7	0.60	0.45	0.50	0.30	0.14
	37.2	0.60	0.41	0.50	0.30	0.12
	37.7	0.40	0.42	0.50	0.20	0.08
	38.2	0.50	0.34	0.50	0.25	0.09
	38.7	0.40	0.33	0.50	0.20	0.07
	39.2	0.30	0.20	0.50	0.15	0.03
	39.7	0.20	0.15	0.50	0.10	0.02
	40.2	0.10	0.00	0.40	0.04	0.00
RWE	40.5					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.10	0.00	0.40	0.04	0.00
Maximum	2.00	1.35	0.50	1.00	1.33
Average	1.37	0.69	0.50	0.69	0.54
Sum				51.44	40.66

Wetted Width	37.8	*RWE-LWE*
Mean Depth	1.36	*sum cell area / wetted width*
Discharge	40.66	*sum of discharge*

El Sur Velocity Transect # 2

Date:	10/28/2004
Location:	Midstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.4
Levelling Notes:	
Depth to water	1.57
Start time:	10:35
End time:	11:00

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area (*depth * width*)	Cell Discharge (*Vel * Area*)
LWE	2.2					
	2.7	0.40	0.08	0.50	0.20	0.02
	3.2	0.75	0.11	0.50	0.38	0.04
	3.7	1.20	0.14	0.50	0.60	0.08
	4.2	1.20	0.13	0.50	0.60	0.08
	4.7	1.30	0.12	0.50	0.65	0.08
	5.2	1.40	0.10	0.50	0.70	0.07
	5.7	1.40	0.05	0.50	0.70	0.04
	6.2	1.50	0.04	0.50	0.75	0.03
	6.7	1.60	0.04	0.50	0.80	0.03
	7.2	1.75	0.02	0.50	0.88	0.02
	7.7	1.90	0.04	0.50	0.95	0.04
	8.2	2.00	0.09	0.50	1.00	0.09
	8.7	2.15	0.08	0.50	1.08	0.09
	9.2	2.35	0.08	0.50	1.18	0.09
	9.7	2.50	0.06	0.50	1.25	0.08
	10.2	2.55	0.19	0.50	1.28	0.24
	10.7	3.00	0.19	0.50	1.50	0.29
	11.2	3.15	0.26	0.50	1.58	0.41
	11.7	3.15	0.21	0.50	1.58	0.33
	12.2	3.25	0.23	0.50	1.63	0.37
	12.7	3.35	0.24	0.50	1.68	0.40
	13.2	3.50	0.29	0.50	1.75	0.51
	13.7	3.50	0.26	0.50	1.75	0.46
	14.2	3.40	0.30	0.50	1.70	0.51
	14.7	3.60	0.32	0.50	1.80	0.58
	15.2	3.60	0.32	0.50	1.80	0.58
	15.7	3.50	0.45	0.50	1.75	0.79
	16.2	3.60	0.55	0.50	1.80	0.99
	16.7	3.60	0.85	0.50	1.80	1.53
	17.2	3.70	1.08	0.50	1.85	2.00
	17.7	3.40	1.31	0.50	1.70	2.23
	18.2	3.50	1.49	0.50	1.75	2.61
	18.7	3.60	1.78	0.50	1.80	3.20
	19.2	3.20	1.91	0.50	1.60	3.06
	19.7	3.40	2.03	0.50	1.70	3.45
	20.2	3.30	2.07	0.50	1.65	3.42
	20.7	3.30	1.90	0.50	1.65	3.14
	21.2	3.00	1.74	0.50	1.50	2.61
	21.7	3.00	1.50	0.50	1.50	2.25
	22.2	2.80	1.30	0.50	1.40	1.82
	22.7	2.90	1.10	0.50	1.45	1.60
	23.2	2.65	0.97	0.50	1.33	1.29
	23.7	2.40	0.95	0.50	1.20	1.14
	24.2	2.40	0.98	0.50	1.20	1.18
	24.7	2.20	0.74	0.50	1.10	0.81
	25.2	2.00	0.57	0.50	1.00	0.57
	25.7	1.70	0.47	0.50	0.85	0.40
	26.2	1.70	0.52	0.50	0.85	0.44
	26.7	1.50	0.36	0.50	0.75	0.27
	27.2	1.50	0.19	0.50	0.75	0.14
	27.7	1.40	0.16	0.50	0.70	0.11
	28.2	1.35	0.04	0.50	0.68	0.03
	28.7	1.20	0.02	0.50	0.60	0.01
	29.2	0.80	0.19	0.50	0.40	0.08
	29.7	0.60	0.02	0.50	0.30	0.01
	30.2	0.60	0.00	0.50	0.30	0.00
	30.7	0.30	0.00	0.50	0.15	0.00
	31.2	0.30	0.00	0.50	0.15	0.00
	31.7	0.20	0.00	0.50	0.10	0.00
RWE	32.2					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.20	0.00	0.50	0.10	0.00
Maximum	3.70	2.07	0.50	1.85	3.45
Average	2.27	0.53	0.50	1.14	0.79
Sum				67.03	46.68

Wetted Width	30	*RWE-LWE*
Mean Depth	2.23	*sum cell area / wetted width*
Discharge	46.68	*sum of discharge*

El Sur Velocity Transect # 2

Date:	10/28/2004
Location:	Midstream
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	36.2
Still Well:	NA
Depth to water	1.62
Start time:	20:05
End time:	20:27

**=((B16-B15)*0.5)+((B15-B14)*0.5)*

	Distance	Depth	Velocity	Cell Width	Cell Area *depth * width*	Cell Discharge *Vel * Area*
LWE	2.2					
	2.7	0.40	0.06	0.50	0.20	0.01
	3.2	0.80	0.06	0.50	0.40	0.02
	3.7	1.20	0.05	0.50	0.60	0.03
	4.2	1.30	0.04	0.50	0.65	0.03
	4.7	1.30	0.03	0.50	0.65	0.02
	5.2	1.40	0.01	0.50	0.70	0.01
	5.7	1.45	0.03	0.50	0.73	0.02
	6.2	1.50	0.05	0.50	0.75	0.04
	6.7	1.60	0.06	0.50	0.80	0.05
	7.2	1.80	0.07	0.50	0.90	0.06
	7.7	1.90	0.07	0.50	0.95	0.07
	8.2	2.00	0.08	0.50	1.00	0.08
	8.7	2.20	0.07	0.50	1.10	0.08
	9.2	2.30	0.07	0.50	1.15	0.08
	9.7	2.55	0.08	0.50	1.28	0.10
	10.2	2.55	0.09	0.50	1.28	0.11
	10.7	2.90	0.11	0.50	1.45	0.16
	11.2	3.10	0.12	0.50	1.55	0.19
	11.7	3.15	0.15	0.50	1.58	0.24
	12.2	3.25	0.15	0.50	1.63	0.24
	12.7	3.30	0.14	0.50	1.65	0.23
	13.2	3.50	0.18	0.50	1.75	0.32
	13.7	3.50	0.17	0.50	1.75	0.30
	14.2	3.40	0.18	0.50	1.70	0.31
	14.7	3.50	0.18	0.50	1.75	0.32
	15.2	3.55	0.17	0.50	1.78	0.30
	15.7	3.50	0.35	0.50	1.75	0.61
	16.2	3.50	0.72	0.50	1.75	1.26
	16.7	3.60	1.21	0.50	1.80	2.18
	17.2	3.50	1.06	0.50	1.75	1.86
	17.7	3.40	1.13	0.50	1.70	1.92
	18.2	3.60	1.70	0.50	1.80	3.06
	18.7	3.50	1.74	0.50	1.75	3.05
	19.2	3.20	2.11	0.50	1.60	3.38
	19.7	3.20	2.06	0.50	1.60	3.30
	20.2	3.20	2.04	0.50	1.60	3.26
	20.7	3.20	2.04	0.50	1.60	3.26
	21.2	3.00	1.73	0.50	1.50	2.60
	21.7	2.90	1.51	0.50	1.45	2.19
	22.2	2.90	1.27	0.50	1.45	1.84
	22.7	2.80	1.05	0.50	1.40	1.47
	23.2	2.50	0.99	0.50	1.25	1.24
	23.7	2.20	1.03	0.50	1.10	1.13
	24.2	2.10	0.83	0.50	1.05	0.87
	24.7	2.10	0.82	0.50	1.05	0.86
	25.2	1.80	0.84	0.50	0.90	0.76
	25.7	1.80	0.70	0.50	0.90	0.63
	26.2	1.60	0.51	0.50	0.80	0.41
	26.7	1.50	0.44	0.50	0.75	0.33
	27.2	1.50	0.40	0.50	0.75	0.30
	27.7	1.40	0.27	0.50	0.70	0.19
	28.2	1.40	0.25	0.50	0.70	0.18
	28.7	1.20	0.08	0.50	0.60	0.05
	29.2	0.50	0.00	0.50	0.25	0.00
	29.7	0.50	-0.04	0.50	0.25	-0.01
	30.2	0.50	0.00	0.50	0.25	0.00
	30.7	0.35	0.01	0.50	0.18	0.00
	31.2	0.20	-0.02	0.50	0.10	0.00
	31.7	0.20	0.00	0.40	0.08	0.00
RWE	32					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.20	-0.04	0.40	0.08	-0.01
Maximum	3.60	2.11	0.50	1.80	3.38
Average	2.23	0.53	0.50	1.12	0.77
Sum				65.86	45.56

Wetted Width	29.8	*RWE-LWE*
Mean Depth	2.21	*sum cell area / wetted width*
Discharge	45.56	*sum of discharge*

El Sur Velocity Transect # 3

Date:	10/28/2004
Location:	V-Notch
Pin 1 GPS (Left bank facing upstream):	
Pin 2 GPS (Right bank facing upstream):	
Transect Length Pin to Pin:	37.2
Levelling Notes:	
Depth to water	
Start time:	16:56
End time:	17:17

*=((B16-B15)*0.5)+((B15-B14)*0.5)

	Distance	Depth	Velocity	Cell Width	Cell Area *depth * width*	Cell Discharge *Vel * Area*
LWE	8.5					
	9	0.10	0.00	0.50	0.05	0.00
	9.5	0.20	0.84	0.50	0.10	0.08
	10	0.40	0.47	0.50	0.20	0.09
	10.5	0.60	0.00	0.50	0.30	0.00
	11	0.70	0.34	0.50	0.35	0.12
	11.5	0.80	1.58	0.50	0.40	0.63
	12	1.10	1.81	0.50	0.55	1.00
	12.5	1.30	1.91	0.50	0.65	1.24
	13	1.30	1.94	0.50	0.65	1.26
	13.5	1.30	1.88	0.50	0.65	1.22
	14	1.30	1.83	0.50	0.65	1.19
	14.5	1.20	1.78	0.50	0.60	1.07
	15	1.40	1.75	0.50	0.70	1.23
	15.5	1.40	1.77	0.50	0.70	1.24
	16	1.40	1.78	0.50	0.70	1.25
	16.5	1.45	1.71	0.50	0.73	1.24
	17	1.60	1.75	0.50	0.80	1.40
	17.5	1.70	1.67	0.50	0.85	1.42
	18	1.90	1.67	0.50	0.95	1.59
	18.5	2.10	1.67	0.50	1.05	1.75
	19	2.30	1.68	0.50	1.15	1.93
	19.5	2.60	1.66	0.50	1.30	2.16
	20	2.80	1.73	0.50	1.40	2.42
	20.5	2.90	1.75	0.50	1.45	2.54
	21	3.10	1.81	0.50	1.55	2.81
	21.5	3.15	1.79	0.50	1.58	2.82
	22	3.20	1.80	0.50	1.60	2.88
	22.5	3.10	1.76	0.50	1.55	2.73
	23	3.00	1.69	0.50	1.50	2.54
	23.5	3.10	1.48	0.50	1.55	2.29
	24	3.00	1.34	0.50	1.50	2.01
	24.5	2.90	1.24	0.50	1.45	1.80
	25	2.90	1.16	0.50	1.45	1.68
	25.5	2.65	1.03	0.50	1.33	1.36
	26	2.60	1.04	0.50	1.30	1.35
	26.5	2.30	1.09	0.50	1.15	1.25
	27	2.35	1.05	0.50	1.18	1.23
	27.5	2.05	0.90	0.50	1.03	0.92
	28	1.90	0.64	0.50	0.95	0.61
	28.5	1.75	0.33	0.50	0.88	0.29
	29	1.70	0.16	0.50	0.85	0.14
	29.5	1.60	0.09	0.50	0.80	0.07
	30	1.50	0.01	0.50	0.75	0.01
	30.5	1.40	-0.08	0.50	0.70	-0.06
	31	1.25	-0.12	0.50	0.63	-0.08
	31.5	1.10	-0.17	0.50	0.55	-0.09
	32	0.95	-0.17	0.50	0.48	-0.08
	32.5	0.80	-0.21	0.50	0.40	-0.08
	33	0.65	-0.21	0.50	0.33	-0.07
	33.5	0.50	-0.20	0.50	0.25	-0.05
	34	0.40	-0.12	0.50	0.20	-0.02
	34.5	0.20	0.00	0.40	0.08	0.00
RWE	34.8					

	Depth	Velocity	Cell Width	Cell Area	Cell Discharge
Minimum	0.10	-0.21	0.40	0.05	-0.09
Maximum	3.20	1.94	0.50	1.60	2.88
Average	1.71	1.04	0.50	0.85	1.08
Sum				44.46	56.32

Wetted Width	26.3	*RWE-LWE*
Mean Depth	1.69	*sum cell area / wetted width*
Discharge	56.32	*sum of discharge*

APPENDIX M

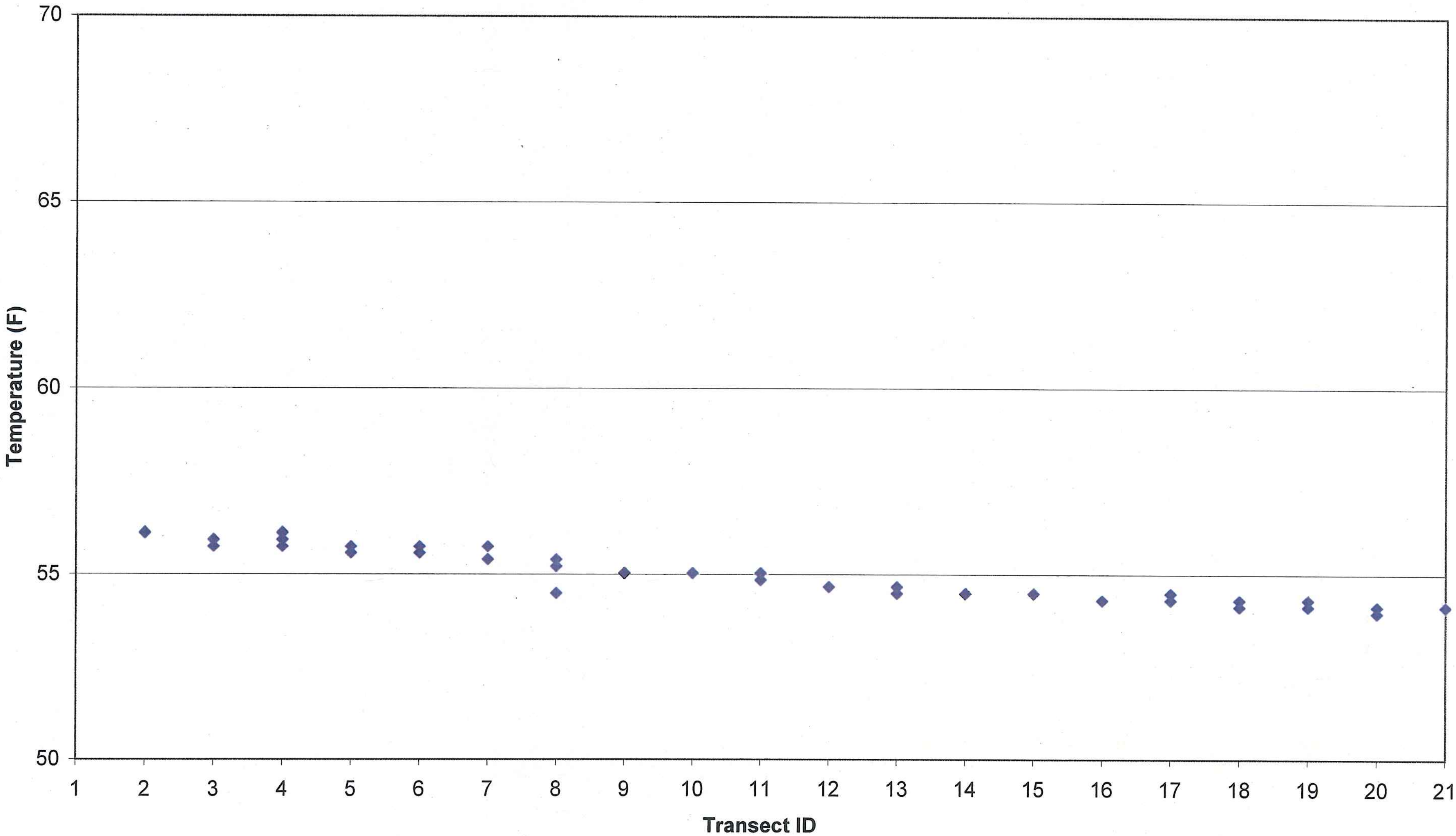
APPENDIX M

WATER QUALITY DATA

Summary of Manually Collected Groundwater Quality Data

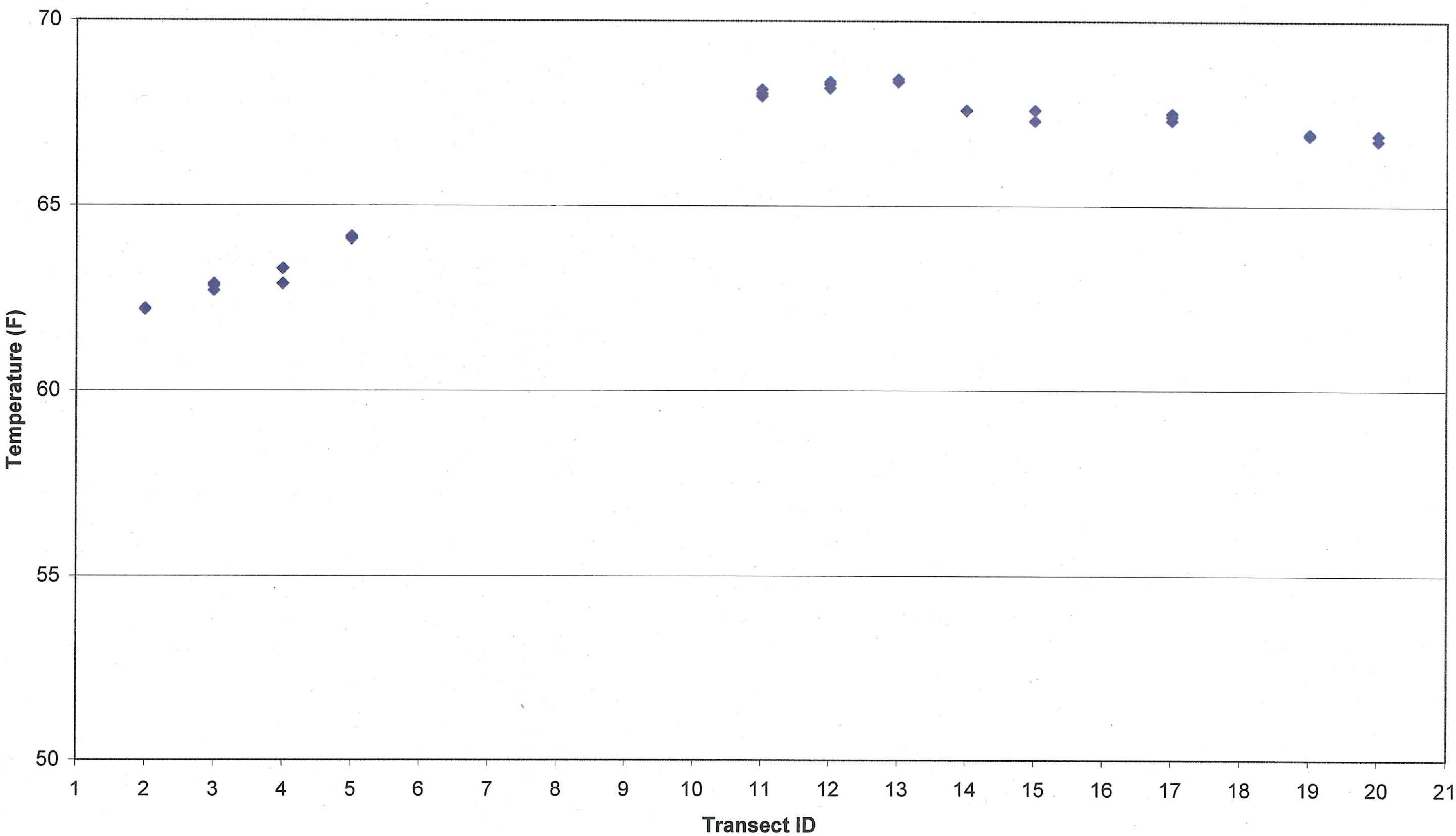
Well	Date	Time	Temp (°C)	Temp (°F)	EC (μS/cm)	DO (mg/L)
ESR-01	10/6/2004	9:50	16.32	61.38	242	11.15
ESR-01	10/14/2004	10:26	15.84	60.51	211	2.67
ESR-01	10/28/2004	14:06	15.51	59.92	219	3.84
ESR-02	8/5/2004	13:00	14.47	58.05	262	0.74
ESR-02	8/18/2004	11:50	14.74	58.53	327	1.69
ESR-02	9/2/2004	11:10	15.59	60.06	266	0.63
ESR-02	9/27/2004	10:30	15.43	59.77	256	1.04
ESR-02	9/30/2004	11:29	15.33	59.59	256	1.45
ESR-02	10/6/2004	9:58	15.94	60.69	257	0.89
ESR-02	10/14/2004	10:18	15.45	59.81	259	1.51
ESR-02	10/28/2004	13:58	15.34	59.61	260	0.83
ESR-03	8/5/2004	13:00	14.86	58.75	245	3.77
ESR-03	8/18/2004	11:50	15.15	59.27	308	3.35
ESR-03	9/2/2004	11:05	15.28	59.50	252	2.54
ESR-03	9/27/2004	10:45	16.17	61.11	262	2.51
ESR-03	9/30/2004	11:38	16.22	61.20	260	2.8
ESR-03	10/6/2004	10:03	16.87	62.37	261	3.7
ESR-03	10/14/2004	10:12	16.69	62.04	263	4.79
ESR-03	10/28/2004	13:54	16.24	61.23	264	3.93
ESR-10A	9/2/2004	11:25	17.96	64.33	383	2.34
ESR-10A	9/27/2004	12:15	17.13	62.83	274	4.6
ESR-10A	10/6/2004	10:35	16.15	61.07	271	3.97
ESR-10A	10/14/2004	10:55	15.68	60.22	275	3.64
ESR-10A	10/28/2004	14:31	14.43	57.97	254	2.94
ESR-10B	9/2/2004	11:22	18.71	65.68	494	0.69
ESR-10B	9/27/2004	12:15	17.2	62.96	486	3.94
ESR-10B	10/6/2004	10:39	16.21	61.18	408	0.31
ESR-10B	10/14/2004	10:58	15.73	60.31	361	0.16
ESR-10B	10/28/2004	14:35	14.84	58.71	310	0.56
ESR-10C	9/2/2004	11:19	18.05	64.49	296	0.25
ESR-10C	9/27/2004	12:15	17.43	63.37	293	1.01
ESR-10C	10/6/2004	10:43	16.28	61.30	282	0.1
ESR-10C	10/14/2004	11:01	15.86	60.55	281	0.24
ESR-10C	10/28/2004	14:37	15.14	59.25	277	0.29
ESR-11	10/6/2004	11:19	16.46	61.63	482	4.23
ESR-11	10/14/2004	11:52	16.05	60.89	479	3.75
ESR-11	10/28/2004	16:15	15.44	59.79	471	2.6
ESR-12	10/6/2004	11:02	16.29	61.32	418	1.57
ESR-12	10/14/2004	11:37	16.08	60.94	427	1.57
ESR-12	10/28/2004	15:50	15.47	59.85	466	1.7
JSA-03	10/6/2004	10:15	15.68	60.22	255	2.01
JSA-03	10/14/2004	10:37	15.23	59.41	261	1.34
JSA-03	10/28/2004	14:16	14.75	58.55	255	2.78
JSA-04	8/5/2004	13:00	14.13	57.43	247	2.48
JSA-04	8/18/2004	11:50	13.73	56.71	304	3.88
JSA-04	9/2/2004	11:00	14.52	58.14	244	4.06
JSA-04	9/27/2004	11:10	13.56	56.41	245	1.85
JSA-04	9/30/2004	11:43	13.7	56.66	242	2.44
JSA-04	10/6/2004	10:21	14.02	57.24	238	3.83
JSA-04	10/14/2004	10:44	13.49	56.28	245	1.58
JSA-04	10/28/2004	14:21	13.6	56.48	251	1.38

Temperature Measurements
Big Sur River - April 18, 2004
El Sur Ranch

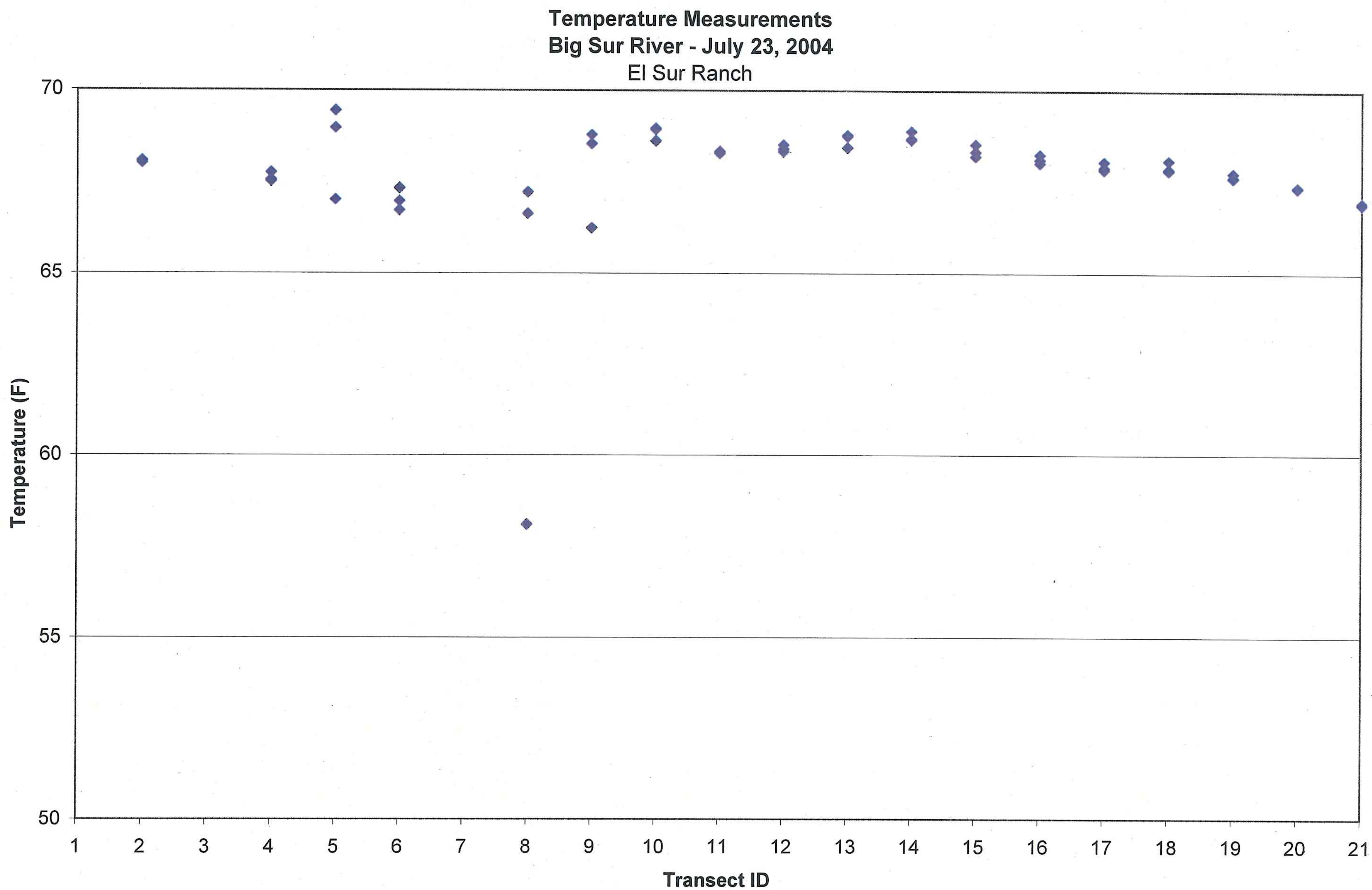


SGI environmental THE SOURCE GROUP, INC.

Temperature Measurements
Big Sur River - July 12, 2004
El Sur Ranch

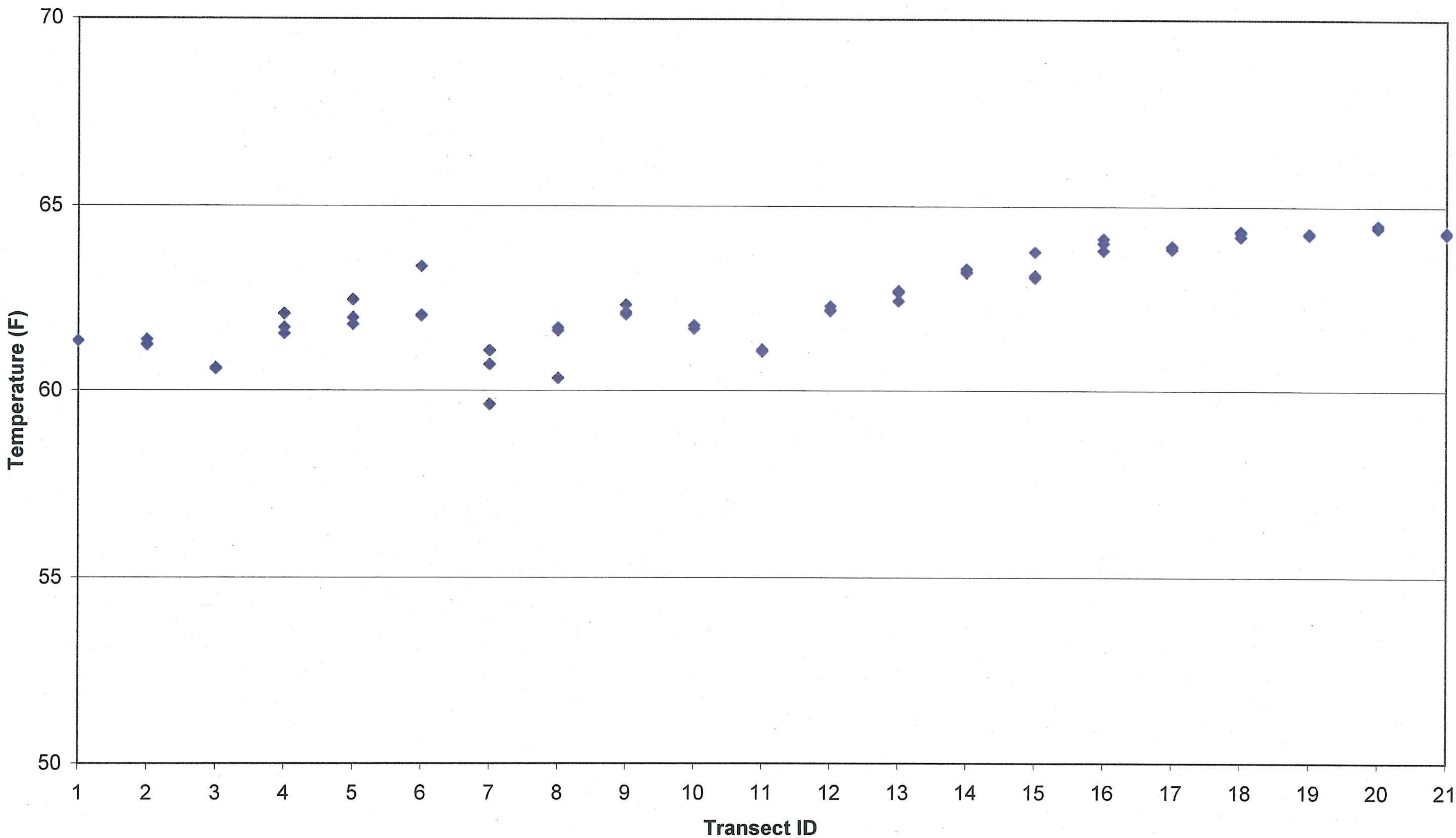


SGI environmental THE SOURCE GROUP, INC.



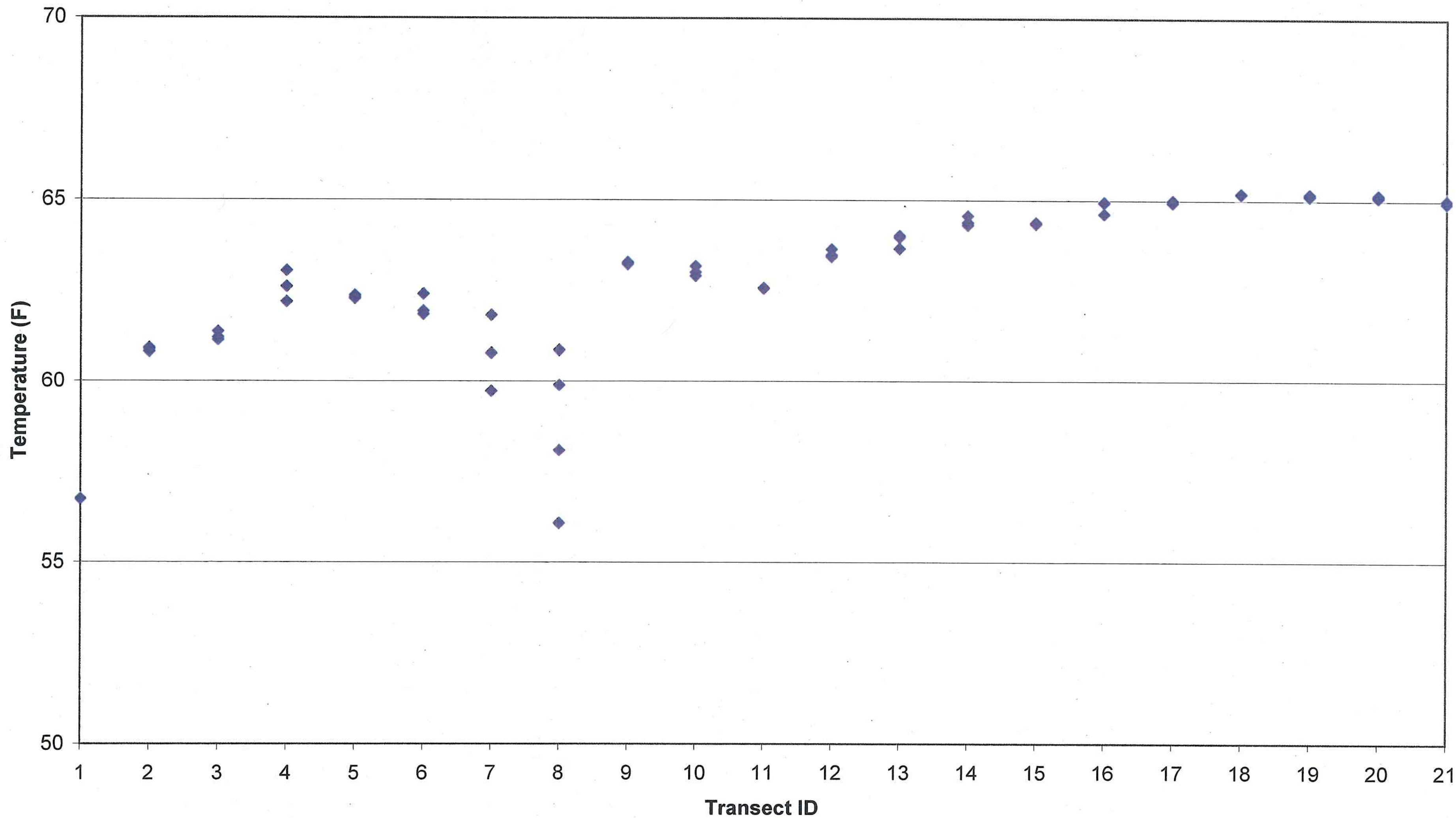
SGI environmental THE SOURCE GROUP, INC.

Temperature Measurements
Big Sur River - August 6, 2004
El Sur Ranch



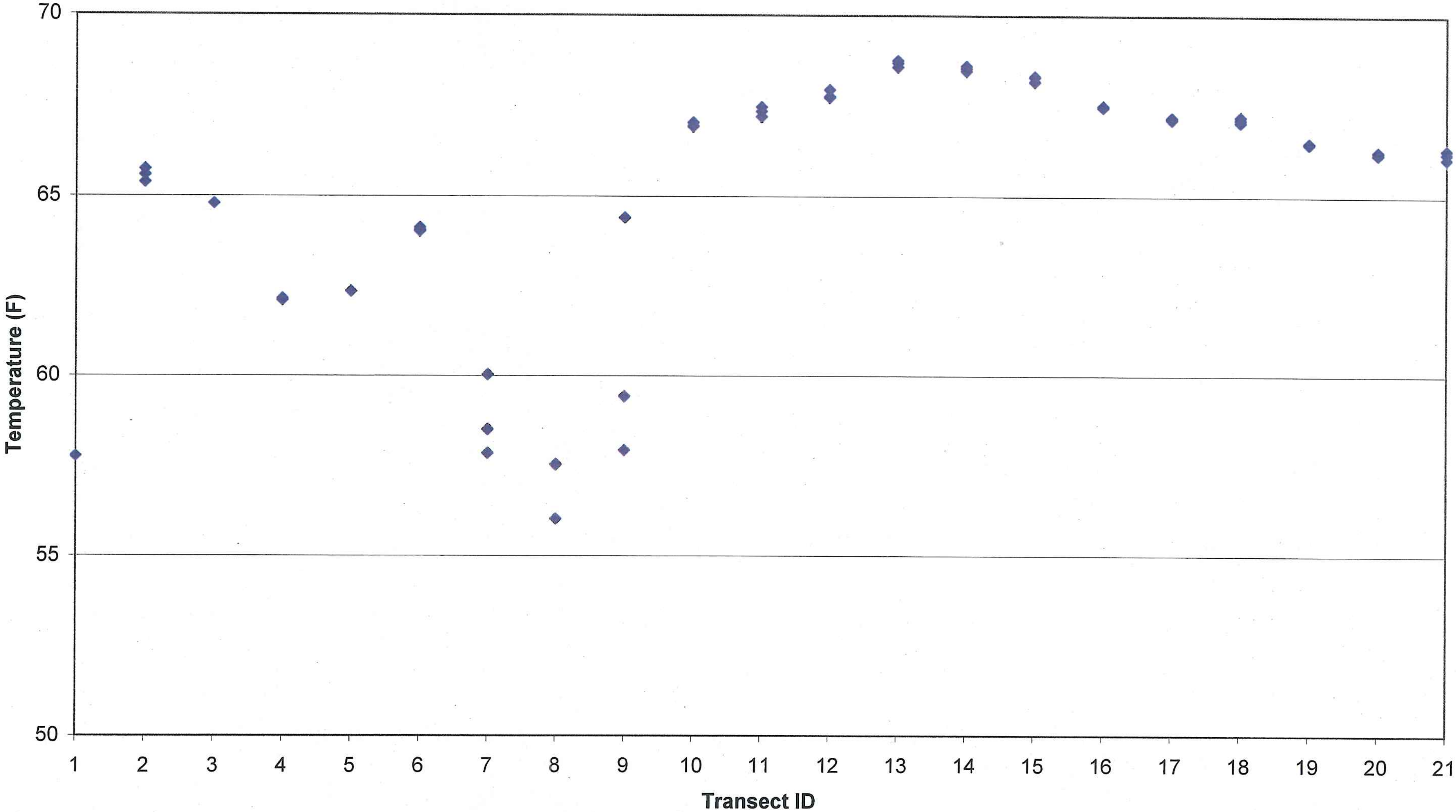
SGI environmental THE SOURCE GROUP, INC.

Temperature Measurements
Big Sur River - August 19, 2004
El Sur Ranch

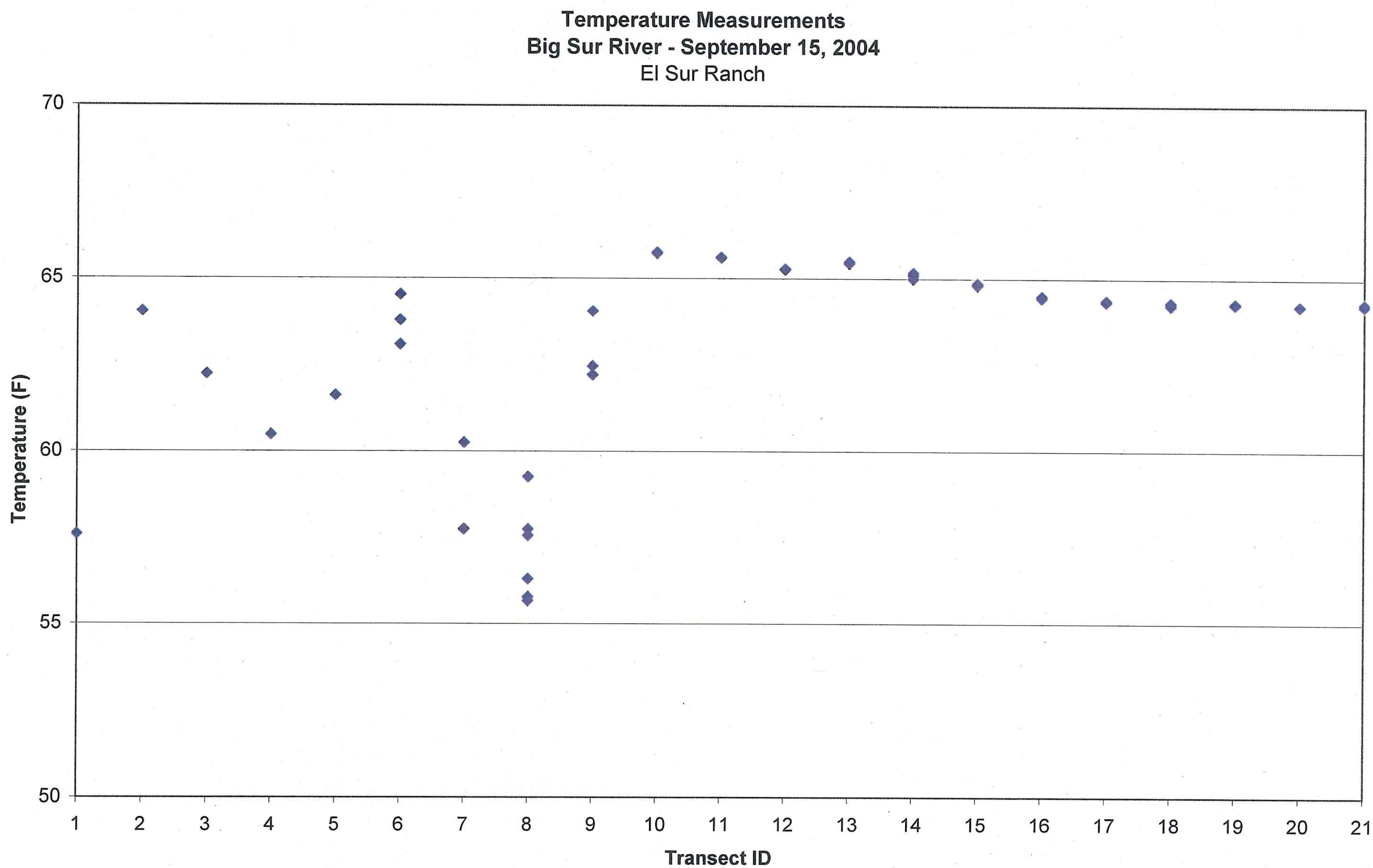


SGI environmental THE SOURCE GROUP, INC.

Temperature Measurements
Big Sur River - September 2, 2004
El Sur Ranch

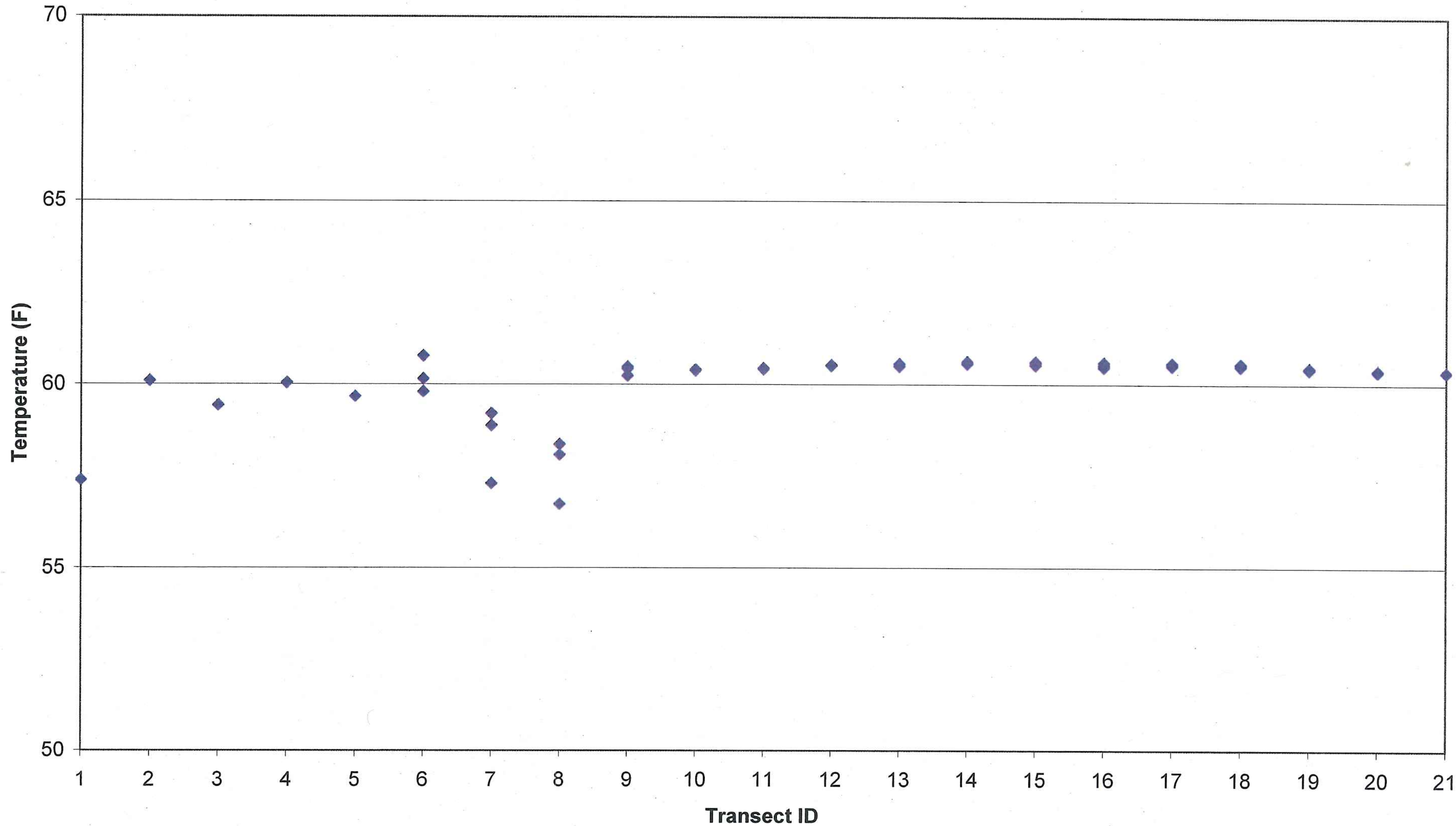


SGI environmental THE SOURCE GROUP, INC.



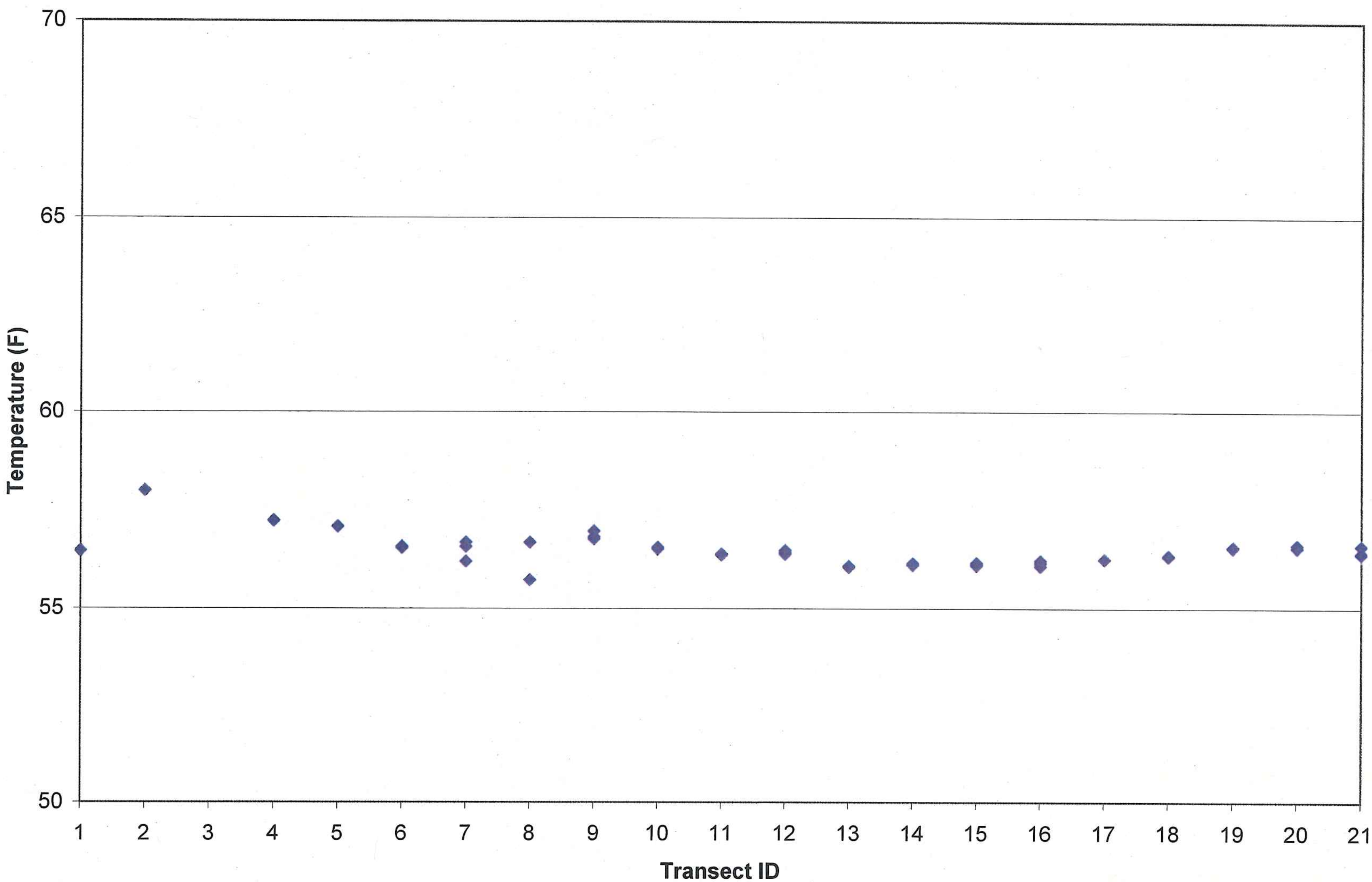
SGI environmental THE SOURCE GROUP, INC.

Temperature Measurements
Big Sur River - September 30, 2004
El Sur Ranch



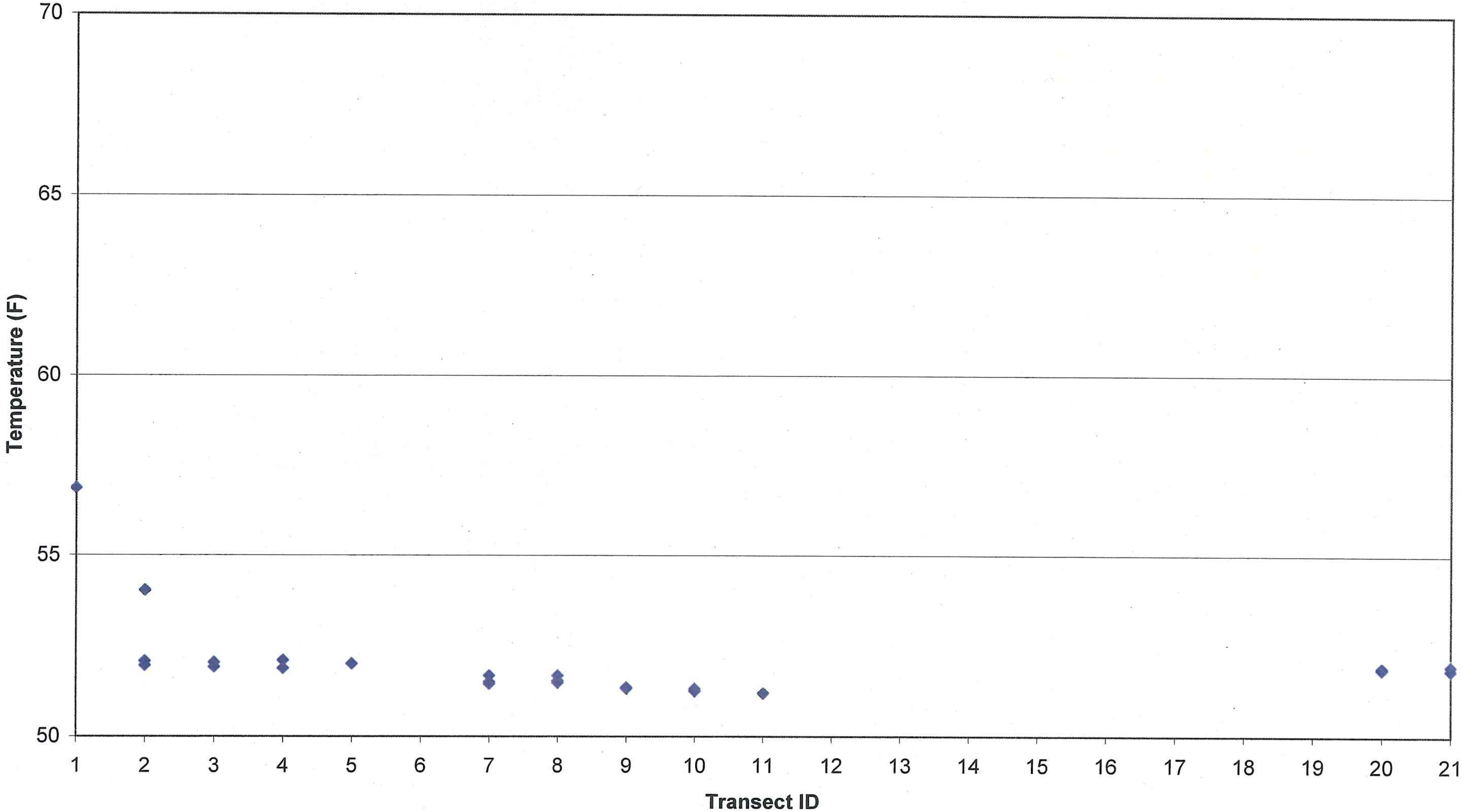
THE SOURCE GROUP, INC.
SGI environmental

Temperature Measurements
Big Sur River - October 15, 2004
El Sur Ranch



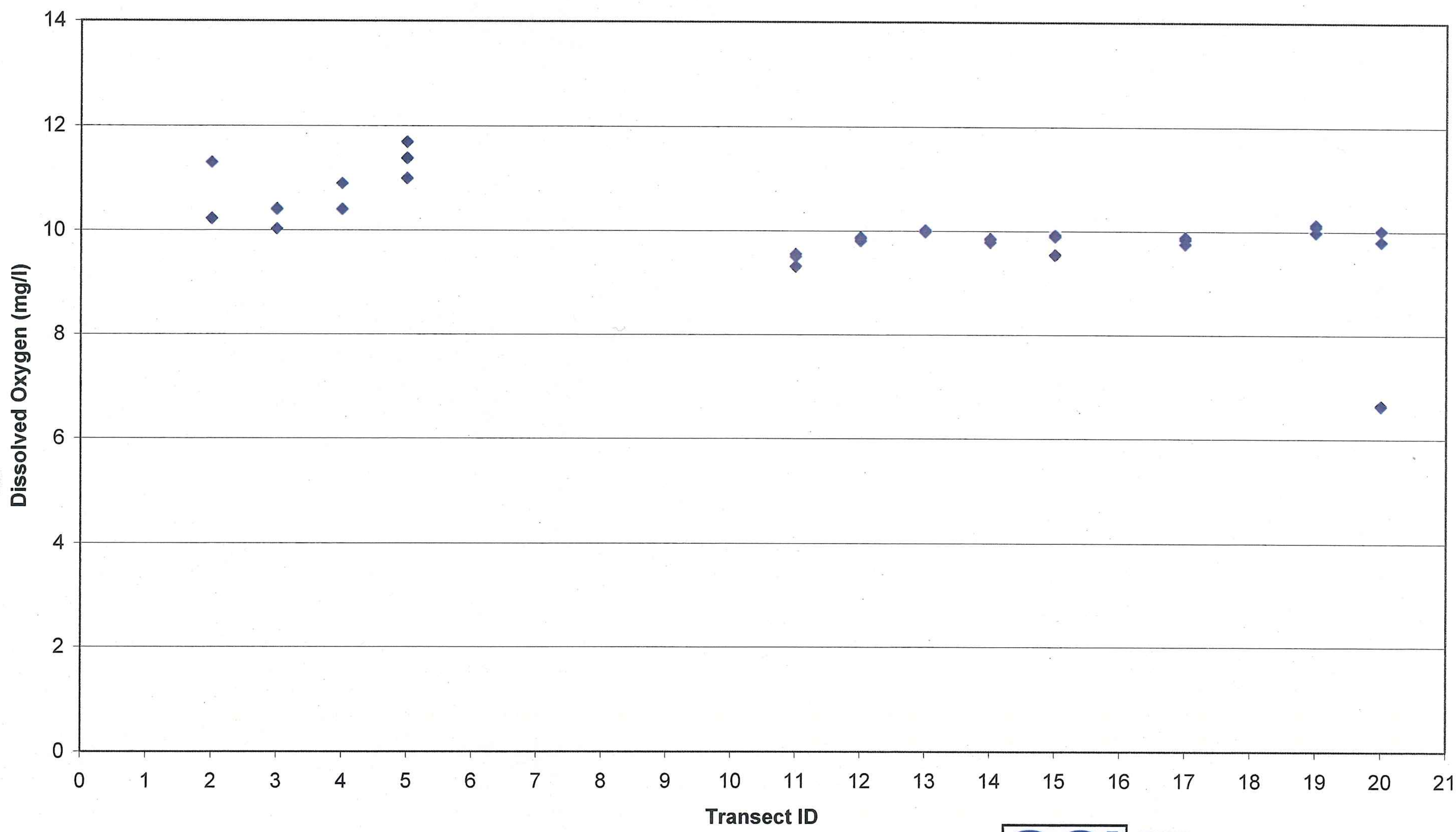
THE SOURCE GROUP, INC.
SGI environmental

Temperature Measurements
Big Sur River - October 28, 2004
El Sur Ranch



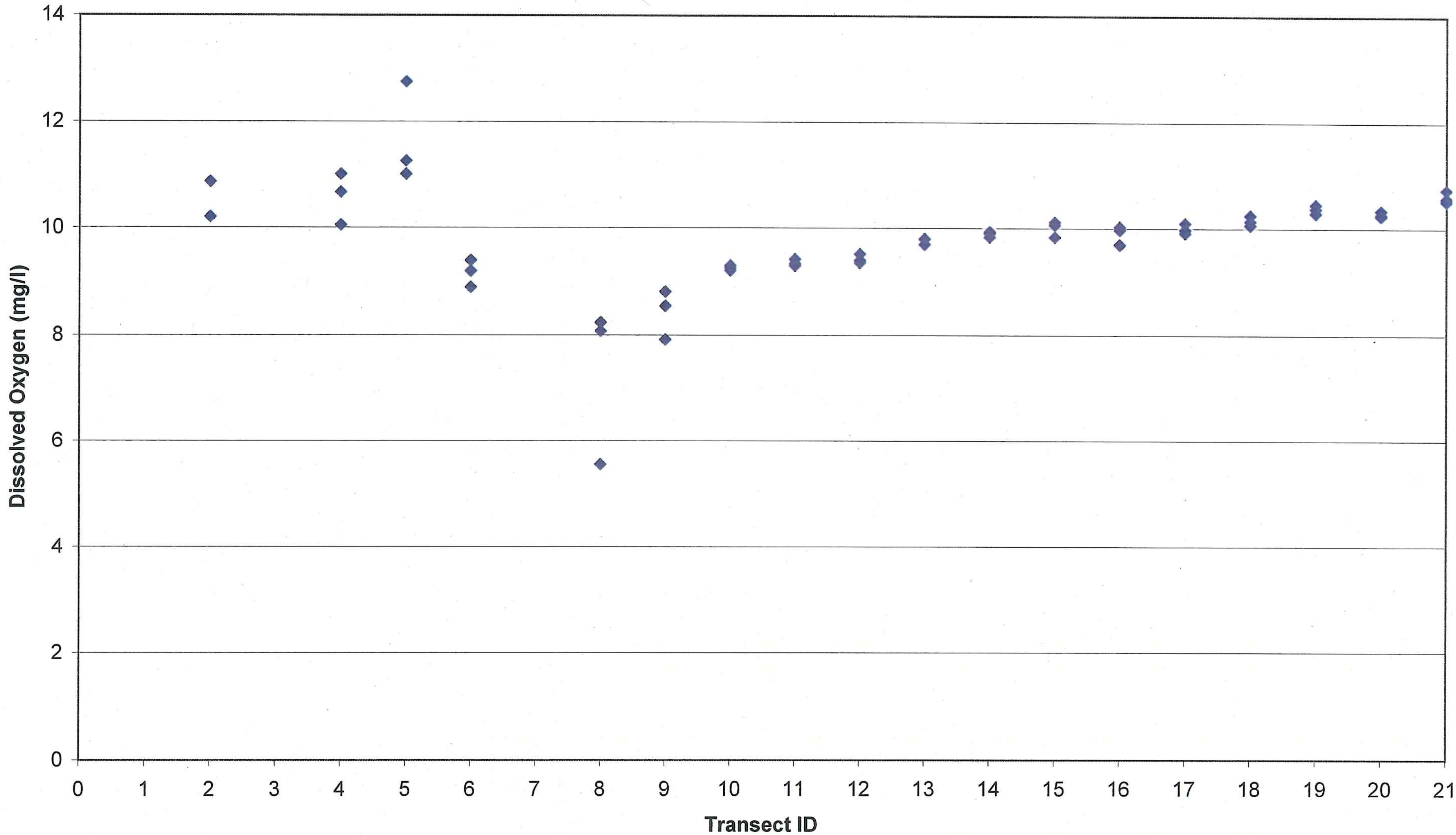
SGI environmental THE SOURCE GROUP, INC.

Dissolved Oxygen Measurements
Big Sur River - July 12, 2004
El Sur Ranch



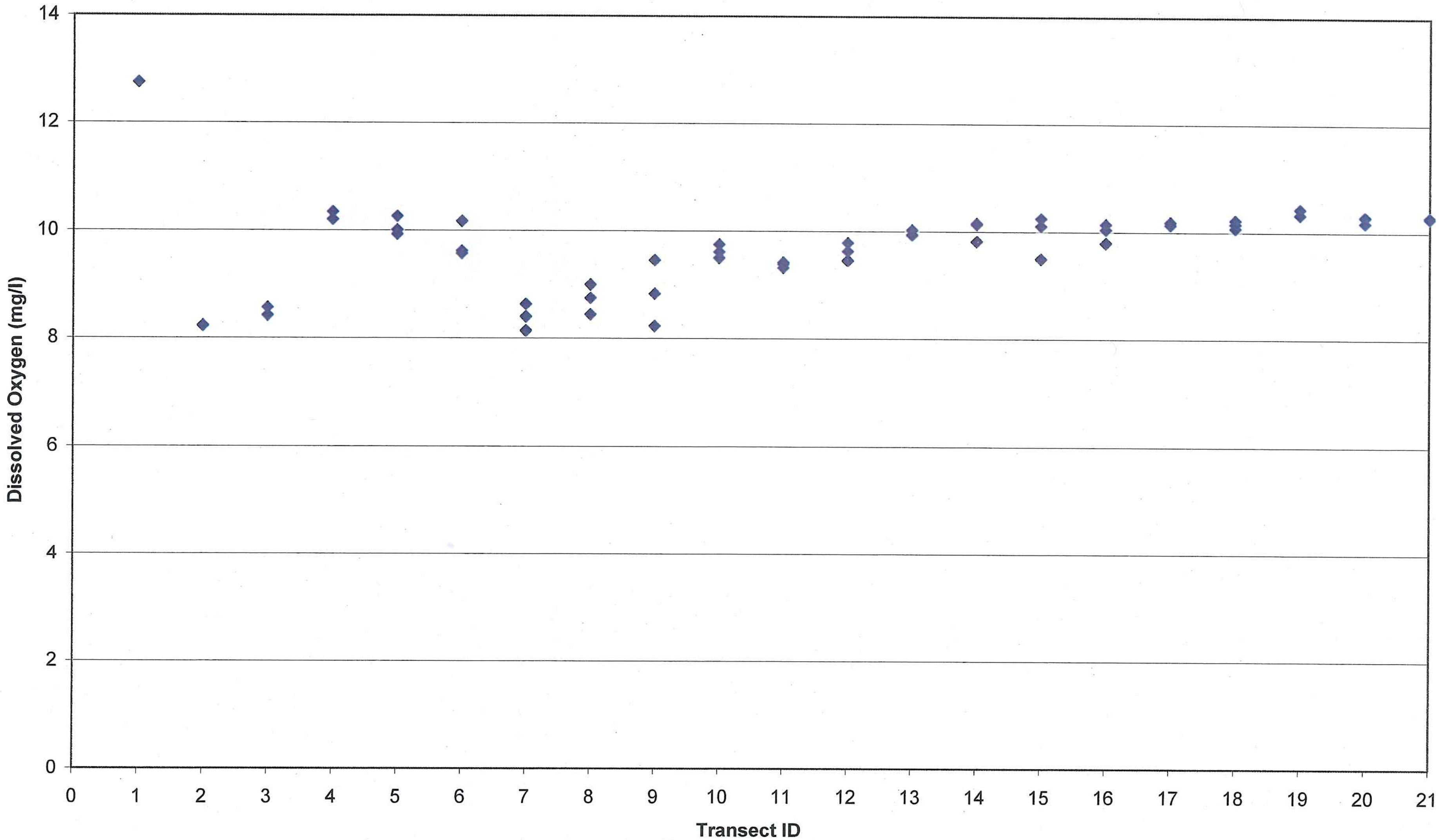
THE SOURCE GROUP, INC.
SGI environmental

Dissolved Oxygen Measurements
Big Sur River - July 23, 2004
El Sur Ranch

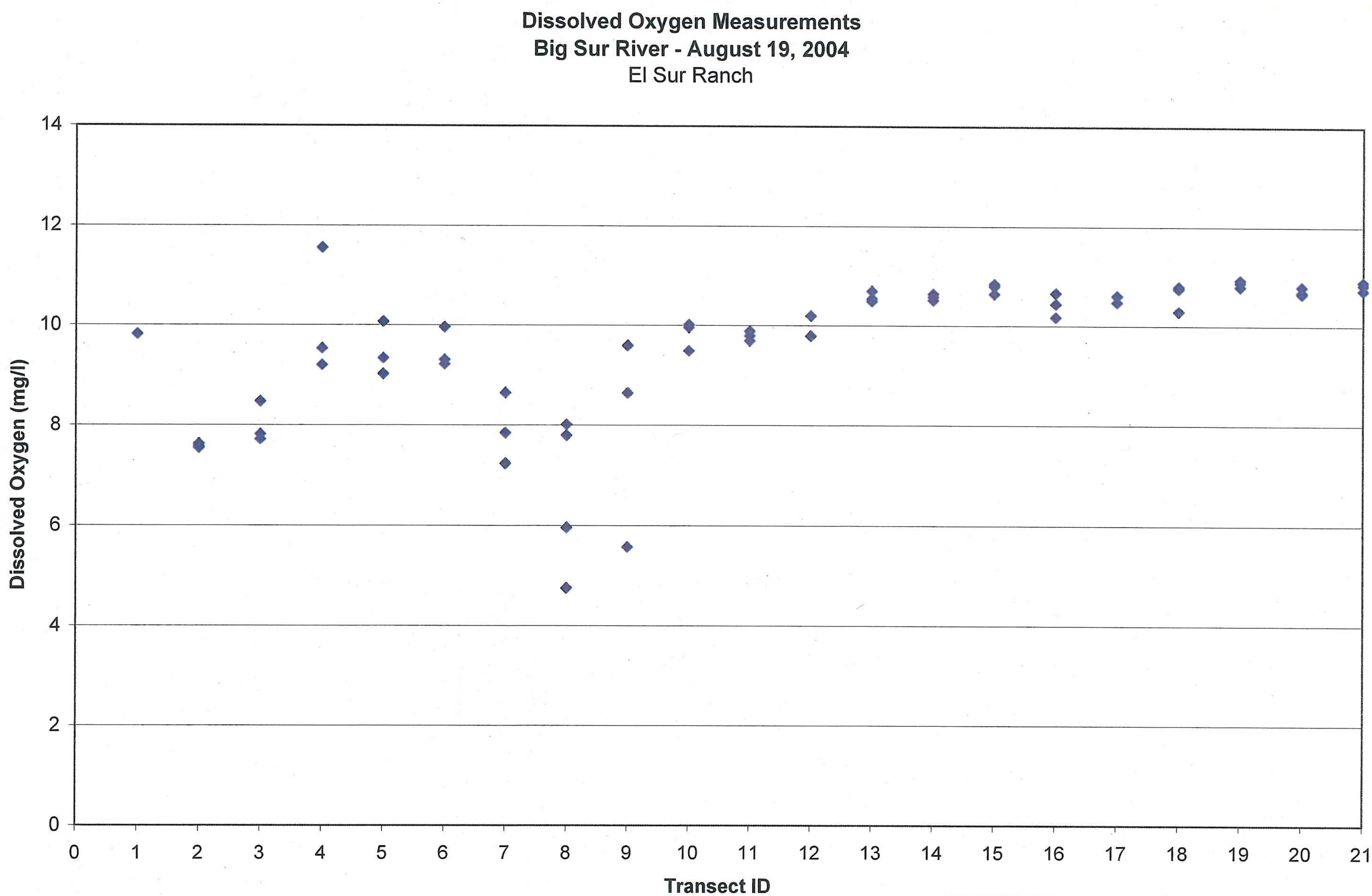


SGI environmental THE SOURCE GROUP, INC.

Dissolved Oxygen Measurements
Big Sur River - August 5, 2004
El Sur Ranch

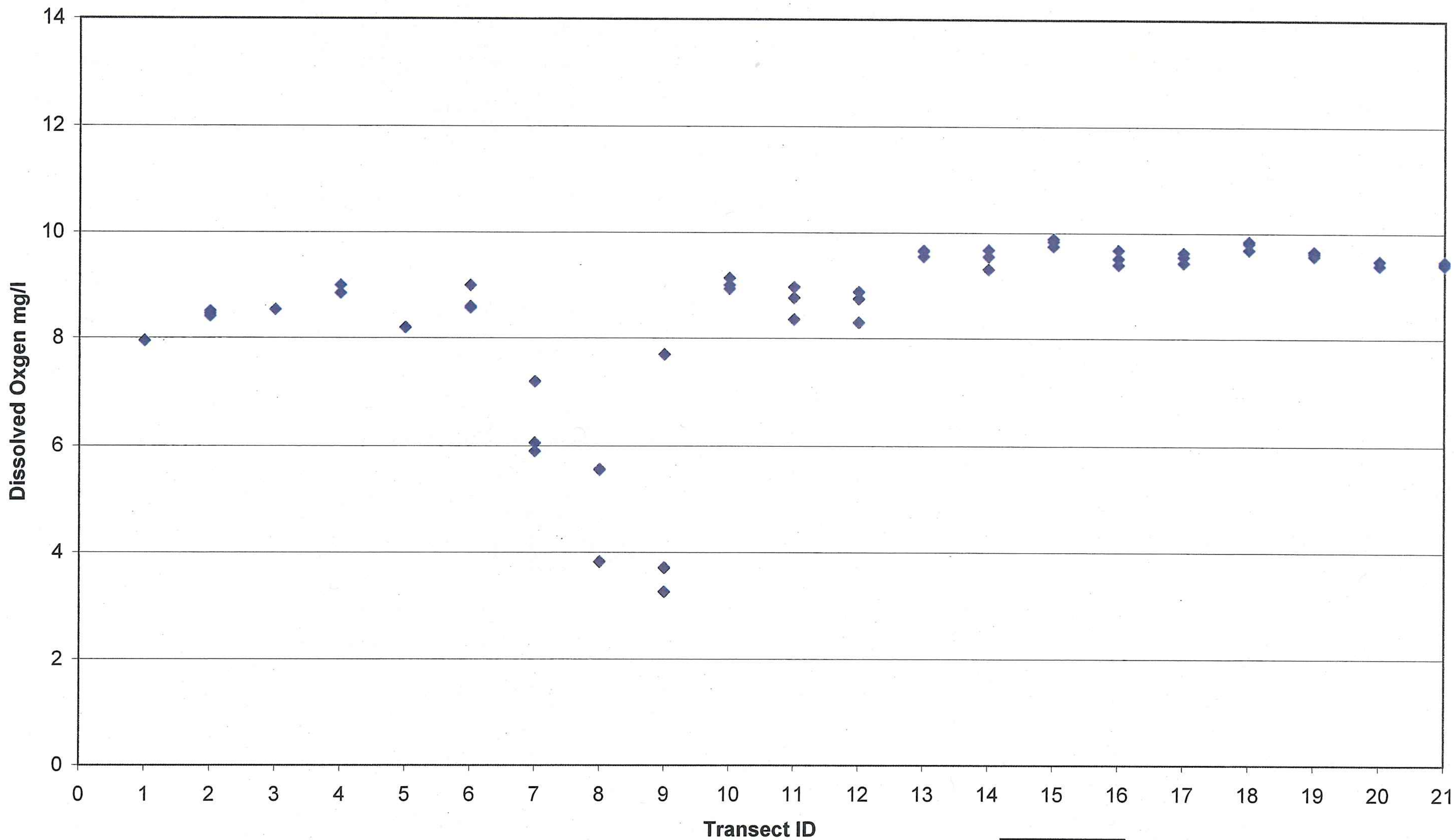


SGI environmental THE SOURCE GROUP, INC.



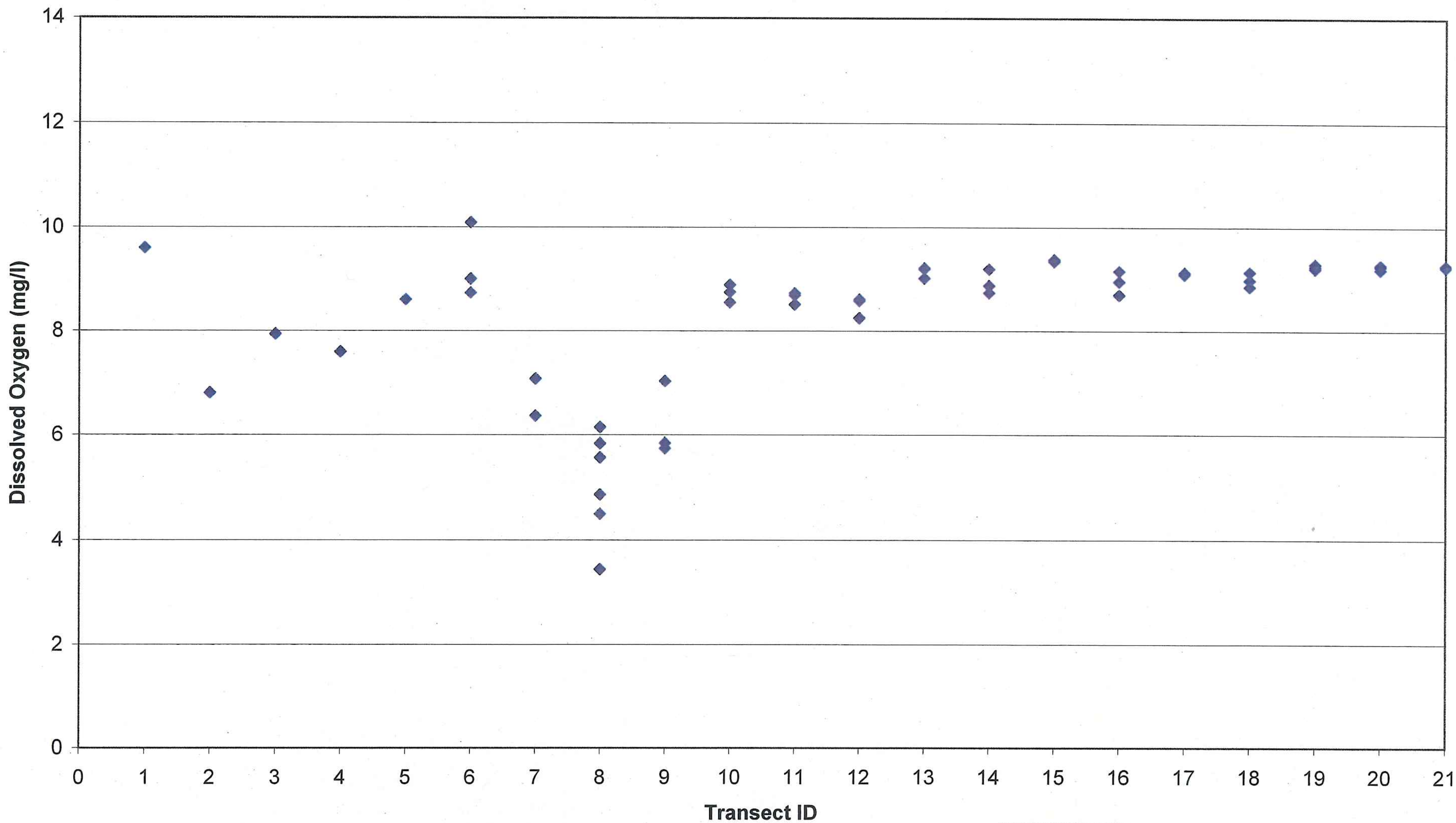
SGI environmental THE SOURCE GROUP, INC.

Dissolved Oxygen Measurements
Big Sur River - September 2, 2004
El Sur Ranch



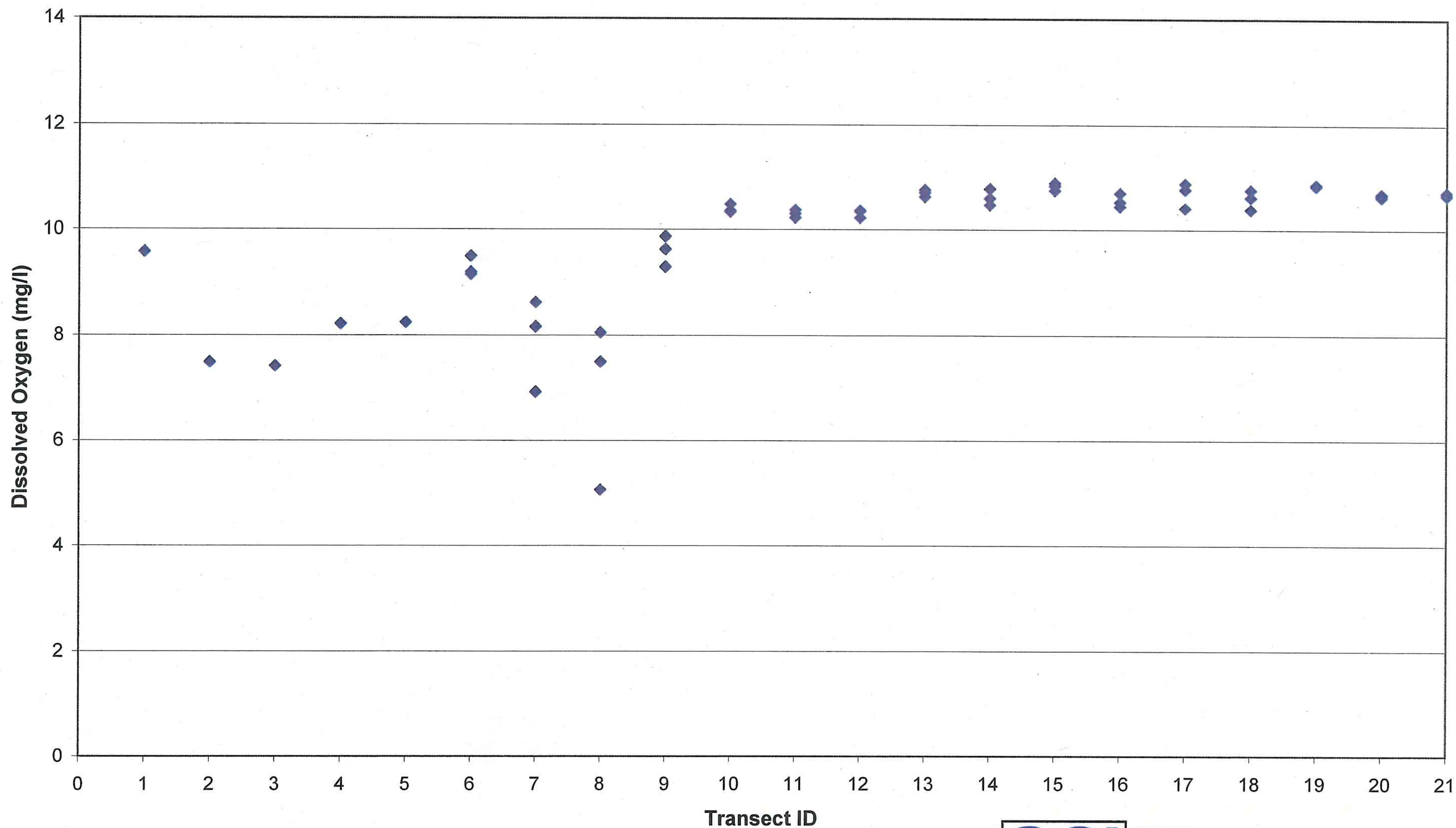
SGI environmental THE SOURCE GROUP, INC.

Dissolved Oxygen Measurements
Big Sur River - September 15, 2004
El Sur Ranch



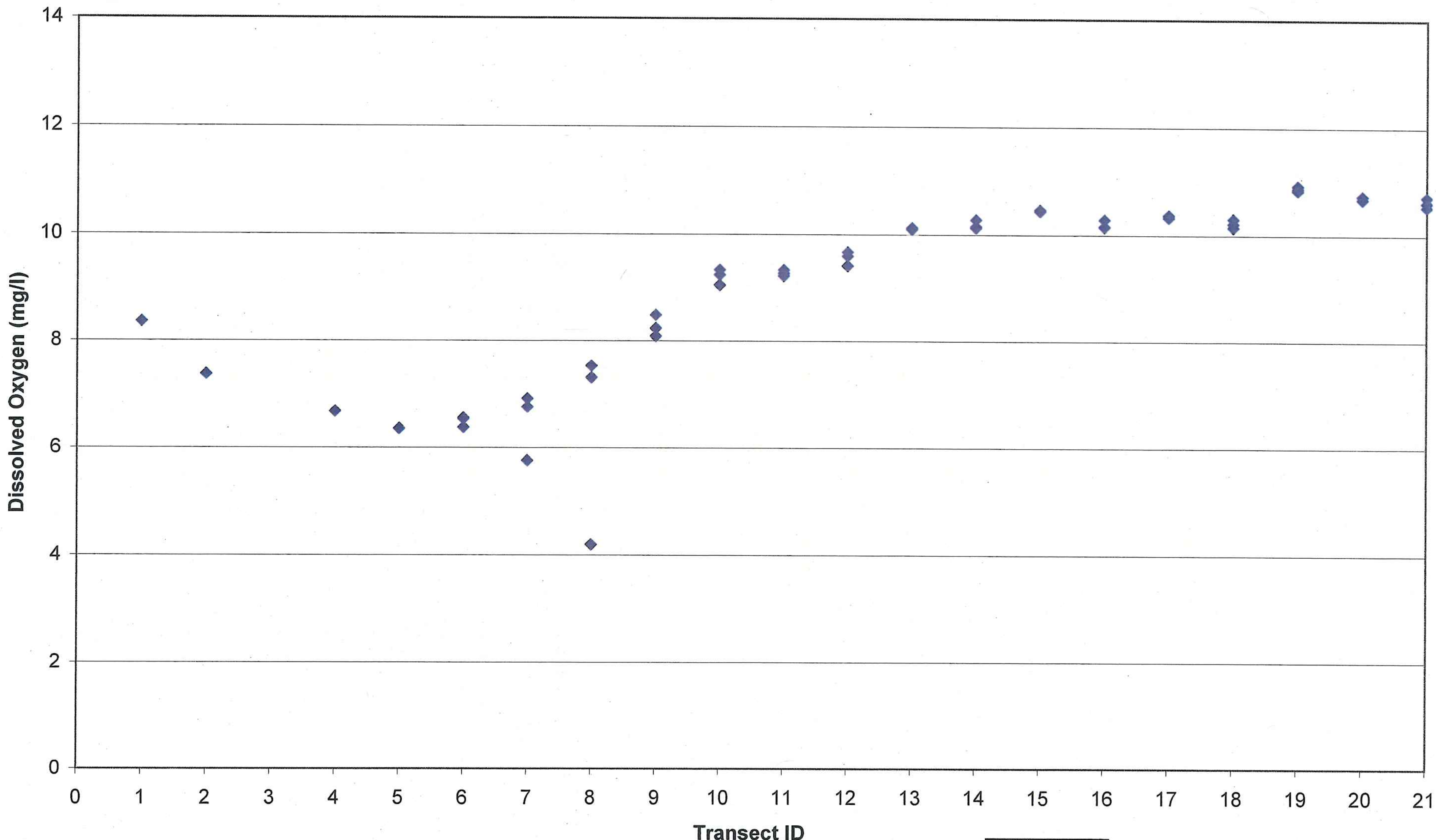
SGI environmental THE SOURCE GROUP, INC.

Dissolved Oxygen Measurements
Big Sur River - September 30, 2004
El Sur Ranch



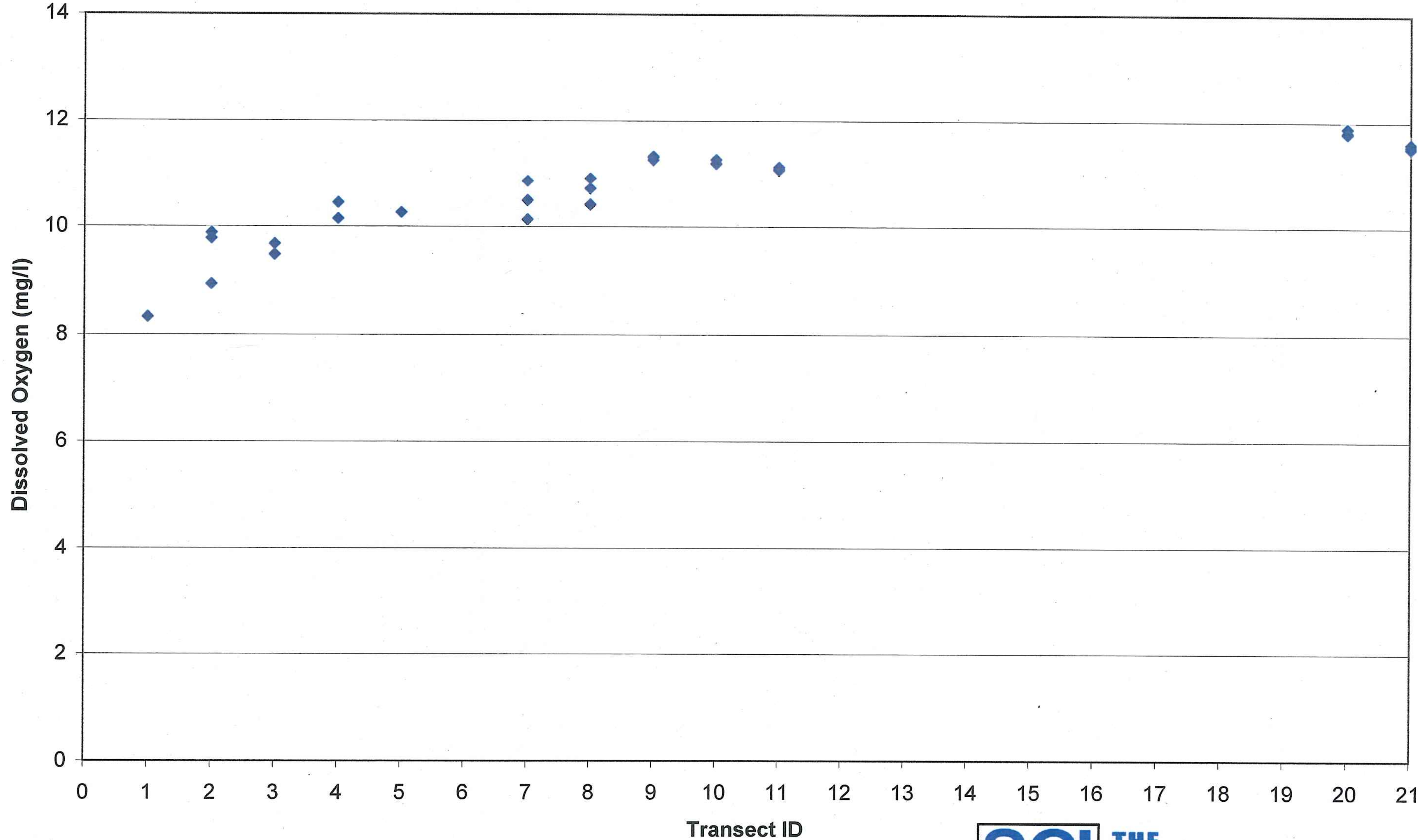
SGI environmental THE SOURCE GROUP, INC.

Dissolved Oxygen Measurements
Big Sur River - October 14, 2004
El Sur Ranch



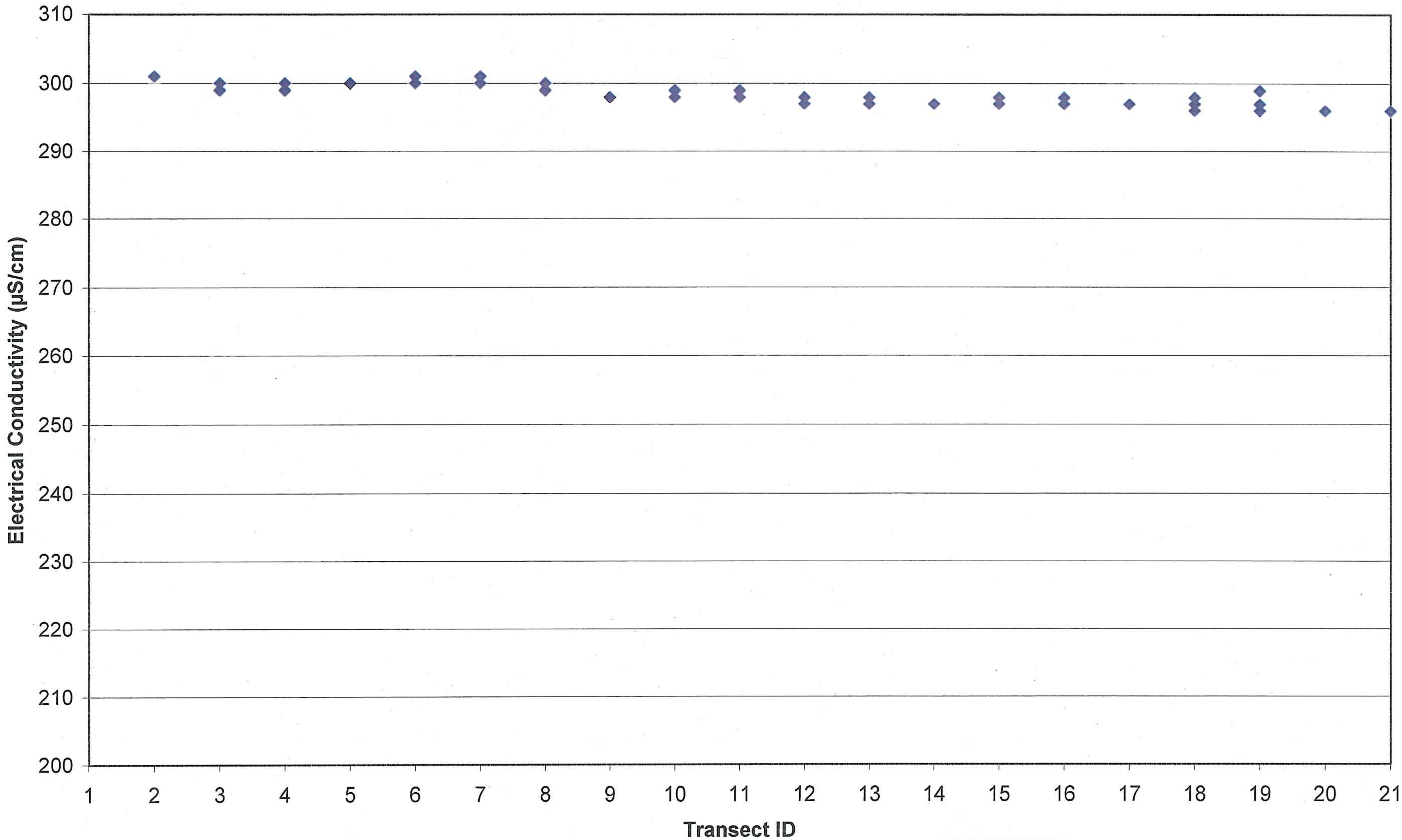
SGI environmental THE SOURCE GROUP, INC.

Dissolved Oxygen Measurements
Big Sur River - October 28, 2004
El Sur Ranch



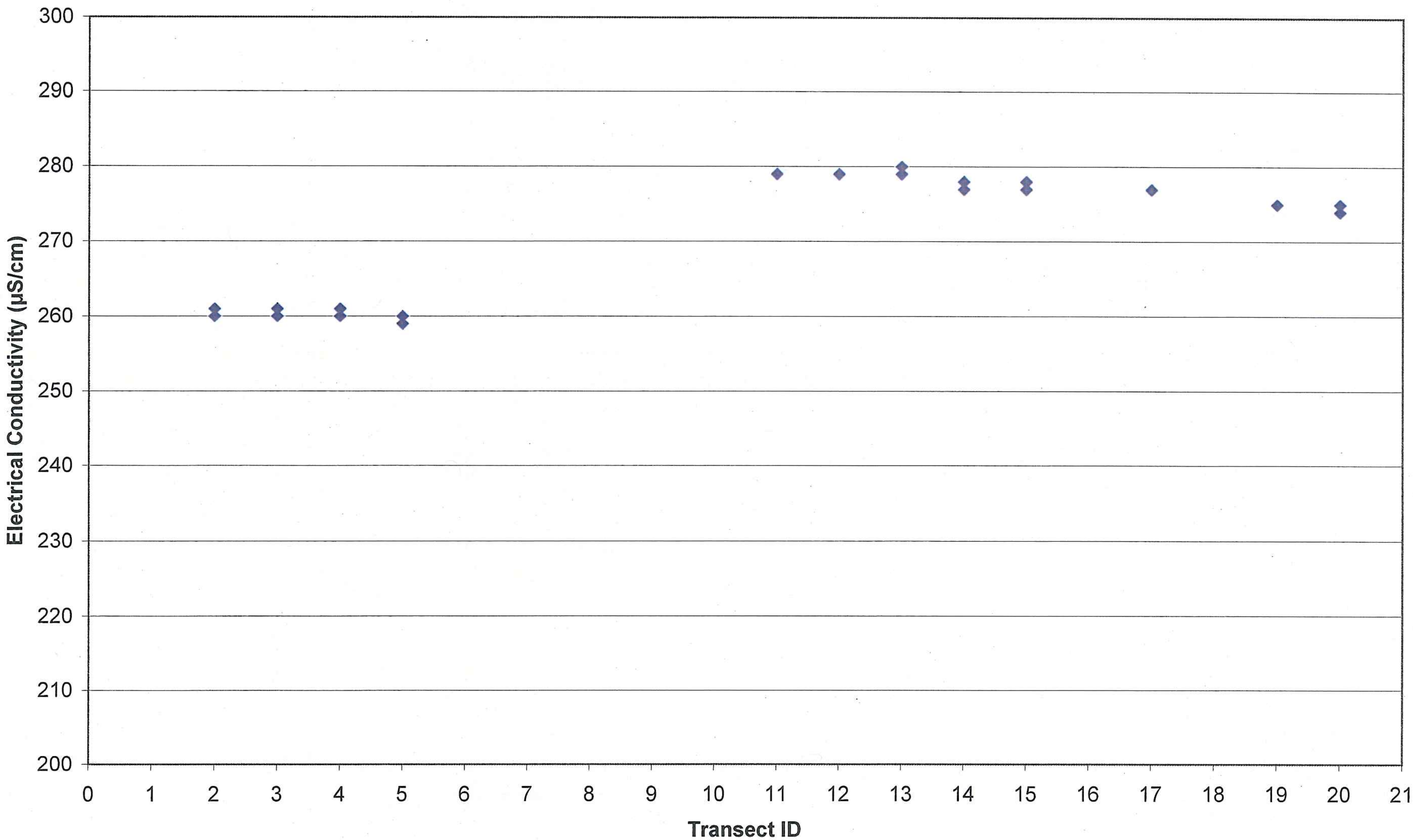
SGI environmental THE SOURCE GROUP, INC.

Electical Conductivity Measurements
Big Sur River - April 18, 2004
El Sur Ranch



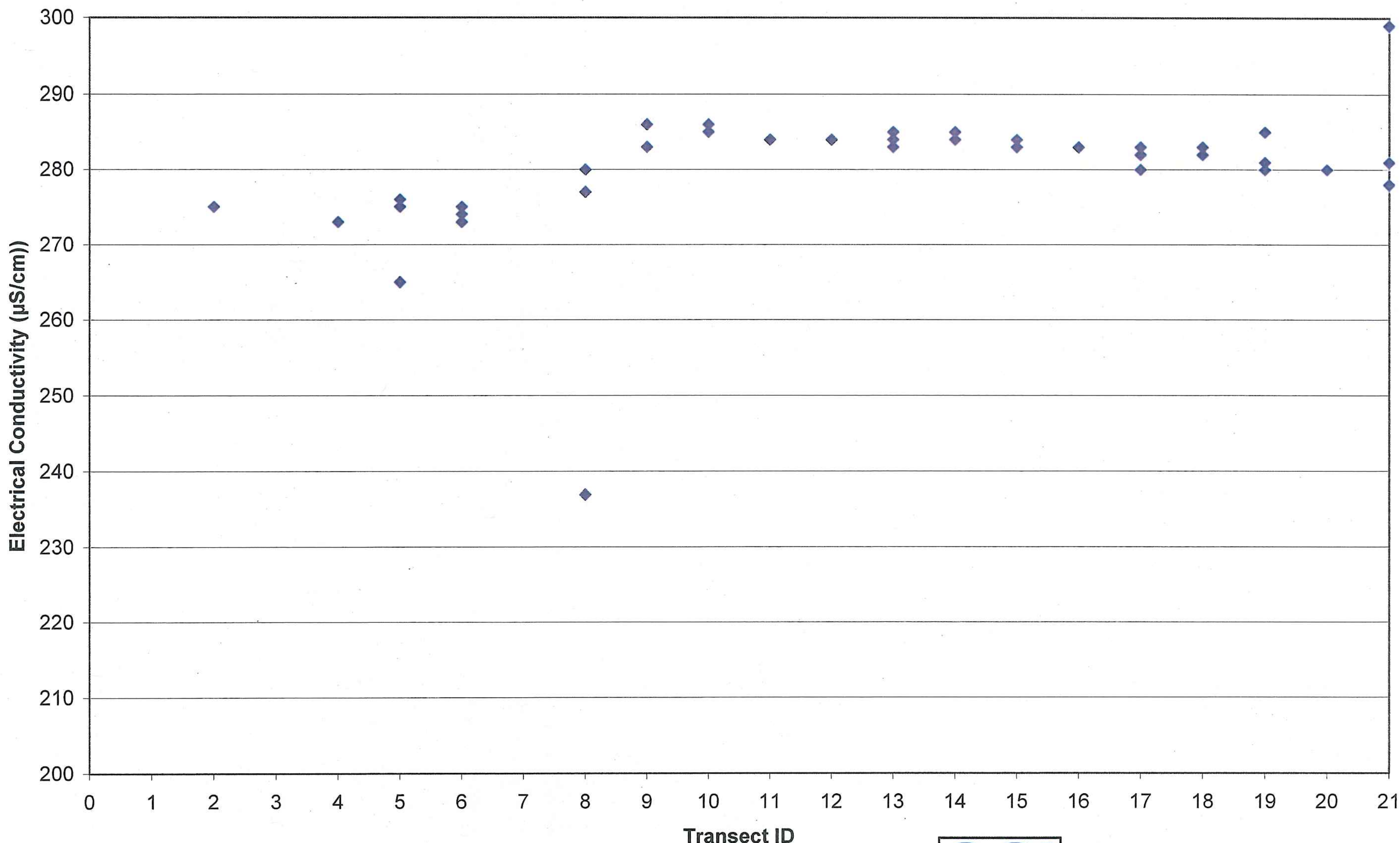
SGI environmental THE SOURCE GROUP, INC.

Electical Conductivity Measurements
Big Sur River - July 12, 2004
El Sur Ranch



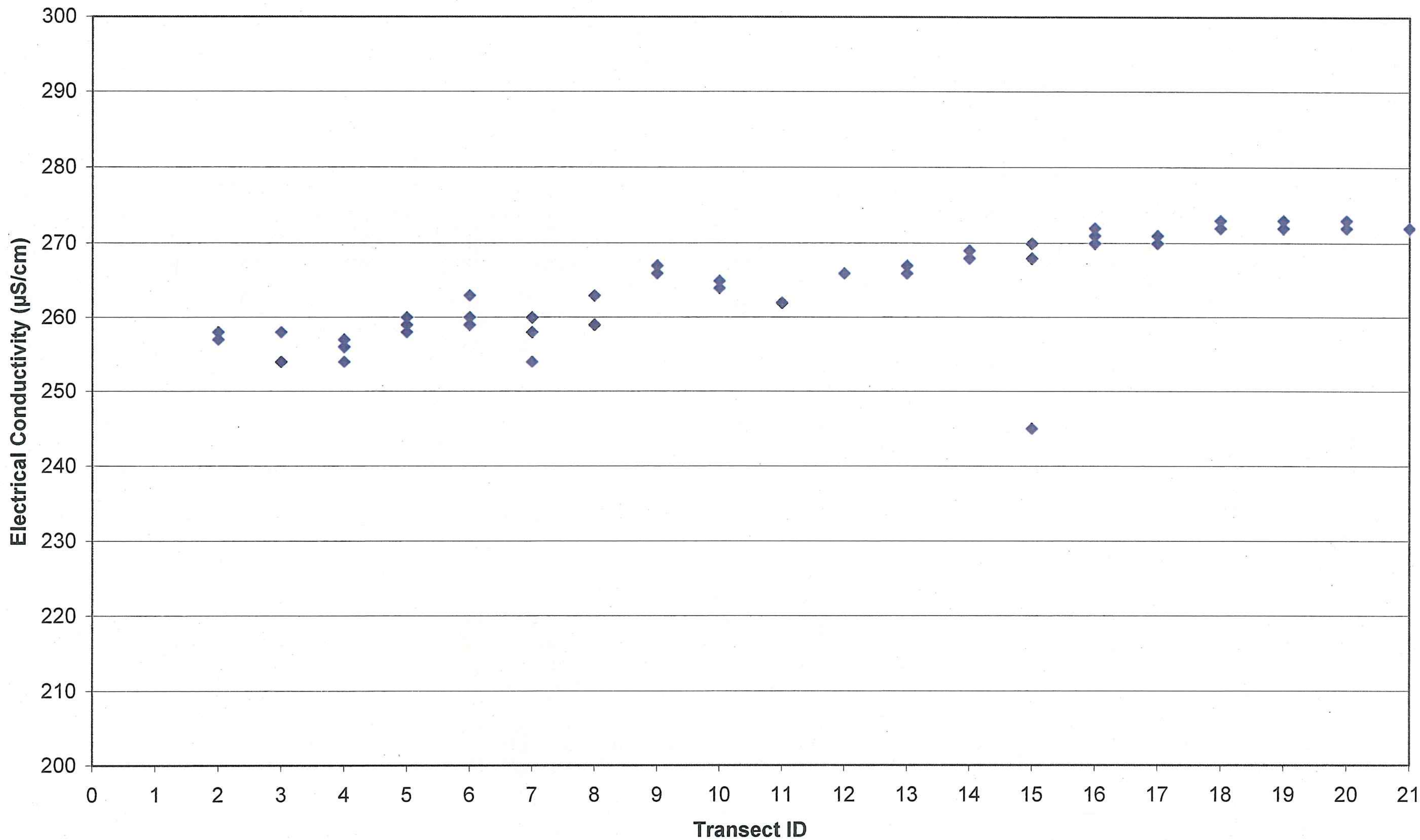
SGI environmental THE SOURCE GROUP, INC.

Electical Conductivity Measurements
Big Sur River - July 23, 2004
El Sur Ranch



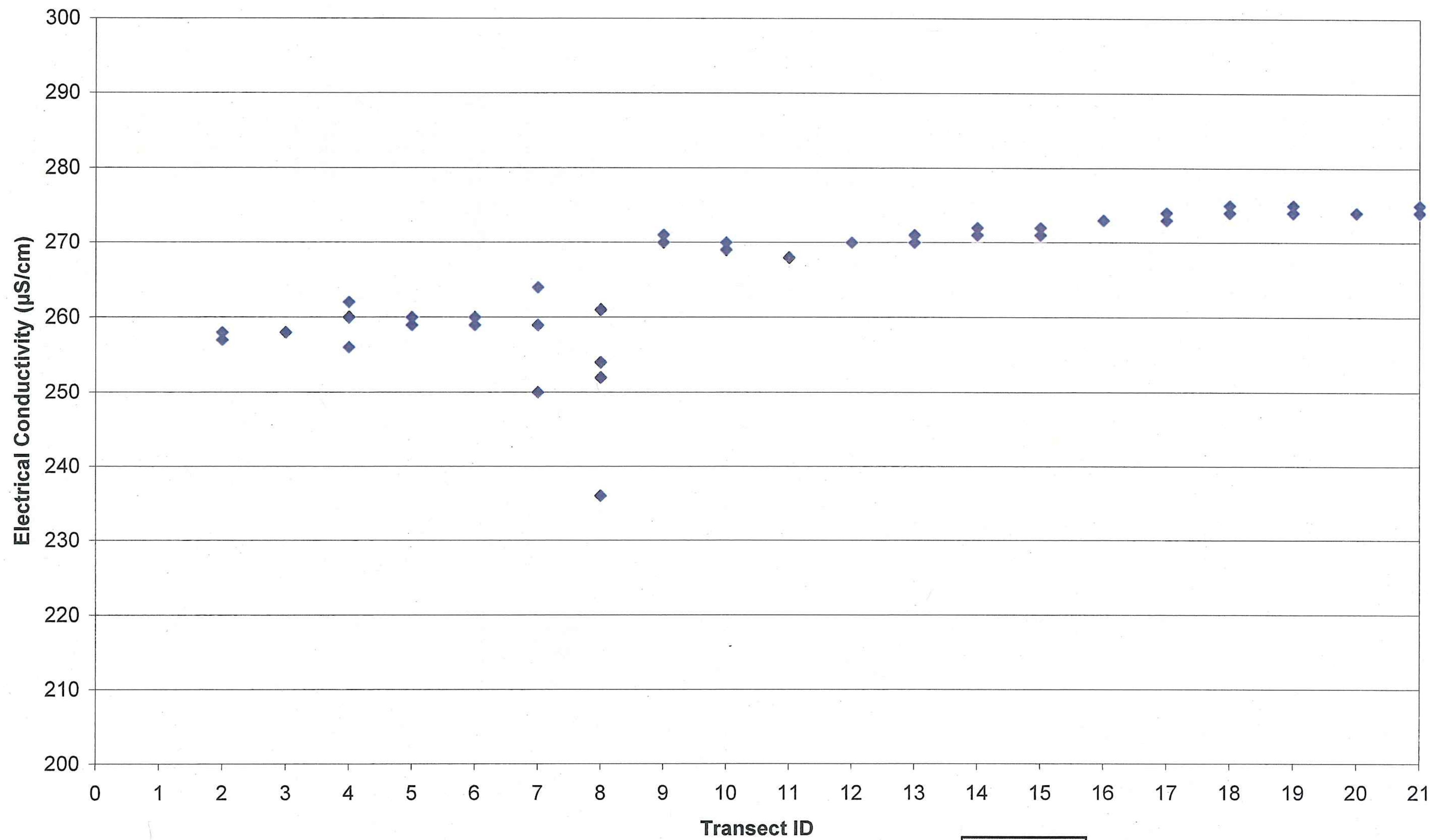
SGI environmental THE SOURCE GROUP, INC.

Electical Conductivity Measurements
Big Sur River - August 5, 2004
El Sur Ranch

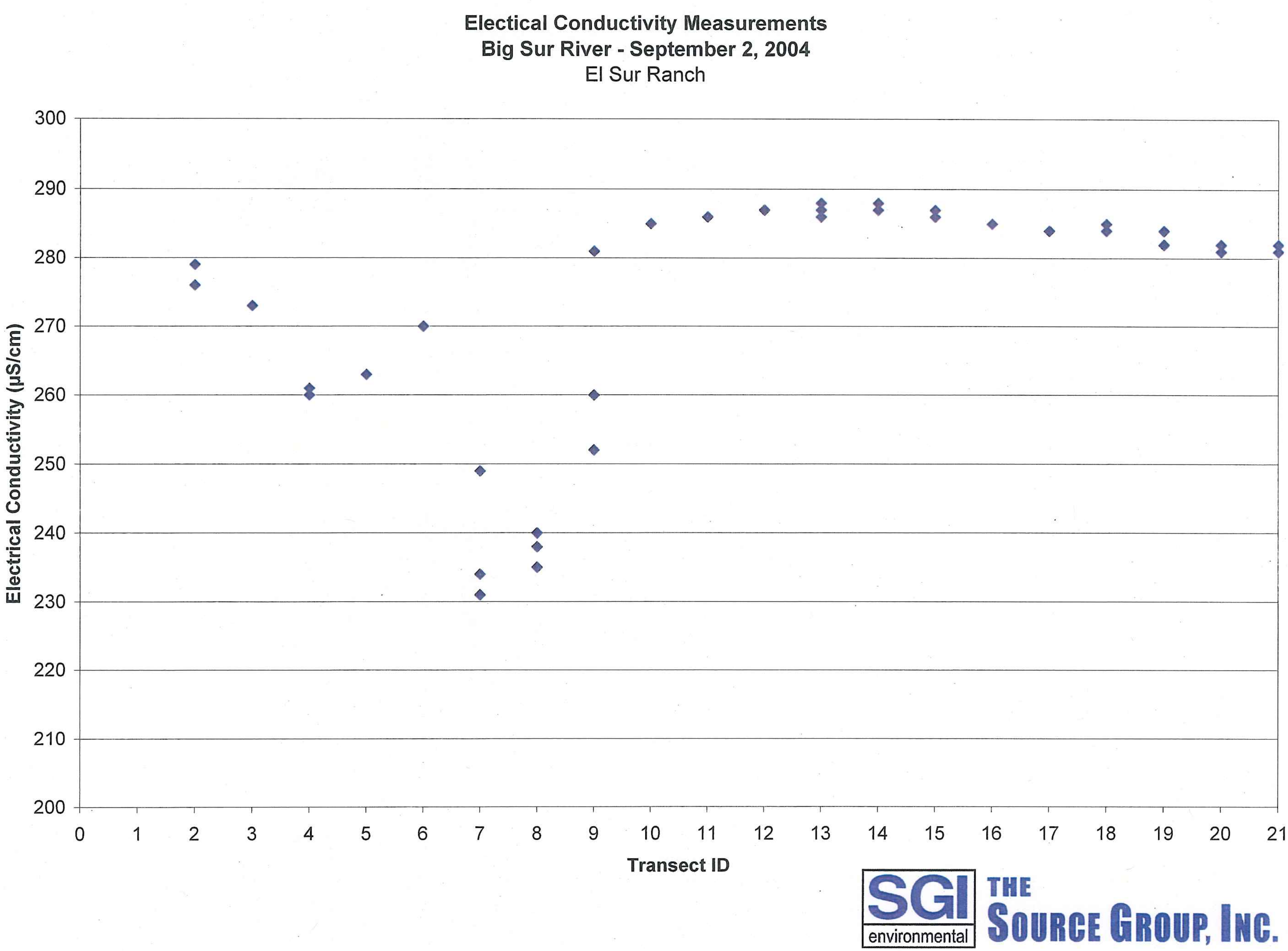


SGI environmental THE SOURCE GROUP, INC.

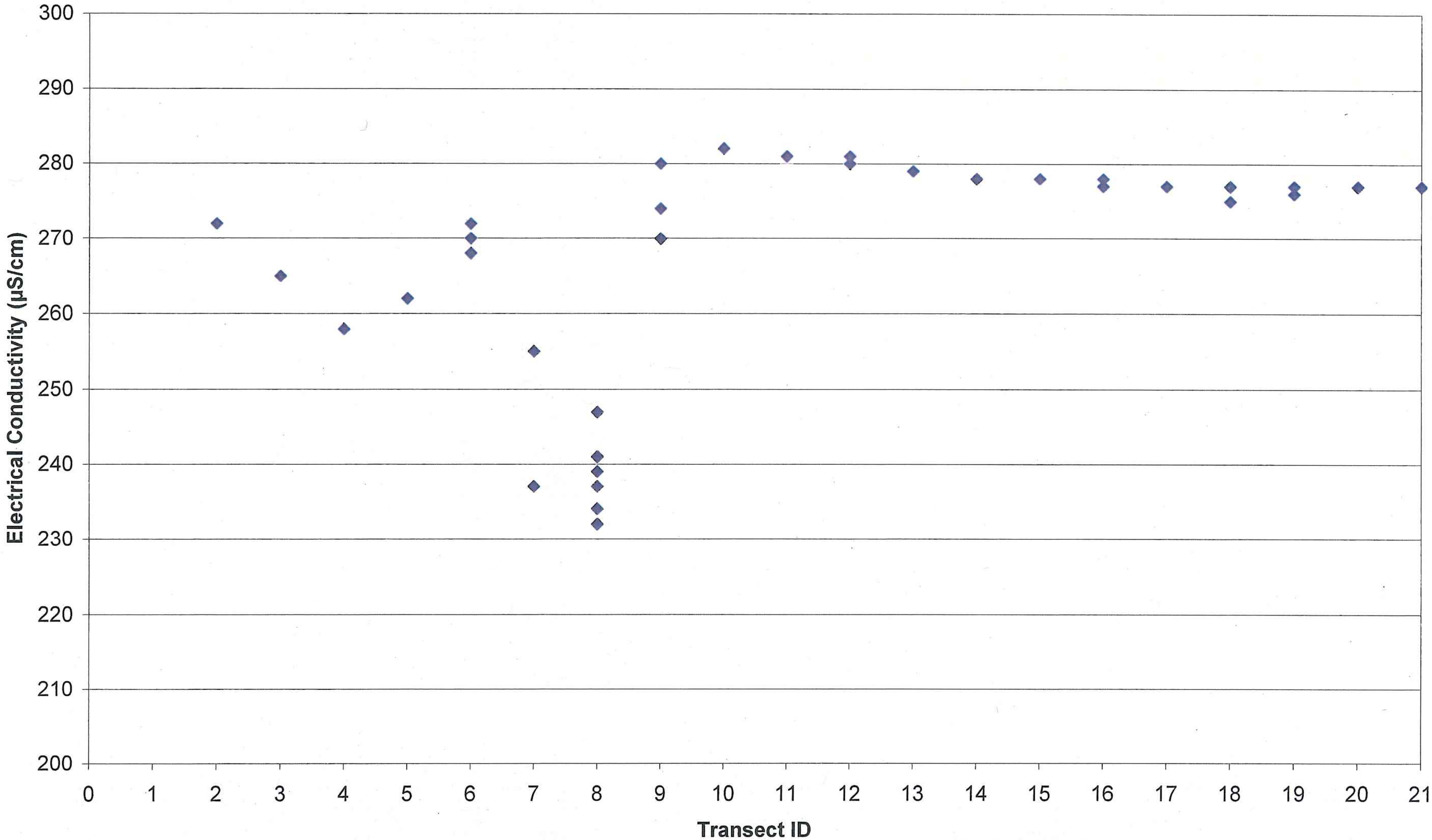
Electical Conductivity Measurements
Big Sur River - August 19, 2004
El Sur Ranch



THE SOURCE GROUP, INC.
SGI environmental

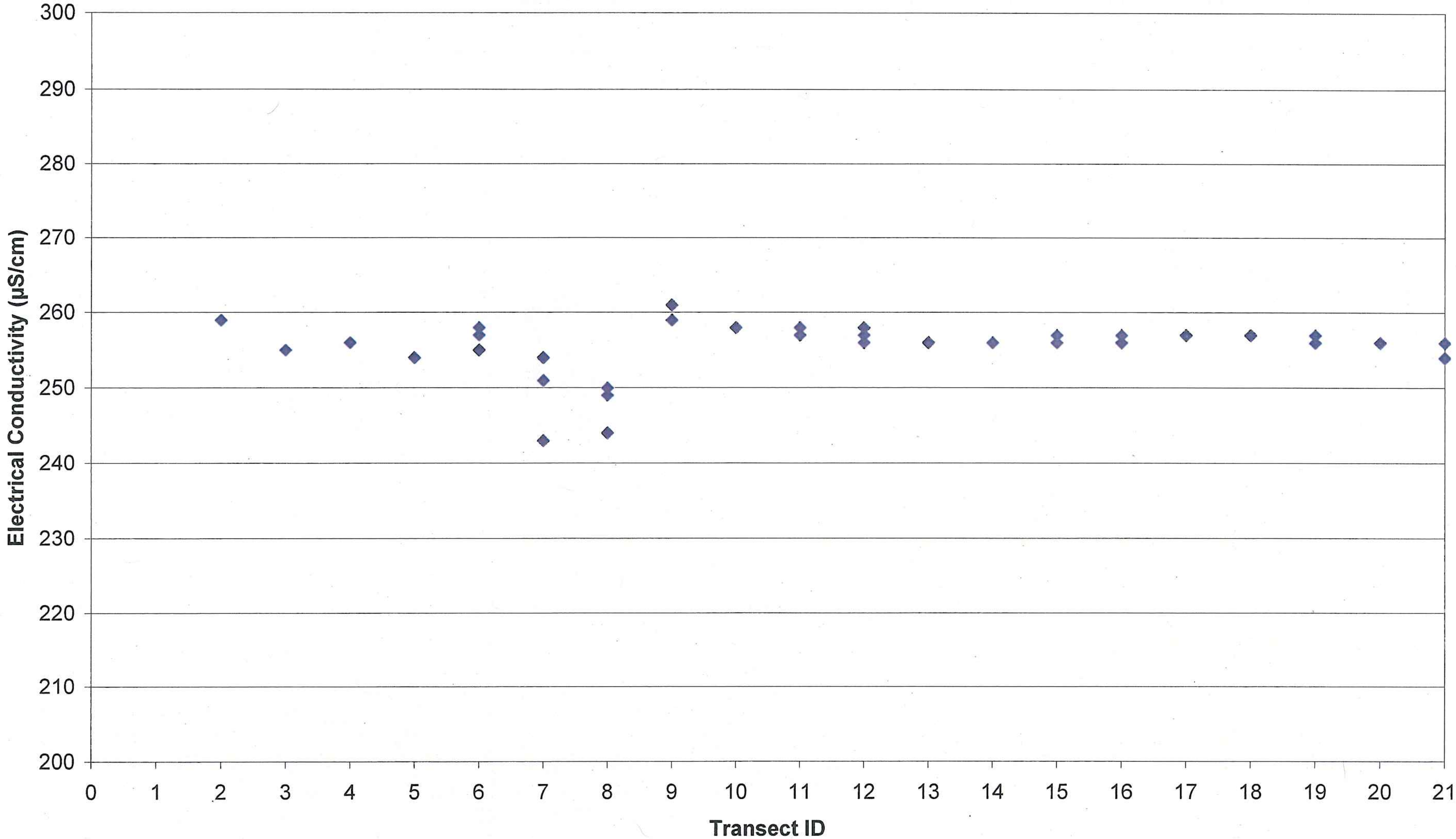

Electical Conductivity Measurements
Big Sur River - September 2, 2004
El Sur Ranch
Electrical Conductivity (µS/cm)
300
290
280
270
260
250
240
230
220
210
200
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Transect ID
SGI
environmental
THE
SOURCE GROUP, INC.

Electical Conductivity Measurements
Big Sur River - September 15, 2004
El Sur Ranch



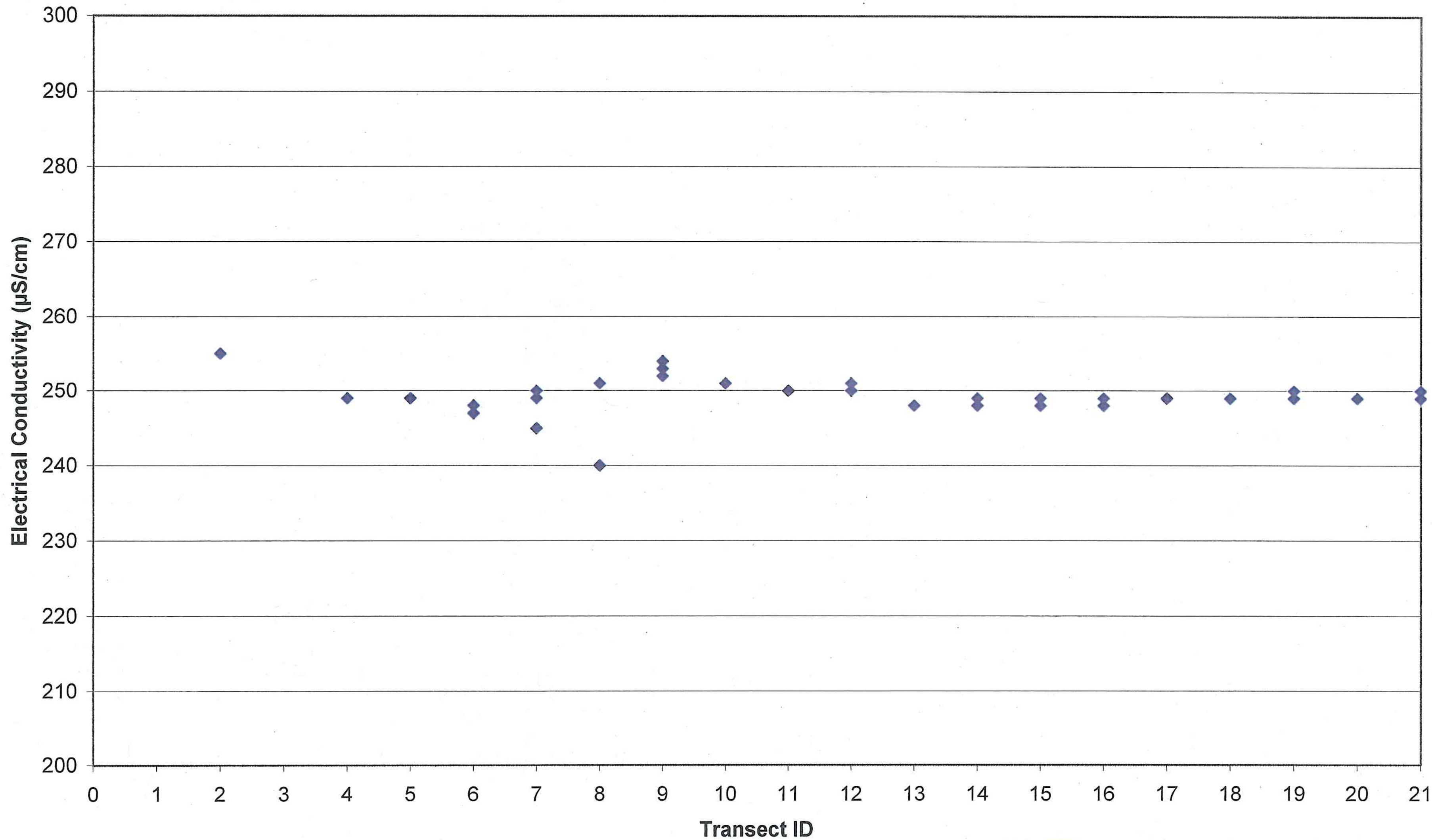
SGI environmental THE SOURCE GROUP, INC.

Electical Conductivity Measurements
Big Sur River - September 30, 2004
El Sur Ranch



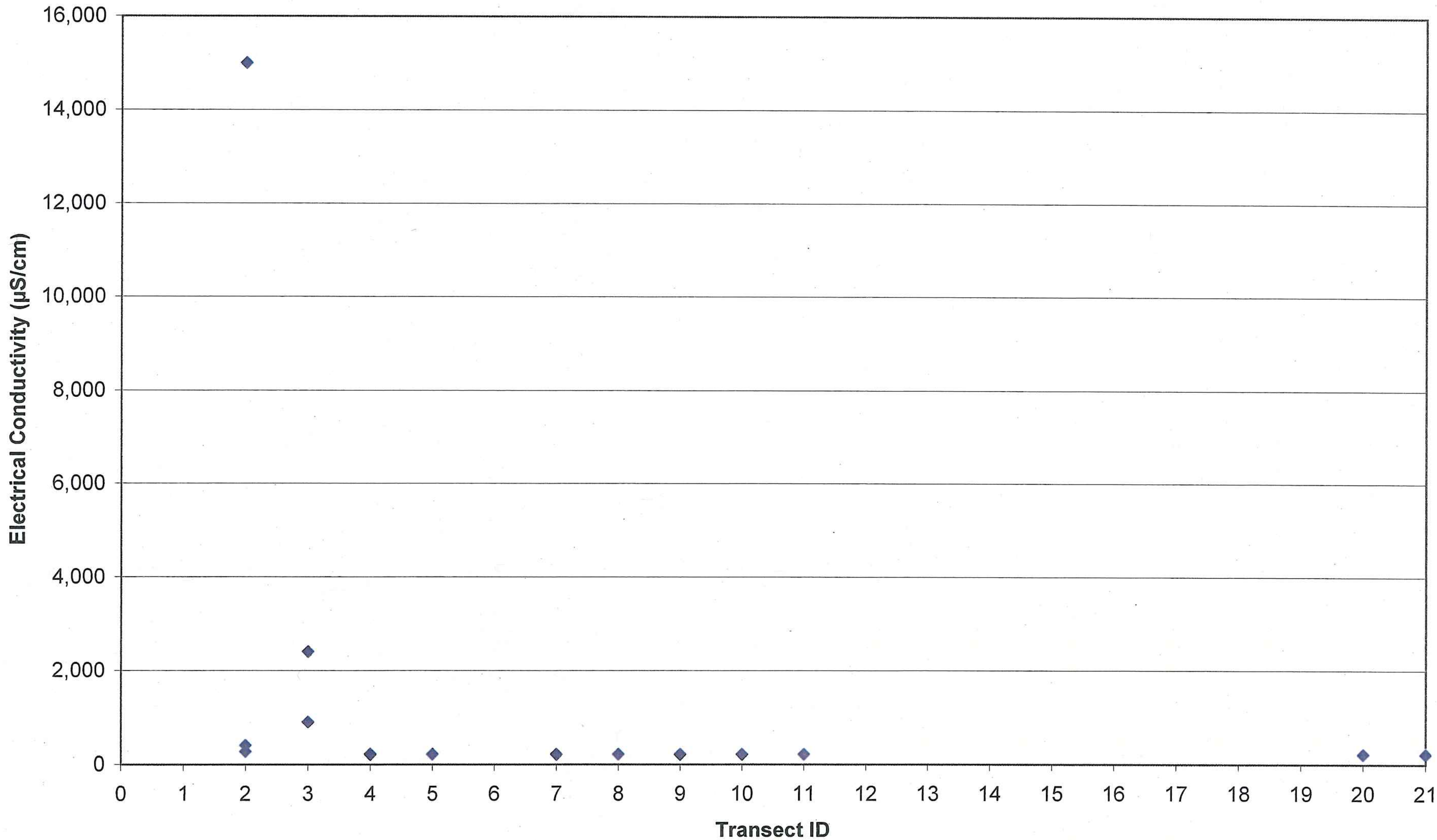
SGI environmental THE SOURCE GROUP, INC.

Electical Conductivity Measurements
Big Sur River - October 15, 2004
El Sur Ranch



SGI environmental THE SOURCE GROUP, INC.

Electical Conductivity Measurements
Big Sur River - October 28, 2004
El Sur Ranch



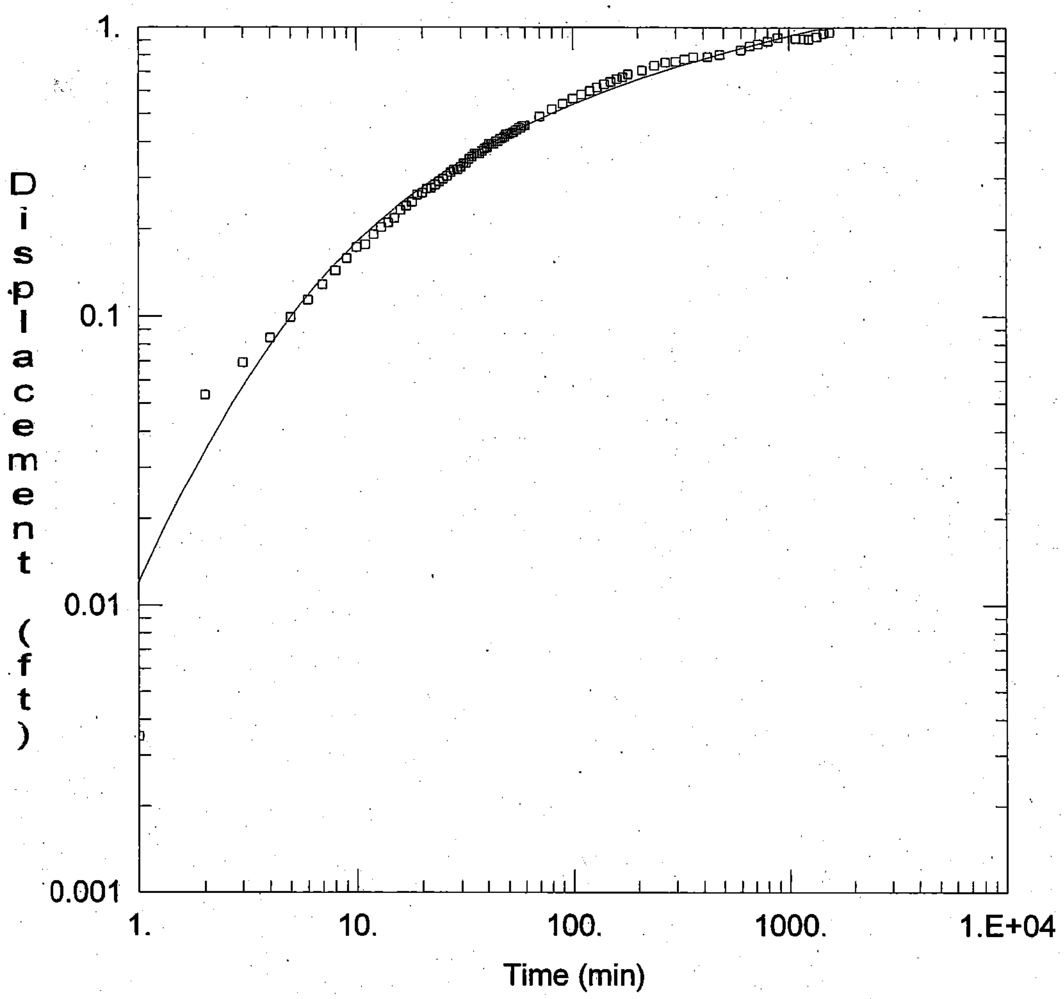
SGI environmental THE SOURCE GROUP, INC.

APPENDIX N

ESR--4

APPENDIX N

AQUIFER DATA ANALYSES



WELL TEST ANALYSIS

Data Set: S:\...\jsa-03.aqt
Date: 05/06/05 Time: 14:49:07

PROJECT INFORMATION

Company: SGI
Client: ESR
Project: 01-ESR-001
Test Location: ESR
Test Well: New Well
Test Date: 9/22/98

AQUIFER DATA

Saturated Thickness: 24. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
New Well	0	0

Observation Wells

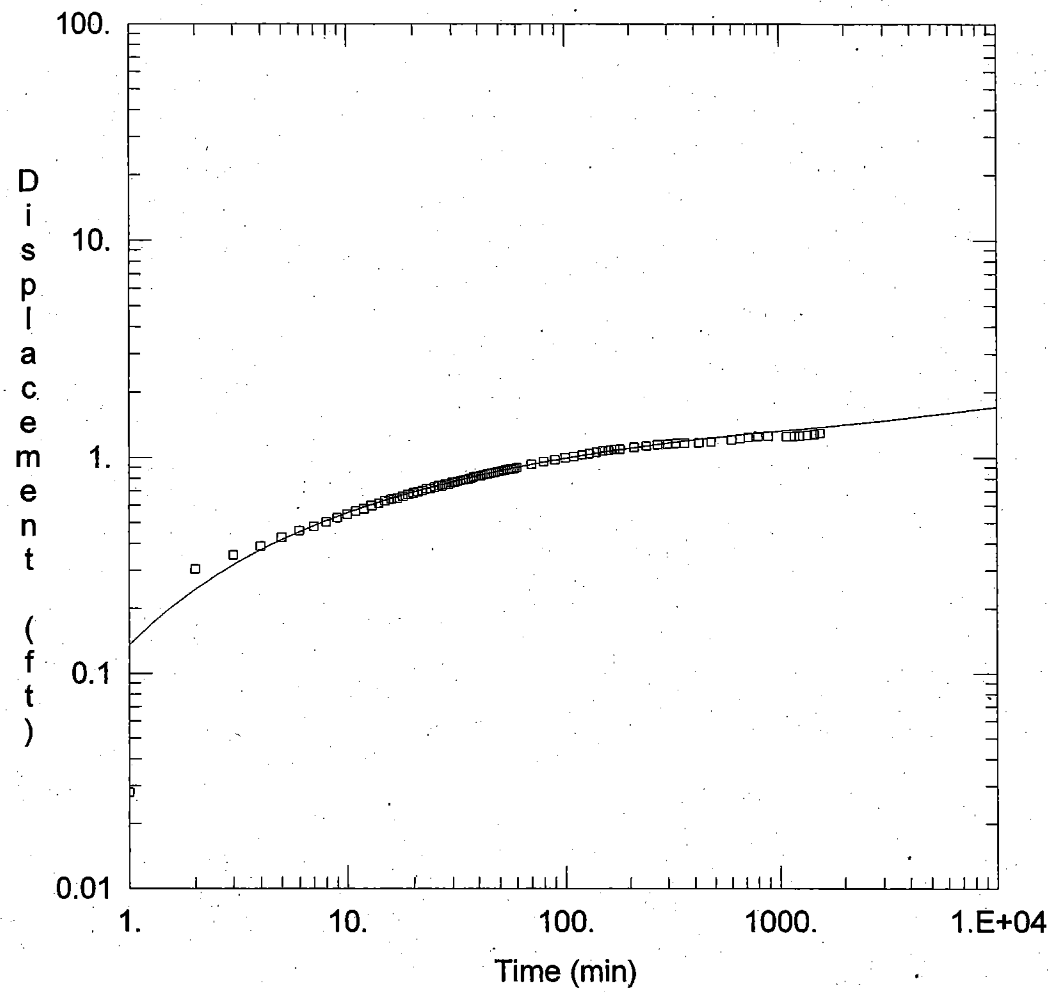
Well Name	X (ft)	Y (ft)
▫ JSA-03	100	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

$T = 70.93\ ft^2/min$

$S = 0.03503$



WELL TEST ANALYSIS

Data Set: S:\...\jsa-04.aqt
Date: 05/06/05
Time: 14:49:16

PROJECT INFORMATION

Company: TSG
Client: ESR
Project: 01-ESR-001
Test Location: ESR
Test Well: New Well
Test Date: 9/22/98

AQUIFER DATA

Saturated Thickness: 24. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
New Well	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ JSA-04	36	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

$T = 52.92\ ft^2/min$
$S = 0.07683$

ESR--4

APPENDIX O

ESR--4

APPENDIX O

EVAPOTRANSPIRATION (ET) DATA

Allen, R.G., M. Smith, L.S. Pereira, A. Perrier. 1994. An update for the calculation of reference evapotranspiration. ICID Bulletin 1994 Vol 43 No 2.

Doo...oos, J. and W.O. Pruitt. 1977. Crop Water Requirements. FAO Irrigation and Drainage Paper 24, United Nation Food and Agriculture Organization, Rome.

Duffie, J.A. and W.A. Beckman. 1980. *Solar engineering of thermal processes*. John Wiley and Sons, New York. pp. 1-109.

Jensen, M.E., R.D. Burman, and R.G. Allen, Eds. 1990. Evapotranspiration and Irrigation Water Requirements. Amer. Soc. of Civil Eng., New York.

Smith, M. 1991. Report on the expert consultation on procedures for revision of FAO Guidelines for prediction of crop water requirements. United Nations - Food and Agriculture Organization, Rome, Italy

Tetens, V.O. 1930. Uber einige meteorologische. Begriffe, Zeitschrift fur Geophysik. 6:297-309.

Walter, I.A., R.G. Allen, R. Elliott, M.E. Jensen, D. Itenfisu, B. Mecham, T.A. Howell, R. Snyder, P. Brown, S. Eching, T. Spofford, M. Hattendorf, R.H. Cuenca, J.L. Wright, D. Martin. 2000. ASCE's Standardized Reference Evapotranspiration Equation. Proc. of the Watershed Management 2000 Conference, June 2000, Ft. Collins, CO, American Society of Civil Engineers, St. Joseph, MI.

back

$$\gamma^* = \gamma\left(1+\frac{r_s}{r_a}\right) \approx \gamma\left(1+0.96U_2\right) \qquad \text{when } R_n \le 0 \qquad (24)$$

Δ = slope of the saturation vapor pressure curve (kPa $^oC^{-1}$) at mean air temperature (T)

$$\Delta = \frac{4099 e_a}{(T+237.3)^2} \qquad (25)$$

G = soil heat flux density (MJ m^{-2} h^{-1})

For $R_n \ge 0$, let $G = 0.1\ R_n$, and let $G = 0.5\ R_n$ for $R_n < 0$.

R = radiation term of the Penman-Monteith equation with U_2 the wind speed at 2 m height

$$R = \frac{0.408\Delta\left(R_n - G\right)}{\Delta+\gamma\left(1+0.24U_2\right)} \qquad \text{when } R_n > 0 \qquad (26)$$

and

$$R = \frac{0.408\Delta\left(R_n - G\right)}{\Delta+\gamma\left(1+0.96U_2\right)} \qquad \text{when } R_n \le 0 \qquad (27)$$

where 0.408=1/2.45 converts the units from MJ m^{-2} h^{-1} to mm h^{-1}.

A = aerodynamic term of the Penman-Monteith equation in mm h^{-1} with U_2 the wind speed at 2 m height

$$A = \frac{\left(\frac{37\gamma}{T_M+273}\right)U_2\left(e_a-e_d\right)}{\Delta+\gamma\left(1+0.24U_2\right)} \qquad \text{when } R_n > 0 \qquad (28)$$

and

$$A = \frac{\left(\frac{37\gamma}{T_M+273}\right)U_2\left(e_a-e_d\right)}{\Delta+\gamma\left(1+0.96U_2\right)} \qquad \text{when Rn} \le 0 \qquad (29)$$

ET_o = reference evapotranspiration in mm d^{-1}

$$ET_o = R + A \qquad (30)$$

REFERENCES

Allen, R.G., M.E., Jensen, J.L. Wright, and R.D. Burman. 1989. Operational estimates of evapotranspiration. Agron. J. 81:650-662.

Allen, R.G. and W.O. Pruitt. 1991. FAO-24 Reference evapotranspiration factors. J. of Irrig. and Drainage Engineering. 117(5):758-773.

To convert R_s from W m^{-2} to MJ m^{-2} h^{-1}, multiply by 0.0036.

$R_{\ldots}$ ...et long wave radiation in MJ m^{-2} h^{-1}

$$R_{NL} = -f\,\varepsilon'\sigma(T+273.15)^4 \quad (17)$$

R_N = net radiation over grass in MJ m^{-2} h^{-1}

$$R_N = R_{NS} + R_{NL} \quad (18)$$

STEP 3: Calculate ET_o using the Penman-Monteith equation as presented by Allen et al. (1994)

B_p = barometric pressure in kPa as a function of elevation (E_L) in meters

$$B_p = 101.3\left(\frac{293-0.0065E_L}{293}\right)^{5.26} \quad (19)$$

λ = latent heat of vaporization in (MJ kg^{-1})

$$\lambda = 2.45 \quad (20)$$

γ = ...rometric constant in kPa °C^{-1}

$$\gamma = 0.00163\frac{B_p}{\lambda} \quad (21)$$

r_a = aerodynamic resistance in s m^{-1} is estimated for a 0.12 m tall crop as a function of wind speed (U_2) in m s^{-1} as:

$$r_a = \frac{208}{U_2} \quad (22)$$

γ^* = modified psychrometric constant with r_s = 50 s m^{-1} being the surface resistance for a 0.12 m tall crop is calculated as:

$$\gamma^* = \gamma\left(1+\frac{r_s}{r_a}\right) \approx \gamma(1+0.24U_2) \quad \text{when } R_n > 0 \quad (23)$$

and with r_s = 200 s m^{-1}

$$R_a = \frac{12}{\pi}(60G_{SC})d_r \sin\theta \qquad (9)$$

β = solar altitude in degrees

$$\beta = \frac{180}{\pi}\sin^{-1}[\sin\phi\sin\delta + \cos\phi\cos\delta\cos\omega] \qquad (10)$$

STEP 2: Calculate the hourly net radiation (R_n) expected over grass in MJ m^{-2} h^{-1} using equations from Allen et al. (1994).

R_{SO} = clear sky total global solar radiation at the Earth's surface in MJ m^{-2} h^{-1}

$$R_{SO} = R_a(0.75 + 2.00\times10^{-5}E_L) \qquad (11)$$

where E_L = elevation above mean sea level (m)

e_s = saturation vapor pressure (kPa) at the mean hourly air temperature (T) in °C

$$e_s = 0.6108\exp\left[\frac{17.27T}{T + 237.3}\right] \qquad (12)$$

e_d = actual vapor pressure or saturation vapor pressure (kPa) at the mean dew point temperature

$$e_d = 0.6108\exp\left[\frac{17.27T_d}{T_d + 237.3}\right] \qquad (13)$$

ε' = net surface emissivity for clear sky conditions

$$\varepsilon' = 0.34 - 0.14\sqrt{e_d} \qquad (14)$$

f = a cloudiness function of R_S and R_{SO}

$$f = 1.35\frac{R_S}{R_{SO}} - 0.35 \qquad (15)$$

When $f < 0$ then let $f = 0.595$, and when $f > 1.0$ then let $f = 1.0$.

R_{NS} = net short wave radiation as a function of measured solar radiation (R_S) in MJ m^{-2} h^{-1}

$$R_{NS} = (1 - 0.23)R_S \qquad (16)$$

δ = Declination of the sun above the celestial equator in radians

$$\delta = 0.409 \sin\left(\frac{2\pi}{365} J - 1.39\right) \quad (2)$$

L_m = station longitude in degrees

L_z = longitude of the local time meridian

L_z = 120° for Pacific Standard Time

S_c = solar time correction for wobble in Earth's rotation

$$b = \frac{2\pi(J-81)}{364} \quad (3)$$

$$S_c = 0.1645 sin(2b) - .1255 cos(b) - 0.025 sin(b) \quad (4)$$

t = local standard time (h)

ω = hour angle in radians

$$\omega = \frac{\pi}{12}\left[(t - 0.5) + \frac{(L_z - L_m)}{15} - 12 + Sc\right] \quad (5)$$

ω_1 = hour angle ½ hour before ω in radians

$$\omega_1 = \omega - \left(\frac{1}{2}\right)\left(\frac{\pi}{12}\right) \quad (6)$$

ω_2 = hour angle ½ hour after ω in radians

$$\omega_1 = \omega + \left(\frac{1}{2}\right)\left(\frac{\pi}{12}\right) \quad (7)$$

θ = solar altitude angle in radians

$$\sin\theta = (\omega_2 - \omega_1)\sin\phi\sin\delta + \cos\phi\cos\delta(\sin\omega_2 - \sin\omega_1) \quad (8)$$

R ... traterrestrial radiation (MJ m^{-2} h^{-1})

Penman-Monteith (hourly) Reference Evapotranspiration Equations For Estimating ETo with Hourly Weather Data

Quick Answer ET011

back

Created January 6, 2002
Revised March 6, 2002

R. L. Snyder, Biometeorology Specialist
Department of Land, Air and Water Resources
University of California
Davis, CA 95616, USA

S. Eching, Senior Land and Water Use Analyst
California Department of Water Resources
Office of Water Use Efficiency
P.O. Box 942836
Sacramento, CA 94236, USA

The following text is a description of the steps needed to estimate reference evapotranspiration for a 0.12 m tall reference surface using hourly weather data as adopted by the American Society of Civil Engineers (Walter et al., 2000). Note that the steps are in the same sequence as one would use when write computer code.

STEP 1: Extraterrestrial radiation (R_a) is calculated for each hour using the following equations from Duffie and Beckman (1980).

G_{SC} = solar constant in MJ m^{-2} min^{-1}

$$G_{SC} = 0.082$$

σ = Steffan-Boltzman constant in MJ m^{-2} h^{-1} K^{-4}

$$\sigma = 2.04 \times 10^{-10}$$

ϕ = Latitude in radians converted from latitude (L) in degrees

$$\phi = \frac{\pi L}{180}$$

J = day of the year (1-366)

d_r = correction for eccentricity of Earth's orbit around the sun

$$d_r = 1 + 0.033\cos\left(\frac{2\pi}{365}J\right) \qquad (1)$$

APPENDIX P

APPENDIX P

DOCUMENTS PERTAINING TO 1990 BIG SUR RIVER DIVERSION PROJECT

NA AL HERITAGE STEWARDSHIP PROGRA
PROJECT STATUS REPORT

Project Title: Big Sur River Restoration
Unit Name: Andrew Molera State Park
Prepared By: Steve Zembsch
Reference Number: 224-491-08-01
Fiscal Year: 1989/90 Prepared 12/90

INTRODUCTION

The Big Sur River is the major drainage through Andrew Molera State Park (Fig. 1). At least eighty years of flood control efforts, agriculture, road building, water diversions and general watershed development have tipped the hydrologic scale in favor of aggradation. The increase in sediment load has further destabilized the river and intensified vegetative disturbances initiated by agriculture (including irrigation) and flood control (levee construction, channel dredging and straightening). The first phase of this project was to restore the proper hydraulic geometry relationships (width, depth and velocity as a function of discharge) to a section of the river adjacent to the parking lot (Fig. 2, Plate 1). This phase necessarily resulted in a temporary disturbance to riparian vegetation and aquatic habitat. The long-term stability rendered by the project results in an overall increase in aquatic habitat and a more structurally diverse, stable riparian habitat.

METHODS AND MATERIALS

USGS hydrologic data was analyzed to determine the "bankfull" (channel forming) discharge. Cross-sections and a longitudinal profile were surveyed to determine the existing channel condition (Fig. 3). The idealized dimensions were determined based on the discharge analysis in conjunction with other important watershed characteristics such as slope, sediment supply, basin size, sediment size and rainfall intensity. The final design was forged after constraints such as cost, existing facilities, historical features and sensitive habitat were factored in.

The following permits/regulations were obtained/complied with:
- Army Corps of Engineers Section 404; project was determined to be exempt
- Coastal Development Permit granted by the Coastal Commission
- Department of Fish and Game Streambed Alteration "Agreement" (1601)
- California Environmental Quality Act, Categorically Exempt (1:15301 (h)

Eucalyptus trees adjacent to the Cooper cabin that were killed by the August 1989 fire were removed and their rootwads were saved for use in the bank. The district accomplished this phase with a D7 bulldozer. The excavator then went into the grove and removed the rest of the stumps and cleaned up the site.

Construction began in the middle of July, 1990. A condition of the DFG 1601 was the diversion of the river around the project site. This involved the construction of a 250 foot channel where the floodplain meets the terrace known as Creamery meadow. An existing overflow channel was used to minimize disturbance to the aquatic resources and the riparian habitat (Plate 2). Fish were removed from the channel by electroshocking. Three passes were made, removing most, but not all of the fish. The river was dammed and directed into the diversion channel.

Once in the diversion channel, the river immediately disappeared into its gravels. Four years of drought and an "aggressive" groundwater pumping operation (3,000 gallons an hour during a protracted drought) a half a mile downstream converted this stretch of the Big Sur River into a "net losing reach". It took the better part of a day for the river to reach the end of the diversion channel. By that time, the downstream reach had also sunk into its gravels (Plate 3), euphemistically leaving the gill-dependent resources in an overly dry environment. The downstream reach, a long, straight riffle-run, remained dry for the rest of the project. There were diurnal fluctuations in the length of the dry reach, but it averaged about 600 feet.

The new channel was constructed using a Caterpillar D7 bulldozer and a Komatsu 220 excavator (Plate 4). Down trees were located in the floodplain and were skidded to areas accessible by a 10 yard end dump, which transported them to the project site (Plates 5,11). The root wads were saved and the trees bucked into 25-35 foot logs. These were placed into the eroding bank in an interlocking fashion along with large (1 ton) rock and poorly sorted stream gravels (roughly 6 inch minus).

The rest of the bank was counter-buttressed with stream gravels, providing free-draining ballast (plate 6). The root wads were oriented such that the plane of the fan was perpendicular to the flow vectors and the bole pointed downstream (plates 7, 10). This creates excellent localized fish habitat and provides a very stable, natural appearing bank protection (plate 8).

Willows were buried in the gravels of the floodplain to increase their chances of resprouting. Many showed signs of vigorous resprouting as of early December. Willow sprigs will be placed in January. The floodplain was recontoured to create a positive grade to the thalweg. This was accomplished with a minimum disturbance to the coastal riparian scrub by leaving the vegetation on a pedestal (plate 13). Seeds from Sycamore (Platanus racemosa) and California big-leaf maple (Acer macrophyllum) were collected for propagation and later planting.

Large boulders (1 ton+) were placed in the active channel immediately upstream from the meander to act as convergence structures. Placed in a parabolic orientation with the apex pointing upstream, these structures increase point velocities in the thalweg and direct flow to the thalweg. They are placed about 1/4 to 1/2 a diameter apart.

RESULTS, EVALUATIONS, CONCLUSIONS

The necessity of a diversion channel for this type of work is questionable. For a net losing reach, such a channel undoubtedly results in more disruption than it prevents. The amount of disturbance to instream resources is minimal during low flows and aquatic resources are completely adapted to these elevated sediment levels. The DFG warden insisted that a diversion channel be used as a condition of the "agreement" (1601). The unexpected loss of the surface flow downstream from the project was a major impact that was avoidable. This situation was exacerbated by the groundwater pumping downstream.

The elimination of overflow channels across the floodplain will restore stability to this critical riparian area. A more structurally diverse riparian community such as a Sycamore-cottonwood riparian forest will replace the riparian scrub that now exists. This will be facilitated by active revegetation.

A single, defined channel with proper width-depth ratio has been created in place of a braided, shallow, migrating channel (plates 12, 14). Fish habitat has been increased, particularly for salmonids. The stabilization of the bank has reduced downstream sedimentation and protected a very large coast live oak (Quercus agrifolia) and the trail to the campground.

RECOMMENDATIONS

The next phase of this project should be accomplished in the live stream. Fish can be removed from the project site and then the reach can be netted off to prevent migration during the construction phase. The disturbed floodplains and areas where bank protection materials were collected should be revegetated as specified in the resource management plan. The cross-sections and profile should be resurveyed every spring for at least three years. Monitoring of the revegetated areas could be accomplished in conjunction with this survey.

The adjacent landowner should be encouraged, legally if need be, to leave the water in the river during periods of low flow. Groundwater extraction so close to the river is tantamount to sucking it right out of the channel. Cows can go without water longer than fish can.

COSTS

Salary and Wages, Assoc. Resource Ecologist	$3,000.00
Contract, Wildland Hydrology Consultants (design)	2,000.00
Contract, Kim Younger Construction (heavy equipment rental)	8,000.00
TBA District (Eucalyptus Removal)	2,000.00
Future TBA District (Bulldozer Rental)	4,000.00
Total	$15,000.00

REFERENCES AND CONTACT

California Department of Parks and Recreation, 1989, Biotic Survey, IPU Facility, Andrew Molera State Park.

California Department of Parks and Recreation, 1989, Cultural Resource Inventory, Andrew Molera State Park, Davis, et al.

California Department of Parks and Recreation. Natural Resource Inventory, Andrew Molera State Park, 1989. Animal Life. Comrack, Lyann.

ibid. Aquatic Resources, Rischbieter, Doug.

ibid. Hydrology, Comrack, Lyann.

ibid. Plant Life. Martin and Roye.

Lane, E.W., 1955, Design of Stable Channels: American Society of Civil Engineers, Transcripts, v. 120, pp. 1234-1279.

Leopold, L.B., Wolman, M.G., and Miller, J.P., 1964, Fluvial Processes in Geomorphology, W.H. Freeman and Co., San Francisco, 522 pp.

Pasquinelli, R., 1989, Plans and Specifications for Revegetation of the Bull Creek Channel, unpublished.

Prunuske, L., 1987, Groundwork, Marin County Resource Conservation District, 60 ppg.

Rosgen, D.L., and Fittante, B.L., Fish Habitat Structures - A Selection Guide Using Stream Classification, unpublished.

Rosgen, D.L., 1985, A Stream Classification System, In: Riparian Ecosystem and Their Management; Reconciling Conflicting Uses. Proceedings of the First North American Riparian Conference, Tucson, AZ, GTR-RM-120, pp.91-95.

U.S. Geological Survey, 1981, Water Resources Data-California Water Year 1981. Vol. 2, USGS Water Data Report CA-81-2, USGS Sacramento, CA 319 pp.

U.S. Geological Survey, 1990, Open files; discharge notes, hydrographs, miscellaneous hydrologic data for the Big Sur River; Salinas Field Station, Salinas, CA.

Zembsch, Steven J., Big Sur River Management Plan, January 1990, California Department of Parks and Recreation.

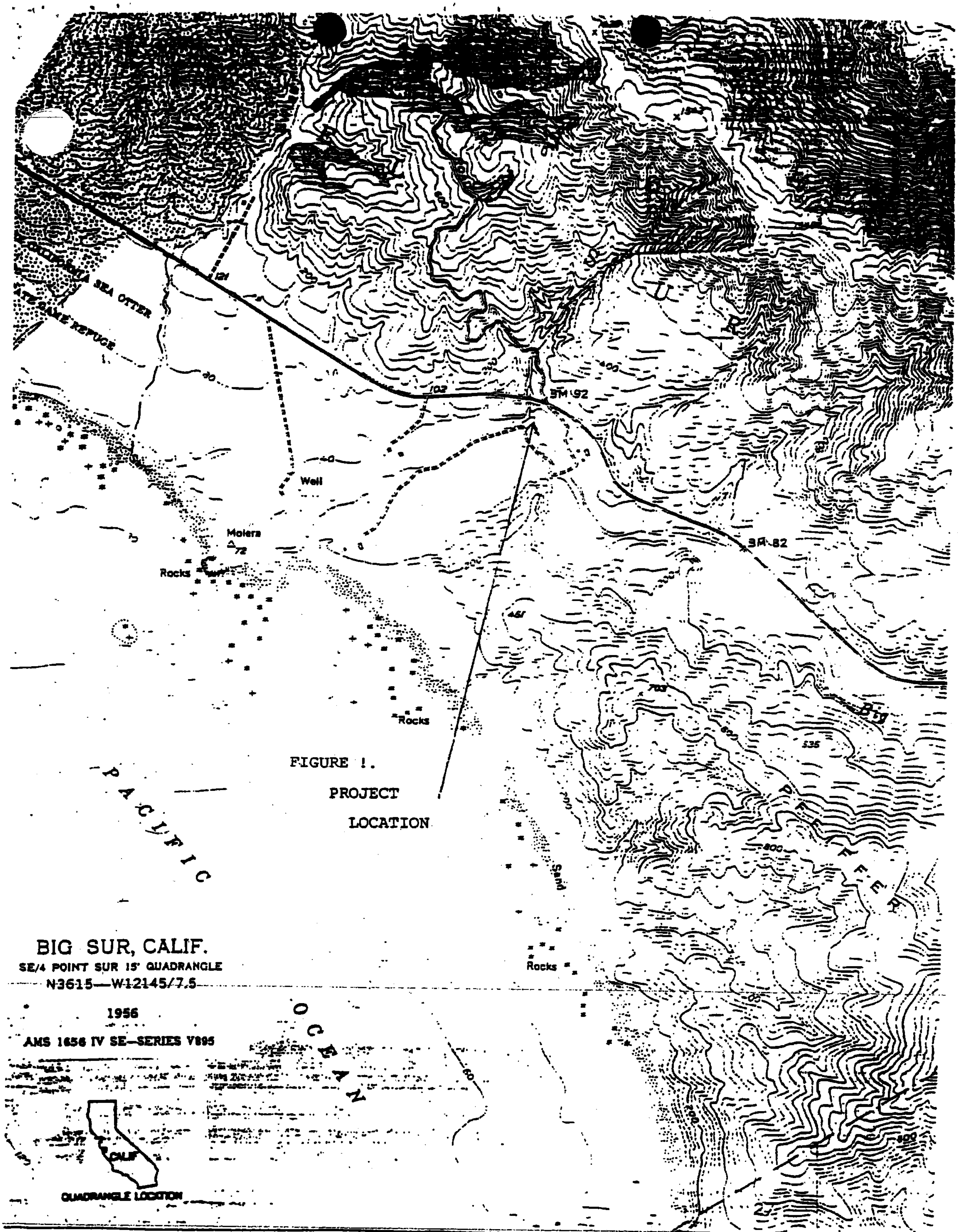


FIGURE 1. PROJECT LOCATION

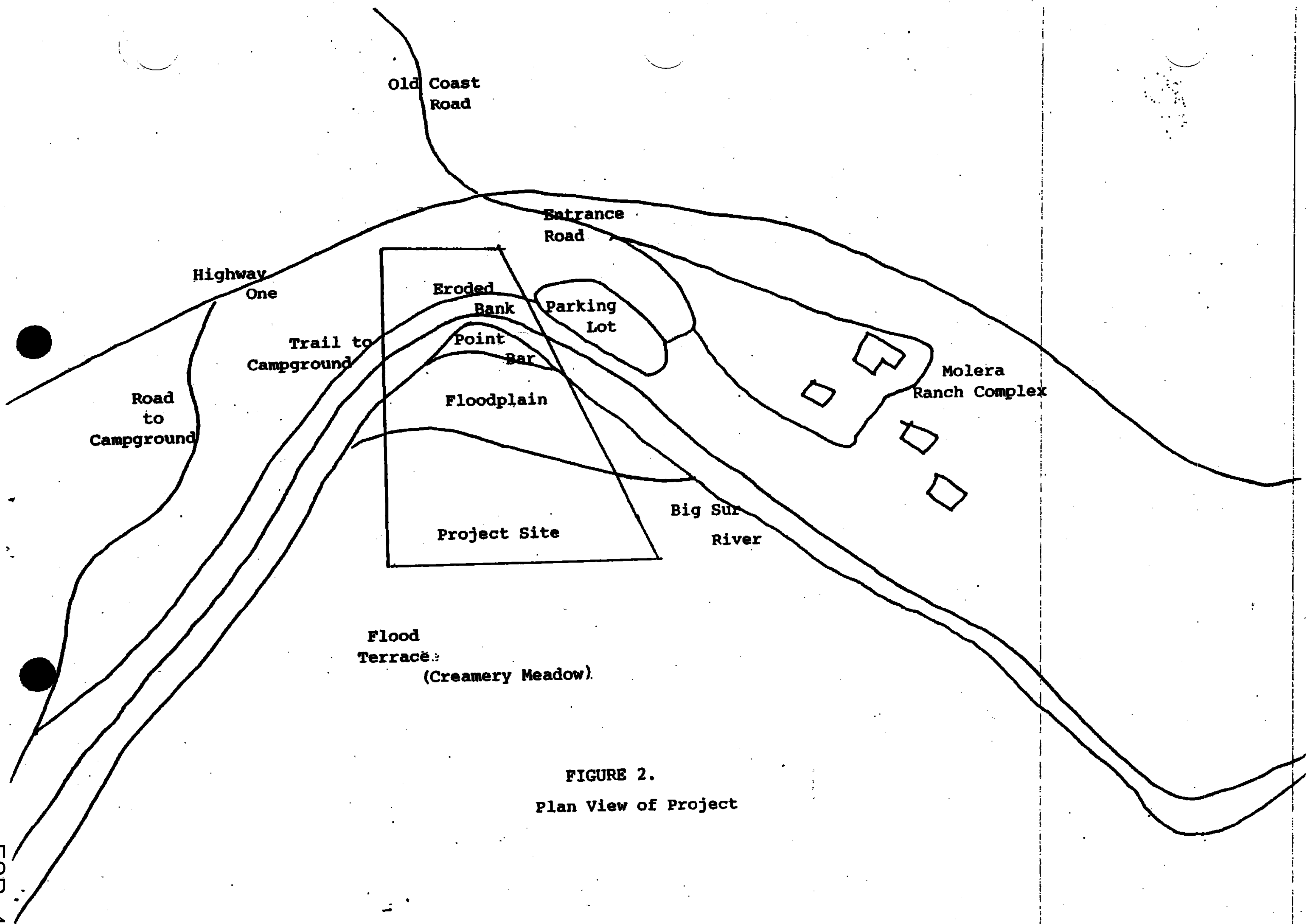
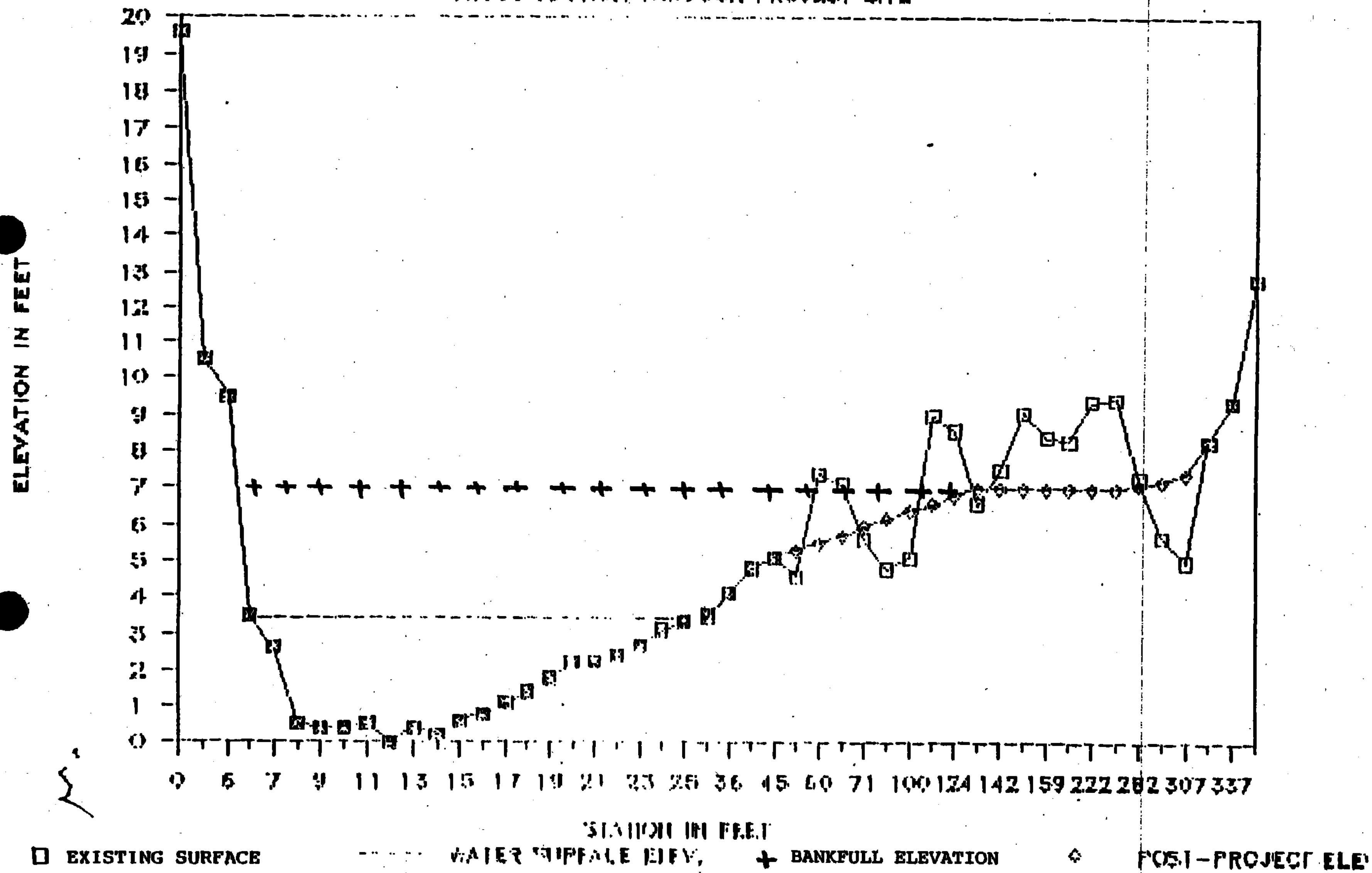


FIGURE 2.

Plan View of Project

BIG SUR RIVER, ANDREW MOLERA SP

CROSS SECTION THROUGH PROJECT SITE



Figure

Plate 1. Overall view of the project site. The river has been diverted; it normally occupies the strip to the right and above the excavator. The floodplain is just above the active channel, with the terrace (Creamery meadow) at the top of the photo.

Plate 2.
[illegible]ighty Big Sur River has been reduced to a trickle after four years of drought, aggressive downstream groundwater extraction and diversion around the project site. This photo shows the outlet of the diversion channel shortly after diversion.

Plate 3. The long riffle-run dried up for about 600 feet just downstream from the diversion. This resulted in the ultimate stress for gill-dependent resources. This section of river did not flow again until the rains started in late November.

Plate 4. The straight reach of the project site has been roughed out. The convergence structures are being placed. The thalweg runs diagonally from left to right in the phot

Plate 5. The dozer is procuring bank protection materials and skidding them across the river to a location accessible by the excavator and dump truck. The minimum disturbance to natural resources was a paramount concern during this phase.

Plate 6. The excavator is backfilling the bank protection with free-draining channel material. The dozer is "feeding" the excavator to maximize efficiency. This material solves two problems- excess material in the active channel and bank failure from the "drawdown effect". The backfill is excellent for counter-butressing the slope.

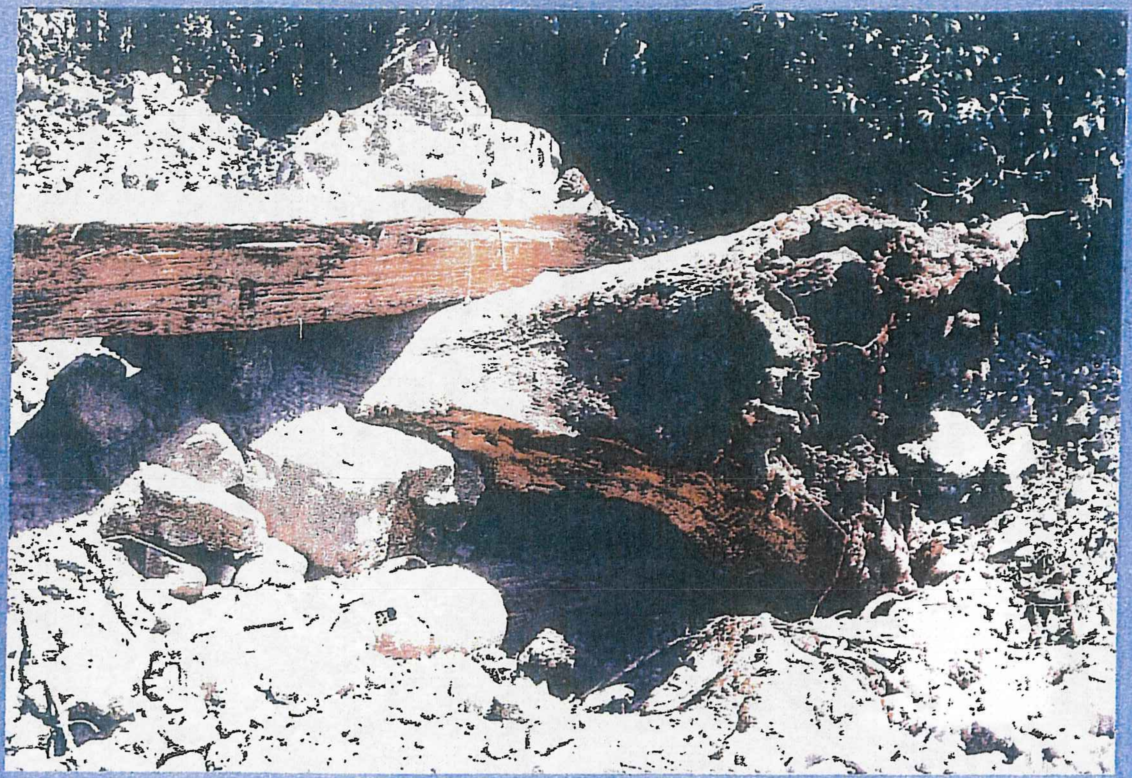


Plate 7. The rootwads are placed on a "footer" log which acts as a foundation. Boulders are used to prevent the winnowing of fines from between the woody material. The entire structure is backfilled to counteract bouancy forces. Stability is also achieved by the interlocking placement and the orientation of the rootwad to flow vectors.

Plate 8. Close-up of rootwad showing the excellent fish habitat (once the river is restored to the site). There is tremendous variance in localized velocity.

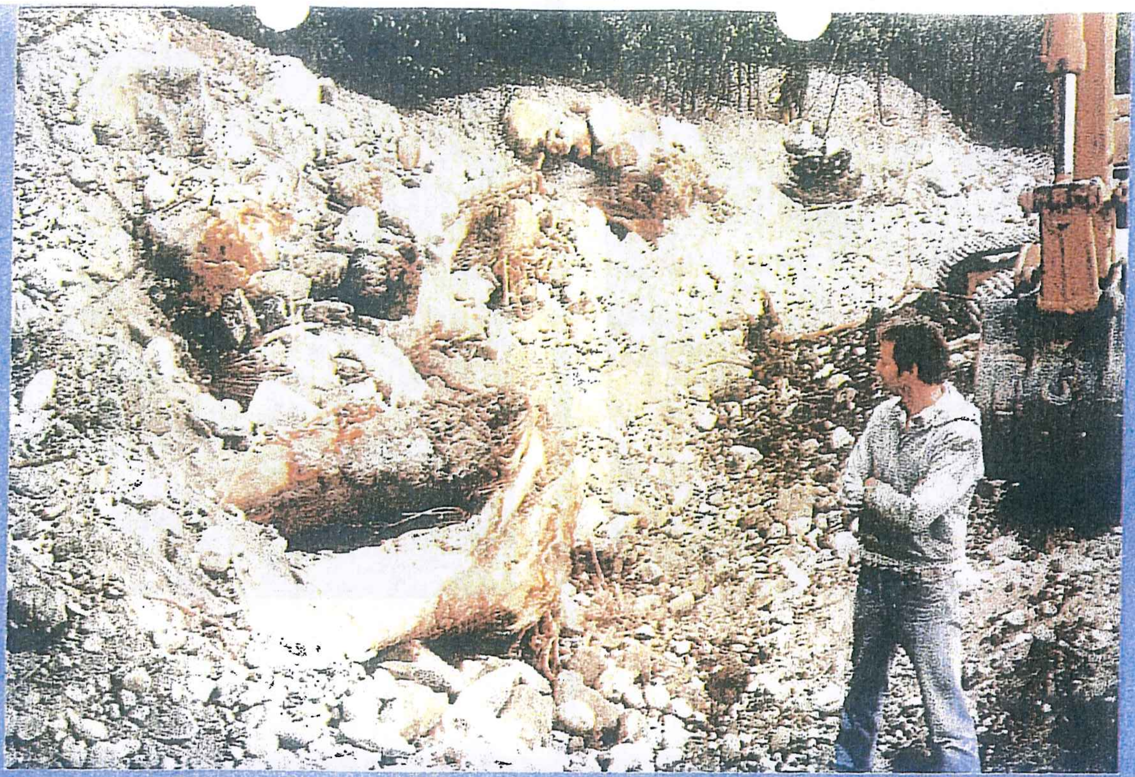


Plate 9. The excavator operator inspects his work. Having an excavator operator who understands the principles involved not only expedites the construction, it is essential for properly constructing the bank protection.

Plate 10. Now the site is ready for water. This is looking downstream. Note the orientation of the rootwads and the slope of the point bar. The point bar is the depositional feature on the left side of the photo. It is critical for dissipating the river's energy during high flow. It's shape and slope determine its effectiveness for this task.

Plate 11. Bank protection materials (down trees) were skidded from this site. It will be revegetated, using sycamore, big-leaf maple and cottonwood trees.

Plate 12. The same view as Plate 10, only this photo shows the flowing river. Again note the shape and slopes of the various features.

Plate 13. The recontoured floodplain. Existing native vegetation was preserved by leaving it on pedestals. This site will likely succeed to a Sycamore-cottonwood riparian forest.

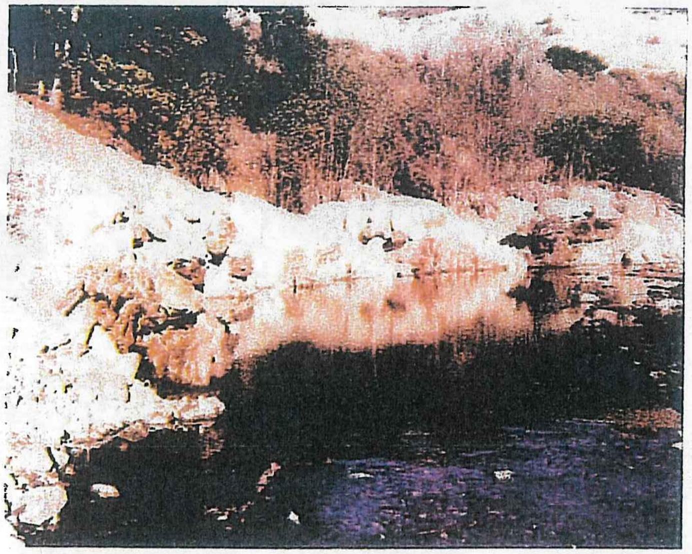


Plate 14. This is the meander reach lo upstream. Meanders form natural pools based on the energy grade of a stable syst

The department has 30 days from date of receipt of a completed application in which to make its recommendations. This time period does not begin until the department receives the appropriate fee (see attached fee schedule).

T.H.P. No. ____________

Notification No. ____________ Received ____________

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

NOTIFICATION OF REMOVAL OF MATERIALS AND/OR ALTERATION OF LAKE, RIVER, OR STREAMBED BOTTOM, OR MARGIN

A. APPLICANT Pursuant to Sections 1601–1607 of the California Fish and Game Code

I, Steven Zembsch (Name of Applicant) of 2211 GardenRoad, Monterey CA 93940 (Mailing Address)

Representing California Department of Parks and Recreation (Name and address of Individual, Agency, Company, etc. owning property or doing work)

Hereby notify the California Department of Fish and Game of operations to be carried out by or for me

from June 1, 1990 (Starting Date) to June 30, 1990 (Ending Date) on or affecting

Big Sur River (Name of Stream, River, or Lake) of Monterey County, tributary to Pacific Ocean (Major Water Body)

Located 50' downstream from parking lot at Andrew Molera State Park (Distance and Direction to Landmarks)

Section 15 Township 195 Range 1E

USGS Map Big Sur 7.5' Co. Assessor's Parcel No. N/A

Property owners name and address (if different from applicant) ____________

Steven Zembsch (Name of Person to Be Contacted at Site During Operations) is responsible for operations at the site.

He can be reached at 2211 Garden Road, Monterey CA 93940 (Mailing Address) 649-7115 (Telephone)

B. Description of operation 1. The nature of said operations will be as follows:
Check all squares which apply.

- [X] Soil, sand, gravel, and/or boulder removal or displacement
- [ ] Water diversion or impoundment
- [ ] Mining—other than aggregate removal
- [ ] Road or bridge construction
- [X] Levee or channel construction
- [ ] Timber harvesting or any related activity required for harvesting timber
- [ ] Temporary, recreational or irrigation dam
- [X] Fill or spoil in bed, bank, or channel
- [ ] Other—Describe below

2. Type of material removed, displaced or added ☐ Soil ☒ Sand ☒ Gravel ☒ Boulders
Volume 500 yard^3
3. Equipment to be used in the described site Caterpillar 225 excavator
4. Use of water (i.e., domestic, irrigation, gravel, washing, etc.) 0 Quantity ____
5. Describe type and density of vegetation to be affected, and estimate area involved.
Coyote bush, 20%; bare ground 50%, willows 30%
6. What actions are proposed to protect fish and wildlife resources and/or mitigate for project impacts? This project is a fish habitat enhancement.

7a. Does project have a local or state lead agency or require other permits? ☒ Yes ☐ No Coastal Development & Section 404, Army Corp

7b. If 7a answer is yes, please attach or identify any available environmental document.

7c. For state-designated wild and scenic rivers, a determination of the project's consistency with the California Wild and Scenic Rivers Act must be made by the Secretary for Resources. Until the Secretary determines the project is consistent with the Act, the Department cannot issue a valid agreement. A tentative agreement will be issued, conditioned upon a finding of consistency by the Resources Secretary.

7d. THIS AGREEMENT IS NOT INTENDED AS AN APPROVAL OF A PROJECT OR OF SPECIFIC PROJECT FEATURES BY THE DEPARTMENT OF FISH AND GAME. INDEPENDENT REVIEW AND RECOMMENDATIONS WILL BE PROVIDED BY THE DEPARTMENT AS APPROPRIATE ON THOSE PROJECTS WHERE LOCAL, STATE, OR FEDERAL PERMITS OR OTHER ENVIRONMENTAL REPORTS ARE REQUIRED.

8. Briefly describe proposed construction methods. Attach diagram or sketch of the location of your operation to clearly indicate the stream or other water and access and distance from named public road. Indicate locked gates with an "X". Show existing features with a solid line (————) and proposed features with a broken line (– – – – – – –). Show compass direction. Attach larger scale map if necessary.

NO CARBON NEEDED
FG2023 (Rev. 11/87)

____________ Signature of Applicant ____________ Date

APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT

(33 CFR 325)

OMB APPROVAL NO. 0702-0036
Expires 30 June 1989

The Department of the Army permit program is authorized by Section 10 of the River and Harbor Act of 1899, Section 404 of the Clean Water Act and Section 103 of the Marine, Protection, Research and Sanctuaries Act. These laws require permits authorizing activities in or affecting navigable waters of the United States, the discharge of dredged or fill material into waters of the United States, and the transportation of dredged material for the purpose of dumping it into ocean waters. Information provided on this form will be used in evaluating the application for a permit. Information in this application is made a matter of public record through issuance of a public notice. Disclosure of the information requested is voluntary; however, the data requested are necessary in order to communicate with the applicant and to evaluate the permit application. If necessary information is not provided, the permit application cannot be processed nor can a permit be issued.

One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (*see sample drawings and instructions*) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

1. APPLICATION NUMBER *(To be assigned by Corps)*

2. NAME AND ADDRESS OF APPLICANT

Dept. of Parks and Recreation
Central Coast Region
2211 Garden Road
Monterey, CA 93940

Telephone no. during business hours

A/C ( ) ____________ (Residence)
A/C (408) 649-7115 (Office)

3. NAME, ADDRESS, AND TITLE OF AUTHORIZED AGENT

Steve Zembsch
Associate Resource Ecologist
2211 Garden Road
Monterey, CA 93940

Telephone no. during business hours

A/C ( ) ____________ (Residence)
A/C (408) 649-7115 (Office)

Statement of Authorization: I hereby designate and authorize ____________ to act in my behalf as my agent in the processing of this permit application and to furnish, upon request, supplemental information in support of the application.

SIGNATURE OF APPLICANT | DATE

4. DETAILED DESCRIPTION OF PROPOSED ACTIVITY

4a. ACTIVITY

Logs, rootwads and boulders will be interlocked along a 220' x 12' failing streambank. The pre-disturbance channel dimensions will be restored, further reducing point velocities along the affected stream bank. See attached detail of structure and cross-sections.

4b. PURPOSE

Lateral migration of stream channel threatens public access trail to campground and beach. Work to begin on 6/1/90 and complete by 6/30/90.

4c. DISCHARGE OF DREDGED OR FILL MATERIAL

There will be no net removal or fill of channel materials.

RECEIVED
MAR 16 1990

5. NAMES AND ADDRESSES OF ADJOINING PROPERTY OWNERS, LESSEES, ETC., WHOSE PROPERTY ALSO ADJOINS THE WATERWAY

ne - California Dept. of Parks and Recreation owns both sides of the river from ½ miles upstream of the project site all the way to the ocean.

6. WATERBODY AND LOCATION ON WATERBODY WHERE ACTIVITY EXISTS OR IS PROPOSED

Big Sur River (see map)

7. LOCATION ON LAND WHERE ACTIVITY EXISTS OR IS PROPOSED

ADDRESS:

Highway 1, 50 feet downstream from parking lot of Andrew Molera State Park
STREET, ROAD, ROUTE OR OTHER DESCRIPTIVE LOCATION

Monterey	CA	
COUNTY	STATE	ZIP CODE

Monterey County Planning Dept. - Coastal Unit
LOCAL GOVERNING BODY WITH JURISDICTION OVER SITE

8. Is any portion of the activity for which authorization is sought now complete? ☐ YES ☒ NO
If answer is "Yes" give reasons, month and year the activity was completed. Indicate the existing work on the drawings.

9. List all approvals or certifications and denials received from other federal, interstate, state or local agencies for any structures, construction, discharges or other activities described in this application.

ISSUING AGENCY	TYPE APPROVAL	IDENTIFICATION NO.	DATE OF APPLICATION	DATE OF APPROVAL	DATE OF DENIAL
CA Dept. of Fish and Game	1603		3/1/90	N/A	N/A
Monterey County	Coastal Dev.		2/23/90	N/A	N/A

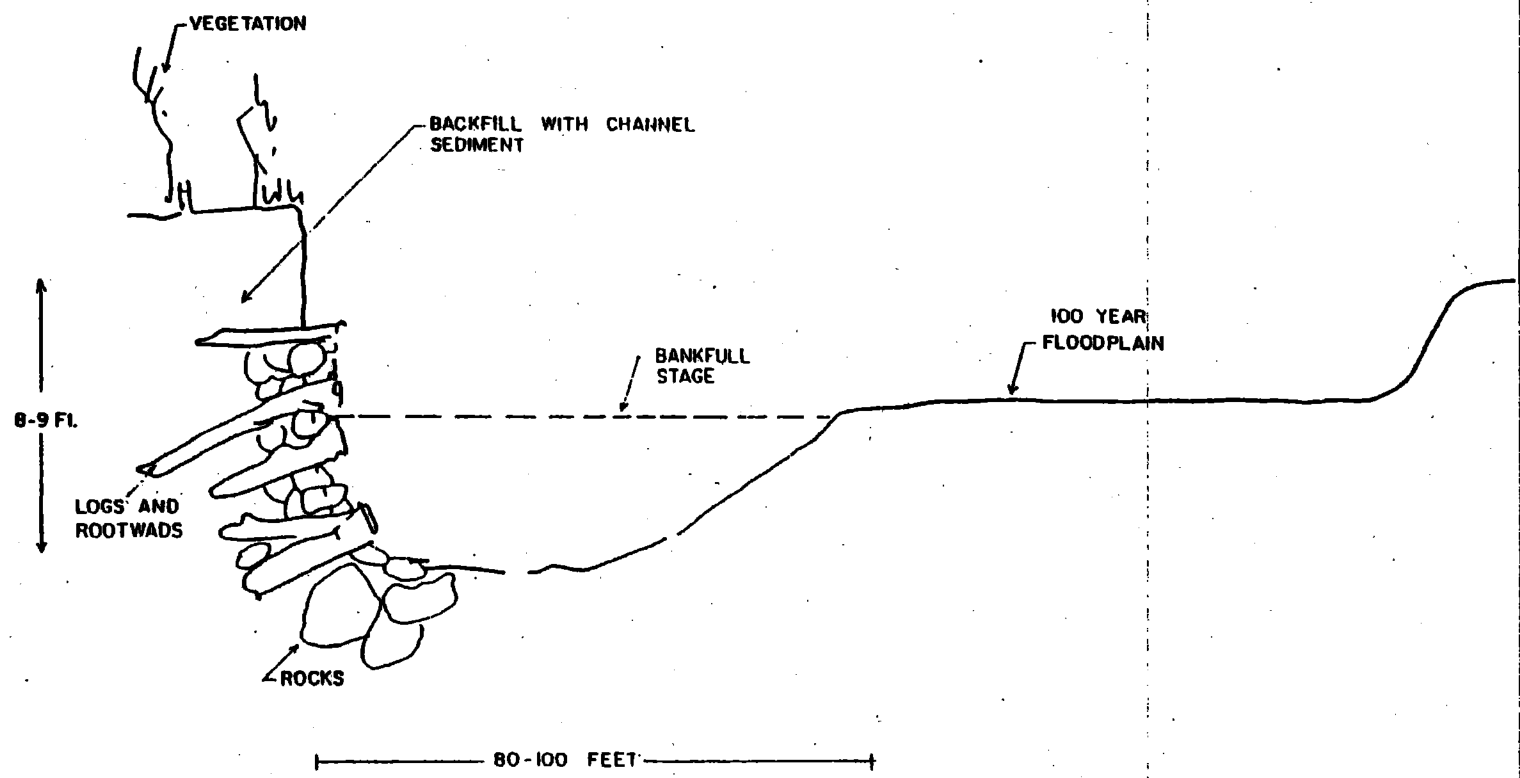
10. Application is hereby made for a permit or permits to authorize the activities described herein. I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities or I am acting as the duly authorized agent of the applicant.

SIGNATURE OF APPLICANT	DATE	SIGNATURE OF AGENT	DATE

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in Block 3 has been filled out and signed.

U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of The United States knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.

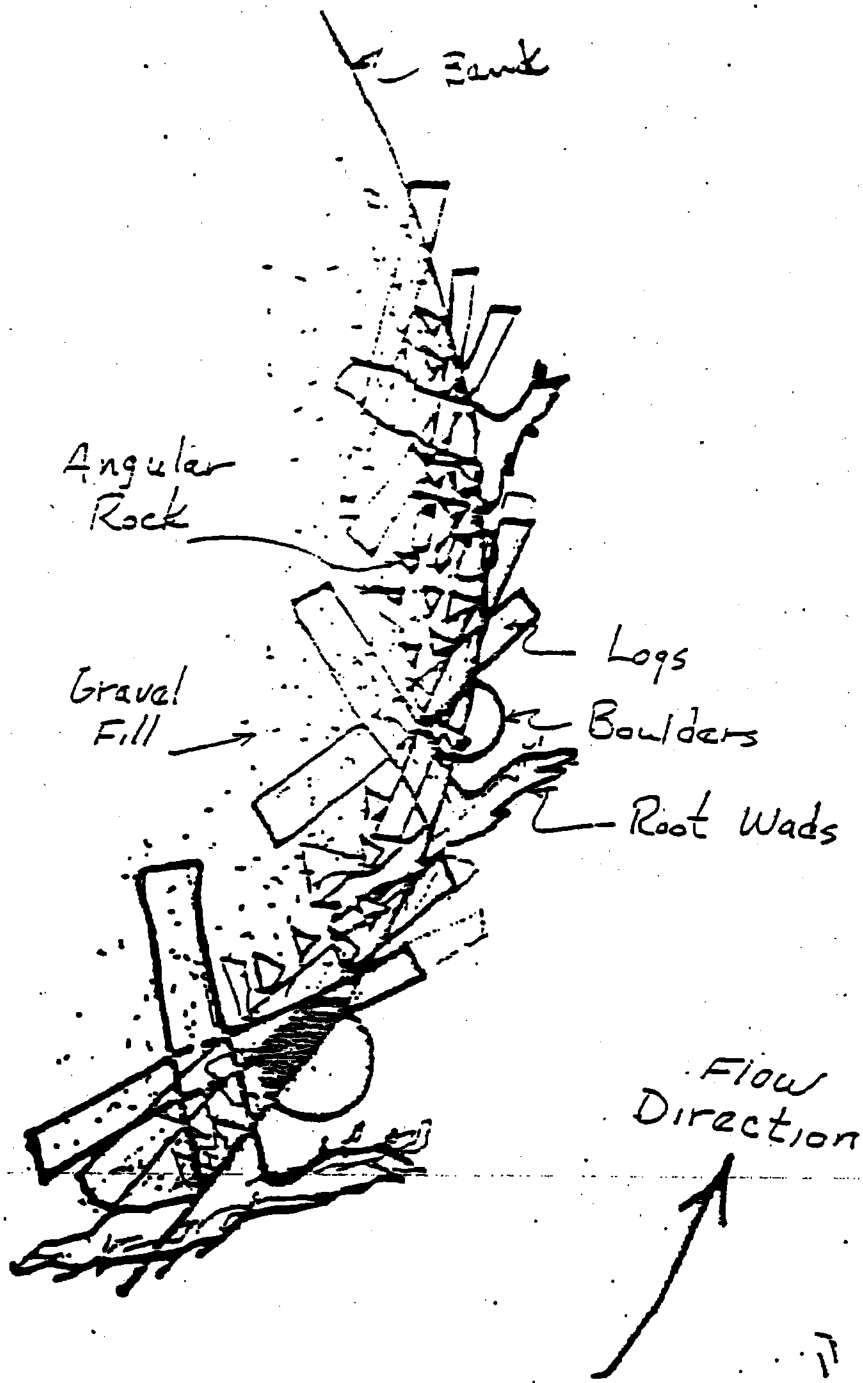
Do not send a permit processing fee with this application. The appropriate fee will be assessed when a permit is issued.

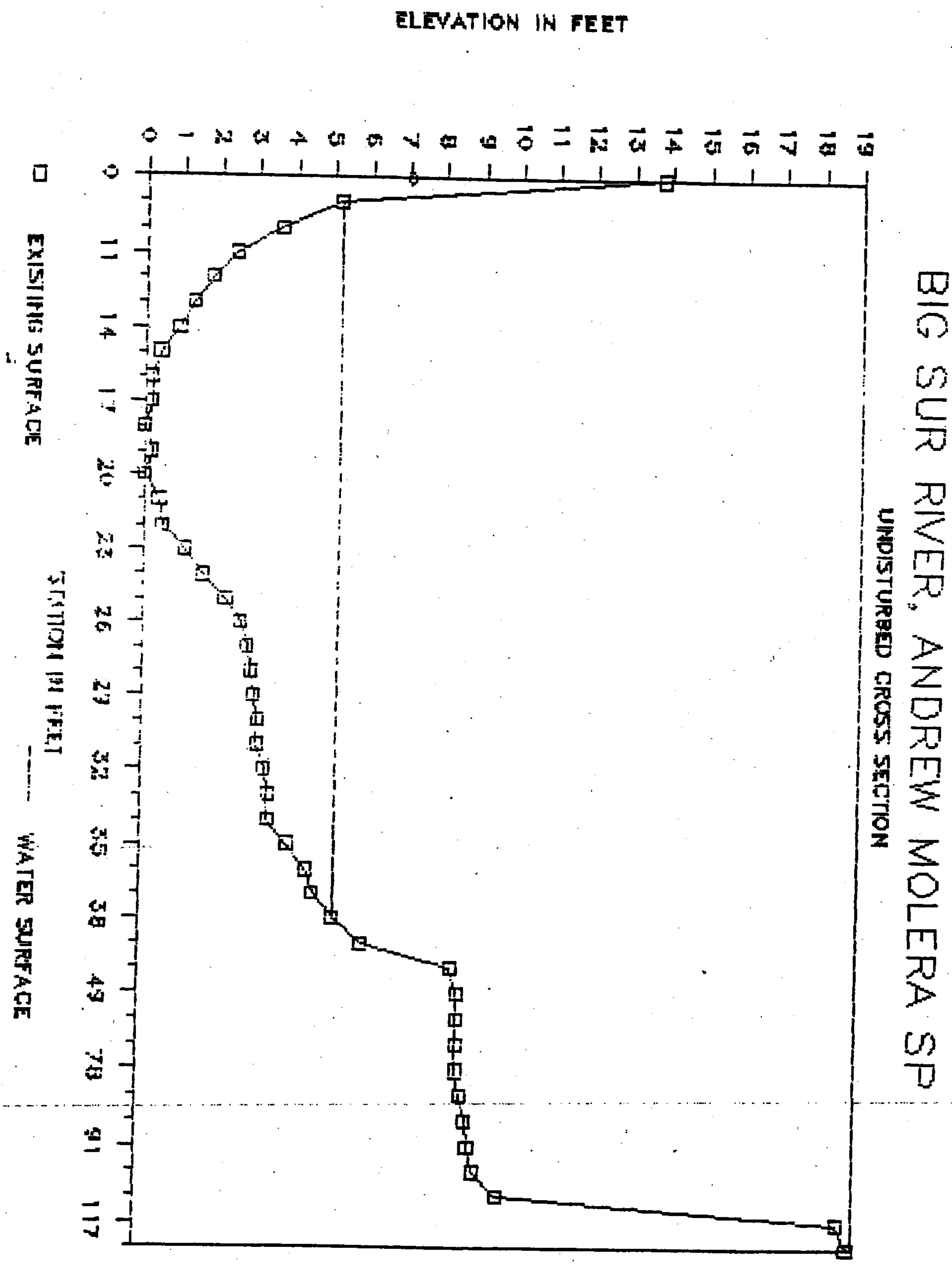


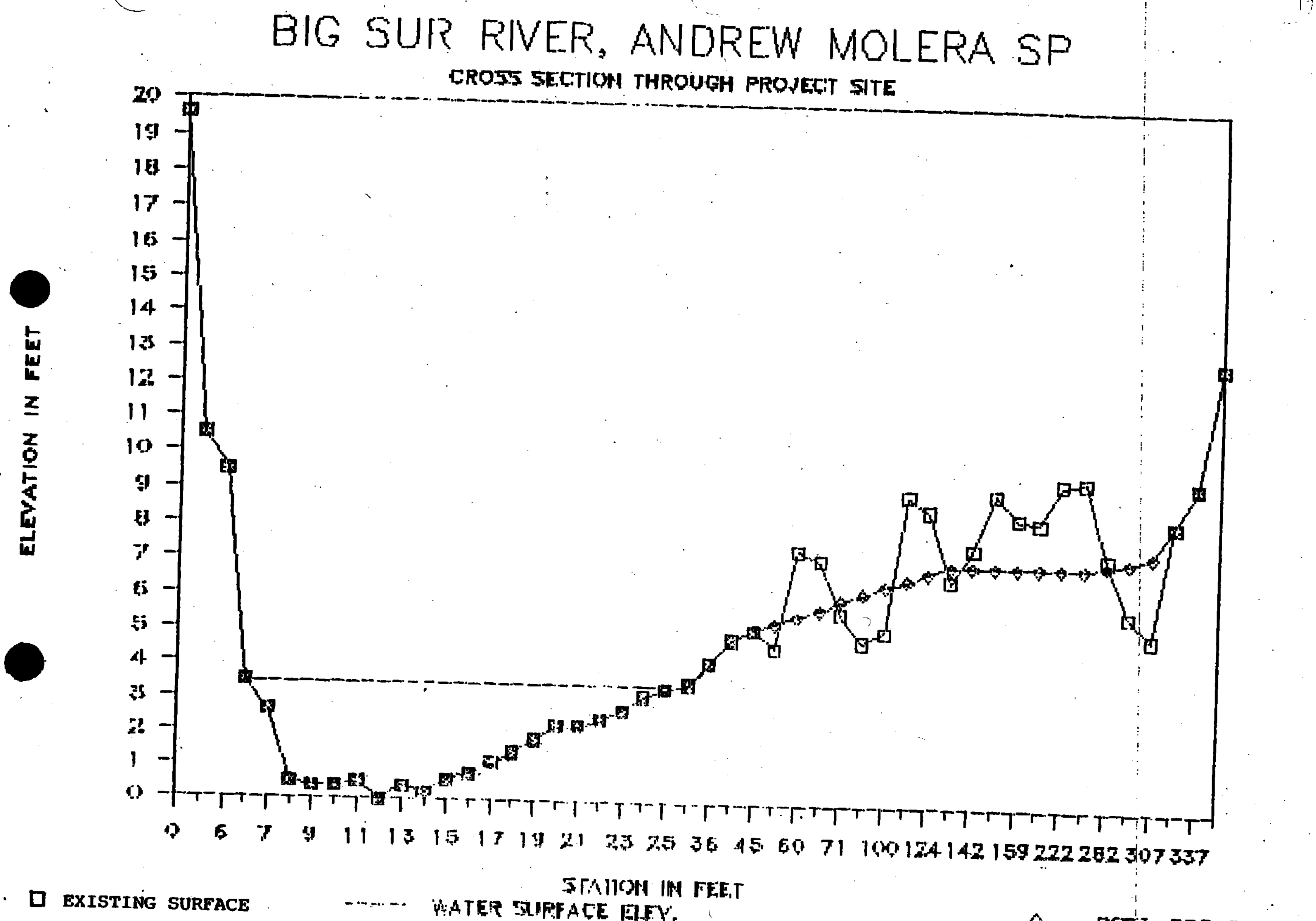
Adapted from drawings by Wildland Hydrology Consultants, Ft. Collins, CO.

BANK PROTECTION TECHNIQUE

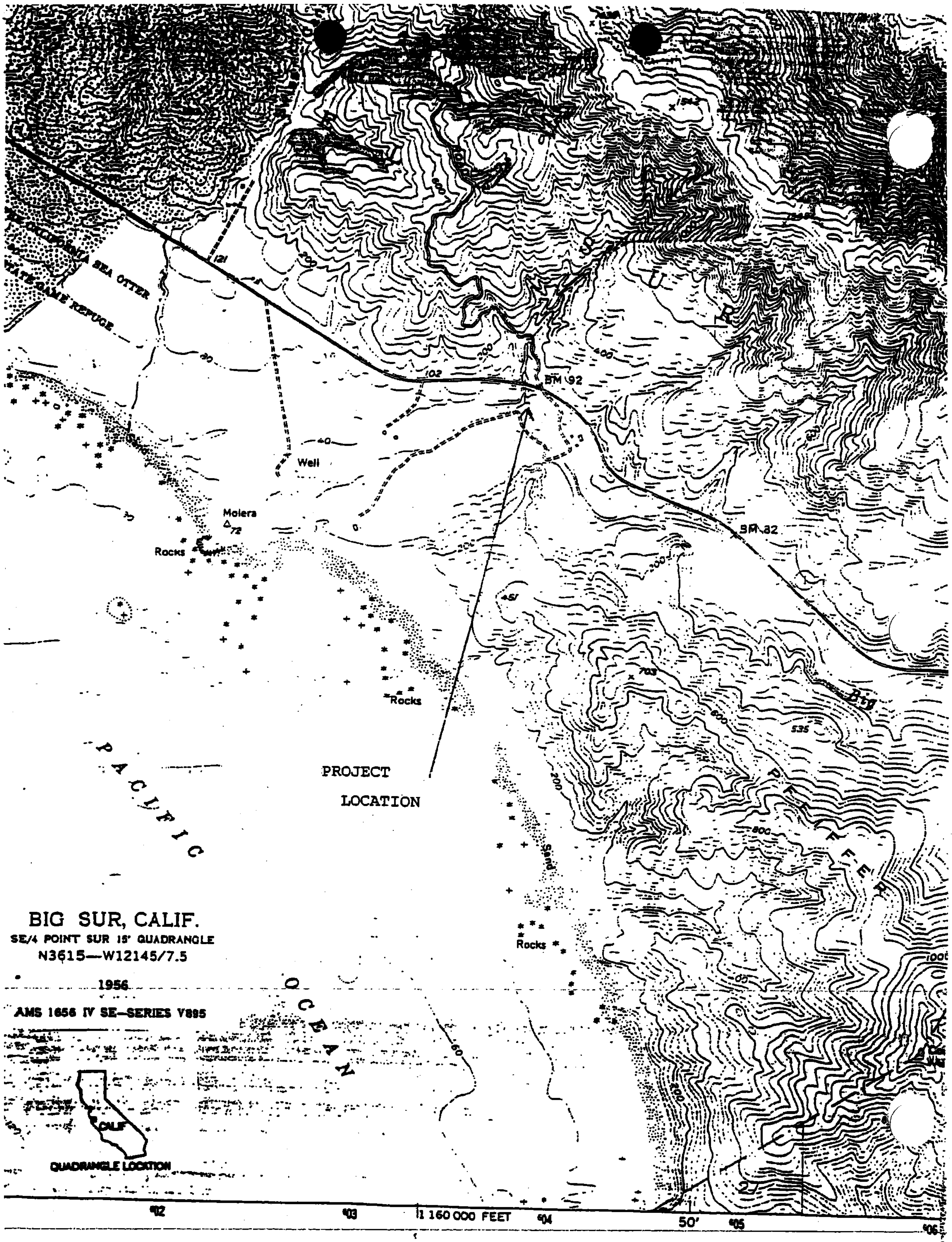
Schematic drawing of orientation and arrangement of native materials for bank stabilization work.




BIG SUR RIVER, ANDREW MOLERA SP
UNDISTURBED CROSS SECTION
ELEVATION IN FEET
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
0 11 14 17 20 23 26 29 32 35 38 49 78 91 117
STATION IN FEET
EXISTING SURFACE
WATER SURFACE



BIG SUR RIVER, ANDREW MOLERA SP
CROSS SECTION THROUGH PROJECT SITE
ELEVATION IN FEET
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
6
7
9
11
13
15
17
19
21
23
25
36
45
60
71
100
124
142
159
222
282
307
337
STATION IN FEET
EXISTING SURFACE
WATER SURFACE ELEV.
POST-PROJECT ELE


CALIFORNIA SEA OTTER
STATE GAME REFUGE
BM 92
Well
Molera
Rocks
BM 32
Big
PROJECT
LOCATION
PACIFIC
OCEAN
Sand
Rocks
BIG SUR, CALIF.
SE/4 POINT SUR 15' QUADRANGLE
N3615—W12145/7.5
1956
AMS 1656 IV SE—SERIES V895
CALIF
QUADRANGLE LOCATION
1 160 000 FEET
50'

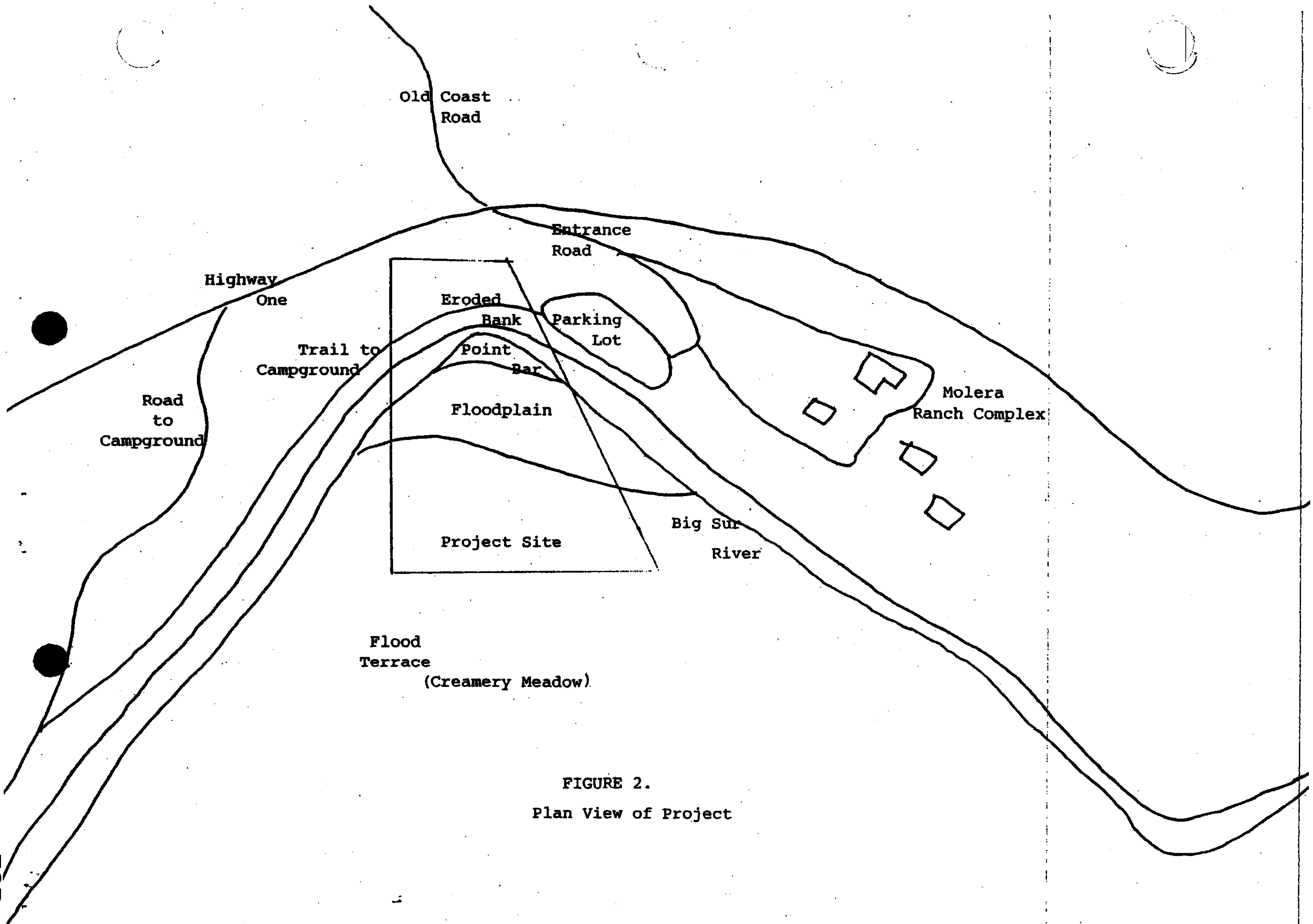


FIGURE 2.
Plan View of Project

#2

Natural Heritage Stewardship Program Completion Report

Project Title: River Management Plan
Unit Name: Big Sur District
Prepared By: Ken Gray, Monterey District

Fiscal Year: NHS 89/90
Date Prepared: August 15, 1994

Statement of Problem

The Big Sur River watershed was damaged by the Marble-Cone fire in 1977. Within Pfeiffer Big Sur and Andrew Molera State Parks extensive work was undertaken to increase the channel capacity and reduce erosion. The anticipated heavy flows did not occur but the streambed aggrated, the stream channel became braided in sections, and streambank erosion is occurring.

Overall Objectives and Description of Work Proposed

The funded project proposed a hydrologic study of the Big Sur River and development and implementation plan for restoring the river to a more natural state. The emphasis was to be on following a management strategy similar to that developed for Humboldt Redwoods State Park.

Methods and Materials

Associate Resource Ecologist Steve Zembsch transferred from the Northern Region where he was managing river restoration projects in Humboldt Redwoods State Park partly to work on this project. Steve prepared the attached Big Sur River Management Plan and implemented an instream river restoration project described in the attached status report.

Results, Evaluations and Conclusions

The project was successful in that the instream work succeeded in arresting a streambank erosion problem that was threatening a large oak tree and the access trail to the Andrew Molera campground. There has been some deterioration of the downstream portion of the root-wad structure but the bank is stable. Willows and other vegetation is increasingly becoming established along the shoreline, decreasing the likelihood of further damage.

We underestimated the funds required to accomplish a comprehensive hydrology study so the plan that was prepared provided a good framework for the instream project but did not fully address specific future project needs.

There was considerable public controversy associated with using heavy equipment in the river. Before any additional similar work is undertaken there should be a significant public relations effort undertaken. We also need to keep the local park staff informed regarding the project so they can assist with public relations efforts.

The regulatory requirements related to in-stream restoration are extensive and time consuming. Needed small scale follow-up work requiring equipment in the river was not accomplished because the regulatory permits could not be obtained in time to take advantage of the available equipment. Future budgeting should include significant funds for regulatory compliance.

The in-stream work was performed in the summer of 1990, a critically dry year. When the river was moved into a temporary diversion channel the stream dried up subjecting us to public criticism. We think that the river would have stopped flowing at about the same time but since we were working in the river it didn't look good for us. We filed a water rights complaint stating our belief that the real reason the river dried up was that excessive underflow was being withdrawn to irrigate an adjacent pasture. The State Water Resource Control Board supported our complaint and the adjacent landowner is now attempting to obtain an appropriated water right; we have filed a protest on that application.

Maps and a cost breakdown are in the attached status report.

Big Sur District - 89/90 NHS - River Management Plan - $23,700

Expenditures & Encumbrances

	FY89/90	FY90/91	FY91/92	Total	Orig. Alloc.	Balance
SW	$3304	$333	$0	$3637	$3,637	$0
Travel	$287	$100	$67	$454	$454	$0
OH	$359	$43	$7	$409	$409	$0
DC	$12,000	$0	$7,186	$19,186	$19,200	$14
Total	$15,950	$476	$7,274	$23,686	$23,700	$14

1994

CALIFORNIA – RESOURCES AGENCY PETE WILSON, Governor

ARTMENT OF PARKS AND RECREATION
'EREY DISTRICT
3ARDEN ROAD
'EREY 93920
549-2836

September 12, 1994

Ed Anton, Chief
Division of Water Rights
State Water Resource Control Board
P.O. Box 2000
Sacramento, CA 95812-2000

APPLICATION 30166 OF JAMES HILL TO APPROPRIATE BIG SUR RIVER UNDERFLOW IN MONTEREY COUNTY

The California Department of Parks and Recreation (State Parks) is a protestant to the above named application. Department representatives have met with Nick Wilcox of your staff regarding the process the State Board will follow when considering this application. We are concerned that continued pumping by the applicant during the lengthy review process will result in continued negative impacts to the aquatic and riparian resource of the Big Sur River within Andrew Molera State Park. We request that the State Board order Mr. Hill to cease or significantly reduce his water withdrawals until final action is taken on the application.

In August 1990 State Parks submitted a complaint to the State Board regarding the pumping of Big Sur River underflow by Mr. Hill. In the summer of 1990 about 3,000 lineal feet of the lower Big Sur River went dry. The summer of 1990 was a critically dry drought period in the Big Sur area. We believe that Mr. Hill's continued pumping during this dry period caused the elimination of all surface flow in the river. During other dry years, including 1994, the river flow is low but continues to the river mouth lagoon. The low flows may be insufficient to provide optimum habitat for Steelhead and other aquatic organisms in the lower river and lagoon and to sustain the riparian habitat.

In response to our 1990 complaint, State Board staff completed an investigation which concluded that Mr. Hill's wells divert from the river underflow and that the diversion was only partially covered under a claim of riparian right. Mr. Hill was directed to cease diverting to nonriparian land or file an application to obtain an appropriative water right covering his diversions. Mr. Hill subsequently filed Application 30166. State Parks submitted a protest to the State Board in May 1994 in response to the Public Notice of this application.

Mr. Hill's application to divert 1800 acre feet per annum to irrigate 292 acres of pasture is excessive. We understand that the rate of 6 acre feet per acre is high for irrigated pasture, and far in excess of that required by prevailing climatic conditions. During irrigation periods, surface water flows across Mr. Hill's pastures causing erosion. An ephemeral drainage on his property flows during and following his irrigation events causing erosion across the ocean beach. The surface flow sometimes crosses his property line, flooding state park trails.

The Big Sur River was designated a protected waterway by the State Legislature in 1973. The Big Sur River Protected Waterway Plan was adopted by the Monterey County Board of Supervisors in 1985 and certified by the California Coastal Commission in 1986. It states as its main goal "to maintain and enhance the value of the lower Big Sur River and its watershed as a domestic water supply, fish and wildlife habitat, and recreational and scenic resources and to mitigate adverse effects and facilities on these resources". The special status of the River provides additional justification for the State Board to take immediate action to protect this important resource.

In addition, fisheries research in the central coast of California has demonstrated that river mouth lagoons are vital rearing habitat areas for young steelhead. The Big Sur River mouth lagoon is one of the few central coast streams that is not artificially regulated and which receives perennial flows. The California Department of Fish and Game is managing steelhead as a depleted resource. The Fish and Game Commission has adopted a steelhead habitat enhancement policy to protect native waters and restore depleted habitat. The lower Big Sur River is an important resource for steelhead which should be protected and enhanced.

State Parks is requesting that the State Board order that the nonriparian water withdrawals be either ended or significantly reduced until a final decision is reached on Mr. Hill's application. Ending or reducing the diversion during the annual summer drought period would be the highest priority. If you have any questions about this request please contact State Parks Monterey District Resource Ecologist Ken Gray at (408) 649-2862.

Sincerely,

Mary R. Wright

Mary R. Wright
District Superintendent

cc: Robert J. Baiocchi
California Sportfishing
Protection Alliance
P.O. Box 357
Quincy, CA 95971

Keith Anderson
Department of Fish and Game
20 Lower Ragsdale Drive, Suite 100
Monterey, CA 93940

Chuck Marshall
Department of Fish and Game
3930 La Panza Road
Creston, CA 93432

Les Strnad
California Coastal Commission
725 Front Street, Suite 300
Santa Cruz, CA 95060

Nick Wilcox
Division of Water Rights
P.O. Box 2000
Sacramento, CA 95812-2000

James J. Hill
P.O. Box 1588
Monterey, CA 93940

Lawrence Horan
Horan, Lloyd, Karachale et al.
P.O. Box 3350
Monterey, CA 93942-3350

Adolph Moskovitz
Kronick, Moskovitz, Tiedemann and Girard
400 Capitol Mall
Sacramento, CA 95814-4417

Mark Eikenberry
Andrew Molera State Park

Victor Roth
Monterey District

Helf Ky

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

In Response Refer To:
NOV 5 2002 151416 SWR-01-SR-347:SKL

FISH & GAME
NOV 7 2002
YOUNTVILLE

Mr. Kyriacos C. Kyriacou
State Water Resources Control Board
Division of Water Rights
P.O. Box 2000
Sacramento, California 95812-2000

Dear Mr. Kyriacou:

By this letter National Marine Fisheries Service (NOAA Fisheries) comments to the Notice of Preparation (NOP) for an Environmental Impact Report (EIR) for Appropriative Water Right Permit Application 30166 by El Sur Ranch. El Sur Ranch seeks to appropriate 1,800 acre-feet per year (AFA) of Big Sur River underflow for the purpose of pasture irrigation at a maximum rate not to exceed 5.84 cubic feet per second (cfs) and a year around season of diversion.

Basis of Comments

Steelhead trout inhabit the Big Sur River. The South Central California Coast ESU of steelhead trout have been federally listed as threatened under the Endangered Species Act (ESA). The proposed activity may cause "take" of listed species. A brief summary of the life history needs of steelhead and the ESA history of this species is included in Enclosure A. Enclosure A is incorporated into this comment letter by reference.

Proposed Project

El Sur Ranch is located just north of the Andrew Molera State Park in Monterey County, California. An irrigation system constructed sometime in the 1950s provided flood irrigation to 292 acres of pasture. Water was pumped from two wells. The "Old Well" was constructed sometime in the mid-1950s and the "New Well was constructed in 1985.

Water from these wells was thought to be groundwater and water withdrawal was, therefore, non-jurisdictional. However, studies responding to a complaint by California Department of Parks and Recreation (CDPR) found that these wells were diverting underflow rather than groundwater. Therefore, the water withdrawal activities were without a valid basis of right, were illegal, and required an appropriative water right.

Comments

State Water Resources Control Board (SWRCB) considers the legal baseline for this project to be pre-project conditions or pre-CEQA conditions, whichever is later. In the case of El Sur Ranch, the baseline should be pre-project conditions in 1975. However, SWRCB is incorrectly considering using current conditions as of the date of the NOP as the Draft EIR baseline because of the change in morphology of the lagoon in the late 1990s.

NOAA Fisheries believes that the proposed baseline is inappropriate. If this baseline is used there will be virtually no difference between this Draft EIR baseline and project conditions because the Draft EIR baseline would include the illegal activities which the permit application seeks to remedy. It is doubtful given the amount of water requested (1800 acre-feet) and the rate of withdrawal (5.84 cfs) that this project would have insignificant effects. A more appropriate approach to determining project related impacts would be to cease all project related operations to collect baseline data.

Applicant seeks 1,800 AFA to flood irrigate 292 acres of pastureland. NOAA Fisheries questions this amount of water duty for irrigated pastureland. This amounts to 6.16 feet of water per acre, which appears to be excessive, unreasonable, and probably wasteful. Applicant must justify this requested amount of water for this purpose.

The removal and reduction of this amount of flow is likely to degrade habitat for steelhead. Applicant proposes to divert flow by means of offset wells with a year around season of diversion. This means there is no means of storing water during the rain season when water is abundant for use during the summer when water is not abundant. Summer base flows will be reduced, estuary habitat quality may be compromised and the opening and closing of the lagoon may change.

The wells are located near the mouth of the river, so flow reduction will have limited effect upstream. However, it is not known how stream flow reduction affects habitat quality in the Big Sur Lagoon for steelhead. Lagoons are important to juvenile steelhead[1]. Many juveniles transform into smolts, a life history phase when juvenile steelhead prepare for ocean life, while in the lagoon. Juveniles probably enter the lagoon in the spring and early summer, a period that coincides with the highest food availability[2]. Juvenile steelhead growth is typically rapid in

[1] Levings, C.D. and D. Boullon. 1997. Criteria for evaluating the survival value of estuaries for salmonids. NOAA_NMFS_NWFSC TM-29: Estuarine and ocean survival of northeastern Pacific salmon: 7pp.

[2] Pearcy, W.G. 1992. Ocean Ecology of the North Pacific Salmonids. Washington Sea Grant Program, University of Washington Press, Seattle.

lagoons[3] and survival of smolts that return as adults increases exponentially with smolt size[4]. Lagoons have supported 25% of the stock's potential sea-run fish production[5].

NOAA Fisheries recommends a study of the effects of reduced stream flows on water quality in the Big Sur Lagoon. Monitor water quality by measuring lagoon depth, dissolved oxygen concentrations, and water temperatures in vertical profiles at known stream flows along longitudinal profiles.

Dynamics of bar building and bar recession in conjunction with lagoons have been studied[6]. Applicant should determine whether reduction in streamflows has changed the timing of opening or closure of the lagoon.

The lower Big Sur River dried in 1990. NOAA Fisheries is concerned with the lack of instream flow requirements. As an interim measure until instream flows are determined, NOAA Fisheries recommends reducing well pumping to one well (3 cfs) when the flows at the USGS gage on the Big Sur River reach 7 cfs and diversions cease when flows reach 5 cfs at the USGS gage.

Last, cumulative effects must be adequately assessed.

NOAA Fisheries recognizes that this project will necessitate rigorous environmental assessment and an effective means for mitigating impacts must be developed. We look forward to working with you and the Applicant to address these issues. If you have any questions or comments concerning the contents of this letter please contact Dr. Stacy Li at (707) 575-6082.

Sincerely,

(acting)

Mark Helvey
Acting Northern California Supervisor
Habitat Conservation Division

cc: James Hill
Robert Floerke, CDFG, Yountville

---

[3] Smith, J.J. 1990. The effects of sandbar formation and inflows on aquatic habitat and fish utilization in Pescadero, San Gregorio, Waddell and Pomponio Creek estuary/lagoon systems, 1985-1989. Prepared for California Department of Parks and Recreation, Resource Protection Division, Natural Heritage Division, Sacramento.

[4] Shapovalov, L. and A.C.Taft. 1954.The life histories of the steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (Oncorhynchus kisutch) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game Fish Bulletin No. 98: 375 pp.

[5] Snider, W.M. 1983. Reconnaissance of the steelhead fishery resource of the Carmel River drainage, Monterey County. California Department of Fish and Game, Environmental Services Branch Administrative Report No. 83-3.

[6] Smith, J.J. 1990. ibid.

ENCLOSURE A

Steelhead occur in the Big Sur River. Steelhead comprising the South-Central California Coast Evolutionarily Significant Unit (ESU) are listed as threatened (62 Fed. Reg. 43937, August 18, 1997) under the ESA. Protective regulations prohibiting "take" of steelhead trout went into effect on July 10, 2000. These regulations make it unlawful to "take" South-Central California Coast steelhead under section 9 of the ESA. These protective regulations describe certain activities that may injure or kill listed steelhead and result in legal liability. These activities include, in part:

> *Physical disturbance or blockage of the streambed where spawners or redds are present concurrent with the disturbance; ...Blocking fish passage through fills, dams, or impassable culverts; or water withdrawal...; and water withdrawals that impact spawning or rearing habitat.*

Winter steelhead enter rivers in the late fall and begin spawning in December (Shapolalov and Taft 1954). Steelhead trout are capable of repeat spawning. Up to thirty percent survive to spawn a second or third time, but in large drainages where fish migrate long distances, the proportion is much lower (Meehan and Bjornn 1991).

Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Juvenile steelhead trout will spend one to three years in fresh water before migrating to the ocean (Busby et al. 1996). Winter steelhead trout prefer water temperatures in the 10°C-15°C (50°-59°F) range with a sustained upper limit of 20°C (68°F) (Barnhart 1986). They can survive short periods up to 27°C (81°F) with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby et al. 1996).

REFERENCES

Barnhart, R. A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) -- steelhead. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.60). U.S. Army Corps of Engineers, TR EL-82-4. 21 pp.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R.S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-NWFSC-27, 261 pp.

Meehan, W. R. and T. C. Bjornn, 1991. Salmonid distributions and life histories. In: W.R. Meehan, ed.; Influences of forest and rangeland management on salmonid fishes and their habitats. Amer. Fish. Soc. Special Publication 19.

Shapovalov, L. and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri*) and silver salmon (*Oncorhynchus kisutch*). Cal. Dep. Fish Game, Fish. Bull. No.98.

APPENDIX Q

APPENDIX Q

NRCE MEMORANDUM – FORECASTING OF LOW FLOWS OF THE BIG SUR RIVER, CALIFORNIA

NRCE

Technical Memorandum

Forecasting of Low Flows of the Big Sur River, California

Water Rights Applicant #30166

Submitted to:
Applicant
El Sur Ranch
Monterey County, California

Prepared by:
Natural Resources Consulting Engineers, Inc.
131 Lincoln Avenue, Suite 300
Fort Collins, Colorado
phone (970) 224-1851/fax (970) 224-1885

March 10, 2005

ESR--4

TABLE OF CONTENTS

ESR--4

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This memorandum presents methods for forecasting flows during the low flow month of September on the Big Sur River in California based on the high winter-spring flows and on flows from preceding years. The objective of this analysis is to find the best method for predicting several months in advance the occurrence of low September flows, those less than 10 cubic feet per second (cfs). The investigations, methods, and results presented in this report represent an extension of and improvement to the methods and results presented in an earlier draft technical memorandum (NRCE, 2004).

The report is organized as follows: the first section contains the introduction to the report, the second section delivers a summary of the findings presented in the report, and the third section presents the data that was used in the investigation. This is followed by a brief discussion of the analysis that was performed to develop the forecasting methods and a presentation of the resulting forecasting relationships. Detailed presentations of the development of the forecasting methodologies are included in Appendices A and B.

SUMMARY OF FINDINGS

Good correlation has been found between the low flows of September and flows of the preceding winter-spring months. Similarly, good correlation was also found between the low flows of September and the average flows for preceding years. Based on these findings, two low-flow forecasting methods have been developed and are presented in this report. All flow data mentioned in this report is from the U.S. Geological Survey (USGS) streamflow gage station 11143000 Big Sur River near Big Sur, California.

Single Variable Forecasting Method

The first method, which was also presented in an earlier memorandum (NRCE, 2004), is a single variable regression method that predicts average September flows using the average flows from the preceding winter-spring months. This method has been updated for this report by including all flow data through February 2005 in its derivation. This method may be used to predict any September flow from any set of winter-spring flows.

Based on this method, if the average flow for January-February is greater than or equal to 55 cfs, the probability that the average September flow will be less than or equal to 6 cfs is 5% or less. If the average flow for January-February is greater than or equal to 80 cfs, the probability that the average September flow will be less than or equal to 6 cfs is 1% or less.

Similarly, if the average flow for January-February is greater than or equal to 215 cfs, the probability that the average September flow will be less than or equal to 10 cfs is 5% or less. If the average flow for January-February is greater than or equal to 290 cfs, the probability that the average September flow will be less than or equal to 10 cfs is 1% or less.

Multiple Variable Forecasting Method

The second method was derived in order to provide a more accurate prediction of lower than normal flows in September. This method may be used to predict unusually low September flows based on the monthly flows of the preceding winter-spring months and based on the average flow of the six preceding water years.

If the first method results in a predicted average September flow of less than approximately 15 cfs, then the second method should be checked to try to develop a more accurate forecast. The ranges of the average monthly flows used in the multiple variable forecasting method are listed in Table 1. This second method provides a more accurate forecast for September flows less than 15 cfs.

Table 1: Ranges of Maximum and Minimum Average Monthly Flows used in the Development of the Multiple Variable Forecasting.

Independent Variable	Range Used in the Regression Analysis Minimum (cfs)	Maximum (cfs)
Q_{Jan}	8.27	191.2
Q_{Feb}	11.4	515.0
Q_{Mar}	16.8	308.3
Q_{Apr}	9.15	81.4
$Q_{6\text{-}years}$	51.9	185.0

In Table 1, Q_{Jan}, Q_{Feb}, Q_{Mar}, and Q_{Apr} are the flows averaged over the months of January, February, March, and April for the year in which the flow forecast is being developed. $Q_{6\text{-}years}$ is the average flow over the preceding six water years.

HYDROLOGIC DATA

Precipitation Data

The precipitation data is measured at the Pfeiffer Big Sur State Park station (National Weather Service (NWS) station number 040790; a.k.a. National Climatic Data Center (NCDC) station 790), which is located in the Big Sur Valley, about 2.5 miles from the ocean and near the Big Sur flow gage station. Table 2 shows the average annual precipitation over the available periods of record for Big Sur and several nearby locations. Very little precipitation occurs in the months from May to October; in fact, over 90% of the mean annual precipitation occurs in the months from November to April for all of these stations.

Table 2: Precipitation (inches) at Selected Locations near the Big Sur, California (Available Periods of Record).

Station ID	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
790 Big Sur	1.71	4.60	7.22	8.20	7.74	6.12	3.03	0.89	0.26	0.03	0.07	0.39	**39.15**
322 Arroyo Seco	0.66	2.29	4.68	4.47	5.40	3.32	1.55	0.46	0.14	0.02	0.05	0.09	**22.15**
1534 Carmel Valley	0.59	2.40	2.93	3.52	2.73	2.50	1.50	0.32	0.10	0.03	0.08	0.18	**15.72**
5795 Monterey	0.80	2.12	3.25	4.46	3.33	3.19	1.40	0.51	0.18	0.06	0.09	0.25	**19.45**
7731 San Clemente Dam	0.79	2.31	3.89	4.54	4.27	3.57	1.69	0.45	0.10	0.03	0.04	0.20	**21.98**

Missing data in the daily precipitation record for this station was filled using the ratio of the monthly means method based on daily data from the NCDC stations 1534 Carmel Valley, 7731 San Clemente Dam, 5795 Monterey, and 322 Arroyo Seco. These stations were selected from among all of the precipitation records in the nearby region based on their high monthly correlations with the 790 Big Sur record. The average, median, and 80% and 90% reliable monthly distributions of the filled precipitation record for NCDC station 790 Big Sur are shown in Figure 1. The filled annual precipitation record for this station is shown in Figure 2. The long-term average annual precipitation at NCDC station 790 Big Sur is 41.3 inches, based on the filled record. The precipitation records were obtained from EarthInfo's NCDC Summary of the Day database (2004) and from the California Irrigation Management Information Systems (CIMIS) network.

Figure 1: Average, Median, and 80% and 90% Reliable Distributions of Monthly Precipitation at NWS Station 040790 Big Sur, California (Filled Record).

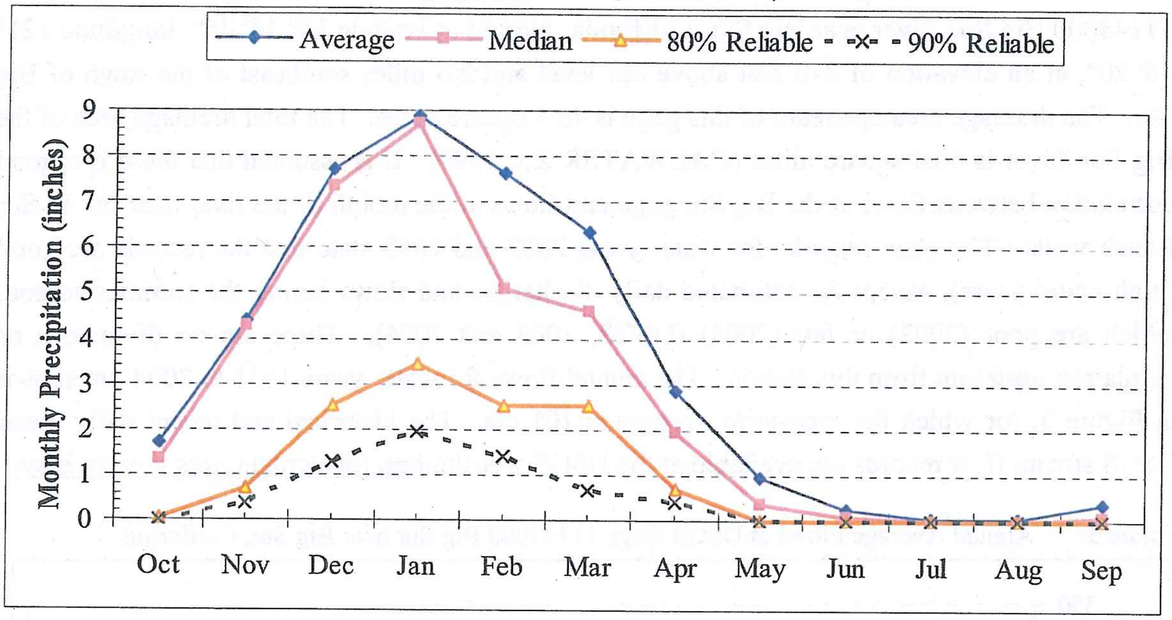
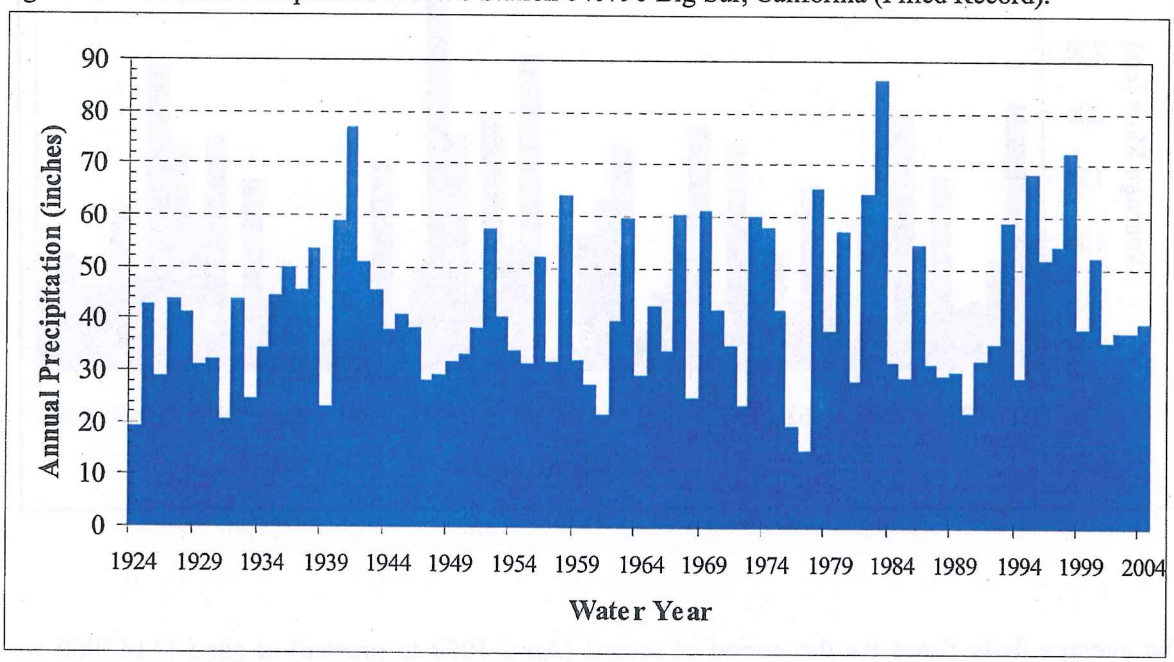


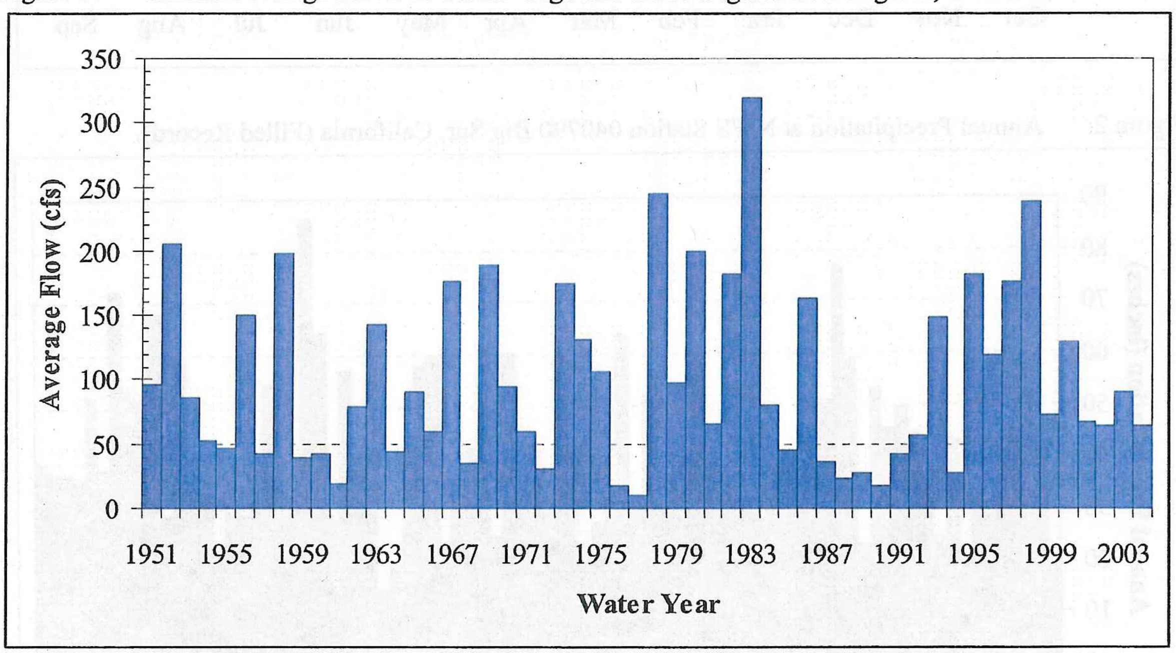
Figure 2: Annual Precipitation at NWS Station 040790 Big Sur, California (Filled Record).



Streamflow Data

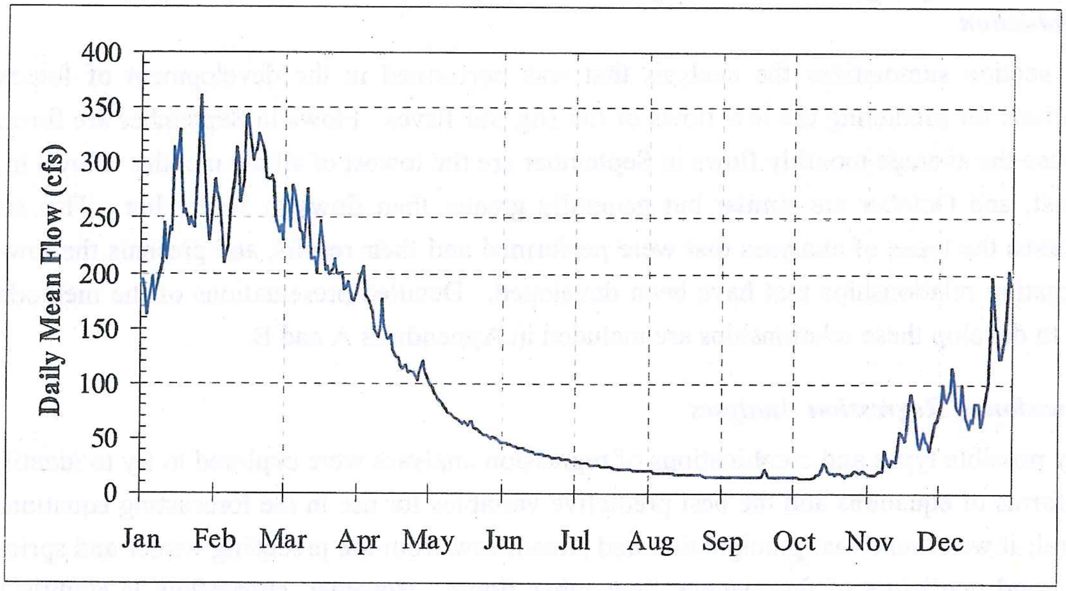
There is one U.S. Geological Survey (USGS) flow gaging station on the Big Sur River: station 11143000 Big Sur River near Big Sur, California, located at latitude 36° 14' 45", longitude 121° 46' 20", at an elevation of 240 feet above sea level and 2.6 miles southeast of the town of Big Sur. The drainage area upstream of this gage is 46.5 square miles. The total drainage area of the Big Sur River is 58.4 square miles (CALWATER 2.2, 1999). It is assumed that there is a good correlation between flows at the Big Sur gage and flows at the mouth of the river near the El Sur Ranch wells. The gage remarks for water years 2002 and 2003 state that the records are good (both water years), except for estimated daily discharges and flows during the summer season, which are poor (2002) or fair (2003) (USGS, 2003 and 2004). There are no diversions or regulation upstream from this station. The annual flows for water years 1951 to 2004 are shown in Figure 3, for which the long-term average is 101 cfs. The historical and recent daily mean USGS stream flow records are available at the USGS website http://waterdata.usgs.gov/nwis/sw.

Figure 3: Annual Average Flows at USGS Gage 11143000 Big Sur near Big Sur, California.



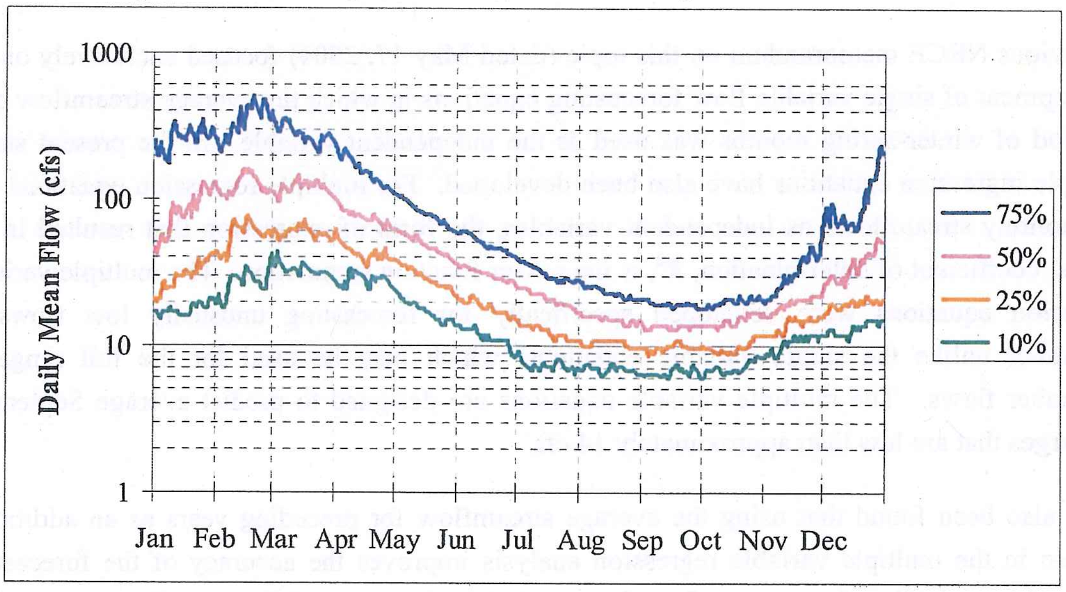
The average daily flows for the period of record (April 1950 to present) at gage 11143000 are shown in Figure 4.

Figure 4: Average Daily Flows at USGS Gage 11143000 Big Sur River near Big Sur, California.



Daily mean discharges of specified non-exceedance frequencies are shown in Figure 5. This figure shows that the median (i.e., 50% non-exceedance frequency) minimum daily flow of 14 cfs occurs in the month of September and the beginning of October. The 10% non-exceedance frequency daily flows bottom out at approximately 6 to 7 cfs during late summer to early fall.

Figure 5: Daily Mean Flows of Specified Non-exceedance Frequencies.



ESR--4

FLOW FORECASTING

Introduction

This section summarizes the analysis that was performed in the development of forecasting equations for predicting the low flows of the Big Sur River. Flows in September are forecasted because the average monthly flows in September are the lowest of all the months. Flows in July, August, and October are similar but generally greater than flows in September. This section discusses the types of analyses that were performed and their results, and presents the low-flow forecasting relationships that have been developed. Detailed presentations of the methodology used to develop these relationships are included in Appendices A and B.

Discussion of Regression Analyses

Many possible types and combinations of regression analyses were explored to try to identify the best forms of equations and the best predictive variables for use in the forecasting equations. In general, it was found that precipitation and streamflow from the preceding winter and spring are both good predictors of the average September flows. However, streamflow is slightly more accurate than precipitation and is easier to obtain, (available online at the USGS website). In addition, these variables are largely redundant due to the high correlation between them. Therefore, streamflow data was selected for use in developing the flow forecasting relationships presented in this study. Correlations of streamflow with air temperature and potential evapotranspiration (ET) data were also investigated, but were not found to significantly improve forecast accuracy.

A previous NRCE memorandum on this topic (dated May 17, 2004) focused exclusively on the development of single variable flow forecasting equations in which the average streamflow over a period of winter-spring months was used as the independent variable. In the present study, multiple regression equations have also been developed. For multiple regression equations that use monthly streamflows as independent variables, the form of expression that resulted in the highest coefficient of determination, R^2, is the power function summation. The multiple variable regression equations were developed specifically for forecasting unusually low flows in September unlike the single variable equations, which may be used for the full range of September flows. The multiple variable equations are designed to predict average September discharges that are less than approximately 14 cfs.

It has also been found that using the average streamflow for preceding years as an additional variable in the multiple variable regression analysis improves the accuracy of the forecasting relationships. Adding the average flow for a period in the range of the preceding two to eight water years was found to improve accuracy; the greatest improvement was found for an averaging period of six years.

Based on the above findings, for the January to March period (for example), the multiple regression equation is of the form:

$$\hat{Q}_{Sept} = A \cdot Q_{Jan}{}^{B} + C \cdot Q_{Feb}{}^{D} + E \cdot Q_{Mar}{}^{F} + IQ_{6-years} + J\,, \qquad (1)$$

where $\hat{Q}_{Sept}$ is the predicted average flow in September in cfs, A, B, C, D, E, F, I, and J are coefficients, and Q_{Jan}, Q_{Feb}, Q_{Mar}, and $Q_{6\text{-}years}$ are respectively the average flows for January, February, March, and the preceding six water years, all in cfs. The multiple variable equations such as (1) are more accurate and yield higher R^2 values than single variable equations that require the same input data. However, the single variable equations are simple enough that look-up tables of their results may be developed and referenced, rather than always necessitating calculations to determine their results.

Summary of Forecasting Relationships

Two sets of flow forecasting relationships have been developed, one based on single variable regression equations and the other based on multiple variable regression equations. The single variable forecasting equations are of the form:

$$\hat{Q}_{Sept} = A \cdot Q_{Jan-XXX}{}^{B}\,, \qquad (2)$$

where $\hat{Q}_{Sept}$ is the predicted average flow in September in cfs, A and B are coefficients, and $Q_{Jan-XXX}$ is the average observed flow over the period used in the prediction, i.e., January-February, January-March, etc. The flow forecasting equations predict the most likely average flow to occur in September based on the observed flows in the winter-spring months earlier in the year. For any given predicted September flow, there is a non-zero probability of a lower flow actually occurring in September. This probability has been characterized by a three-parameter gamma distribution, and the results are presented in figures and tables in this section.

The parameters of the single variable flow forecasting equations and of their associated gamma distributions are presented in Table 3.

ESR--4

Table 3: Summary of the Single Variable Flow Forecasting Equations.

Flow Period	Forecasting Equations			Gamma Distribution Parameters					
	A	B	R^2	μ	σ	γ	x_o	α	β
Jan-Feb	0.37285	2.0153	0.620	5.404E-16	0.27041	0.49184	-1.0996	0.06650	16.53536
Jan-Mar	0.41336	1.6316	0.672	8.211E-16	0.26355	0.48075	-1.0964	0.06335	17.30711
Jan-Apr	0.43078	1.5580	0.728	1.843E-16	0.24446	0.59837	-0.8171	0.07314	11.17165

It can be seen from this table that the R^2 values increase from 0.620 to 0.728 as the flow period increases to include the months of March and April, in addition to January and February. The parameters of the multiple variable flow forecasting equations and of their associated gamma distributions are presented in Table 4.

Table 4: Summary of the Multiple Variable Flow Forecasting Equations.

Required Flow Period	Forecasting Equations									
	Q_{Jan}		Q_{Feb}		Q_{Mar}		Q_{Apr}		$Q_{6\text{-}years}$	
	A	B	C	D	E	F	G	H	I	J
Jan-Feb	0.02225	1.0126	1.80E-03	1.2457	---	---	---	---	0.04104	2.609
Jan-Mar	0.10199	0.7360	3.33E-04	1.4637	4.37E+00	0.0912	---	---	0.03896	-3.875
Jan-Apr	0.09688	0.7305	2.64E-04	1.5000	0	0	1.8534	0.2382	0.03754	-1.589

Flow Period	Gamma Distribution Parameters						Forecast R^2
	μ	σ	γ	x_o	α	β	
Jan-Feb	0.00887	0.13492	1.25851	-0.20554	0.08490	2.5255	0.845
Jan-Mar	0.00796	0.11977	1.37768	-0.16591	0.08250	2.1075	0.866
Jan-Apr	0.00771	0.11731	1.54784	-0.14387	0.09079	1.6696	0.874

It can be seen from the top panel of Table 4 that the R^2 values are higher for the multiple variable forecasting equations than for the single variable equations shown in Table 3, indicating that these equations are more accurate predictors of the average September flows. It can also be seen that coefficients E and F for the equation using the Jan-Apr flows are both zero, which means that this equation does not require the Q_{Mar} flow at all.

Because the multiple variable regression equations were developed specifically for forecasting average September discharges that are less than approximately 14 cfs, they should not be used for flows that are outside the range within which they were developed. The ranges of flows used in the development of the multiple variable regression analysis are listed in Table 5, along with summary statistics for each independent variable.

Table 5: Ranges of Independent Variables Used in the Multiple Variable Regression Analysis along with Comparative Statistical Data.

Independent Variable	Range Used in the Regression Analysis		Statistical Summary of the Full Data Set	
	Minimum (cfs)	Maximum (cfs)	Median (cfs)	Average (cfs)
Q_{Jan}	8.27	191.2	130.7	246.2
Q_{Feb}	11.4	515.0	186.4	284.3
Q_{Mar}	16.8	308.3	147.6	220.5
Q_{Apr}	9.15	81.4	80.3	140.0
$Q_{6\text{-}years}$	51.9	185.0	98.8	101.1

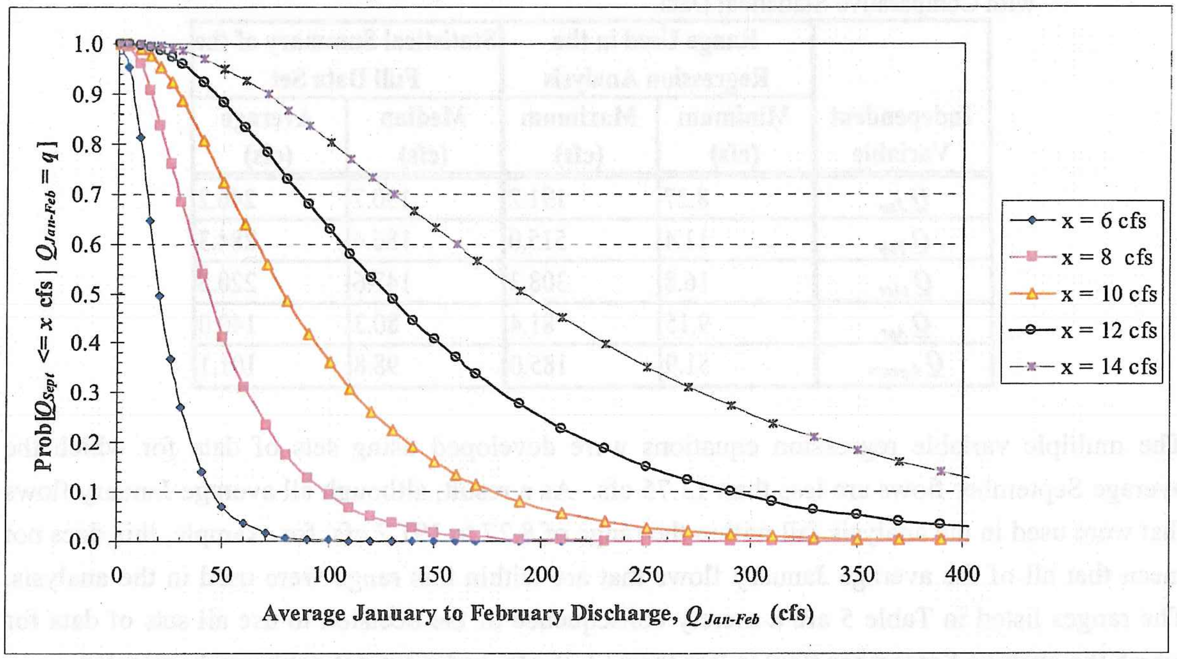
The multiple variable regression equations were developed using sets of data for which the average September flows are less than 13.75 cfs. As a result, although all average January flows that were used in the analysis fall within the range of 8.27 to 191.2 cfs, for example, this does not mean that all of the average January flows that are within this range were used in the analysis. The ranges listed in Table 5 are a merely consequence of the decision to use all sets of data for which the average September flow is less than 13.75 cfs, and were not deliberately selected.

Single Variable Equation Flow Forecasting

The results of the single variable flow forecasting equations have been determined and are presented in figures and tables in this section. Given an observed flow in the winter-spring months, these figures and tables may be used directly to develop the flow forecast for September.

Figure 6 through 8 show the probability that Q_{Sept} (cfs), the average September discharge, will be less than or equal to a specified discharge, x (cfs), given an observed average discharge in the winter to spring months of the year (i.e. January-February, January-March, and January-April). The data shown in these figures is also presented in Tables 6 through 8. Given an observed average discharge over one of these three flow periods, these figures and tables may be used to determine the probability that the actual average September discharge will be less than a threshold discharge, x, in cfs.

Figure 6: Probability that Q_{Sept}, the Average September Discharge (cfs), will be Less Than or Equal to a Specified Discharge, x, given an Observed Average January to February Discharge.



It can be seen from Figure 6 that for an observed average January to February discharge of approximately 200 cfs or more, the probability that the average September discharge will be less than 10 cfs is small, about 8% or less. Based on the available provisional USGS flows to date (through February 28, 2005) the average flow for January-February is 474.4 cfs. Based on this value for $Q_{Jan-Mar}$ and on the coefficients listed in Table 3 for use with Equation (2) the predicted average September flow for this year is 20.3 cfs. The probability that the actual Q_{Sept} for this year will be less than 10 cfs is much less that 1%.

ESR--4

Figure 7: Probability that Q_{Sept}, the Average September Discharge (cfs), will be Less Than or Equal to a Specified Discharge, x, given an Observed Average January to March Discharge.

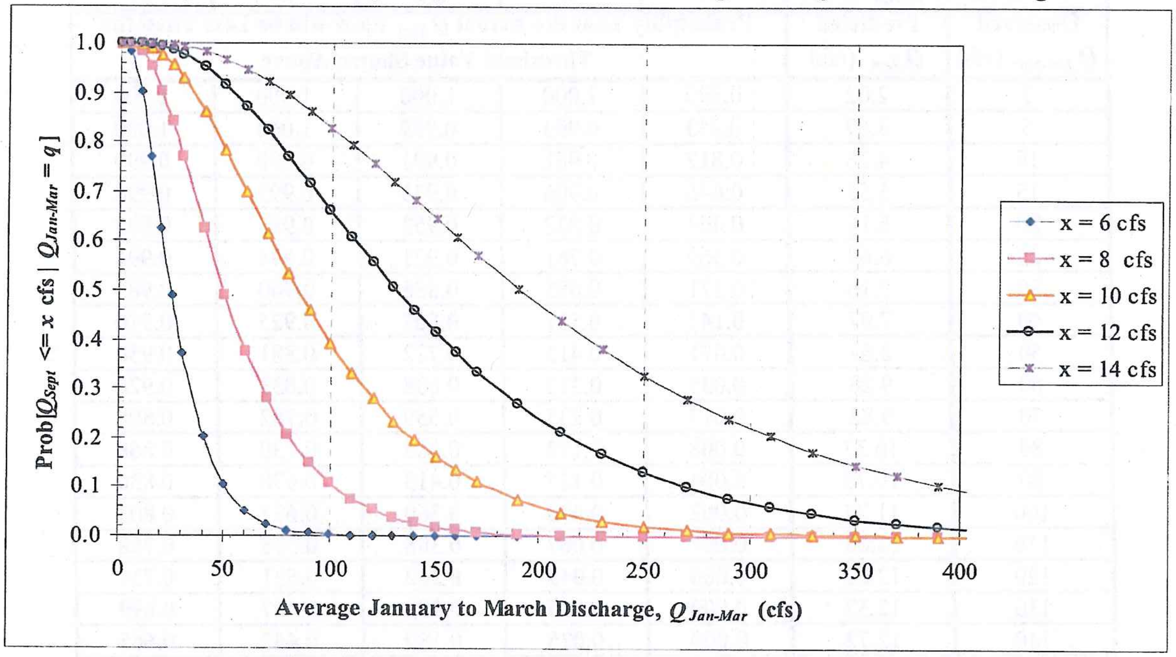


Figure 8: Probability that Q_{Sept}, the Average September Discharge (cfs), will be Less Than or Equal to a Specified Discharge, x, given an Observed Average January to April Discharge.

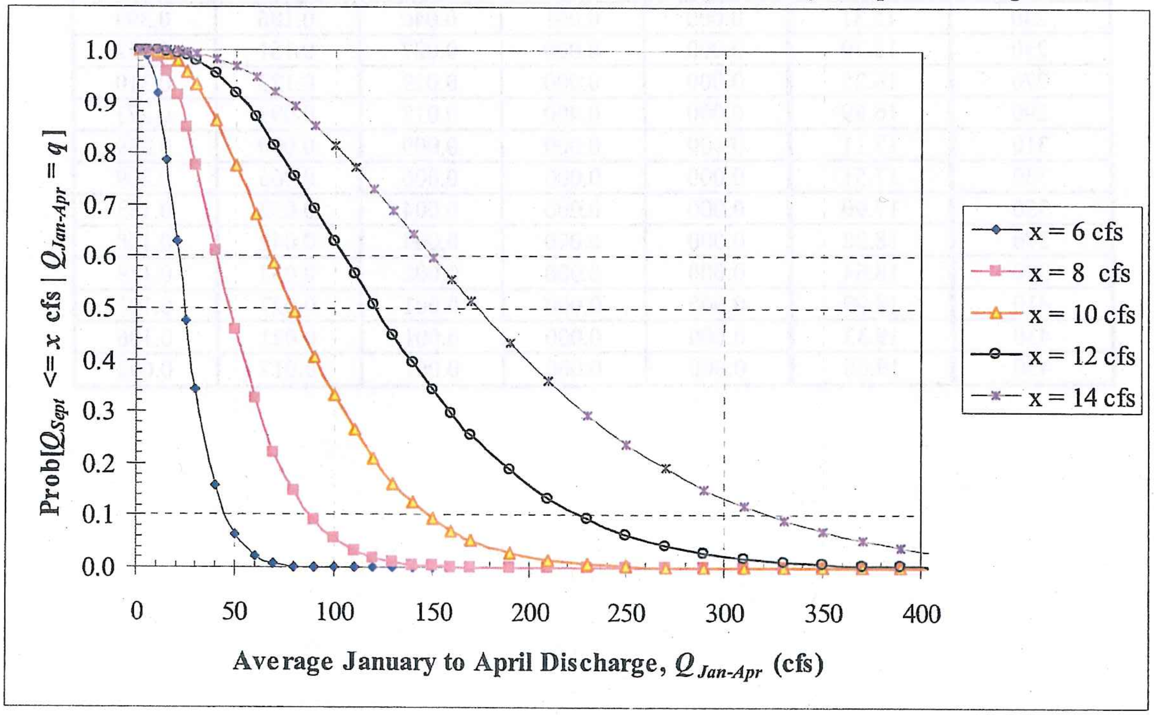


Table 6: Predicted Big Sur River September Average Flow and Probability of Low September Flows based on January to February Big Sur River Average Flows.

Threshold Q_{Sept} (cfs) =		6	8	10	12	14
Observed $Q_{Jan\text{-}Mar}$ (cfs)	**Predicted Q_{Sept} (cfs)**	**Probability That the Actual Q_{Sept} Flow will be Less Than the Threshold Value Shown Above**				
1	2.02	0.999	1.000	1.000	1.000	1.000
5	3.67	0.953	0.993	0.999	1.000	1.000
10	4.76	0.812	0.961	0.991	0.998	0.999
15	5.53	0.646	0.906	0.975	0.993	0.998
20	6.16	0.494	0.837	0.952	0.985	0.995
25	6.69	0.369	0.761	0.921	0.974	0.991
30	7.16	0.271	0.683	0.886	0.960	0.985
40	7.97	0.141	0.537	0.807	0.925	0.970
50	8.67	0.071	0.413	0.722	0.881	0.950
60	9.28	0.035	0.312	0.638	0.833	0.926
70	9.82	0.017	0.233	0.559	0.782	0.898
80	10.33	0.008	0.172	0.485	0.730	0.868
90	10.79	0.004	0.127	0.419	0.678	0.836
100	11.22	0.002	0.093	0.360	0.627	0.802
110	11.63	0.001	0.067	0.308	0.578	0.768
120	12.01	0.000	0.049	0.262	0.531	0.734
130	12.37	0.000	0.035	0.223	0.487	0.699
140	12.72	0.000	0.025	0.189	0.445	0.665
150	13.05	0.000	0.018	0.160	0.406	0.631
160	13.37	0.000	0.013	0.135	0.370	0.599
170	13.68	0.000	0.009	0.114	0.337	0.567
190	14.26	0.000	0.005	0.080	0.277	0.506
210	14.80	0.000	0.002	0.057	0.228	0.450
230	15.31	0.000	0.001	0.040	0.186	0.399
250	15.79	0.000	0.000	0.027	0.151	0.352
270	16.25	0.000	0.000	0.019	0.123	0.310
290	16.69	0.000	0.000	0.013	0.099	0.273
310	17.11	0.000	0.000	0.009	0.080	0.239
330	17.51	0.000	0.000	0.006	0.065	0.209
350	17.90	0.000	0.000	0.004	0.052	0.183
370	18.28	0.000	0.000	0.003	0.042	0.160
390	18.64	0.000	0.000	0.002	0.033	0.139
410	18.99	0.000	0.000	0.001	0.027	0.121
430	19.33	0.000	0.000	0.001	0.021	0.106
450	19.66	0.000	0.000	0.001	0.017	0.092

Table 7: Predicted Big Sur River September Average Flow and Probability of Low September Flows based on January through March Big Sur River Average Flows.

Threshold Q_{Sept} (cfs) =		6	8	10	12	14
Observed $Q_{Jan\text{-}Mar}$ (cfs)	**Predicted** Q_{Sept} (cfs)	**Probability That the Actual Q_{Sept} Flow will be Less Than the Threshold Value Shown Above**				
10	4.23	1.000	1.000	1.000	1.000	1.000
15	5.00	0.984	0.998	1.000	1.000	1.000
20	5.63	0.901	0.984	0.997	0.999	1.000
25	6.17	0.770	0.951	0.989	0.997	0.999
30	6.66	0.625	0.902	0.975	0.993	0.998
40	7.50	0.489	0.840	0.955	0.987	0.996
50	8.22	0.372	0.771	0.928	0.978	0.993
60	8.86	0.204	0.626	0.862	0.951	0.982
70	9.45	0.105	0.491	0.783	0.915	0.967
80	9.98	0.052	0.374	0.699	0.872	0.947
90	10.48	0.025	0.279	0.615	0.823	0.922
100	10.95	0.012	0.205	0.534	0.771	0.894
110	11.39	0.005	0.149	0.460	0.717	0.863
120	11.81	0.002	0.106	0.392	0.662	0.829
130	12.20	0.001	0.075	0.332	0.609	0.793
140	12.58	0.000	0.053	0.280	0.556	0.757
150	12.95	0.000	0.037	0.234	0.507	0.719
160	13.30	0.000	0.025	0.195	0.459	0.682
170	13.63	0.000	0.017	0.162	0.415	0.644
190	14.27	0.000	0.012	0.134	0.374	0.607
210	14.88	0.000	0.008	0.110	0.336	0.571
230	15.45	0.000	0.004	0.074	0.269	0.502
250	15.99	0.000	0.002	0.049	0.213	0.439
270	16.51	0.000	0.001	0.032	0.168	0.380
290	17.00	0.000	0.000	0.021	0.131	0.328
310	17.48	0.000	0.000	0.013	0.102	0.282
330	17.93	0.000	0.000	0.008	0.079	0.241
350	18.38	0.000	0.000	0.005	0.061	0.205
370	18.80	0.000	0.000	0.003	0.046	0.174
390	19.22	0.000	0.000	0.002	0.035	0.147
410	19.62	0.000	0.000	0.001	0.027	0.124
430	20.01	0.000	0.000	0.001	0.020	0.104
450	20.39	0.000	0.000	0.000	0.015	0.087
470	20.76	0.000	0.000	0.000	0.011	0.073
490	21.12	0.000	0.000	0.000	0.008	0.061

Table 8: Predicted Big Sur River September Average Flow and Probability of Low September Flows based on January through April Big Sur River Average Flows.

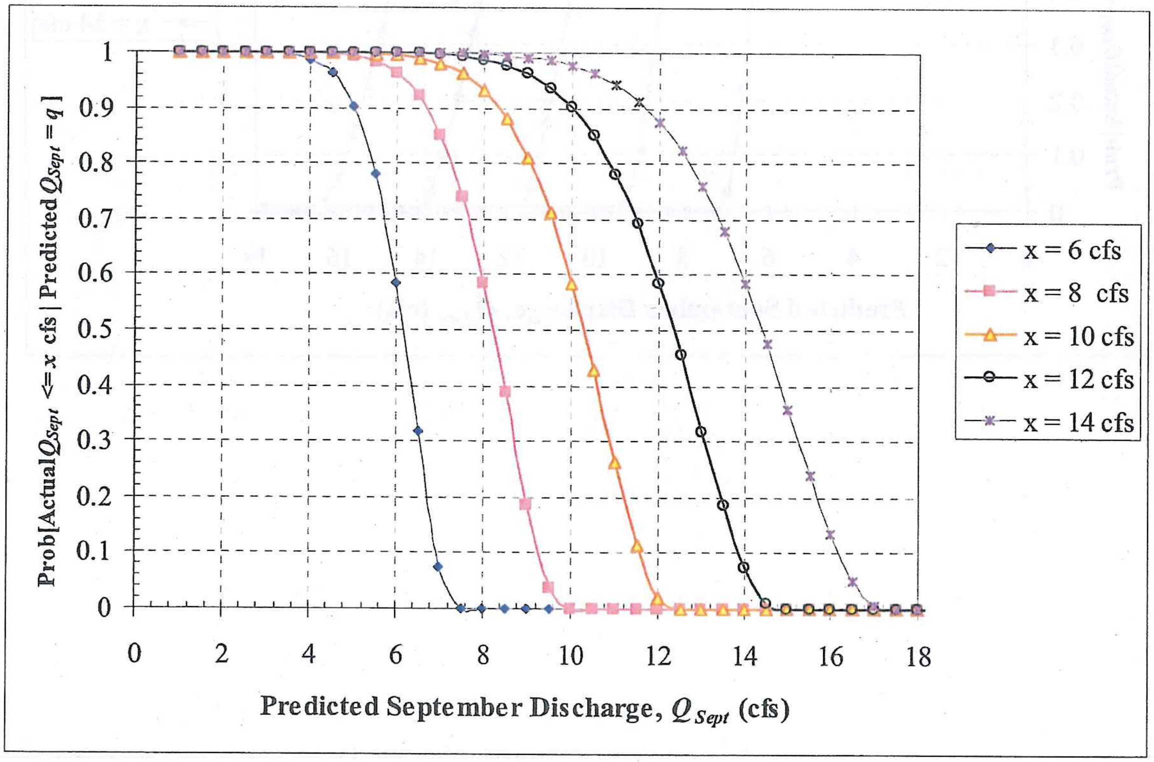
Threshold Q_{Sept} (cfs) =		6	8	10	12	14
Observed $Q_{Jan\text{-}Apr}$ (cfs)	Predicted Q_{Sept} (cfs)	Probability That the Actual Q_{Sept} Flow will be Less Than the Threshold Value Shown Above				
10	4.20	1.000	1.000	1.000	1.000	1.000
15	5.00	0.989	0.999	1.000	1.000	1.000
20	5.66	0.917	0.988	0.998	1.000	1.000
25	6.23	0.786	0.959	0.991	0.998	0.999
30	6.74	0.630	0.911	0.979	0.994	0.998
40	7.63	0.477	0.848	0.960	0.989	0.996
50	8.40	0.344	0.775	0.934	0.980	0.993
60	9.09	0.159	0.613	0.864	0.954	0.984
70	9.71	0.063	0.458	0.778	0.917	0.969
80	10.29	0.022	0.326	0.683	0.870	0.948
90	10.82	0.006	0.222	0.586	0.815	0.921
100	11.33	0.002	0.145	0.493	0.756	0.890
110	11.80	0.000	0.092	0.407	0.693	0.855
120	12.25	0.000	0.056	0.331	0.629	0.816
130	12.68	0.000	0.033	0.265	0.566	0.774
140	13.09	0.000	0.018	0.209	0.506	0.731
150	13.49	0.000	0.010	0.163	0.448	0.687
160	13.87	0.000	0.005	0.125	0.394	0.643
170	14.24	0.000	0.002	0.094	0.344	0.598
190	14.93	0.000	0.001	0.071	0.298	0.555
210	15.59	0.000	0.001	0.052	0.257	0.512
230	16.22	0.000	0.000	0.027	0.187	0.432
250	16.81	0.000	0.000	0.013	0.133	0.359
270	17.38	0.000	0.000	0.006	0.093	0.295
290	17.92	0.000	0.000	0.003	0.063	0.239
310	18.44	0.000	0.000	0.001	0.042	0.191
330	18.94	0.000	0.000	0.000	0.027	0.151
350	19.43	0.000	0.000	0.000	0.017	0.118
370	19.90	0.000	0.000	0.000	0.011	0.092
390	20.36	0.000	0.000	0.000	0.006	0.070
410	20.80	0.000	0.000	0.000	0.004	0.053
430	21.23	0.000	0.000	0.000	0.002	0.040
450	21.65	0.000	0.000	0.000	0.001	0.029
470	22.06	0.000	0.000	0.000	0.001	0.021
490	22.46	0.000	0.000	0.000	0.000	0.015

Multiple Variable Equation Flow Forecasting

The results of the multiple variable flow forecasting equations have been determined and are presented in figures and tables in this section. Given a set of observed monthly average flows in the winter-spring months, the forecasting equation (Equation 1) is used in conjunction with the coefficients listed in the top panel of Table 4 to calculate the predicted average September discharge, $\hat{Q}_{Sept}$, in cfs. The tables and figures below may then used with the predicted $\hat{Q}_{Sept}$ value to determine the probability that the actual Q_{Sept} value will be less than a threshold discharge, x, also in cfs. The user should check to see if the values of all of the independent variables fall approximately within the min-max ranges listed in Table 5. If they do not, then the single variable forecasting equation should be used instead.

Figure 9 through 11 show the probability that Q_{Sept} (cfs), the average September discharge, will be less than or equal to a specified discharge, x (cfs), given a predicted average September discharge, $\hat{Q}_{Sept}$ (cfs), that is predicted from the observed average monthly discharges for the winter-spring months. The data shown in these figures is also presented in Tables 9 through 11.

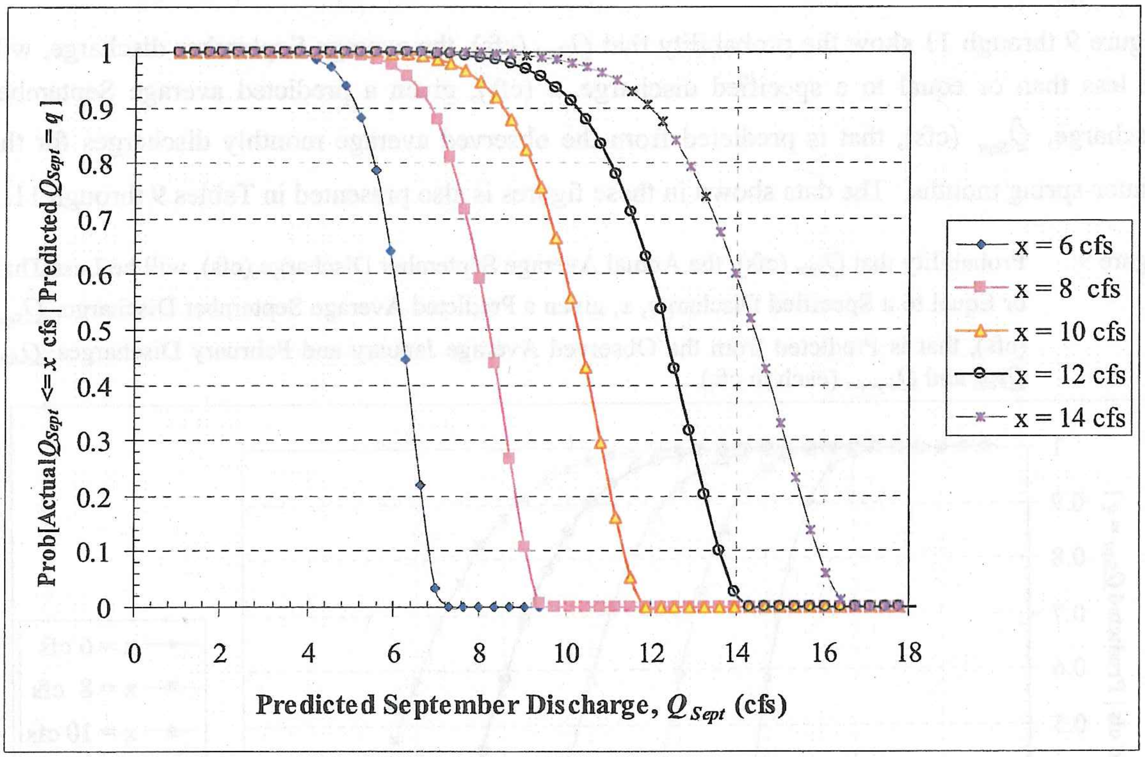
Figure 9: Probability that Q_{Sept} (cfs), the Actual Average September Discharge (cfs), will be Less Than or Equal to a Specified Discharge, x, given a Predicted Average September Discharge, $\hat{Q}_{Sept}$ (cfs), that is Predicted from the Observed Average January and February Discharges, Q_{Jan}, Q_{Feb}, and $Q_{6\text{-}years}$ (each in cfs).



ESR--4

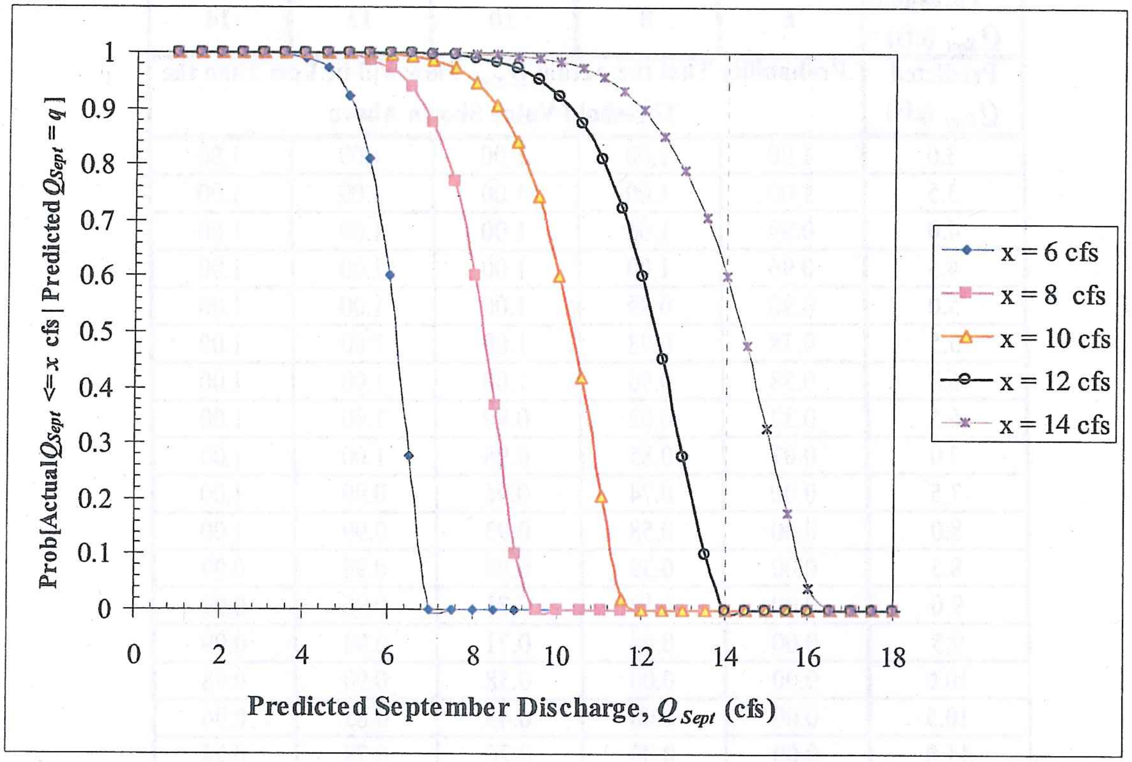
For the current year $Q_{Jan} = 560.6$ cfs, $Q_{Feb} = 378.8$ cfs (based on provisional data), and $Q_{6-years} = 81.53$ cfs. It can be seen that $Q_{Jan} = 560.6$ cfs exceeds the maximum average January flow of 191.2 cfs given in Table 5. Therefore, the single variable forecasting equation should be used for this year instead of the multiple variable equation. The results for this year using the single variable equation are presented at the end of the preceding section, which showed that the predicted average September flow for this year (2005) is 20.3 cfs.

Figure 10: Probability that Q_{Sept} (cfs), the Actual Average September Discharge (cfs), will be Less Than or Equal to a Specified Discharge, *x*, given a Predicted Average September Discharge, $\hat{Q}_{Sept}$ (cfs), that is Predicted from the Observed Average January through March Discharges, Q_{Jan}, Q_{Feb}, Q_{Mar}, and $Q_{6\text{-}years}$ (each in cfs).



ESR--4

Figure 11: Probability that Q_{Sept} (cfs), the Actual Average September Discharge (cfs), will be Less Than or Equal to a Specified Discharge, x, given a Predicted Average September Discharge, $\hat{Q}_{Sept}$ (cfs), that is Predicted from the Observed Average January through April Discharges, Q_{Jan}, Q_{Feb}, Q_{Mar}, Q_{Apr}, and $Q_{6\text{-}years}$ (each in cfs).



ESR--4

Table 9: Probability that the Actual Average September Discharge will be Less than or Equal to a Threshold Discharge, Given a Predicted Average September Discharge $\hat{Q}_{Sept}$ (cfs) that is Predicted Based on the January and February Average Discharges, Q_{Jan} and Q_{Feb} (cfs), and on the Average for the Preceding Six Water Years, $Q_{6\text{-}years}$ (cfs).

Threshold Q_{Sept} (cfs) =	**6**	**8**	**10**	**12**	**14**
Predicted Q_{Sept} (cfs)	**Probability That the Actual Q_{Sept} Flow will be Less Than the Threshold Value Shown Above**				
3.0	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00
4.0	0.99	1.00	1.00	1.00	1.00
4.5	0.96	1.00	1.00	1.00	1.00
5.0	0.90	0.99	1.00	1.00	1.00
5.5	0.78	0.98	1.00	1.00	1.00
6.0	0.58	0.96	1.00	1.00	1.00
6.5	0.32	0.92	0.99	1.00	1.00
7.0	0.07	0.85	0.98	1.00	1.00
7.5	0.00	0.74	0.96	0.99	1.00
8.0	0.00	0.58	0.93	0.99	1.00
8.5	0.00	0.39	0.88	0.98	0.99
9.0	0.00	0.19	0.81	0.96	0.99
9.5	0.00	0.04	0.71	0.94	0.99
10.0	0.00	0.00	0.58	0.90	0.98
10.5	0.00	0.00	0.43	0.85	0.96
11.0	0.00	0.00	0.26	0.78	0.94
11.5	0.00	0.00	0.11	0.69	0.91
12.0	0.00	0.00	0.02	0.58	0.87
12.5	0.00	0.00	0.00	0.46	0.82
13.0	0.00	0.00	0.00	0.32	0.76
13.5	0.00	0.00	0.00	0.19	0.68
14.0	0.00	0.00	0.00	0.07	0.58

Table 10: Probability that the Actual Average September Discharge will be Less than or Equal to a Threshold Discharge, Given a Predicted Average September Discharge $\hat{Q}_{Sept}$ (cfs) that is Predicted based on the January through March Average Discharges, Q_{Jan}, Q_{Feb}, and Q_{Mar} (cfs) , and on the Average for the Preceding Six Water Years, $Q_{6\text{-}years}$ (cfs).

Threshold Q_{Sept} (cfs) =	**6**	**8**	**10**	**12**	**14**
Predicted Q_{Sept} (cfs)	**Probability That the Actual Q_{Sept} Flow will be Less Than the Threshold Value Shown Above**				
3.0	1.00	1.00	1.00	1.00	1.00
3.5	0.98	1.00	1.00	1.00	1.00
4.0	0.95	1.00	1.00	1.00	1.00
4.5	0.88	0.99	1.00	1.00	1.00
5.0	0.77	0.97	1.00	1.00	1.00
5.5	0.64	0.93	0.99	1.00	1.00
6.0	0.51	0.88	0.98	1.00	1.00
6.5	0.38	0.80	0.96	0.99	1.00
7.0	0.27	0.71	0.92	0.98	1.00
7.5	0.18	0.61	0.88	0.97	0.99
8.0	0.12	0.51	0.82	0.95	0.99
8.5	0.08	0.41	0.75	0.92	0.98
9.0	0.05	0.32	0.67	0.88	0.96
9.5	0.03	0.25	0.59	0.83	0.94
10.0	0.02	0.18	0.51	0.77	0.91
10.5	0.01	0.14	0.43	0.71	0.88
11.0	0.01	0.10	0.36	0.64	0.84
11.5	0.00	0.07	0.29	0.57	0.79
12.0	0.00	0.05	0.23	0.51	0.74
12.5	0.00	0.03	0.18	0.44	0.68
13.0	0.00	0.02	0.14	0.38	0.62
13.5	0.00	0.01	0.11	0.32	0.57
14.0	0.00	0.01	0.08	0.27	0.51

ESR--4

Table 11: Probability that the Actual Average September Discharge will be Less than or Equal to a Threshold Discharge, Given a Predicted Average September Discharge $\hat{Q}_{Sept}$ (cfs) that is Predicted based on the January through April Average Discharges, Q_{Jan}, Q_{Feb}, Q_{Mar}, and Q_{Apr} (cfs), and on the Average for the Preceding Six Water Years, $Q_{6\text{-}years}$ (cfs).

Threshold Q_{Sept} (cfs) =	**6**	**8**	**10**	**12**	**14**
Predicted Q_{Sept} (cfs)	**Probability That the Actual Q_{Sept} Flow will be Less Than the Threshold Value Shown Above**				
3.0	0.99	1.00	1.00	1.00	1.00
3.5	0.98	1.00	1.00	1.00	1.00
4.0	0.94	0.99	1.00	1.00	1.00
4.5	0.89	0.98	1.00	1.00	1.00
5.0	0.80	0.96	0.99	1.00	1.00
5.5	0.69	0.93	0.98	1.00	1.00
6.0	0.55	0.89	0.97	0.99	1.00
6.5	0.41	0.83	0.95	0.99	1.00
7.0	0.27	0.75	0.93	0.98	0.99
7.5	0.16	0.66	0.89	0.96	0.99
8.0	0.08	0.55	0.84	0.94	0.98
8.5	0.03	0.45	0.78	0.92	0.97
9.0	0.01	0.34	0.72	0.89	0.96
9.5	0.00	0.24	0.64	0.85	0.94
10.0	0.00	0.16	0.55	0.80	0.92
10.5	0.00	0.09	0.47	0.75	0.89
11.0	0.00	0.05	0.38	0.69	0.86
11.5	0.00	0.02	0.30	0.62	0.82
12.0	0.00	0.01	0.22	0.55	0.77
12.5	0.00	0.00	0.16	0.48	0.73
13.0	0.00	0.00	0.10	0.41	0.67
13.5	0.00	0.00	0.06	0.34	0.61
14.0	0.00	0.00	0.04	0.27	0.55

ESR--4

REFERENCES

Bobee, B. (1975) "The Log Pearson Type 3 Distribution and its Application in Hydrology." *Water Resources Research*, V. 11 (5). pp. 681-689.

California Watersheds (CALWATER 2.2). (1999). California Department of Forestry and Fire Protection, Edition: 2.2. Online. Avaiable http://gis.ca.gov/meta.epl?oid=5298.

California Irrigation Management Information System (CIMIS). (2005). Online. Available http://wwwcimis.water.ca.gov/cimis/welcome.jsp.

EarthInfo. (2004). *National Climatic Data Center Summary of the Day.* CD-ROM Database.

Natural Resources Consulting Engineers, Inc. (NRCE). (2004). *Forecasting of Low Flows of the Big Sur River, California, Draft Technical Memorandum.* Prepared for Ms. Janet Goldsmith, Esq. and the El Sur Technical Team.

Salas, J.D., Smith, R.A., Tabios III, G.Q., and Heo, J.H. (1995). *Statistical Computer Techniques in Water Resources and Environmental Engineering.* Colorado State University, Fort Collins, Colorado.

United States Geological Survey (USGS) (2004). *Water Resources Data, California, Water Year 2003, Volume 2, Pacific Slope Basins from Arroyo Grande to Oregon State Line except Central Valley.* Water-Data Report CA-03-2, by Smithson, J.R., Webster, M.D., Pope, G.L., Friebel, M.F., and Freeman, L.A. Sacramento, California. Online. Available http://water.usgs.gov/pubs/wdr/.

United States Geological Survey (USGS). (2003). *Water Resources Data, California, Water Year 2002, Volume 2, Pacific Slope Basins from Arroyo Grande to Oregon State Line except Central Valley.* Water-Data Report CA-02-2, by Freeman, L.A., Smithson, J.R., Webster, M.D., Pope, G.L., and Friebel, M.F. Sacramento, California.

APPENDIX A: DEVELOPMENT OF SINGLE VARIABLE FORECASTING EQUATIONS

Introduction

This appendix summarizes the analysis that was performed in the development of single flow variable forecasting equations for predicting the low flows of the Big Sur River. Flows in September are forecasted because the average monthly flows in September are the lowest of all the months. Flows in July, August, and October are similar but generally greater than flows in September. Although single variable equations were developed based on three flow periods (i.e., Jan-Feb, Jan-Mar, and Jan-Apr), this appendix presents the data used for the Jan-Mar period only. The methodology for the other two periods is the same as is presented here. The period of record available for this analysis includes all available flow data from April 1950 to January 2005. Daily flow data after September 30, 2003 (the end of water year 2003) are provisional and are subject to change by the USGS prior to official publication in the annual water data report. Recent provisional daily flow data up to the present may be obtained from the USGS website http://nwis.waterdata.usgs.gov/nwis/dv/?site_no=11143000&agency_cd=USGS.

Regression Analysis

Figure 12 shows a scatter plot of monthly discharges for September versus average discharges from the preceding January to March period of the same year. The bottom panel of Figure 12 displays the same data as the top panel, except that the axes are shown on a logarithmic scale. Both panels in this figure display the best-fitted log-log space linear regression line along with 95% confidence intervals about the regression line.

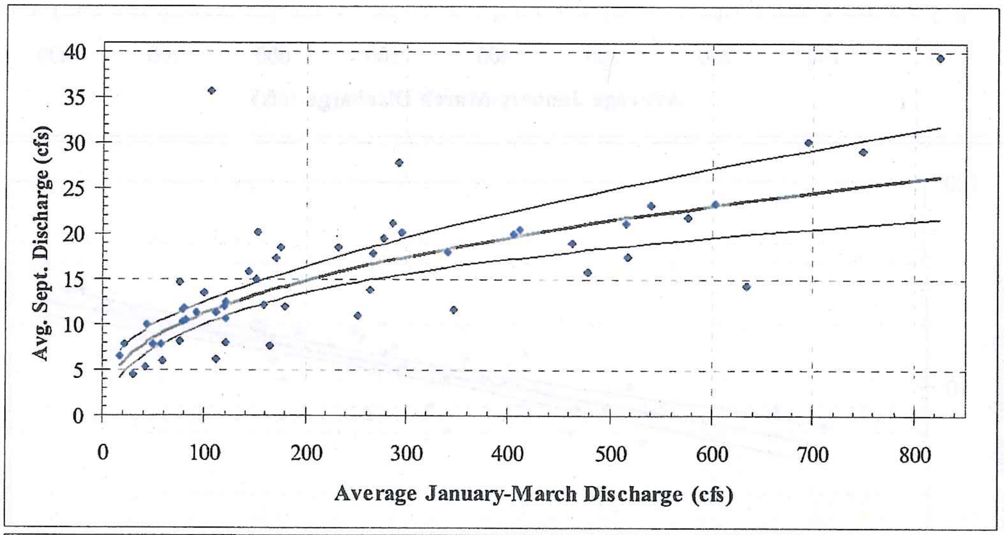
The relationship between the September flows and the January to March flows is illustrated by regression lines, for which the coefficient of determination, R^2, is 0.525 (in non-logarithmic space). However, there is an outlier among the low flows for which the September flow is 35.6 cfs and the January to March flow is 105.5 cfs in the year 1959. In September 1959, the El Sur Station recorded 8.7 inches of precipitation, which is nearly 16 times greater than the average 0.55 inches for September. Based on the rainfall record and on Figure 12, it was determined that this months value is an outlier, and as such it was discarded from the analysis. The revised plots are shown in Figure 13. Both panels in this figure display the best-fit log-log space linear regression line, along with 95% confidence intervals about the regression line.

Figure 13 shows that the 95% confidence limits about the linear regression line have narrowed, indicating a more solid relationship. The coefficient of determination, R^2, for this regression has increased to 0.672. The resulting equation is:

$$\hat{Q}_{Sept} = 1.6316 Q_{Jan-Mar}^{\ 0.41336} \quad \text{(A-1)}$$

where $\hat{Q}_{Sept}$ is the predicted average flow for the month of September in cubic feet per second (cfs) and $Q_{Jan-Mar}$ is the observed average flow for the months of January to March in cfs from the same year. This equation has a mean absolute error of 2.94 cfs, which is 19.1% of the mean September flow of 15.3 cfs.

Figure 12: Regression of September Average Monthly Flows versus Average Flows for the Proceeding January to March Period of the Same Year.



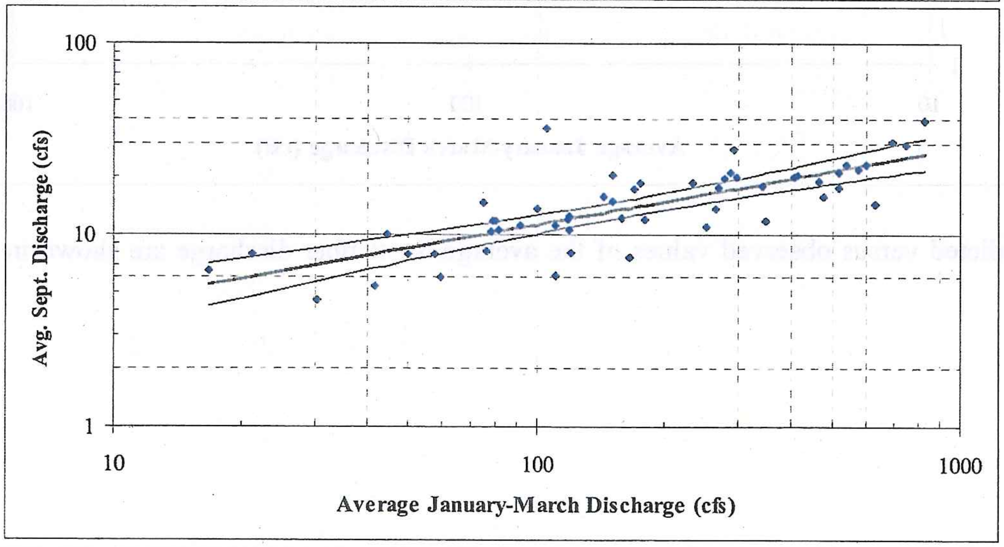
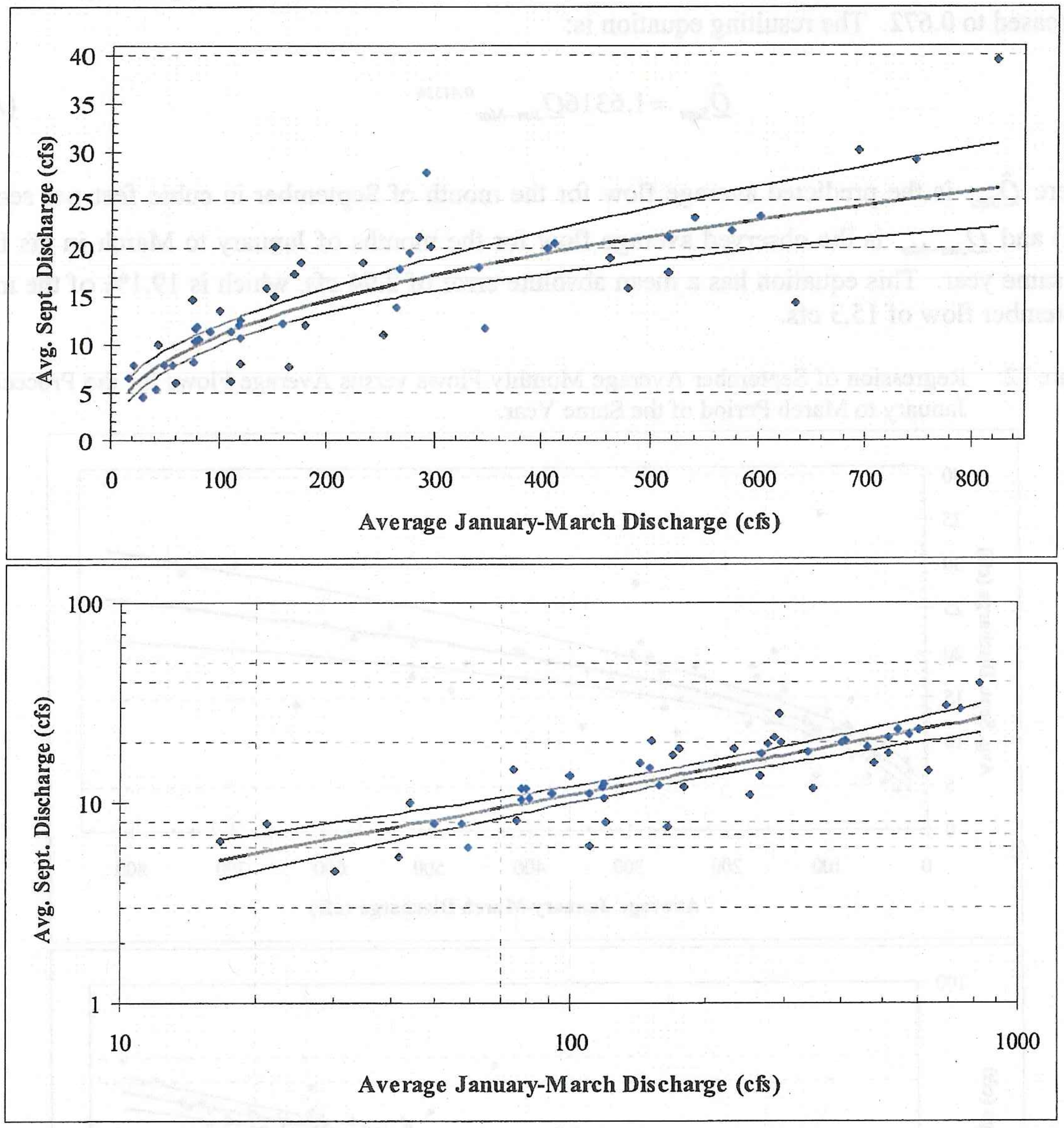
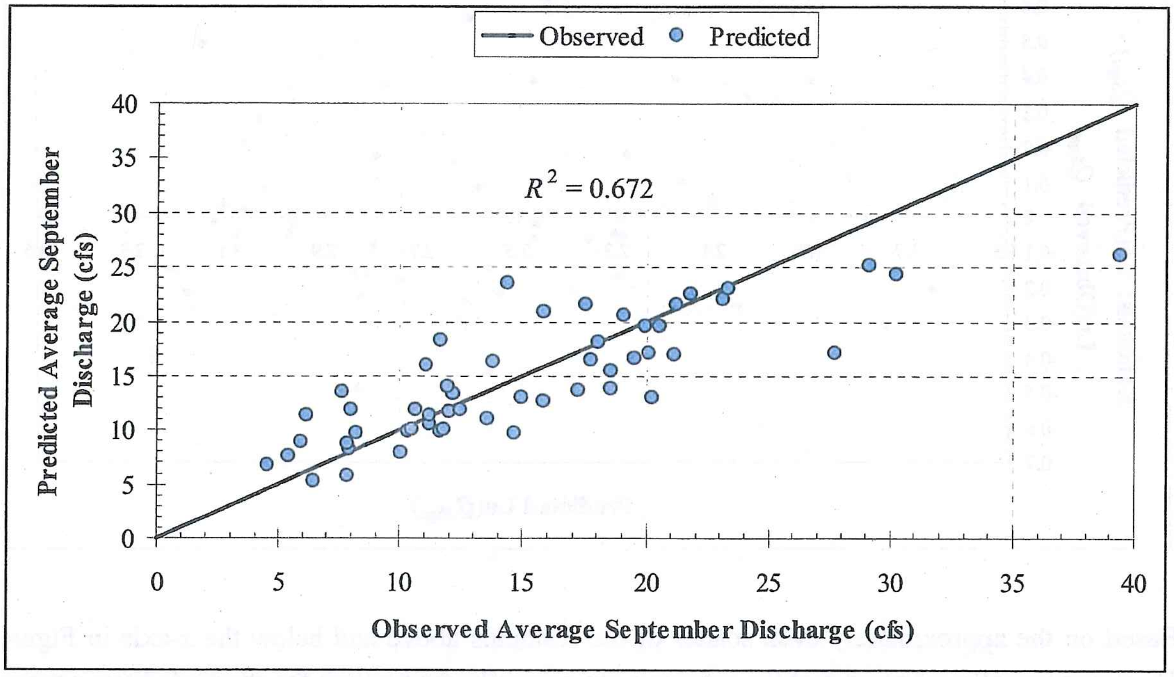


Figure 13: Regression of September Average Monthly Flows versus Average Flows for the Proceeding January to March Period of the Same Year, with Outlier Removed.



The predicted versus observed values of the average September discharge are shown in Figure 14.

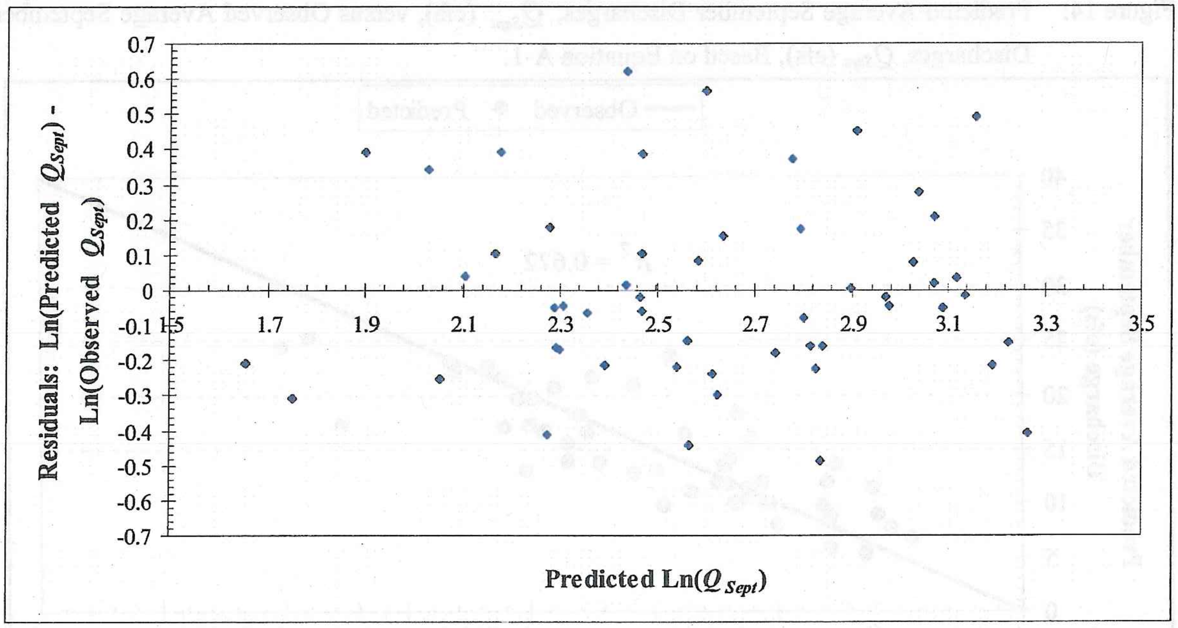
Figure 14: Predicted Average September Discharges, $\hat{Q}_{Sept}$ (cfs), versus Observed Average September Discharges, Q_{Sept} (cfs), Based on Equation A-1.



Probabilistic Flow Forecasting

Equation A-1 provides the best (most likely) forecast of the average September discharge in cfs for a given average January to March discharge, also in cfs. The scatter of the data about the fitted regression shown in Figure 13 demonstrates that there is some uncertainty associated with the forecasted flow predicted using Equation A-1. For any given forecasted flow $\hat{Q}_{Sept}$, there is a non-zero possibility that the actual probability Q_{Sept} could be less than the forecasted $\hat{Q}_{Sept}$. To quantify this probability, the residuals of the linear regression were examined. These are shown in Figure 15.

Figure 15: Residuals of the Best Fit Regression Equation, in Logarithmic Space.



Based on the approximately even scatter of the residuals above and below the x-axis in Figure 15, it was initially assumed that the residuals are normally distributed; the residuals have a mean of zero, a standard deviation of 0.264, and a skewness of 0.481. Fits using several alternative statistical distributions were attempted. A plot of the fitted normal distribution to the residuals, shown in Figure 16, indicates that the normal distribution provides a reasonable fit to the residuals. Of these, the three-parameter gamma ("tri-gamma") distribution was found to provide a slightly better fit to the residuals: $R^2 = 0.993$ for tri-gamma versus $R^2 = 0.985$ for Normal. This finding was the same for all forecasting equations that have been developed: the tri-gamma distribution provides a better fit to the regression residuals than the Normal distribution in all cases. Consequently, the tri-gamma distribution was selected for use in the development of all forecasting equations used in this study. The fitted tri-gamma distribution is also shown in Figure 15.

The gamma distribution with three parameters has a probability density function (PDF) of the form (Bobee, 1975):

$$f(x) = \frac{1}{|\alpha|\Gamma(\beta)}\left(\frac{x - x_o}{\alpha}\right)^{\beta-1} \exp\left(-\frac{x - x_o}{\alpha}\right) \qquad \text{(A-2)}$$

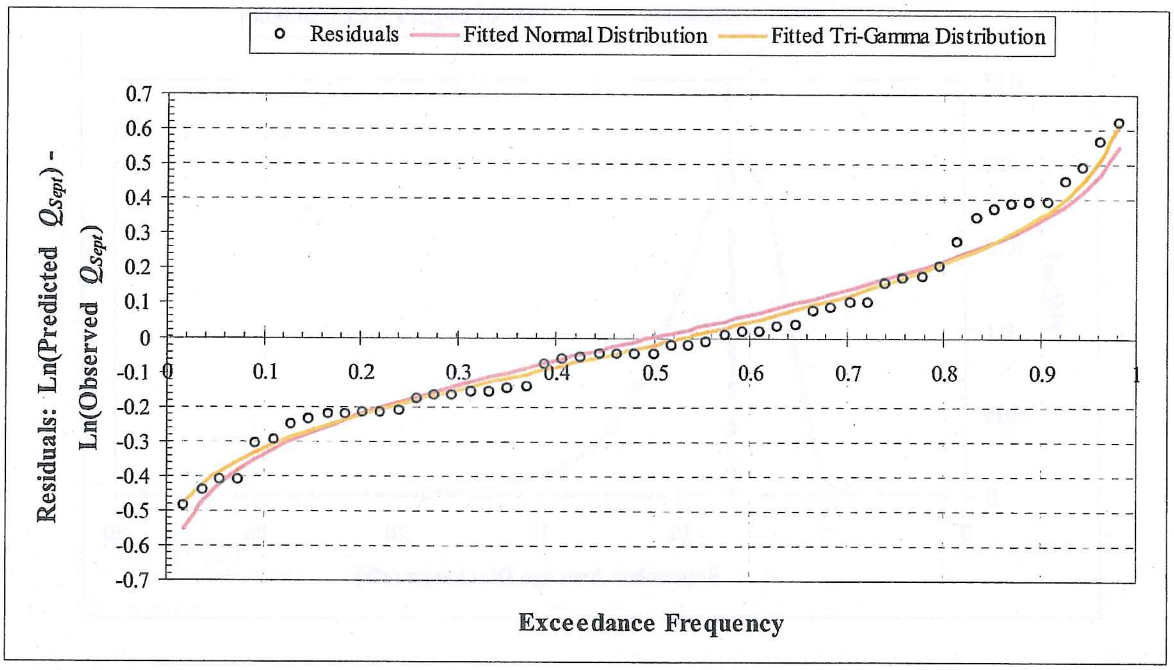
ESR--4

Where $x_o \le x < \infty$ for $\alpha > 0$ and $-\infty < x \le x_o$ for $\alpha < 0$, α and β are the shape parameters, x_o is the location parameter. Parameter α may be positive or negative and β must be positive. The method of moments was used to estimate parameter values based on the following equations:

$$\hat{\beta} = \left(\frac{2}{\hat{\gamma}}\right)^2, \ \hat{\alpha} = \frac{\hat{\sigma}\hat{\gamma}}{2}, \text{ and } \hat{x}_o = \hat{\mu} - \hat{\alpha}\hat{\beta} \qquad \text{(A-3, A-4, and A-5)}$$

where $\hat{\mu}$, $\hat{\sigma}$, and $\hat{\gamma}$ are respectively the sample mean, sample standard deviation, and sample skewness (Salas et al., 1995).

Figure 16: Cumulative Distribution of Residuals and Fitted Normal and Tri-Gamma Distributions.

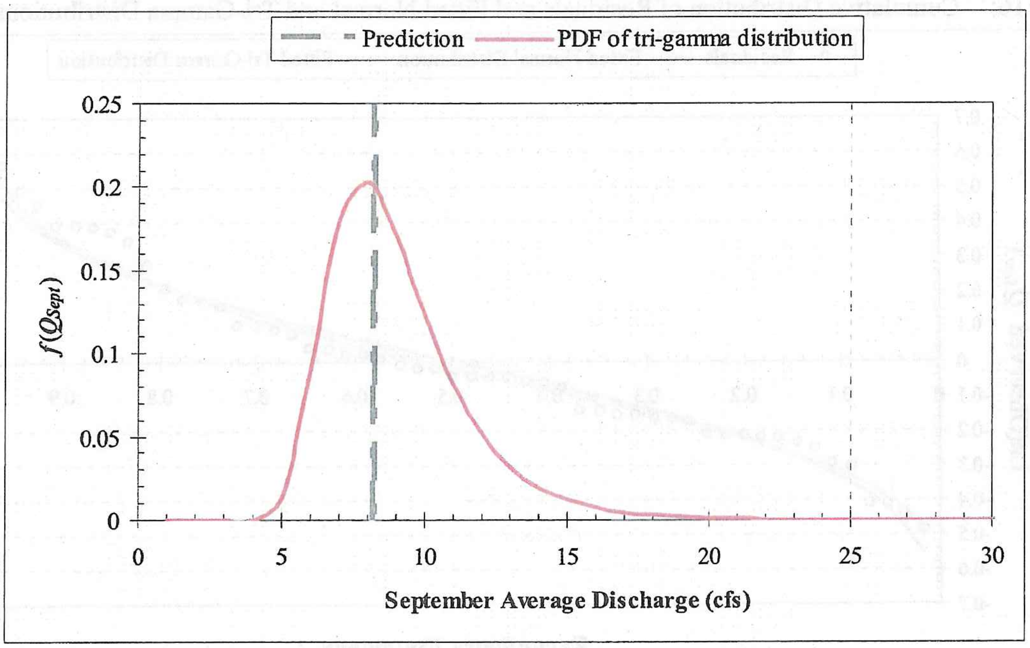


Using the fitted distribution for the residuals, the following more complete equation may be written to describe the relationship between the flows in September and the flows from January to March:

$$\hat{Q}'_{Sept} = \exp\{0.48956 + 0.41336 Ln(Q_{Jan-Mar}) + \varepsilon(\mu = 0, \sigma = 0.264, \gamma = 0.481)\} \qquad \text{(A-6)}$$

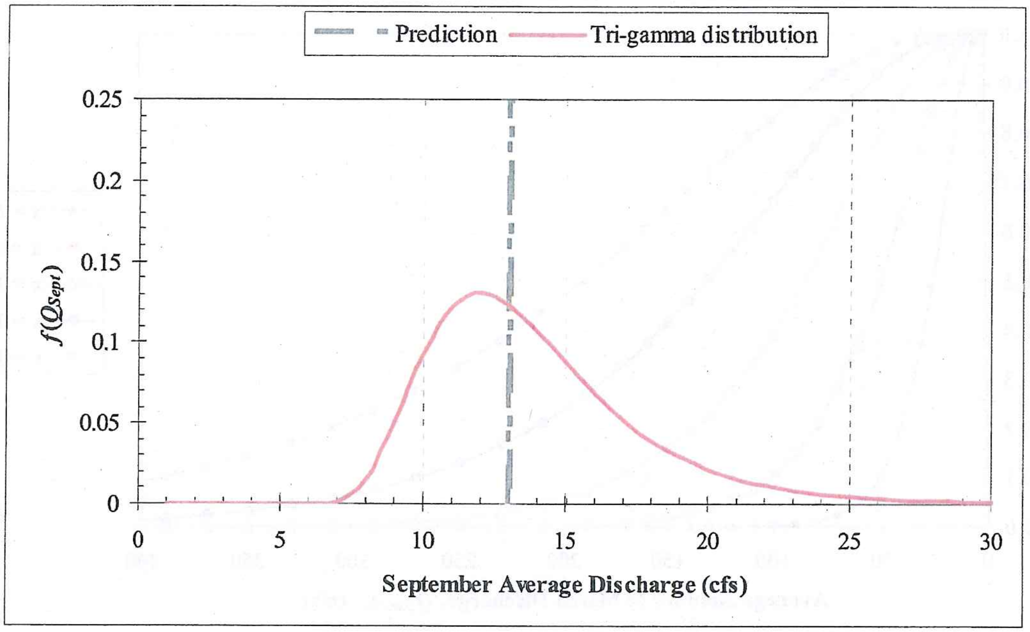
where ε is a three-parameter gamma distributed random deviate with mean $\mu = 0$, standard deviation $\sigma = 0.264$, and skewness $\gamma = 0.481$ and $\hat{Q}'_{Sept}$ is a now expressed as a stochastic variable with mean equal to $\hat{Q}_{Sept}$. Other than the ε term, this is the same as Equation A-1, except that it is now expressed in logarithmic space. Equation A-6 is illustrated for example average January to March discharges of 50 cfs and 150 cfs in Figure 17 and 18, respectively. The "Prediction's" shown in these figures were obtained using Equation A-1, and the tri-gamma distributions about the predicted values are shown. It can be seen from these figures that as the $Q_{Jan-Mar}$ flow increases (and, as a result, $\hat{Q}_{Sept}$ also increases) the shape of the PDF becomes lower and wider, which indicates that the variability and uncertainty of the September flow increases.

Figure 17: Predicted $\hat{Q}_{Sept}$ (cfs) and PDF of $\hat{Q}'_{Sept}$ for an Observed $Q_{Jan-Mar}$ = 50 cfs.



ESR--4

Figure 18: Predicted $\hat{Q}_{Sept}$ (cfs) and PDF of $\hat{Q}'_{Sept}$ for an Observed $Q_{Jan-Mar}$ = 150 cfs.



Using the model given by Equation A-6, it is possible to define the probability of Q_{Sept} being less than or equal to any desired threshold discharge x in cfs, given an observed value of $Q_{Jan-Mar} = q$. This probability is equal to the area under the PDF to the left of the given value of $Q_{Jan-Mar} = q$. This may be expressed as:

$$P\left[Q_{Sept} \leq x \mid Q_{Jan-Mar} = q\right] = \int_{-\infty}^{Ln[x]} f\left(\mu = Ln\left[\hat{Q}_{Sept}\right], \sigma = 0.264, \gamma = 0.481\right) \quad \text{(A-7)}$$

where $\hat{Q}_{Sept}$ is given by Equation A-1 and $f(\mu, \sigma, \gamma)$ denotes the probability density function of the tri-gamma distribution with mean μ, standard deviation σ, and skewness γ.

Figure 19 shows the probabilities predicted by Equation A-7 for a range of January to March flows and for a several threshold discharges, x.

ESR--4

Figure 19: Probability that Q_{Sept}, the Average September Discharge (cfs), will be Less Than or Equal to a Specified Discharge, x, given an Observed Average January to March Discharge.

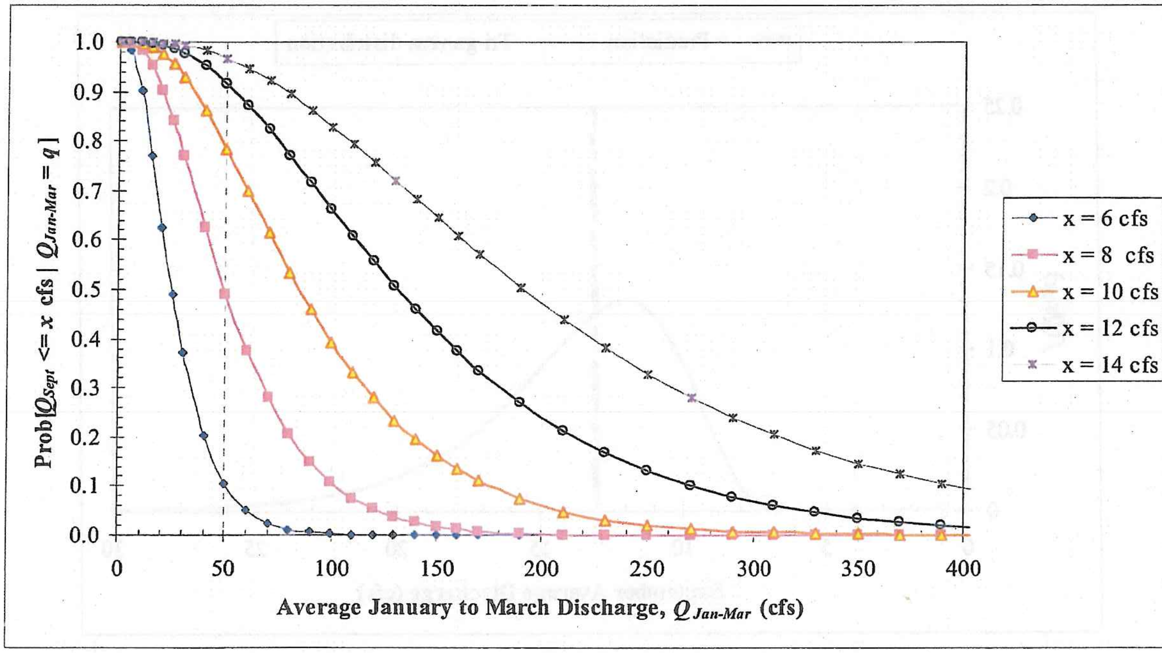
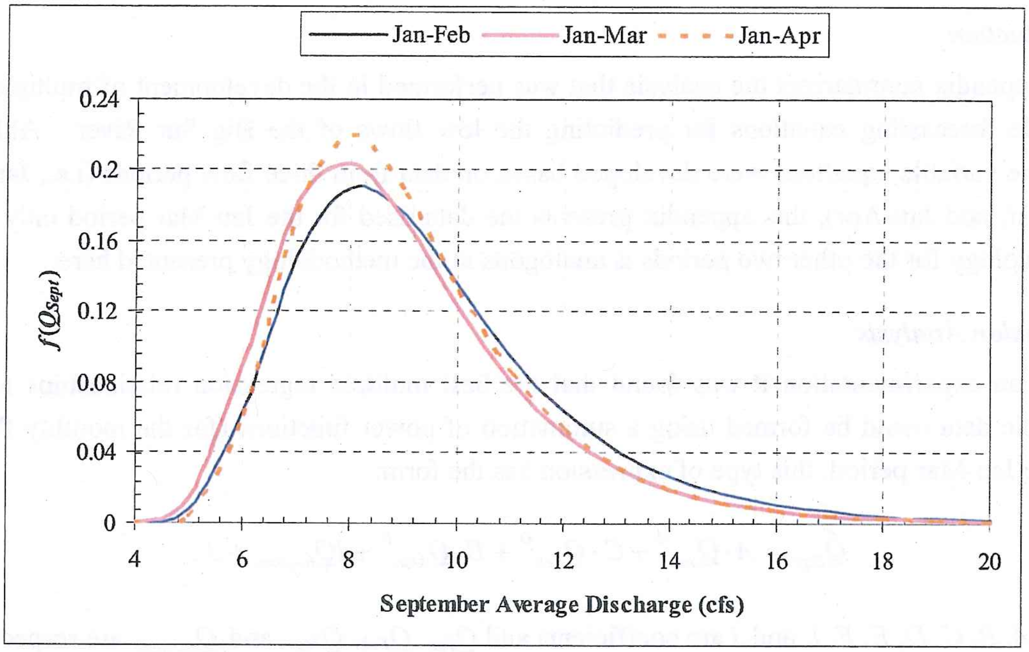


Figure 19 shows that for discharges greater than about 200 cfs, the probability that Q_{Sept} would be less than or equal to 10 cfs is quite small, about 5% or less.

As stated above, the methodology used to develop the forecasting equations based on the average January-February and the average January-April flows is the same as presented here. The accuracy of the forecasting equations improves as the period on which the forecasts are based increases. Therefore, the January-February flow will enable an initial rough flow forecast that may be refined in the each of the following two months by using the more accurate equations for the later periods. The improvement in the accuracy equations is a result of a reduction in the variability about the fitted regression lines. This is illustrated in Figure 20, which shows the PDFs of $\hat{Q}'_{Sept}$ for a given $Q_{Jan-XXX} = 50$ cfs based on the forecasting equations for the three periods, Jan-Feb, Jan-Mar, and Jan-Apr.

ESR--4

Figure 20: PDFs of $\hat{Q}'_{Sept}$ for a given $Q_{Jan-XXX} = 50$ cfs based on the Forecasting Equations for the Three Periods, Jan-Feb, Jan-Mar, and Jan-Apr.



It can be seen from Figure 20 that the PDFs generally become taller and narrower as the durations of the periods increase, from Jan-Feb to Jan-Apr, due to the reductions in uncertainty and variability associated with predictions that are based on the longer periods.

APPENDIX B: DEVELOPMENT OF MULTIPLE VARIABLE FORECASTING EQUATIONS

Introduction

This appendix summarizes the analysis that was performed in the development of multiple flow variable forecasting equations for predicting the low flows of the Big Sur River. Although multiple variable equations were developed based on data from three flow periods (i.e., Jan-Feb, Jan-Mar, and Jan-Apr), this appendix presents the data used for the Jan-Mar period only. The methodology for the other two periods is analogous to the methodology presented here.

Regression Analysis

Based on experimentation it was found that the best multiple regression relationships for the available data could be formed using a summation of power functions (for the monthly flows). For the Jan-Mar period, this type of expression has the form:

$$\hat{Q}_{Sept} = A \cdot Q_{Jan}{}^{B} + C \cdot Q_{Feb}{}^{D} + E \cdot Q_{Mar}{}^{F} + IQ_{6-years} + J\,, \qquad \text{(B-1)}$$

where A, B, C, D, E, F, I, and J are coefficients and Q_{Jan}, Q_{Feb}, Q_{Mar}, and $Q_{6-years}$ are respectively the average flows for January, February, March (each in the current year), and for the preceding six water years, in cfs. The values of the coefficients in Equation B-1 were determined based on an iterative trial and error process. The objective function used in these iterations was the maximization of the coefficient of determination, R^2, of the resulting fit to the observed data. Because Equation B-1 is a function of four independent variables, it is not possible to present it in graphical form. The resulting values of the coefficients are shown in Table 12; for these coefficients, Equation B-1 has $R^2 = 0.866$. This equation is an improvement over the single variable forecasting equation for the same period (presented in Appendix A), which has $R^2 = 0.672$.

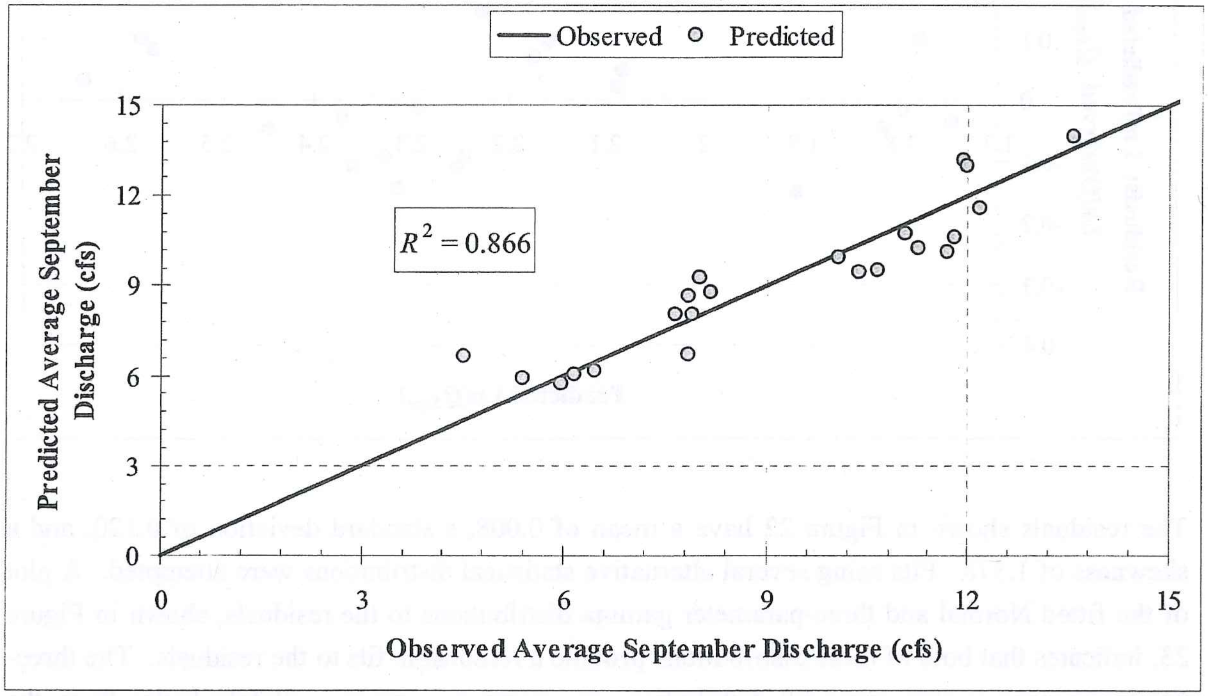
Table 12: Coefficients of the Multiple Variable Flow Forecasting Equation B-1 for Predicting September Flows from the Flows of January, February, March (of the present year), and from the Average for the Preceding Six Water Years.

Independent Variable	Coefficient	Value
Q_{Jan}	A	0.101994
	B	0.736041
Q_{Feb}	C	0.000333
	D	1.463683

Independent Variable	Coefficient	Value
Q_{Mar}	E	4.371275
	F	0.091191
$Q_{6-years}$	I	0.038958
	J	-3.87499

The predicted versus observed values of the average September discharge are shown in Figure 21.

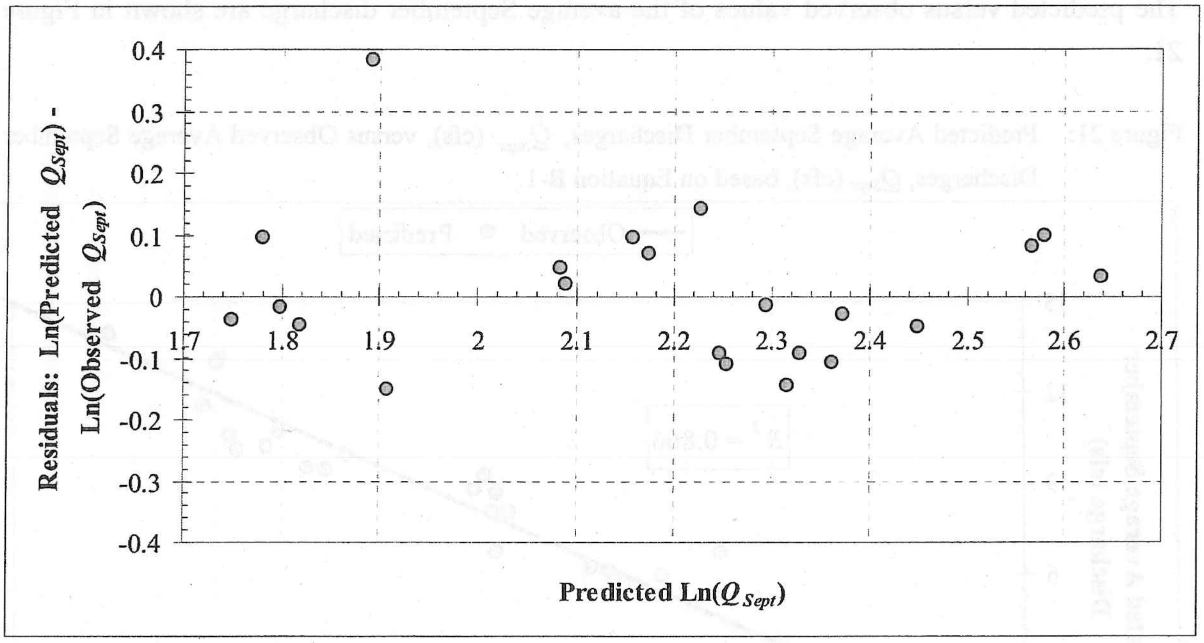
Figure 21: Predicted Average September Discharges, $\hat{Q}_{Sept}$ (cfs), versus Observed Average September Discharges, Q_{Sept} (cfs), based on Equation B-1.



Probabilistic Flow Forecasting

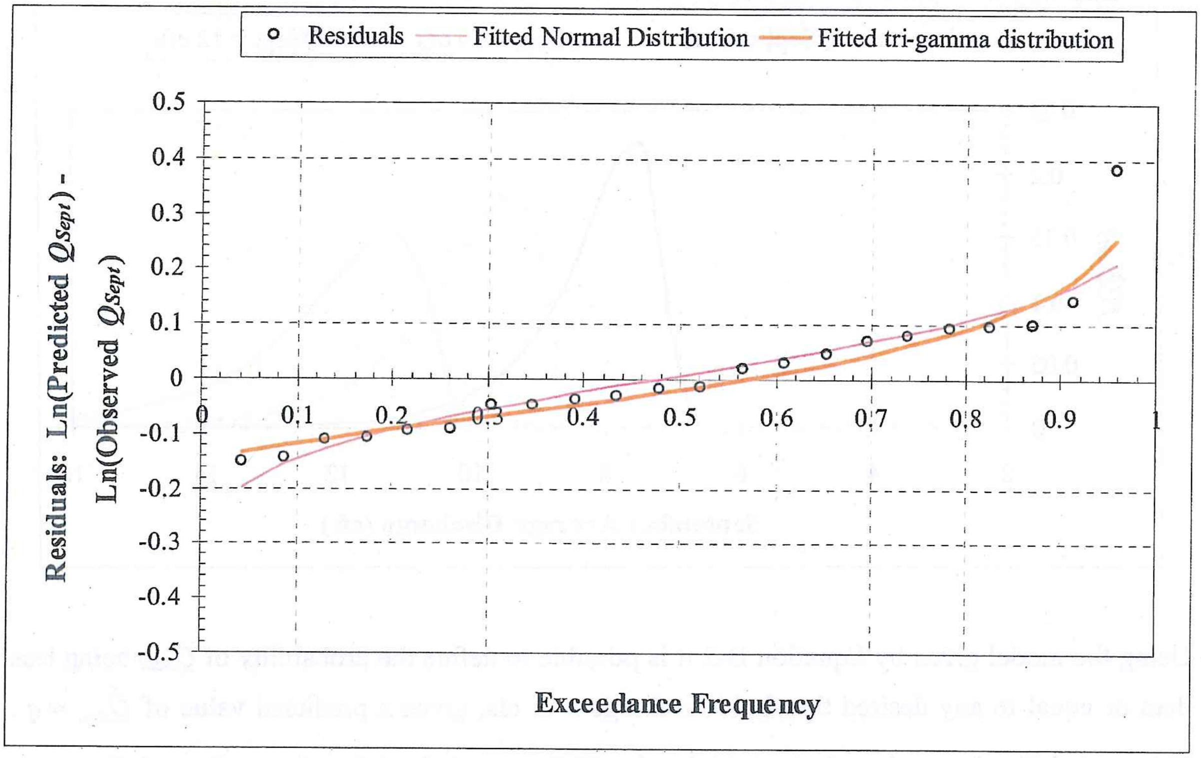
Equation B-1 provides the best (most likely) forecast of the average September discharge in cfs for a given set of average January, February, and March discharges, also in cfs. However, for any given forecasted flow $\hat{Q}_{Sept}$, there is a non-zero possibility that the actual probability Q_{Sept} could be less than the forecasted $\hat{Q}_{Sept}$. To quantify this probability, the residuals of the linear regression were examined. These are shown in Figure 22.

Figure 22: Residuals of the Best Fit Multiple Regression Equation, in Logarithmic Space.



The residuals shown in Figure 22 have a mean of 0.008, a standard deviation of 0.120, and a skewness of 1.378. Fits using several alternative statistical distributions were attempted. A plot of the fitted Normal and three-parameter gamma distributions to the residuals, shown in Figure 23, indicates that both of these distributions provide a reasonable fits to the residuals. The three-parameter gamma ("tri-gamma") distribution was found to provide a slightly better fit to the residuals. This finding was the same for all forecasting equations that have been developed: the tri-gamma distribution provides a better fit to the regression residuals than the Normal distribution in all cases. Consequently the tri-gamma distribution was selected for use in the development of all forecasting equations used in this study. The fitted tri-gamma distribution is shown in Figure 22. The tri-gamma distribution is further discussed in Appendix A.

Figure 23: Cumulative Distribution of Residuals and Fitted Normal and Tri-Gamma Distributions.

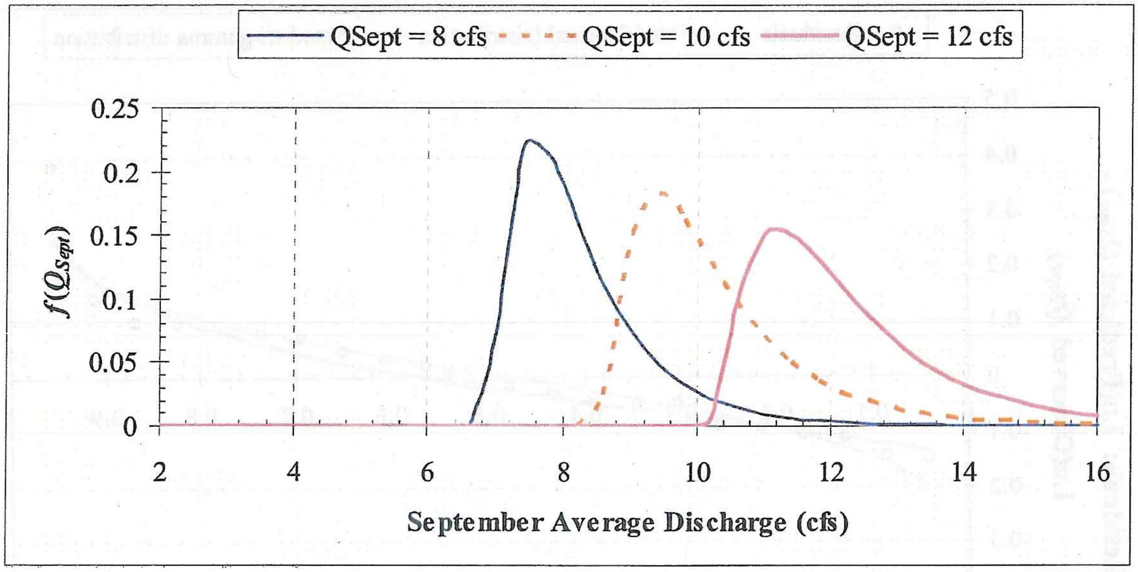


Using the fitted distribution for the residuals, the following more complete equation may be written to describe the relationship between the flows in September and the flows from January to March:

$$\hat{Q}_{Sept} = A \cdot Q_{Jan}{}^{B} + C \cdot Q_{Feb}{}^{D} + E \cdot Q_{Mar}{}^{F} + IQ_{6-years} + J + \exp\{\varepsilon(\mu = 0.008, \sigma = 0.120, \gamma = 1.378)\} \quad \text{(B-2)}$$

where ε is a three-parameter gamma distributed random deviate with mean $\mu = 0.008$, standard deviation $\sigma = 0.120$, and skewness $\gamma = 1.378$ and $\hat{Q}'_{Sept}$ is a now expressed as a stochastic variable with mean equal to $\hat{Q}_{Sept}$. Other than the ε term, this is the same as Equation B-1. Equation B-2 is illustrated for several example values of predicted September average discharges in Figure 24. It can be seen from this figure that as the predicted $\hat{Q}_{Sept}$ flow increases, the shape of the PDF becomes lower and wider, which indicates that the variability and uncertainty of the actual September flow increases.

Figure 24: PDF of $\hat{Q}'_{Sept}$ for Several Values of Predicted $\hat{Q}_{Sept}$ (in cfs).



Using the model given by Equation B-2 it is possible to define the probability of Q_{Sept} being less than or equal to any desired threshold discharge x in cfs, given a predicted value of $\hat{Q}_{Sept} = q$. This probability is equal to the area under the PDF to the left of the given value of $\hat{Q}_{Sept} = q$. This may be expressed as:

$$P\left[Q_{Sept} \le x \mid \hat{Q}_{Sept} = q\right] = \int_{-\infty}^{Ln[x]} f\left(\mu = Ln\left[\hat{Q}_{Sept}\right], \sigma = 0.120, \gamma = 1.378\right) \quad \text{(B-3)}$$

where $\hat{Q}_{Sept}$ is given by Equation B-1 and $f(\mu, \sigma, \gamma)$ denotes the probability density function of the tri-gamma distribution with mean μ, standard deviation σ, and skewness γ.

Figure 25 shows the probabilities predicted by Equation B-3 for a range of predicted average September flows and for a several threshold discharges, x.

Figure 25: Probability that Q_{Sept}, the Average September Discharge (cfs), will be Less Than or Equal to a Specified Discharge, x, given a Predicted Average September Discharge.

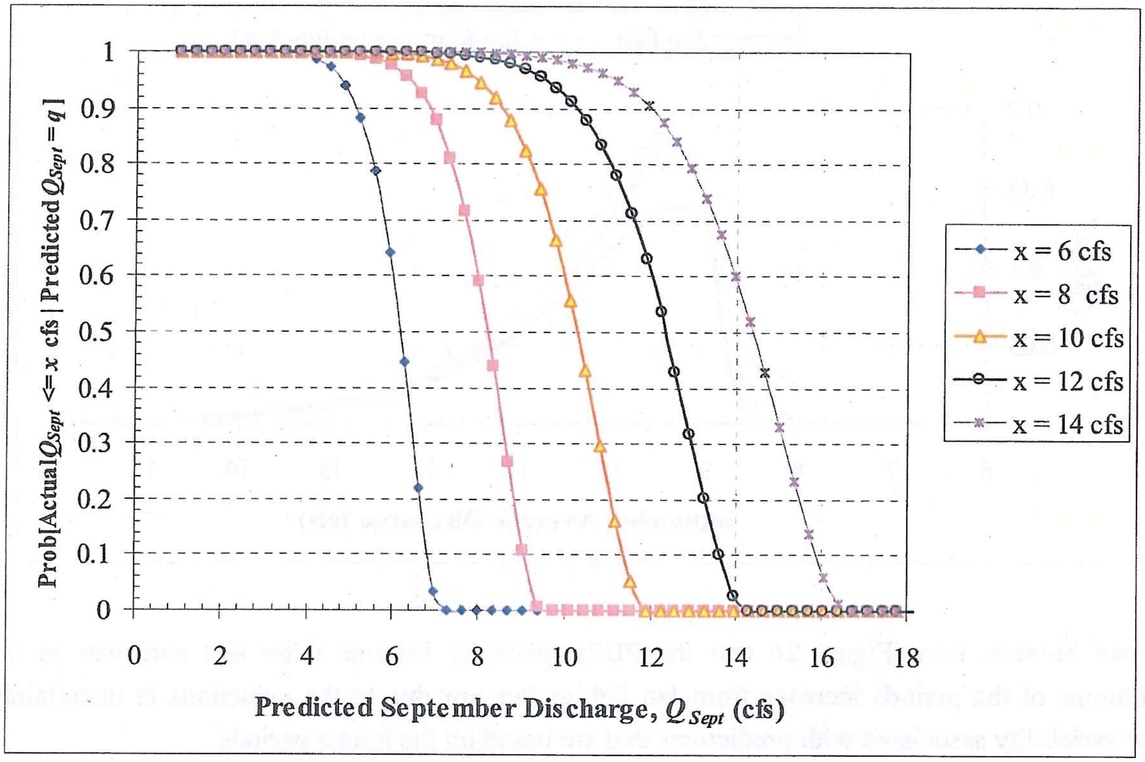
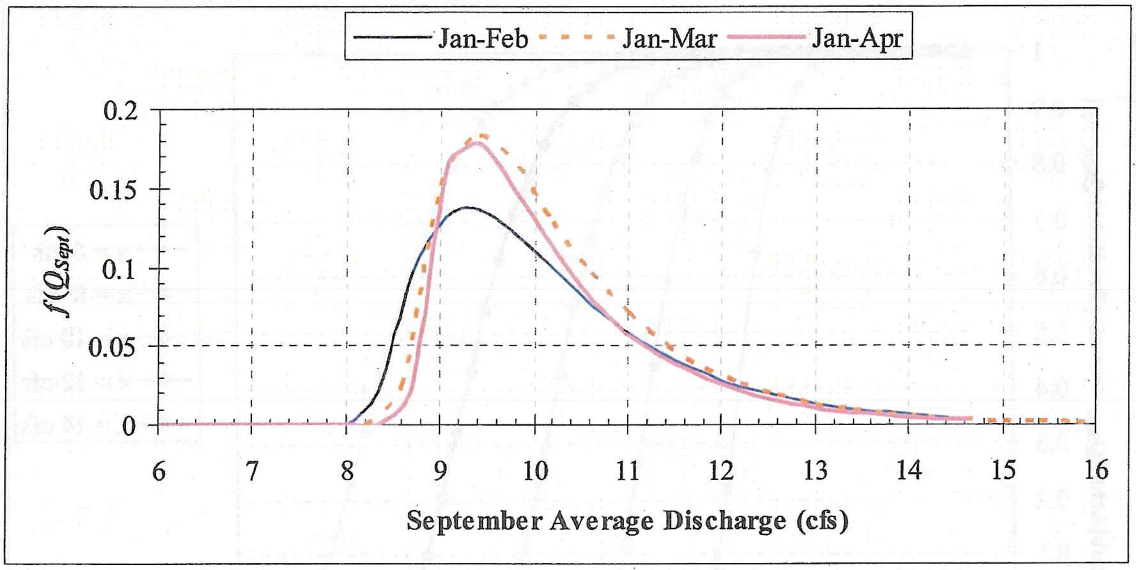


Figure 25 shows that for predicted September discharges greater than about 12 cfs, the probability that the actual Q_{Sept} would be less than or equal to 10 cfs is nearly zero.

As stated above, the methodology used to develop the forecasting equations based on the January, February, and $Q_{6-years}$ flows and based on the January, March, April, and $Q_{6-years}$ flows is the same as is presented here. The accuracy of the forecasting equations improves slightly as the period on which the forecasts are based increases. The improvement in the accuracy equations is a result of a reduction in the variability about the fitted regression lines. This is illustrated in Figure 26, which shows the PDFs of $\hat{Q}'_{Sept}$ for a given $Q_{Sept} = 10$ cfs based on the forecasting equations for the three periods, Jan-Feb, Jan-Mar, and Jan-Apr.

Figure 26: PDFs of $\hat{Q}'_{Sept}$ for a given Q_{Sept} =10 cfs based on the Forecasting Equations for the Three Periods, Jan-Feb, Jan-Mar, and Jan-Apr.



It can be seen from Figure 26 that the PDFs generally become taller and narrower as the durations of the periods increase from Jan-Feb to Jan-Apr due to the reductions in uncertainty and variability associated with predictions that are based on the longer periods.

ESR--4