Surface Water, Groundwater, and Sediment Transport Monitoring, Water Year 2010, Grady Ranch, Marin County, California

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

LIST OF FORMS

LIST OF FORMS (CONTINUED)

APPENDICES

1. INTRODUCTION

1.1 Purpose

The Grady Ranch project lies within Marin County, California, approximately 6 miles northwest of City of San Rafael and 4.5 miles southwest of the City of Novato, in the headwaters of Miller Creek watershed (Figure 1). Upper Miller Creek watershed has a rural, sparsely developed character. South-facing valley slopes of Big Rock Ridge comprise the relatively natural portion of Grady Ranch, donated as a conservation easement to the Marin County Open Space District by Skywalker Properties in the mid 1990's, and north-facing valley slopes of Loma Alta drain the Rocking H Ranch (formerly Luiz Ranch), of which the upper portion is also relatively undisturbed and in an Open Space District conservation easement (Figure 2). The most significant existing improvement to the property is the bridge over Miller Creek (installed 1941), which allows dirt road access leading up Grady Creek to former dairy and homestead.

The Miller Creek valley has incised during historical times, and continues to incise. The upstream knickpoint is currently stabilized at Grady Bridge by the concrete footer spanning the channel beneath the bridge and concrete rubble. The creek bed elevation drops 11 feet immediately downstream of Grady bridge, and remnants of an intermediate (inset) terrace level, up to 12 feet above the existing thalweg, are still present along portions of left bank of the creek (Brown and Hecht, 2011). Substantial incision and channel change over the past 17 years can be noted from a detailed 1993 topographic map (see Vandivere, 1994).

A stream and valley restoration plan is proposed on Grady Ranch as part of the proposed facility and associated infrastructure to be used primarily for advanced, digital technology-based entertainment production. The proposed project, planned for the Grady Creek watershed, is outlined in the precise development plan (PDP) (CSW/ST2, 2009a and 2009b) and is tiered off of the Grady Ranch Master Plan (Nichols-Berman, 1996).

Balance Hydrologics, Inc. (Balance) was asked to conduct multi-year pre-construction hydrologic monitoring on Grady Ranch that includes: a) rainfall, b) stream gaging of Miller Creek and its primary tributaries, c) sediment transport, d) groundwater level monitoring, and e) water quality sampling. This report presents the findings from the first year of monitoring during water year 2010[1], and develops initial conclusions subject to refinement and revision as a longer, more robust set of observations are developed.

1.2 Prior and Concurrent Work

Balance prepared a series of reports related to restoration planning and hydrologic and geomorphic assessment. As part of the PDP submittal, Balance prepared a geomorphic assessment of upper Miller Creek, Grady Creek, and their tributaries on Grady Ranch (Brown and others, 2008), and then an updated summary of the existing channel stability in upper Miller Creek on Grady Ranch was subsequently conducted by Brown and Hecht (2011a). A broad understanding of the stream and valley floor restoration vision was illustrated in the memo by Brown and Hecht (2009) as a response to comments to the PDP. A summary the proposed restoration effort was then presented by Brown and Hecht (2011) with discussion of several often-posed questions and aspects of the project in relation to other restoration efforts within northern California. The restoration plans and the feasibility were described by Owens and others (2008, 2011), a project alternatives analysis by (Brown and others, 2011), and stormwater changes related specifically to the project by Ballman and Cayot (2008) and CSW/ST2 (2009a). To document channel conditions downstream of Grady Ranch and to summarize planning efforts during recent years, Balance, in response to comments to the PDP, conducted a baseline reconnaissance characterization of the reaches of Miller Creek extending downstream from the project site to San Pablo Bay (Woyshner and others, 2011). Separate analyses were conducted concurrently to assess biologic issues (WRA, 2008, 2010) and a geotechnical investigation of the site was conducted by AMEC Geomatrix (2008).

Unlike most watersheds in the North Bay, a watershed assessment has not been completed for the Miller Creek catchment, although important preliminary drafts of sections were prepared prior the economic disruptions which have affected the region beginning in 2008 (see Woyshner and others for details). At an individual site level, previous work related to stream restoration has been conducted within the upper Miller Creek watershed. Philip Williams and Associates (PWA) with David Gates and Associates (DGA) prepared a report related to watershed assessment and planning (PWA and DGA, 1981). PWA and Clearwater Hydrology prepared a series of reports and plans related to hydrologic analysis and restoration design

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[1] Most hydrologic and geomorphic monitoring occurs for a period defined as a water year, which begins on October 1 and ends on September 30 of the named year. For example, water year 2010 (WY2010) began on October 1, 2009 and ended on September 30, 2010.

(Vandivere, 1984; Vandivere, 1985; Vandivere and Mock, 1985). These studies were the basis for rehabilitation of an incised reach of Miller Creek downstream of Grady Ranch, which included in-stream grade stabilization and laying back and revegetating banks to reduce flow velocities and associated erosion. Summaries of the restoration are included in post-construction assessments by Haltiner and others (1996), Yin and Pope-Daum (2004), and Woyshner and others (2011).

Data collected in Miller Creek is compared in this report to similar data collected in other streams. The primary comparison is with San Geronimo Creek at the community of Lagunitas, where Balance staff have operated a stream gage for MMWD since 1979. Data for that gage have been recently summarized through 2008 (Hecht, Strudley and Brown, 2010). Streamflow and sediment-transport data have also been collected and analyzed at the gage in 2009 and 2010 (Owens and Hecht, 2010). Earlier flow and sediment-transport data for San Geronimo Valley tributaries were collected during the early 1980s (Hecht, 1983), but no sustained data collection has occurred since. Useful and significant geomorphic analysis of the San Geronimo Valley has also been developed as part of recent watershed-planning efforts sponsored by Marin County (Stillwater Sciences, 2009, and Prunuske Chatham, 2010). Other sediment studies in central Marin or in the east-draining watershed have occurred on regulated tributaries, where dams and releases have altered the channels, and limit the comparability to Miller Creek.

1.3 Commencement of Work

On December 22, 2009, Balance was authorized to proceed with an aquifer characterization and surface-water and groundwater monitoring program, as part of multi-year pre-construction hydrologic monitoring on Grady Ranch that included the following tasks:

- Install a tipping-bucket rain gage and monitor rainfall during water year 2010;
- Install 2 stream gages on Miller Creek, one at Grady Bridge and one at the property line, and 4 tributary gages, one each on Grady Creek, Landmark Creek, S3 Tributary, and S4 Tributary, gage flows during water year 2010;
- Sample bedload and suspended sediment and specific conductance at all the stream gages and establish preliminary rating curves, used to calculate sediment loads;
- Install 4 monitoring wells and monitor water levels during water year 2010, in addition to monitoring groundwater level in an existing monitoring well on the ranch;

- Subcontract with Norcal Geophysical Consultants to conduct seismic refraction survey lines across the valley floor to evaluate depth to bedrock; and,

- Collect water quality samples from the wells and at the gaging stations for analyses of general mineral composition as a method of fingerprinting the source of the samples.

Table 1 describes the wells and gaging stations we visited throughout water year 2010 and Figure 3 maps their locations.

2. SETTING

2.1 Climate and Hydrologic Setting

Grady Ranch has a Mediterranean climate, with wet winters and generally dry summers. The site receives an average of 34 inches of rain (Rantz, 1971). Summer high temperatures routinely reach 90°F, with lows of approximately 50°F. Winter daily temperature range is smaller, with highs between 50 and 60°F and lows between 40 and 50°F. Miller Creek, where it runs through Grady Ranch, is an intermittent stream, flowing only during the winter, spring and early summer (occasionally) in response to precipitation events and the discharge of shallow groundwater. Flow seldom, if ever, persists beyond early July. The watershed area of Miller Creek at the downstream property line of Grady Ranch is 2.8 square miles. As is typical of small, coastal streams in California, the creek's discharge is extremely variable, sometimes changing rapidly over several orders of magnitude during a day.

2.2 Geologic and Geomorphic Setting

Grady Ranch lies within the Coast Range geomorphic province of California and is underlain by Mesozoic rocks of the Franciscan Complex. A number of primary faults, including the San Andreas, are largely responsible for the present form of the Coast Range province. Grady Ranch, along with much of the rest of eastern Marin County, is found within a relatively coherent block of crust known as the Bay Block. It is bounded on the east and west by right-lateral strike-slip faults: the Rogers Creek/Hayward and San Andreas respectively. Although most of the motion along these two faults is in a shearing sense, a small component of the motion along these faults is compressional, which has generated the mountains and generally steep topography of the project site, Marin County and the Coast Range at large. Grady Ranch is approximately 8.5 miles east of the trace of the San Andreas Fault and 6 miles west of the Rogers Creek/Hayward Fault.

Within the project area, along Big Rock Ridge, the Franciscan Complex is dominated by graywackes and shales of the Novato Quarry terrane that are Jurassic and Cretaceous in age (Blake and others, 2000). To the south and within discrete bands surrounding the more intact Novato Quarry terrane is Franciscan mélange, a complex mixture of highly fractured rocks bound within a soft matrix of crushed shale (and other fine-grained sediments) or serpentinite.

Where exposed on the surface, the mélange matrix erodes easily, leaving behind a rounded landscape, with subtle rolling hills and knobs. At Big Rock Ranch, the topographic saddle through which the Lucas Valley Road passes and which separates the Miller Creek watershed from the Nicasio Creek watershed, a block of Franciscan serpentinite outcrops. It is associated with a section of former oceanic crust (Sloan, 2006).

Below Big Rock Ranch, Quaternary alluvium overlies the Franciscan Complex bedrock within the valley bottom along Miller Creek. This alluvium is the result of hundreds of thousands to millions of years of net valley filling with sediment transported downstream by Miller Creek. These unconsolidated, stratified sands, silts, clays, gravels and cobbles form a veneer of up to 100 feet thick over the bedrock below. In a number of places, Miller Creek has re-incised into these sediments, leaving cliffs of up to 35 feet (Figure 3).

In addition to the erosion, transport and deposition of sediment associated with Miller Creek, landslides and debris flows also dominate geomorphic processes within the steep portions of the project area. Slumping and other types of failure of the incised creek banks can also radically, rapidly alter the landscape, and have significant effects on the channel form both up and downstream of the channel failure. Earthquakes and intense, high-magnitude rain events can both serve as triggers for these episodic, geomorphic events.

3. METHODS

3.1 Rainfall

We installed a tipping bucket rain gage on October 11, 2009 on the old dairy trough located approximately 165 feet northwest of the property gate at Lucas Valley Road (Figure 3). The gage recorded the time of each bucket tip corresponding to 0.01 inches of rain. The recorded rainfall total for water year 2010 was 35.65 inches[2], which is about 105 percent of the long-term average annual rainfall, estimated to be approximately 34 inches (Rantz, 1971). Daily and cumulative rainfall data for water year 2010 are shown in Figure 2 and Form 1. For comparison, rainfall during water year 2010 at a nearby Balance station, located on the west side of Loma Alta in Lagunitas, Marin County, was 110 percent of the average annual rainfall (Owens and Hecht, 2010). Antecedent to water year 2010 was three years of below normal rainfall (http://marinwater.org/controller?action=menuclick&id=221). Water year 2006 was wetter than normal, including a major storm on Dec. 31, 2005 which generated flooding and mudflows throughout the Miller Creek watershed and Lucas Valley.

3.2 Stream Gaging

We installed six stream gaging stations on Grady Ranch (Figure 1): one real-time station on Miller Creek above Grady Bridge[3], one station on each of the four main tributaries flowing into Miller Creek, and one station on Miller Creek at the property line. Two of the tributaries, Landmark Creek and S3 Tributary, are located upstream of Grady Bridge, and the other two tributaries are located downstream of Grady Bridge, Grady Creek and S4 Tributary. The watershed area of the real-time station on Miller Creek above Grady Bridge is 2.1 square miles; the watershed area of Grady Creek, Landmark Creek, and S3 Tributary is 0.4 square miles; and, the watershed area of S4 Tributary is 0.3 square miles. The watershed area of Miller Creek at the downstream property line of Grady Ranch is 2.8 square miles.

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[2] NOAA's Big Rock meteorological station located 1.8 miles east of our rain gage confirms that there was no rainfall in water year 2010 prior to our rain gage installation, e.g., between October 1 and October 10 (http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?caCBIR).

[3] Real-time stage, streamflow, specific conductance, and temperature data are available at www.balancehydro.com/onlinegaging.php. Private gage login required.

We verified our gaging records during at Grady Ranch during 2010 with gaged flows from MMWD's San Geronimo Creek at Lagunitas station, with a watershed area of 8.7 square miles.

We installed a staff plate and datalogger at each gaging station and collected a continuous record of water level (stream stage) for water year 2010. The stage record was converted to streamflow with a stage-discharge rating curve developed with periodic hand streamflow measurements at a range of stages. We used modified U. S. Geological Survey methods to measure streamflow by measuring depth and velocity at many verticals across a cross section of the creek (Rantz and others, 1982). Based on our staff plate readings and streamflow measurements (Appendix A), we created an empirical stage-to-discharge relationship referred to as a stage-discharge "rating curve" (Appendix B). As is typically done, we calibrated the stage record to observations of gage height and then applied stage shifts to the data to account for local fill and scour associated with sediment-transporting storm events. After the stage record is corrected, we apply the stage-discharge rating curve to convert each stage value to streamflow. Our results are presented as daily flow, which are totaled from data recorded and calculated every 15 minutes (Forms 2 – 6) and plotted as annual hydrographs (Figures 5 – 9).

At all of our gages except on Landmark Creek, we measured flows up to 30 to 40 percent of the seasonal peak flow (on January 20th). Landmark Creek is more difficult to access than the other gages and due to time constraints it was not visited during the peak flow event on January 20.[4] To extrapolate beyond the range of measured flow, we extended the rating curves based on professional judgment and verified with extrapolated stage to velocity and stage to cross sectional area rating curves. As with all open-channel gaging of natural streams, some uncertainty remains (especially at high flows) in spite of efforts to be as precise as possible, and data is regarded preliminary and subject to revision as additional measurements are collected.

Three stations were relocated after the streams dried down in preparation for continued gaging during water year 2011:

- The gaging station on Miller Creek at the property line was severely damaged from the first high flows of the season. No data are available for this station during water year 2010. It was relocated to an eddy pool about 600 feet upstream of the property line.

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[4] Our highest measurement on Landmark Creek was ~2 percent of the seasonal peak.

- During water year 2010, sediment filled in the pool at the real-time gage above Grady Bridge. We moved the instrumentation to a pool just upstream on the opposite bank on October 7, 2010.

- At the Grady Creek station, the bank slumped on March 2, 2010 and buried the staff plate and datalogger sensor. We moved the instrumentation just upstream to a pool on the opposite bank on October 19, 2010. The new Grady Creek gage is located upstream of the slump, so as not to be affected by this sediment transported downstream.

3.3 Sediment Transport

3.3.1 Types of sediment sampled

We distinguish two types of sediment in transport: bedload sediment and suspended sediment. *Bedload sediment* is supported by the bed; it rolls and saltates along the bed, commonly within the lowermost 3 inches. Movement can be either continuous or intermittent, but is generally much slower than the mean velocity of the stream. In the Miller Creek channels, as elsewhere in the Bay Area, bedload consists primarily of medium and coarse sands and gravels.

Suspended sediment is supported by the turbulence of the water, and is transported at a rate approaching the mean velocity of flow. In these streams, suspended sediment consists of fine sands, silts, and clays, and tends to be entrained at lower flows than bedload. As a result, fine sediment may be deposited on top of the coarse sands and gravels used for fish spawning further downstream, or can be deposited in pools that are used for summer rearing downstream of Bridgegate Drive.[5]

3.3.2 Field methods for sampling sediment

Standard methods and equipment reviewed by the Federal Interagency Sedimentation Project (FISP) were used to make measurements of sediment transport. Field measurements of sediment discharge are made either by hand samplers applied in transects across the channel at wadeable flows or with cable-suspended samplers from the bridge railing at high flows. We use Helley-Smith 3-inch bedload samplers, and DH-48, DH-81 and D-74 suspended-sediment

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[5] At Grady Ranch, spawning and rearing occurs in the bedrock headwater canyons upstream of the valley. Elsewhere in the Miller Creek watershed, almost nothing is known about where steelhead spawn and rear (Liz Lewis, pers. comm., 2010), which was the subject of a NOAA Fisheries field stud of the stream system during 2010. Comments re spawning and rearing downstream are based on local accounts, presently unsubstantiated.

samplers. Bedload- and suspended-sediment samples are taken at multiple verticals across the creek to collect a representative sample (Emmett, 1980; Edwards and Glysson, 1999, and older references cited therein). For bedload-sediment sampling we first establish the active-bed width by observation and/or preliminary sampling, then sample within that portion of the creek. For suspended-sediment sampling, we use two sampling methods depending on conditions; both methods are used and endorsed by the USGS to collected suspended-sediment samples that are representative of the mean sediment concentration of a stream. The two methods are the equal-discharge-increment method (EDI) and the equal-width-increment method (EWI) (Edwards and Glysson, 1999). With both methods we collect depth-integrated samples at multiple verticals across the creek.

Bedload samples were dried and weighted at Balance's office. Suspended-sediment samples are analyzed by Soil Control Lab in Watsonville, California, a state-certified laboratory.

3.3.3 Sediment-rating curves

The principal purpose of sediment sampling is to develop an annual empirical relationship between the amount of sediment transported at a given flow. These "sediment-rating curves" are valuable for year-to-year comparisons since these curves are diagnostic of the processes of sediment movement through the stream system. As the position or shape of the curve changes, a different relationship between streamflow and sediment transport is expressed, indicating decreases or increases in sediment supply (c.f., Hecht and Owens, 2006). Water year 2010 rating curves provide a clear, rigorous baseline against which post-project conditions can be quantified.

These rating curves are the basis for calculating the volume of sediment transported past the gaging station for each 15-minute period and hence for each day. This continuous record of sediment discharge is vastly simplified from the many individual events, processes, and occurrences that influence the actual discharge of sediment, but experience has shown it to be a useful and reasonably accurate approximation of this complex reality (c.f., Edwards and Glysson, 1999; Emmett, 1980).

For the purposes of this study, we measured bedload- and suspended-sediment discharge at all five gages (Appendix C) and developed preliminary sediment-rating curves at Miller Creek above Grady Bridge based on samples collected at flows ranging from 2.50 to 80.8 cfs (Figure 13). We recognize that extrapolating our curves above 80.8 cfs may be overestimating sediment transport, as some streams have a diminishing rate of increasing transport at highest flows; this may not be the case for Miller Creek, particularly downstream of Grady Bridge where vertical banks are actively collapsing. While future sampling during high flows may elucidate this relationship, water year 2010 sediment data and totals should be considered preliminary and subject to revision due to the irregular and supply-driven nature of sediment discharge in small streams (c.f., Edwards and Glysson, 1999). We will collect another year of sediment transport data before attempting to develop preliminary sediment-rating curves at tributary gages, given fewer samples were collected and the number of samples can limit the precision of the results.

3.4 Groundwater Monitoring

On October 20 – 21, 2009, we observed the installation of four monitoring wells drilled by Taber Consultants to depths ranging from 30 to 40 feet (Appendix D). MW-1, -2, and -3 were located at sites we selected near Miller Creek, and MW- 4 near Grady Creek (Table 3). Prior to installing the monitoring wells, AMEC Geomatrix had conducted a geotechnical investigation of the site in 2008 and, in the course of that study, had installed one monitoring well (RW-6). The well log for RW-6 is also located in Appendix D.

Monitoring well locations are shown on Figure 3. MW-1 and MW-2 are upstream of Grady Bridge. MW-1 is located furthest upstream between the Landmark Creek confluence and S3 confluence, about 1000 feet from Grady Bridge. MW2 is about 100 upstream of Grady Bridge. MW-3 is roughly 350 feet downstream from Grady Bridge and MW-4 is approximately 400 feet upstream from Miller Creek (and Grady Bridge). RW-6 is between Miller Creek and S4 Tributary about 300 feet downstream from Grady Bridge. The wells are located on the valley floor, which is an older stream terrace. They are drilled into alluvium and intersect the shallow water table in the alluvium. We screened the wells to document how and how far groundwater rises during the wet season, falls during the dry season, and interacts with surface water.

Monitoring wells MW-1. -2, -3, and -4 were drilled to bedrock with an 8-inch hollow-stem auger using track mounted CME-55 drill rig.[6] We logged the excavated soils and screened the

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[6] Monitoring well RW-6 was drilled an additional 16 feet into bedrock to a depth of 52 feet with a track-mounted CME-55 4-inch diameter rotary wash (AMEC, 2008).

wells to monitor the most permeable horizon. The wells were constructed of 2-inch, schedule 40 PVC pipe screened with 0.02-inch slots and blank riser consisting of the remaining pipe length to approximately 3 feet above ground surface. We chose to fill the annulus with 30-mesh Monterey sand overlain by a betonite plug, which was then overlain by a concrete grout slurry seal. Cement was also mounded on the ground surface around the wells to drain radially away from the wells, inhibiting ponding of surface water around the casing. All of the wells were vented and secured with a locking cap and "stove pipe."

We collected a continuous record of groundwater water level in all five monitoring wells. Depth-to-water measurements were taken at each monitoring well on each site visit. We calibrated the water surface elevation record to these observations (Figure 17).

3.5 Water Quality

Our limited 2010 water-quality monitoring program had two objectives:

1) to assess aquatic habitat and wetting and drying conditions along Miller Creek and its tributaries using temperature, and
2) to evaluate surface-groundwater interactions, dynamically using specific conductance and temperature, and (on a one-time basis) assess recharge areas and flow paths qualitatively using tracing with general minerals analysis ("major-ion fingerprinting").

We collected continuous temperature data at all the gages, making calibrative hand measurements during site visits. Figure 14 shows the daily water temperature record at the Miller Creek above Grady Bridge real-time station. Additional temperature loggers were also placed in pools on Miller Creek upstream and downstream of Grady Bridge to investigate how this knickpoint affects seasonal wet-up and dry-down dates (Figure 10). For data reference, the maximum daily temperatures in Miller Creek above and below the bridge and in Grady Creek are tabulated in Appendix E.

We also collected continuous specific conductance[7] data at the Miller Creek above Grady Bridge real-time station (Figure 15) and made measurements with hand meters recently calibrated

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[7] Specific conductance measures the ability of the water to conduct electricity, and is a widely used index for salinity or total dissolved solids (TDS). Rainwater has very low specific conductance and, as water passes over and through the ground, salts are dissolved, increasing the specific conductance. Higher

with potassium hydroxide standards at this and all the tributary gages. Specific conductance was converted to an equivalent value at 25 °C according to the accepted polynomial relationship between specific conductance and temperature (see observer log footnotes).

Water-quality samples were collected from the five monitoring wells (MW-1 through -4 and RW-6), from Grady Creek and Landmark Creek during dry-season baseflow, and from bedrock well #B. On November 11, 2009, Forster Pump and Engineering had drilled well #B to a depth of 400 feet and installed perforated casing below a depth of 160 feet (Appendix J). While it was being tested for yield, we collected a water quality sample on November 17, 2009. Bedrock well #B is located near MW-2. The water-quality samples for general-minerals analysis were field filtered through 0.45 micron glass-fiber filter, then preserved and transported per Standard Methods to a California-certified analytical laboratory to be analyzed within acceptable holdtimes for general minerals (Table 2). Laboratory reports are compiled in Appendix F (and Appendix J for bedrock well #B).

3.6 Geophysical Surveys and Geotechnical Borings

As part of the geotechnical investigation (AMEC Geomatrix, 2008), seismic refraction lines[8] and borehole logging were used to develop a geologic map and cross sessions across the property where the proposed commercial building and associate infrastructure is planned (Appendix G). Supplemental seismic refection lines were conducted in October 2009 by Norcal Geophysical Consultants (Norcal) to further characterize the lower Grady Creek and the ridge east to the property boundary (Appendix G). Tiered off this survey, we requested to extend lines across the valley bottom to evaluate the depth of alluvium (Appendix H). Electrical resistivity[9] lines of the lower Grady Creek, S4 Tributary fan, and interconnecting Miller Creek terrace areas were then conducted in January 2010 by Norcal as part of a groundwater supply exploration directed by others (Appendix I). A water-well drilling campaign was executed by Forster Pump and Engineering in November 2009, February 2010, and August 2010. The driller's well completion reports (logs) are compiled in Appendix J.

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specific conductance indicates transmittal through salt-bearing geologic formations or longer residence times in the ground.

[8] The seismic refraction method utilizes the refraction of seismic waves on geologic layers and rock/soil units to characterize the subsurface geologic conditions and geologic structure.

[9] Electrical resistivity (ER) of soils is a function of porosity, water content, ionic concentration of pore water, clay content, and permeability. ER survey are commonly used to map vertical extent of soil types, stratigraphy, clay aquitards, and saline water, and evaluate depth to groundwater and to bedrock.

At a later date, the findings of these subsurface investigations will be used in correspondence with the monitoring data to develop a hydrogeologic framework model that refers to the model grid location and size, model layering, and assignment of property zones to replicate the conceptual understanding of the site. This is the basis of a groundwater flow model and hydrogeologic assessment that will evaluate the effects of the proposed creek and valley restoration plan on groundwater elevations, and eventually on the likely duration of flow in channels used for steelhead migration.

4. DISCUSSION

4.1 Hydrologic Summary

Water year 2010 (WY2010) began with an unusually large storm early in the season, the largest intensity storm of WY2010 that produced 4.74 inches of rain on October 13, 2009 at Grady Ranch (Figure 4). It generated baseflow and wetted pools downstream of Grady Bridge (Figure 10). It was followed by two months of sub-normal rainfall, although the baseflow continued downstream of the bridge, though it receded at times and places, and in places to near-negligible levels. A moderate storm occurred on December 12, sufficient to generate surface runoff and cause very short-lived flow at Landmark Creek and S3 and S4 tributaries. Isolated light rain fell until another moderate storm took place on January 12. This 1.1-inch event pushed the cumulative rainfall total to 10.99 inches and resulted in flow at all the gages, except Grady Creek. A series of large storms followed during the third week of January, which initiated flow at the Grady Creek gage and produced the seasonal peak flow on January 20[10] at all gages. Several moderate storms typical of the region sustained flows in February, but then March was relatively dry and all of the streams except for Grady Creek and S4 Tributary dried down towards the end of the month. More rain fell in April than had fallen in March, and these spring showers wetted up the creeks, some of which had gone temporarily dry at the gage sites, and sustained flows in the creeks that remained wet. Very light showers continued into May, but all the gages were dry by May 2.

Annual hydrographs for all five creeks are plotted in Figure 5 through 9. S3 Tributary was the only stream to dry up in the middle of February and therefore represents the most intermittent stream onsite. The total monthly flow (the volume discharged) at each of the five gages are summarized in Table 3. Of the four tributaries, Grady Creek had the highest unit discharge and generated considerably more flow during WY2010, particularly later in the season (Table 3). Unit hydrographs are plotted in Figure 15. "Unit flow" is calculated by dividing the daily mean flow by the watershed area and allows for comparison of the response to rainfall among different watersheds. In general, the magnitude of streamflow is governed by the size of the watershed, so that a larger watershed produces higher flows. However, differences among

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[10] High water marks observed in the field indicate that the January 20 event was approximately a bankfull event, which roughly corresponds to a 1.5-year recurrence flood or a flood with an exceedance probability of 67 percent.

streams in wet- and dry-season baseflows also reflect variations in the topography, geology, and land use within their watersheds. In March and April, Grady Creek and S4 Tributary exhibit higher falling-limb flows than the other streams, which suggests these stations may be augmented by groundwater discharge.[11] Grady Creek also need slightly more precipitation to generate flow, the watershed ostensibly requiring more groundwater recharge to initially fill the alluvial aquifer which subsequently allowed the flow in Grady Creek to persist a few days longer than in other tributaries.

We also compared unit flows at Miller Creek above Grady Bridge to the San Geronimo Creek station at Lagunitas (Figure 12). Coincident timing of the peaks corroborated our gaging, but most notably, Miller Creek flowed intermittently – dry for more than eight months of the year. In contrast, San Geronimo Creek had continuous flow.[12] Miller Creek is higher in its watershed with mudflow deposits and deeper alluvium than San Geronimo Creek,, which drains over bedrock at the gage beneath Lagunitas Road, where all groundwater and baseflow is forced to the surface. We also found of note that the two streams have similar magnitudes of *unit-flow* peaks, even though Miller Creek receives ~25 percent less rainfall, attesting to the 'flashiness' of the flows on Miller Creek. San Geronimo Creek has four times the watershed area and considerably more conifer-forested slopes with deep soils, which tends to delay runoff and sustain longer baseflows.

4.2 Sediment Transport

Bedload and suspended sediment transport was measured in the Miller Creek because (a) they are factors impairing habitat quality downstream from Grady Ranch, and (b) because – when noticeably greater than in adjoining streams -- they help identify channels which are rapidly incising or which are otherwise disturbed.

As occurs universally, sediment discharge increased as flow increased (Figure 13). On Miller Creek, the sediment-rating curves for bedload and for suspended-sediment are similar to each other, characterizing a stream with abundant supply, and with sediment readily available for

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[11] Big Rock Ridge is stratigraphically capped by weathered fine-grained sandstone that respond as an aquifer and, at times, the source of landslides and mudflows in the tributaries, as observed following high duration-intensity storms such as December 31, 2005 and January 4, 1982.

[12] Continuous flow and wetted bedrock pools were noted in the canyon further upstream of Grady Creek, Landmark Creek, and N1 Tributary.

transport. The magnitude of sediment transported is similar in contrast to San Geronimo Creek, which had 17 times more suspended-sediment load that bedload during WY2010 (Table 4). Furthermore, Miller Creek transported considerably more sediment per unit volume of flow than San Geronimo Creek – 5 times the concentration of suspended sediment and 64 times the concentration of bedload (Table 4). Roughly half of the sediment load was discharged during the 24-hour seasonal peak flows on January 20, 2010. The peak flow on that date rose to a level which we had previously identified as morphologic bankfull.

Landmark Creek, S3 Tributary, Grady Creek, and S4 Tributary have higher rates of transport at any given flow than Miller Creek, a much larger watershed (Figure 13). This condition is a typical and nearly universal throughout Marin County (c.f., Hecht, 1983) and the Bay Area (c.f., Hecht and Owens, 2006) given that smaller watersheds have briefer, flashier hydrographs flowing through smaller, steeper channels.

For streams of a given size, a much higher rate of transport at a given flow can be an indicator of active channel incision. Hecht and Owens (2006) showed that incising channels elsewhere in the Bay Area manifested transport rates typically 5 to 10 greater at a given flow than streams from otherwise similar watersheds which are not incising.

4.3 Water Quality

We found that water temperatures in Miller Creek and Grady Creek were within the reported acceptable range for steelhead habitat (Appendix E). Maximum daily temperatures increased as streamflows receded, the creeks dried down, and weather became seasonally warmer, but remained in an acceptable level for steelhead habitat (Figure 14). Specific conductance (plotted in Figure 15) typically remained stable at roughly 200 umhos per centimeter (@ 25°C) during periods of baseflow, diminishing sharply as rainfall runoff increased during storm events. The specific conductance values are similar to other central Marin streams, such as San Geronimo Creek and the tributaries of Lagunitas Creek, suggesting that flow emanates from the alluvial aquifer rather than deeper bedrock sources (see discussion in Hecht and others, 2010). The ionic signatures of the samples support this finding, as illustrated when plotted on a Piper diagram (Figure 13); monitoring wells MW-1, -2, -3, and RW-6 are similar to the surface water samples, and can be characterized as a calcium carbonate groundwater source with a significant portion of magnesium, which is typical for the region.

In contrast to the alluvial groundwater and surface-water samples, the ionic signature of the sample collected from the bedrock well #B is dominated by sodium and chloride. This signature is also apparent MW-4 (near upper Grady Creek), which either suggests groundwater contributions from bedrock or from the recently placed bentonite (clay) in the well annulus when completing the well. Re-sampling during dry-season 2011 could address the likely source of groundwater from MW-4.

Well #B also has elevated concentrations of iron, aluminum, and fluoride (above California Title 22 drinking water standards, as shown in Table 2). The boron concentration was also elevated (8.38 mg/L), a level higher than tolerated by nearly all ornamental plants and California natives[13]. The contrasting low levels of boron in stream water is a second line of evidence pointing toward alluvium as the overwhelming source of groundwater entering the streams, in contrast to bedrock.

4.4 Surface-water and Groundwater Interactions

At the end of the dry season, groundwater elevations were considerably lower than during mid-winter (Figure 17). The largest seasonal fluctuation in groundwater elevation was observed in the upstream monitoring well MW-1 (18 feet), and the smallest furthest downstream in MW-3 (8 feet). MW-2 near Grady Bridge and MW-4 near Grady Creek fluctuated 16 feet, and RW-6 fluctuated 15 feet. This pattern reflects the potential for groundwater storage in the valley aquifer. When the storms commenced during WY2010, aquifer recharge elevated the groundwater levels in the valley alluvium. Groundwater elevations rebounded significantly with each storm, then receded between storms. Once 11 inches of rain had fallen, flow became continuous on Miller Creek, with groundwater levels stabilizing at a high winter level. Water levels for MW-1, -3, and -4 remained relatively stable during the following mid-winter storms, while MW-2 (closest to Grady Bridge knickpoint) and particularly RW-6 declined over time. RW-6 also showed the largest storm rebound, owing to its higher declining rates water levels. In addition to intersecting sands and gravels, RW-6 is located between Miller Creek and the S4 Tributary, which may account for the greater and more rapid rates of decline. The dry-season recession began in May for all wells except MW-3,

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[13] Boron is important in agriculture. Small amounts are essential to plant growth. Greater concentrations in soil and irrigation water are harmful, however, and the toxic concentration for some plants such as lemon or orange trees is as low as 1 mg/L. (Hem, 1985). Boron at these levels is not thought to negatively affect mammals, including humans.

which began its decline in July. MW-3 is overlain by 15 feet of a silty clay mudflow deposit, which confines the alluvium.

At three sites, water elevations at the gaging stations were compared to an adjacent monitoring well:

- Miller Creek above Grady Bridge (Figure 18). Largely driven by the 11-foot knickpoint immediately downstream, this reach loses water to the alluvial aquifer. Groundwater recharge keeps groundwater levels high until a mid-winter dry spell or the onset of the dry season when streamflow recedes, feeding the groundwater which discharges at and beneath the foot of the Grady Bridge knickpoint. This artificial and anthropogenic condition induces infiltration above the bridge, prematurely desiccating the channel early in the drydown season. .

- Grady Creek (Figure 19) and S4 Tributary (Figure 20). Grady Creek and S4 Tributary gain water from the aquifer and dries down in response to receding groundwater levels.

5. CONCLUSIONS AND RECOMMENDATIONS

Grady Ranch lies in the headwaters of Miller Creek watershed where flows in the alluvial channels are intermittent, but perennial in portions of the bedrock headwater canyons.[14]

The rainfall total and seasonal distribution of storms were roughly normal during water year 2010, except for an unusually large early season storm on October 13th that initiated flow for the season downstream of Grady Bridge 11-foot knickpoint. Upstream of Grady Bridge, the channel was dry until mid-January after 11 inches of cumulative rainfall. Flows also dried back briefly during the March dry spell and then on May 1st for the remainder of the dry season, while flows downstream of Grady Bridge were continuous until July 4th. The seasonal pattern of flow observed on Miller Creek above Grady Bridge was similar to pattern of flow monitored the four principal tributaries on Grady Ranch.

Grady Creek needed the most rain to generate continuous streamflow to its confluence with Miller Creek, owing to a higher rate of alluvial groundwater recharge in its watershed. Of the four tributaries we monitored, Grady Creek had the highest unit discharge and generated considerably more flow during WY2010, particularly later in the season. Flow in Grady Creek and the S4 Tributary persisted longer into the spring than others, while S3 Tributary was most intermittent. Grady Creek generate more runoff than the other gaged tributaries, which are of nearly equal area (Table 3); this will be further assessed with gaging data from year-two (WY2011).

The analysis of surface-water and groundwater interaction shows that Miller Creek above Grady Bridge is a losing reach, while tributaries Grady Creek and S4 are gain water from groundwater discharge. Miller Creek below Grady Bridge also appears to be a gaining reach. Results of water quality sampling and a general mineral analysis suggests that flow emanates primarily from the alluvial aquifer rather than deeper bedrock sources, with the possible exception of contributions from deeper bedrock groundwater at the mouth Grady Creek (which would need re-testing to confirm).

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[14] Perennial flows were observed on bedrock canyon channel of Grady Creek, Landmark Creek and N1 Tributary. Tributary watershed south of Lucas Valley Road were on off site private property and not investigated.

Groundwater levels in the valley alluvium fluctuated annually – from wet-season recharge to dry-season recession – 15 to 18 feet across most of the valley. Groundwater flow closely parallels the main streams. Depth to water below stream channels was 9 to 15 feet during late dry season, reflecting a potential for aquifer storage if the high groundwater discharge rates to the incised channels were retarded by restoration. In addition, restoring higher groundwater during the months of spring will result in a more persistent flow through the creek system.

Sediment transport rates were high relative to San Geronimo Creek, particularly bedload transport. Rates were also elevated relative to those in other Marin County streams of similar size and geomorphic location. The elevated rates may be associated with ongoing channel incision, as the watershed is presently well-vegetated, with minimal disruption or bare surfaces to account for the high loads observed. Rates may also be episodically elevated due to the effects of the Dec. 31, 2005 storm, one of the largest during the past century or two in this watershed.

A stream and valley restoration plan proposed on Grady Ranch is related to a proposed digital technology-based entertainment production facility and associated infrastructure planned for the Grady Creek watershed. This report presents findings from year-one of a multi-year pre-construction hydrologic monitoring on Grady Ranch. In addition to data collected and presented in this report, we intend to use data collected from year-two monitoring to establish a conceptual understanding of groundwater flow at the site. A groundwater flow model will then be developed to evaluate the effects of the proposed creek and valley restoration plan on groundwater levels and streamflow persistence.

6. LIMITATIONS

This report was prepared in general accordance with the accepted standard of practice existing in Northern California at the time the investigation was performed. No other warranties, expressed or implied, are made. It should be recognized that interpretation and evaluation of dynamic flow and subsurface conditions is a difficult and inexact art. More extensive studies, including those recommended above, can reduce some of the uncertainties associated with this study.

Balance Hydrologics has prepared this report for the client's exclusive use on this particular groundwater study. Analyses and information included in this report are intended for use at the watershed scale and for the planning purposes described above. Analyses of channels and other water bodies, rocks, earth properties, topography and/or environmental processes are generalized to be useful at the scale of a watershed, both spatially and temporally. Information and interpretations presented in this report should not be applied to specific projects or sites without the expressed written permission of the authors, nor should they be used beyond the particular area to which we have applied them.

This study was conducted partly to help calibrate work done by others, which has not been independently verified. Our conclusions and any implied or inferred recommendations are based on a limited range of surface water and groundwater data in a region of relatively complex geology. They are limited to planning purposes and should not be used for design or site-specific work. Even with these limitations, all work should be cited with the specific cautions listed in the report, given the brief period of record. If readers are aware of additional data, observations, conditions, or forthcoming changes to the bases of our computations or conclusions, please let us know at the first opportunity, such that this report may be promptly revised. Contacts and responsible individuals are given, such that such notifications can occur easily and quickly.

7. REFERENCES

AMEC Geomatrix, 2008, Geotechnical evaluation, Grady Ranch precise development plan, Marin County, California: Consulting report submitted to CSW|ST2 for Skywalker Properties, Ltd., 36 p., plus appendices.

Blake, M. C., Graymer, R.W., and Jones D. L., 2000. Geologic map and map database of parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California. U.S. Geological Survey Miscellaneous Field Studies MF-2337, 23p.

Brown, S, and Hecht, B, 2011a, Existing channel stability in upper Miller Creek on Grady Ranch, Marin County, California: Balance Hydrologics consulting report prepared for Skywalker Properties, Ltd., 12 p, plus appendices

Brown, S, and Hecht, B, 2011b, Regional analogs to proposed restoration of Miller Creek, Grady Ranch, Marin County, California: Balance Hydrologics consulting report prepared for Skywalker Properties, Ltd., xx p.

Brown, S, and Hecht, B, 2009, Stream and valley floor restoration vision: Consulting report prepared for Skywalker Properties, Ltd., 7 p.

Brown, S, Woyshner, M., and Hecht, B, 2011, Grady Ranch Valley Aquifer and Creek Restoration Plan and Alternatives, Marin County, California: Balance Hydrologics consulting report prepared for Skywalker Properties, Ltd., xx p.

Brown, S., Owens, J., Woyshner, M., Bartholomaus, T., and Hecht, B., 2008, Geomorphic assessment of upper Miller Creek, Grady Creek, and their tributaries, Grady Ranch, Marin County, California: Balance Hydrologics consulting report prepared for Skywalker Properties, Ltd., xx p.

CSW|ST2, 2009a, Grady Ranch precise development plan (DP 09-7), Assessor's Parcels 164-310-15, -17, and -19, 2828 Lucas Valley Road, San Rafael: Submittal to the Marin County Community Development Agency, April 14, 2009

CSW|ST2, 2009b, Response to comments to the Grady Ranch precise development plan (DP 09-7) Notice of Project Status letter (NOPS1) dated May 29, 2009: Submitted to the Marin County Community Development Agency, November 25, 2009

CSW/ST2, 2009c, Preliminary hydrology report. Consulting report prepared as part of the Grady Ranch PDP application to Marin County.

Emmett, W. W., III, 1980, A field calibration of the sediment-trapping characteristics of the Helley-Smith bedload sampler : U.S. Geological Survey Open-File Report 79-411, 48 p.

Edwards, T.K., and Glysson, G.D., 1999, Field methods for measurement of fluvial sediment: Techniques of water-resource investigations of the U.S. Geological Survey. Chapter C2, Book 3, Applications of Hydraulics, U.S. Department of the Interior, Reston, Virginia. (See also techniques and criteria described in older USGS TWRI manuals cited and subsumed in this report.)

Haltiner, J.P., Kondolf, G.M., and Williams, P.B., 1996, Restoration approaches in California. In: Brookes and Shields, (eds.) River Channel Restoration: Guiding Principles for Sustainable Projects. John Wiley and Sons, Chichester, NY, Ch.11.

Hecht, B., 1983, Substrate enhancement / sediment management study. Lagunitas Creek, Marin County, Phase IIIb -- sediment transport and bed conditions, 1979-1982: HEA consulting report prepared for the Marin Municipal Water District, 172 p + appendices.

Hecht, B., and Owens, J., 2006, 2006, Evaluating sediment discharge in unregulated streams tributary to San Francisco and Suisun Bays: Bay-Delta Conference presentation abs.

Hecht, B., Strudley, M. and Brown, S., 2010, Lagunitas Creek sediment and riparian management plan, Marin County, California: streambed monitoring report, 1995-2007, 38 p + 5 appendices

Hem, J. D., 1985, Study and interpretation of the chemical characteristics of natural water: U. S. Geological Survey Water-Supply Paper 2254, Third edition. 263 p.

Nichols-Berman, 1996, Final environmental impact report: Lucasfilm Ltd., Grady Ranch/Big Rock Ranch Master Plan. FEIR prepared for Marin County Community Development Agency. State Clearinghouse No. 95033021. Multiple volumes.

Owens, J. and Hecht, B., 2010, Streamflow and sediment transport in San Geronimo Creek at Lagunitas Road, WY2010: Balance Hydrologics, Inc. consulting report prepared for the Marin Municipal Water District, 18 p.

Owens, J., Hecht, B., Chartrand, S., and Ballman, E., 2011, Feasibility of restoration concept at Grady Ranch, Marin County, California: Balance Hydrologics consulting report prepared for Skywalker Properties, Ltd., 11 p.

Owens, J., Brown, S., Woyshner, M., Ballman, E., and Hecht, B., 2008, Hydrologic and geomorphic recommendations for stream conservation areas at Grady Ranch, Marin County, California: Balance Hydrologics consulting report prepared for Skywalker Properties, Ltd., 26 p.

Prunuske Chatham, with assistance from Stillwater Sciences, 2010, San Geronimo Valley salmon enhancement plan: A guidance document: Consulting report prepared for Marin County, 140 p. + appendices.

Rantz, S.E., 1971, Precipitation depth-duration-frequency relations in the San Francisco Bay region, California, U.S. Geological Survey HUD Basic Data Contribution 25.

Rantz, S.E., 1974, Mean annual runoff in the San Francisco Bay Region, California, 1931-1970: U.S. Geological Survey Map MF-613.

Rantz and others, 1982, Measurement and computation of streamflow: U. S. Geological Survey Water-Supply Paper 2175, volume 1, p. 1-284, volume 2, p. 285-631.

Sloan, D., 2006, Geology of the San Francisco Bay Region: Berkeley, University of California Press, 337p.

Stillwater Sciences, 2009, San Geronimo Valley existing conditions report, prepared for the Marin County Public Works Department.

Vandivere, W., and Mock, N., 2005, Hydraulic and geomorphic assessment of Miller Creek, Monahan property reach, Marin County, CA: Consulting report by Clearwater Hydrology prepared for Monahan Pacific Construction Corp., Marin County, CA, June 3, 2005, 9 p. + appendices.

Vandivere, W.B., 1985, Hydrologic analysis for Deerfield Park Phase I Improvement plan: Phillip Williams and Associates consulting report, 22p. + appendices.

Vandivere, W.B., 1994. Preliminary grading and drainage plan, sheet 7, 1994.

Woyshner, M., Richmond, S., and Hecht, B., 2011, Baseline channel conditions downstream of Grady Ranch, Marin County, California: Balance Hydrologics consulting report prepared for Skywalker Properties, Ltd., 35 p.

WRA, 2011, Dry-season salmonid habitat assessment for Grady Ranch, Marin County, California: report in progress

WRA, Inc., 2008a, Section 7 biological assessment. Consulting report prepared as part of the Grady Ranch PDP application to Marin County.

WRA, Inc., 2008b, Stream restoration and monitoring report. Consulting report prepared as part of the Grady Ranch PDP application to Marin County.

TABLES

Table 1. Gaging station and monitoring well descriptors, Grady Ranch, Marin County, California.

	Gaging Stations					Monitoring Wells				
	Landmark Creek	S3 Tributary	Miller Creek above Grady Bridge	Grady Creek	S4 Tributary	MW-1	MW-2	MW-3	MW-4	RW-6
ID	N3	S3	M1	N4	S4	--	--	--	--	--
Latitude, WGS84 (degrees N)	38.04357	38.04049	38.03958	38.04052	38.03871	38.04121	38.04002	38.03901	38.04049	38.03878
Longitude, WGS84 (degrees W)	122.60661	122.60454	122.60253	122.60103	122.60323	122.60544	122.60269	122.6015	122.60134	122.60247
Date installed	11/16/2009	11/16/2009	11/4/2009	11/4/2009	11/16/2009	10/20/2009	10/20/2009	10/21/2009	10/21/2009	8/24/2009
Watershed area (sq. mi.)	0.4	0.4	2.1	0.4	0.3	--	--	--	--	--
Reference elevation, feet msl (gage height 0.0 or top of well casing)	255.84	227.49	224.01	228.21	207.94	255.61	241.79	236.26	248.99	236.16
Channel bed elevation or ground surface elevation near well, feet msl	262.54	234.24	225.86	235.06	214.54	252.69	238.44	234.27	245.82	233.7
Depth of well seal, feet below ground surface	--	--	--	--	--	17	19	15	15	17.5
Screened interval, feet below ground surface	--	--	--	--	--	20-30	25-35	30-40	20-30	20-52
Bottom of casing, feet below ground surface	--	--	--	--	--	30	35	40	30	52
Bottom of casing elevation, feet msl	--	--	--	--	--	222.69	203.44	194.27	215.82	181.70

Table 2. Summary of field measurements and water quality analyses, Grady Ranch, Marin County, California.

PARAMETER	UNITS	DETECTION LIMIT	MCL	Groundwater Samples									Surface Water Samples	
DESCRIPTORS														
Sample I.D.				091021:1110	091021:1352	091104:1632	091104:0957	091104:1150	091104:1709	091117:1630	091119	091202:1300	091117:1600	091117:1700
Site				MW-3	MW-4	MW-1	MW-2	MW-3	MW-4	Test Well B	Test Well B	RW-6	Landmark Creek	Grady Creek
Assessors parcel number				164-310-15,-17,-19	164-310-15,-17,-19	164-310-15,-17,-19	164-310-15,-17,-20	164-310-15,-17,-21	164-310-15,-17,-22	164-310-15,-17,-20	164-310-15,-17,-20	164-310-15,-17,-20	164-310-15,-17,-22	164-310-15,-17,-22
Latitude, WGS84	degrees			N38.0391	N38.04049	N38.04121	N38.04002	N38.0391	N38.04049	N38.041288	N38.041288	N38.038784	N38.043994	N38.042869
Longitude, WGS84	degrees			W122.60150	W122.60134	W122.60544	W122.60269	W122.60150	W122.60134	W122.604357	W122.604357	W122.602470	W122.606615	W122.598375
Elevation, NGVD29	feet			234	244	252	239	234	244	291	291	235	284	336
Lab used				Soil Control	Soil Control	MBAS	MBAS	MBAS	MBAS	MBAS	Analytical Sciences	MBAS	MBAS	MBAS
Sample collected by				sr, gp	sr, gp	sr, tb	sr, tb	sr, tb	sr, tb	mw	Forester P&E	mw	mw	mw
Sample filtering				yes	yes	no	no	no	no	no		no	no	no
FIELD MEASUREMENTS														
Date	MM/DD/YY			10/21/09	10/21/09	11/4/09	11/4/09	11/4/09	11/4/09	11/17/09	11/19/09	12/2/09	11/17/09	11/17/09
Time	HH:MM			11:10	13:52	16:32	9:57	11:50	17:09	16:30		13:00	16:00	17:00
Specific conductance (@ 25 C°)	umhos/cm			276 (top), 531(bottom)	491	357.4	322.0	306.8						
Conductance (@ field temp)	umhos/cm			220, 360	401.4	290.3	261.5	250.4						
Temperature	deg C			15, 9	15	15.1	15.2	15.3						
WATER QUALITY INDICATORS														
Alkalinity (total)	ng/L CaCO	1		210	170	140	121	122	139	190	170	148	171	163
Hardness (total)	ng/L CaCO	5		160	140						28			
pH	pH Units	0.1	10.6	7.1	6.9	6.8	6.9	7.0	8.2	8.5	8.22	7.3	7.7	8.2
Specific conductance (@ 25 C°)	umhos/cm	1	1600	450	490	349	317	309	866	1033		407	405	394
Total dissolved solids (TDS)	mg/L	10	1000	250	260	243	240	218	518	638		253	250	225
GENERAL MINERALS														
Bicarbonate (as CaCO3)	mg/L	10		205	164	140	121	122	139	190	170	148	171	163
Bicarbonate (as HCO3)	mg/L	1		250	200	171	148	149	170	232	207	181	209	199
Calcium (Ca)	mg/L	0.5		37	33	35	26	26	34	10	9	31	45	50
Carbonate (as CaCO3)	mg/L	6	120	0	0						0			
Carbonate (as CO3)	mg/L	1	120	0	0						0			
Chloride (Cl)	mg/L	1	250	27	43	11	12	10	140	194		20	12	10
Iron (Fe)	mg/L	0.05	0.3	0.31	0						2.1			
Magnesium (Mg)	mg/L	0.5		15	14	15	15	14	12	2	1.2	20	14	13
Manganese (Mn)	mg/L	0.02	0.05	0.19	0.055						0.031			
Potassiuim (K)	mg/L	0.5		5	6.3	1	1.4	2.1	5	4.4		2.4	0.8	0.8
Sodium (Na)	mg/L	0.5		27	36	16	16	13	120	212	210	22	19	16
Sulfate (SO4)	mg/L	1	250	20	26	19	14	11	56	5		22	23	29
TITLE 22 PRIMARY STANDARDS, INORGANIC														
Aluminum (Al)	mg/L	0.05	1								1.7			
Antimony (Sb)	mg/L	0.006	0.01								0			
Arsenic (As)	mg/L	0.002	0.010								0			
Barium (Ba)	mg/L	0.1	1								0.068			
Beryllium (Be)	mg/L	0.001	0								0			
Cadmium (Cd)	mg/L	0.001	0.01								0			
Chromium (Cr)	mg/L	0.001	0.05								0.0056			
Fluoride (F)	mg/L	0.1	1	0.24	0.24						2.2			
Mercury (Hg)	mg/L	0.0002	0								0			
Nickel (Ni)	mg/L	0.01	0.1								0			
Nitrate as (NO3)	mg/L	1	45	2.6	5.1	1	3	2	1	1	0	0.2	0	1
Selenium (Se)	mg/L	0.005	0.05								0			
Thallium (Tl)	mg/L	0.001	0								0			
OTHER CONSTITUENTS														
Boron (B)	mg/L	0.1				0.05	0.06	0.06	0.26	8.38		0.3	0.06	0.14
Copper (Cu)	mg/L	0.05	1	0	0									
Cyanide (CN)	mg/L	0.05									0.16			
Lead (Pb)	mg/L	0.005	0.02											
Sliver (Ag)	mg/L	0.01												
Zinc (Zn)	mg/L	0.05	5	0	0									
Gross Alpha	pCi/L		15											
LAB CHECK														
Major Cations (Ca+Mg+K+Na)	meq/L	--	--	4.38	4.53	3.70	3.26	3.07	8.03	10.00		4.21	4.24	4.28
Major Anions (HCO3+CO3+Cl+SO4)	meq/L	--	--	5.28	5.03	3.51	3.06	2.95	7.90	9.38		3.99	4.24	4.15
Ion Balance (Cations/Anions)	--	--	--	0.83	0.90	1.06	1.07	1.04	1.02	1.07		1.06	1.00	1.03

NOTES

Observer key: sr = Sarah Richmond; gp = Gustavo Porras; tb = Travis Baggett; mw = Mark Woyshner

Lab results: 0 = not detected; blank value = not tested

MCL = Title 22 Maximum Contaminant Level as of June 12, 2003; the MCL of Lead is the Regulatory Action Level

Table 3. Total monthly surface flow in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Month	Landmark Creek (N3) (acer-feet)	S3 Tributary (acer-feet)	Miller Creek above Grady Bridge (M1) (acer-feet)	Grady Creek (N4) (acer-feet)	S4 Tributary (acer-feet)	Miller Creek below S4 (M2=M1+N4+S4) [a] (acer-feet)
Water Year 2010						
October	no data	no data	no data	no data	no data	no data
November	no data	no data	0	0	no data	no data
December	1	1	0	0	3	3
January	113	120	709	170	98	977
February	64	61	454	96	67	617
March	34	27	200	71	39	310
April	29	40	257	78	40	375
May	0	0	0	0	0	0
June	0	0	0	0	0	0
July	0	0	0	0	0	0
August	0	0	0	0	0	0
September	0	0	0	0	0	0
Annual	241	249	1620	415	247	2282
Watershed area (miles^2)	0.4	0.4	2.1	0.4	0.3	2.8
Unit discharge (cfs/mile^2)	0.83	0.86	1.1	1.4	1.1	1.1

Note:

a. Flow in Miller Creek below S4 Tributary was calculated as the sum of Miller Creek above Grady Bridge (station M1), Grady Creek (station N4), and S4 Tributary.

Table 4. Discharge intensity and duration in Miller Creek above Grady Bridge, Marin County, California.

Storm Event		Rainfall (inches)	Runoff Volume (ac-ft)	Mean Flow (cfs)	Mean Unit Flow [a] (cfs/sq.mi.)	Sediment Load		Sediment Concentration	
						Suspended (tons)	Bedload (tons)	Suspended (tons/ac-ft)	Bedload (tons/ac-ft)
Miller Creek above Grady Bridge									
24 hours	January 20, 2010	2.38	135	68.3	32.5	323	242	2.39	1.79
72 hours	January 19-21, 2010	5.78	329	55.3	26.3	477	358	1.45	1.09
7 days	January 18-24, 2010	7.84	512	36.9	17.6	532	399	1.04	0.779
10 days	January 18-27, 2010	9.56 [b]	651	32.8	15.6	555	416	0.852	0.639
30 days	January 18 - February 16, 2010	13.20 [c]	959	16.1	7.67	585	439	0.610	0.458
60 days	January 17 - March 17, 2010	18.45 [d]	1343	11.3	5.37	619	464	0.461	0.345
Total flow	January 12 - April 30, 2010	35.65	1620	7.49	3.57	639	480	0.395	0.296
	Water Year 2010	35.65	1620	2.24	1.07	639	480	**0.395**	**0.296**
							Multiples of San Geronimo Creek =	*5.1*	*64*
San Geronimo Creek at Lagunitas Road									
Total flow	Water Year 2010	50.03	9070	12.50	1.44	706	42	**0.078**	**0.005**
							Percent of Miller Creek above Grady Bridge =	*20%*	*2%*

Notes;

a. Watershed area above gaging station is 2.1 square miles above the Miller Creek station and 8.7 square miles above the San Geronimo Creek station.

b. Rainfall on January 17-26. No rain on January 27.

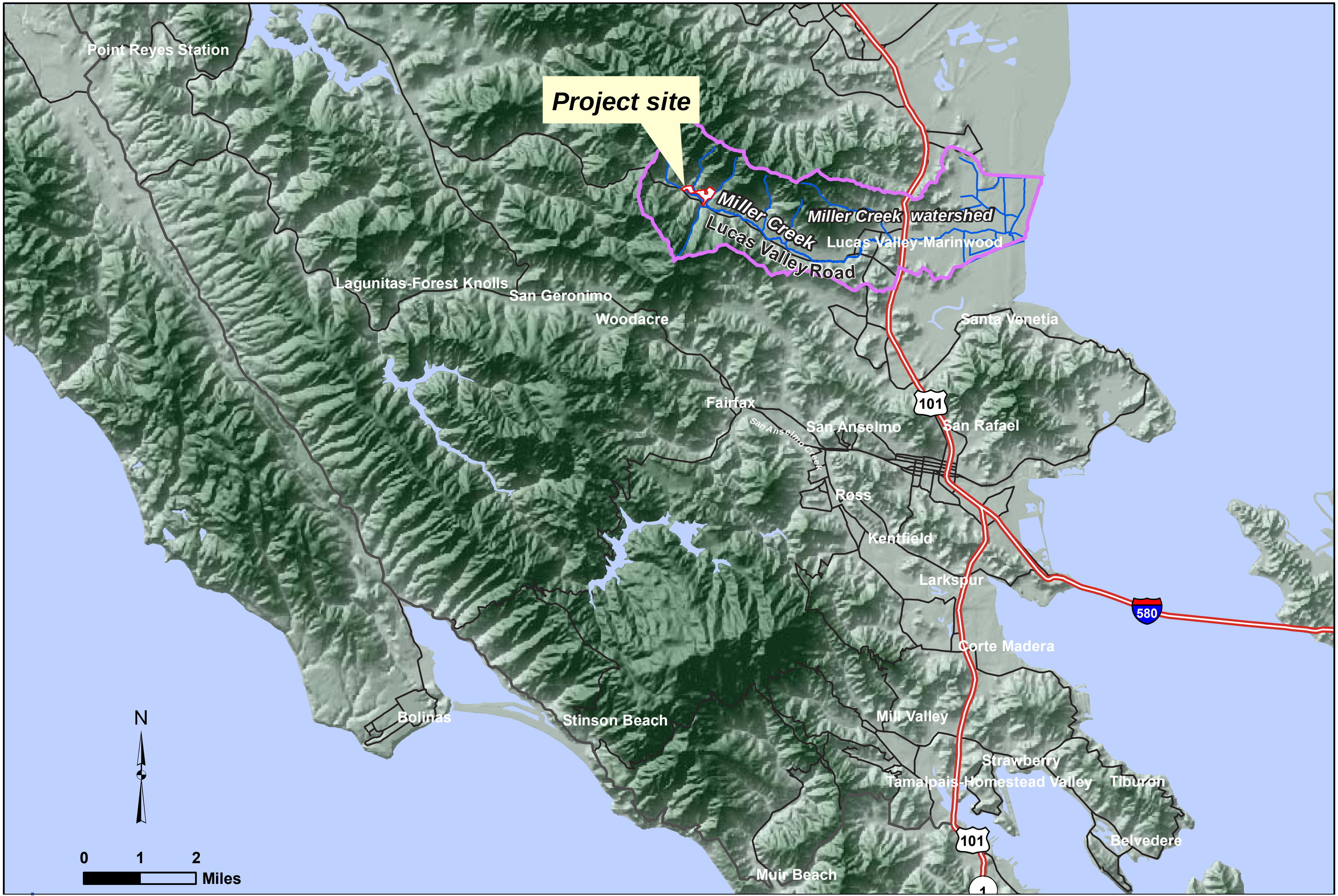
c. Rainfall on January 16 - February 13. No rain on February 14-16.

d. Rainfall on January 16 - March 12. No rain on February 13-17.

e. Values shown with more than 2 or 3 significant figures are the result of electronic calculations and do not imply increased precision.

Data preliminary and subject to revision

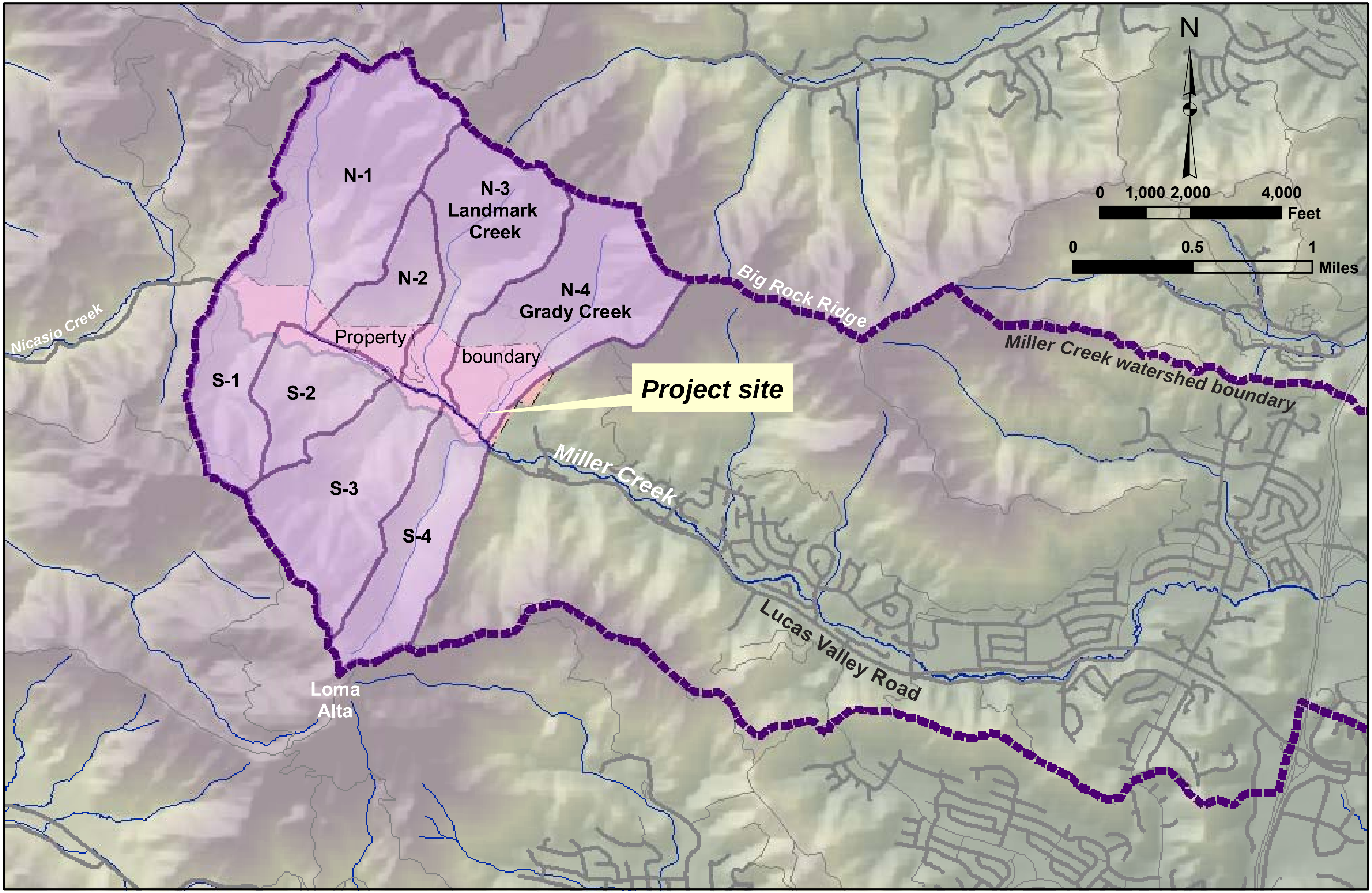
FIGURES



Balance Hydrologics, Inc.

208164 marin _location_map.mxd

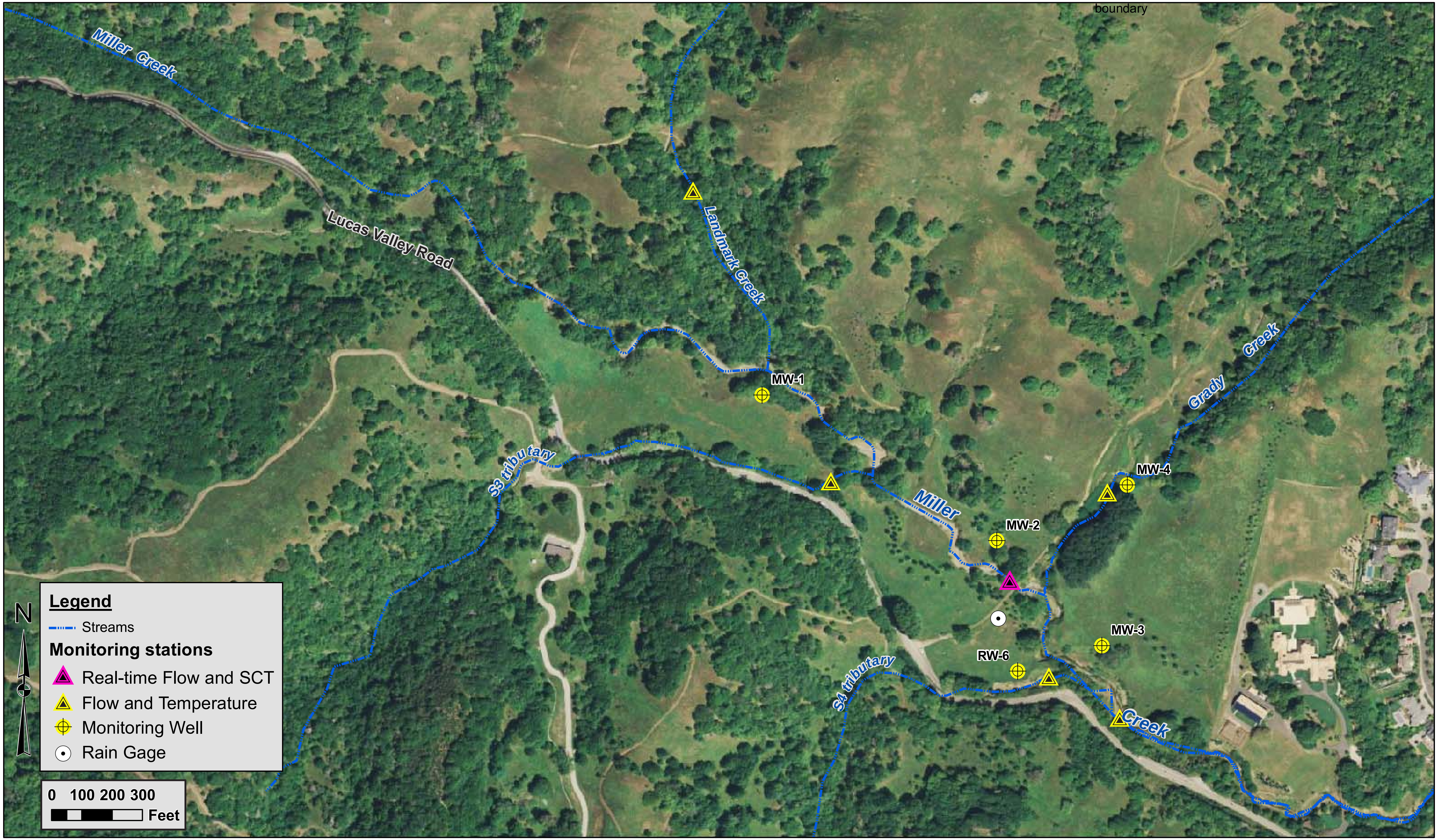
Figure 1. Location of Grady Ranch, Marin County, California



Balance
Hydrologics, Inc.

208164 wsheds & tribs2.mxd

Figure 2. Map of the upper Miller Creek watershed and tributaries, Grady Ranch, Marin County, California.



Aerial photo source: Digital Globe, dated 4-1-09.

Balance Hydrologics, Inc.

208164 monitoring stations.mxd

Figure 3. Monitoring stations at Grady Ranch, Marin County, California.

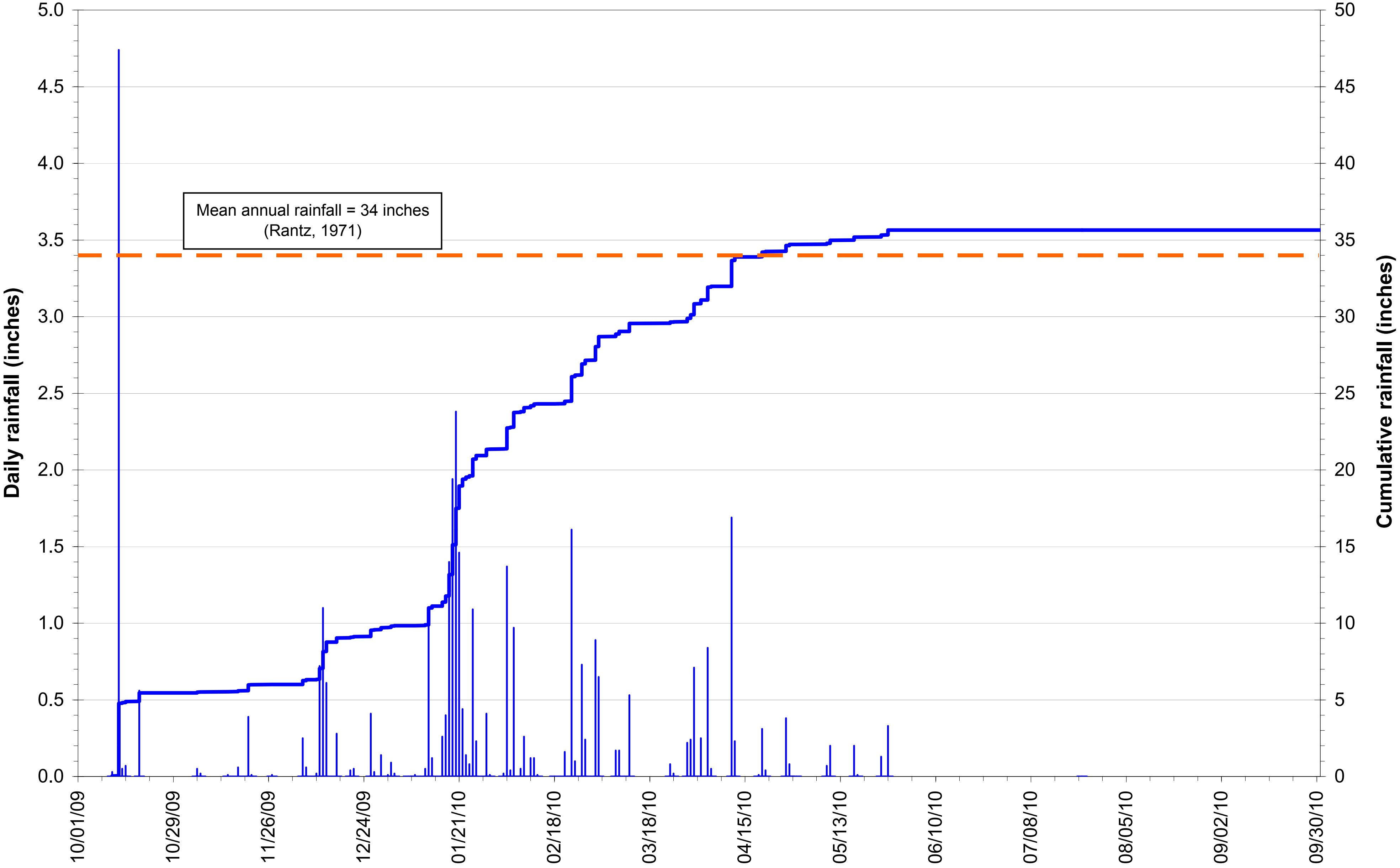


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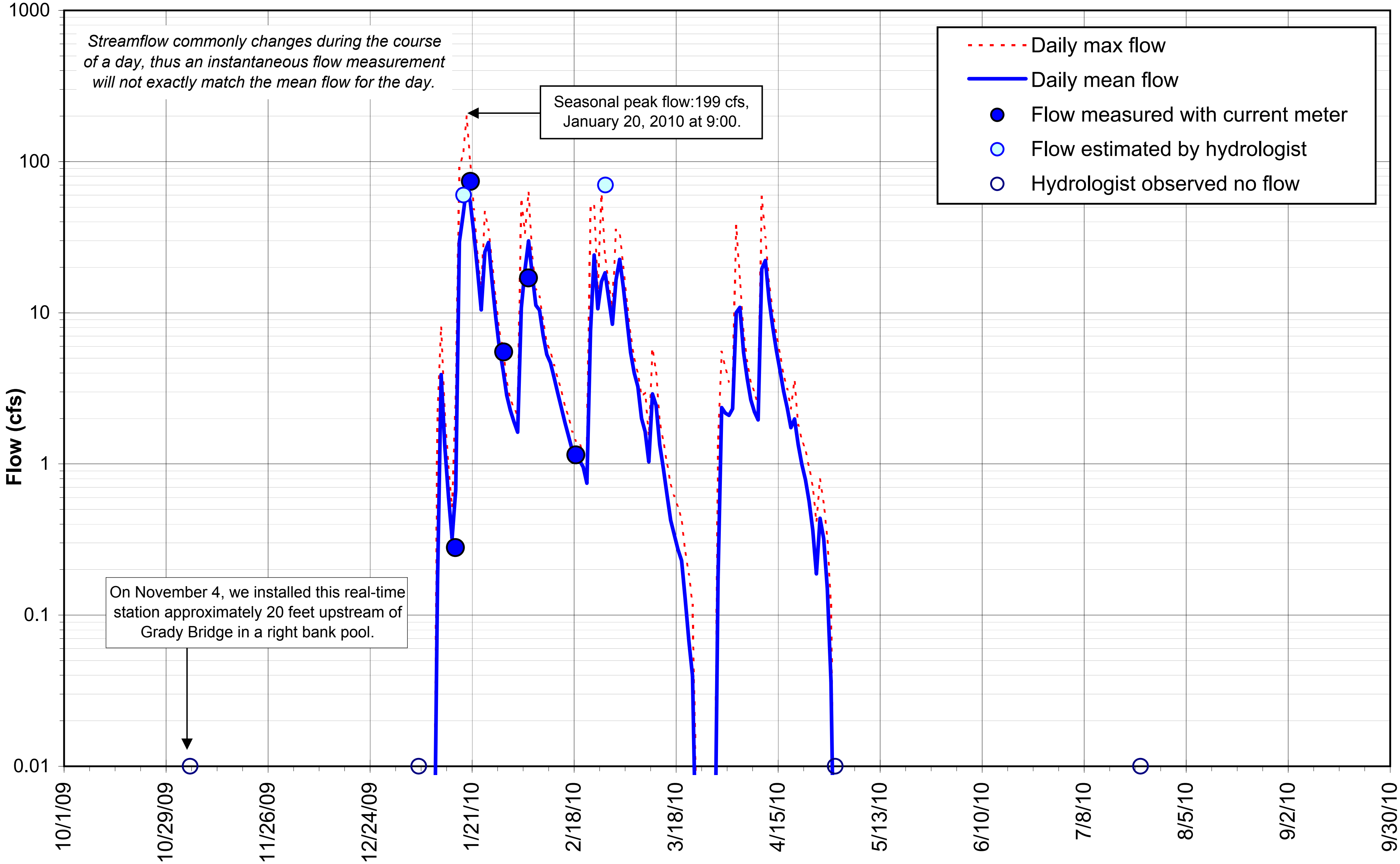
Figure 4. Rainfall at Grady Ranch, water year 2010, Marin County, California. The cumulative rainfall for water year 2010 at Grady Ranch was 35.65 inches, which is approximately 105 percent of the 1906-56 long-term average (Rantz, 1971).



Streamflow commonly changes during the course of a day, thus an instantaneous flow measurement will not exactly match the mean flow for the day.

Seasonal peak flow:199 cfs, January 20, 2010 at 9:00.

On November 4, we installed this real-time station approximately 20 feet upstream of Grady Bridge in a right bank pool.

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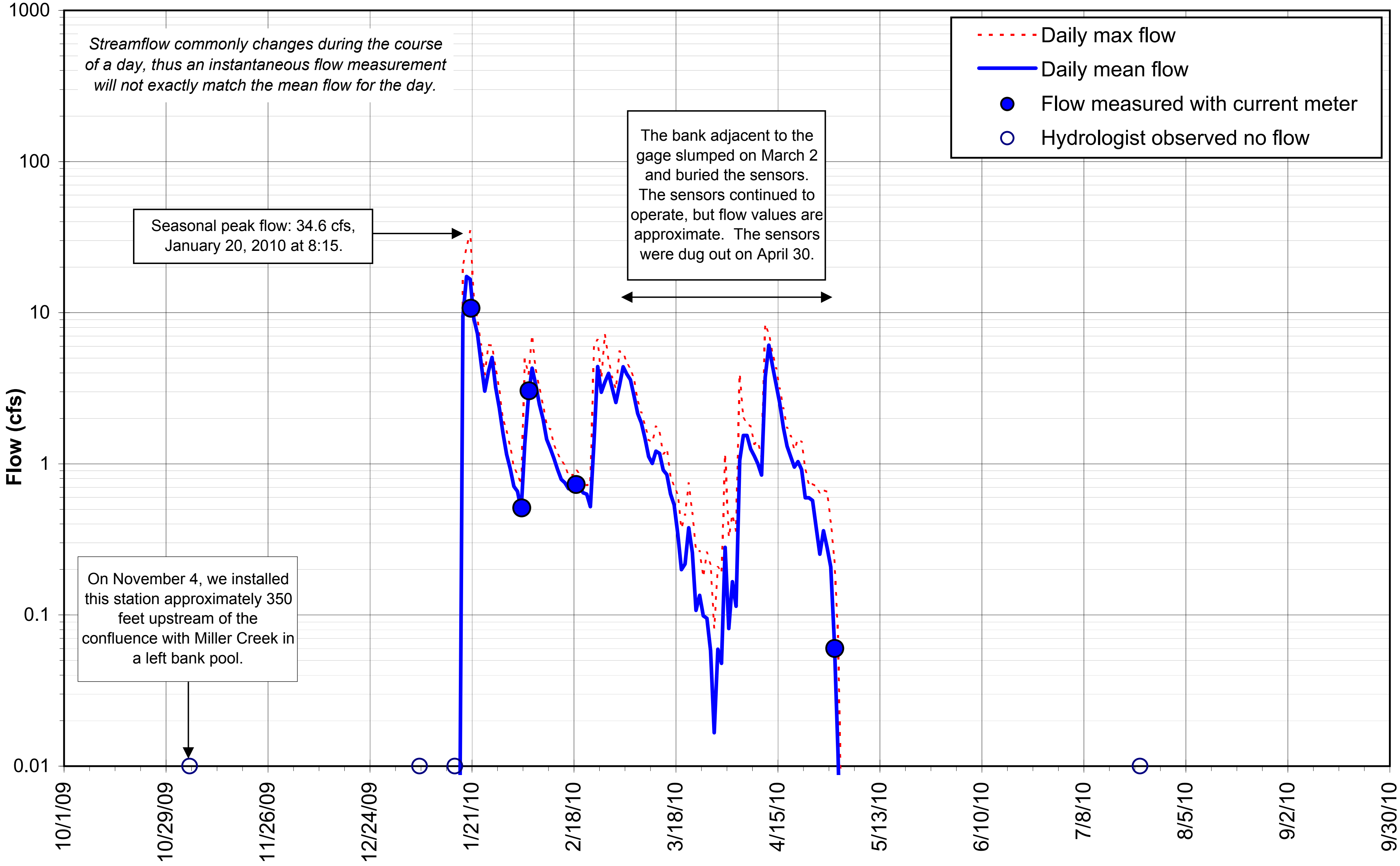
Figure 5. Annual hydrograph for Miller Creek above Grady Bridge, water year 2010, Marin County, California. The channel briefly wetted following the first significant early-season October 13th storm. Flows were continuous from January 12th through March 23rd, and again from March 30th through April 30th. The channel was dry from May 1st through the end of the water year.

Data preliminary and subject to revision



Streamflow commonly changes during the course of a day, thus an instantaneous flow measurement will not exactly match the mean flow for the day.

Seasonal peak flow: 34.6 cfs, January 20, 2010 at 8:15.

The bank adjacent to the gage slumped on March 2 and buried the sensors. The sensors continued to operate, but flow values are approximate. The sensors were dug out on April 30.

On November 4, we installed this station approximately 350 feet upstream of the confluence with Miller Creek in a left bank pool.

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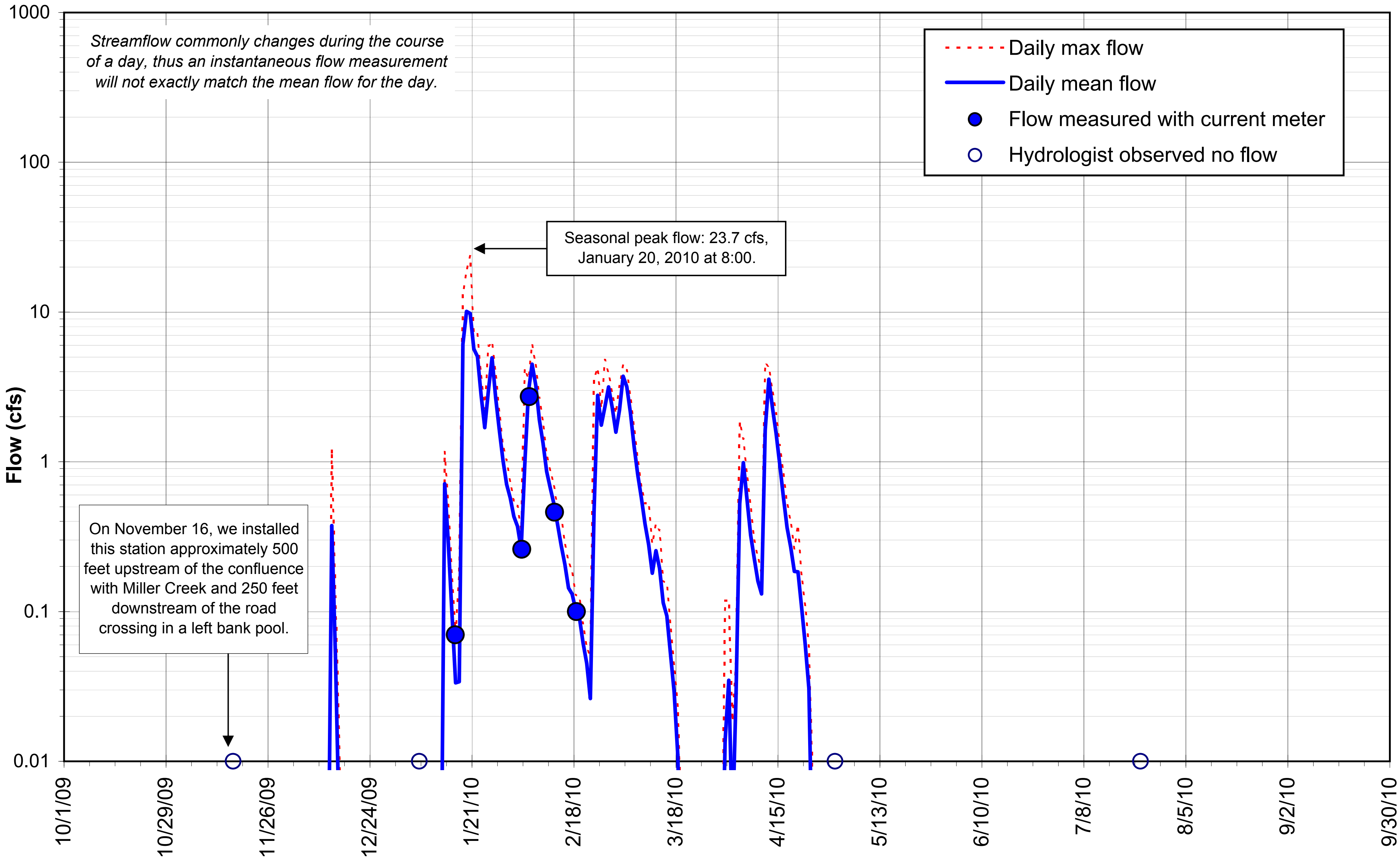
Figure 6. Annual hydrograph for Grady Creek, water year 2010, Marin County, California. The channel briefly wetted following the first significant early-season October 13th storm. Flows were continuous from January 18th through May 1st.

208164 Grady Ck 15data 1-7-11.xls, Dailyflow

Data preliminary and subject to revision



Streamflow commonly changes during the course of a day, thus an instantaneous flow measurement will not exactly match the mean flow for the day.

Seasonal peak flow: 23.7 cfs, January 20, 2010 at 8:00.

On November 16, we installed this station approximately 500 feet upstream of the confluence with Miller Creek and 250 feet downstream of the road crossing in a left bank pool.

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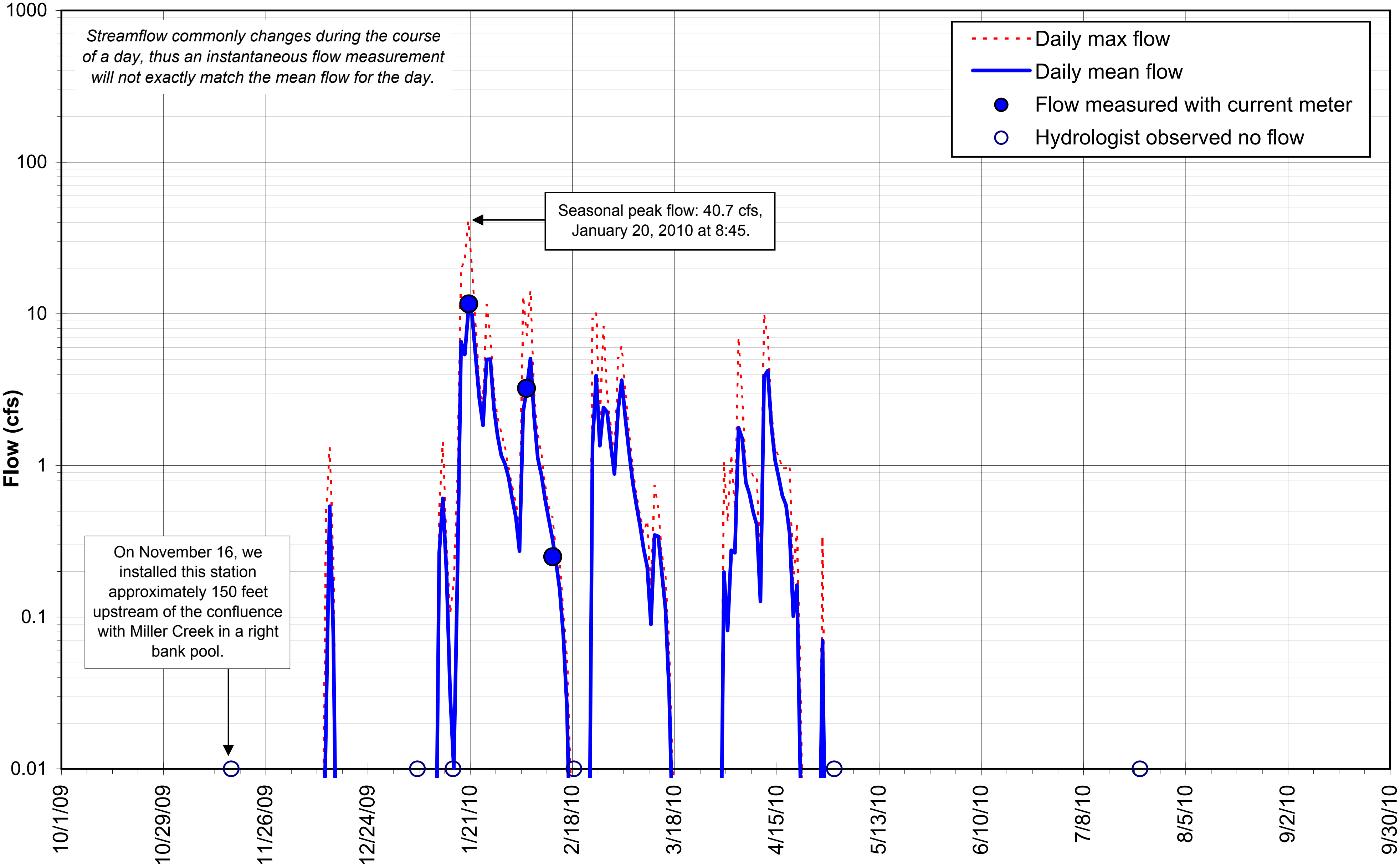
Figure 7. Annual hydrograph for Landmark Creek, water year 2010, Marin County, California. The channel briefly wetted following the first significant early-season October 13th storm. Flows were continuous from January 13th through March 18th, and then from March 31st through April 23rd.

208164 Landmark Ck 15data 3-7-11.xls, Dailyflow

Data preliminary and subject to revision



Streamflow commonly changes during the course of a day, thus an instantaneous flow measurement will not exactly match the mean flow for the day.

Seasonal peak flow: 40.7 cfs, January 20, 2010 at 8:45.

On November 16, we installed this station approximately 150 feet upstream of the confluence with Miller Creek in a right bank pool.

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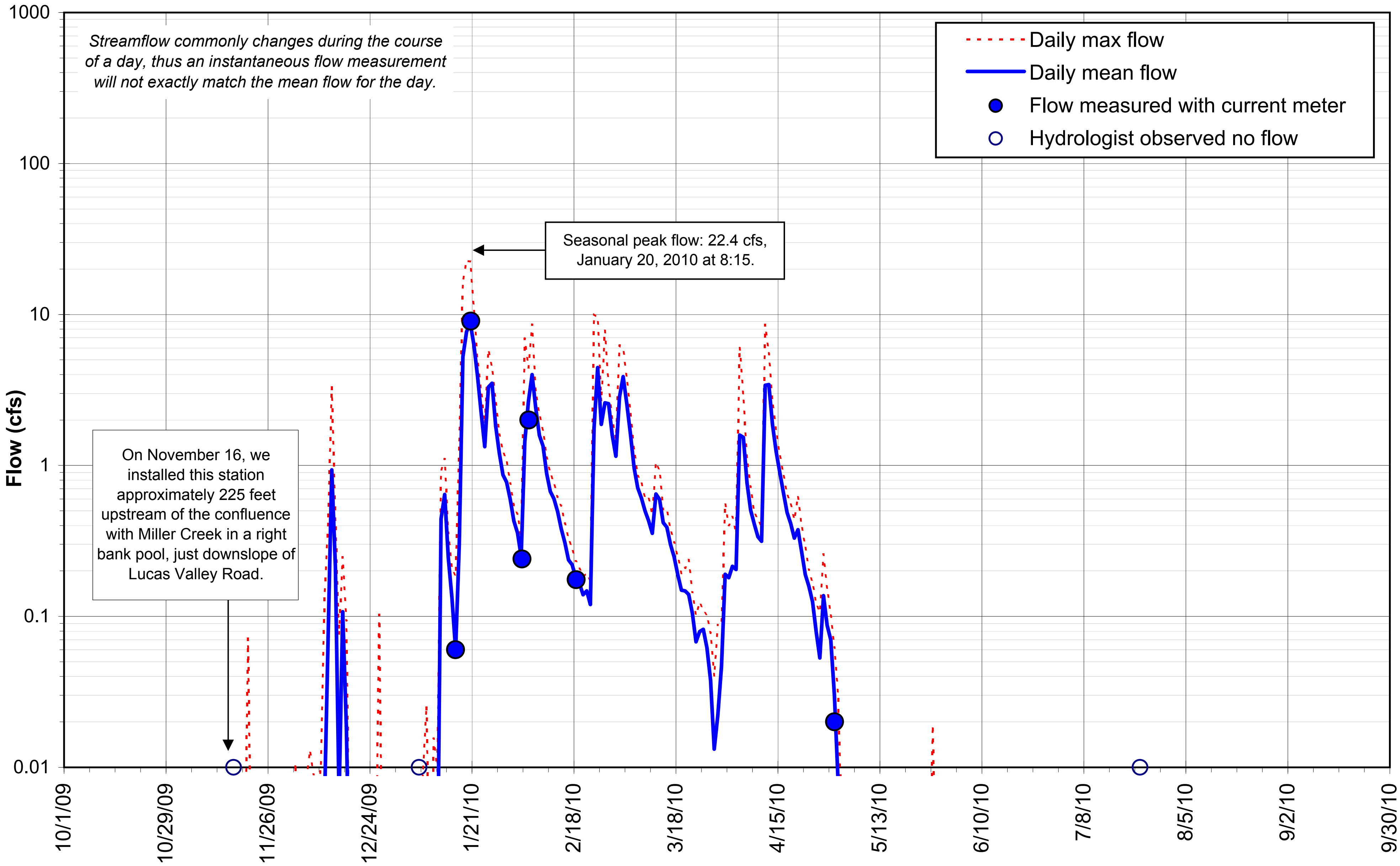
Figure 8. Annual hydrograph for S3 tributary, water year 2010, Marin County, California. The channel briefly wetted following the first significant early-season October 13th storm. Flows periodically dried down throughout the wet season.

Data preliminary and subject to revision



Streamflow commonly changes during the course of a day, thus an instantaneous flow measurement will not exactly match the mean flow for the day.

Seasonal peak flow: 22.4 cfs, January 20, 2010 at 8:15.

On November 16, we installed this station approximately 225 feet upstream of the confluence with Miller Creek in a right bank pool, just downslope of Lucas Valley Road.

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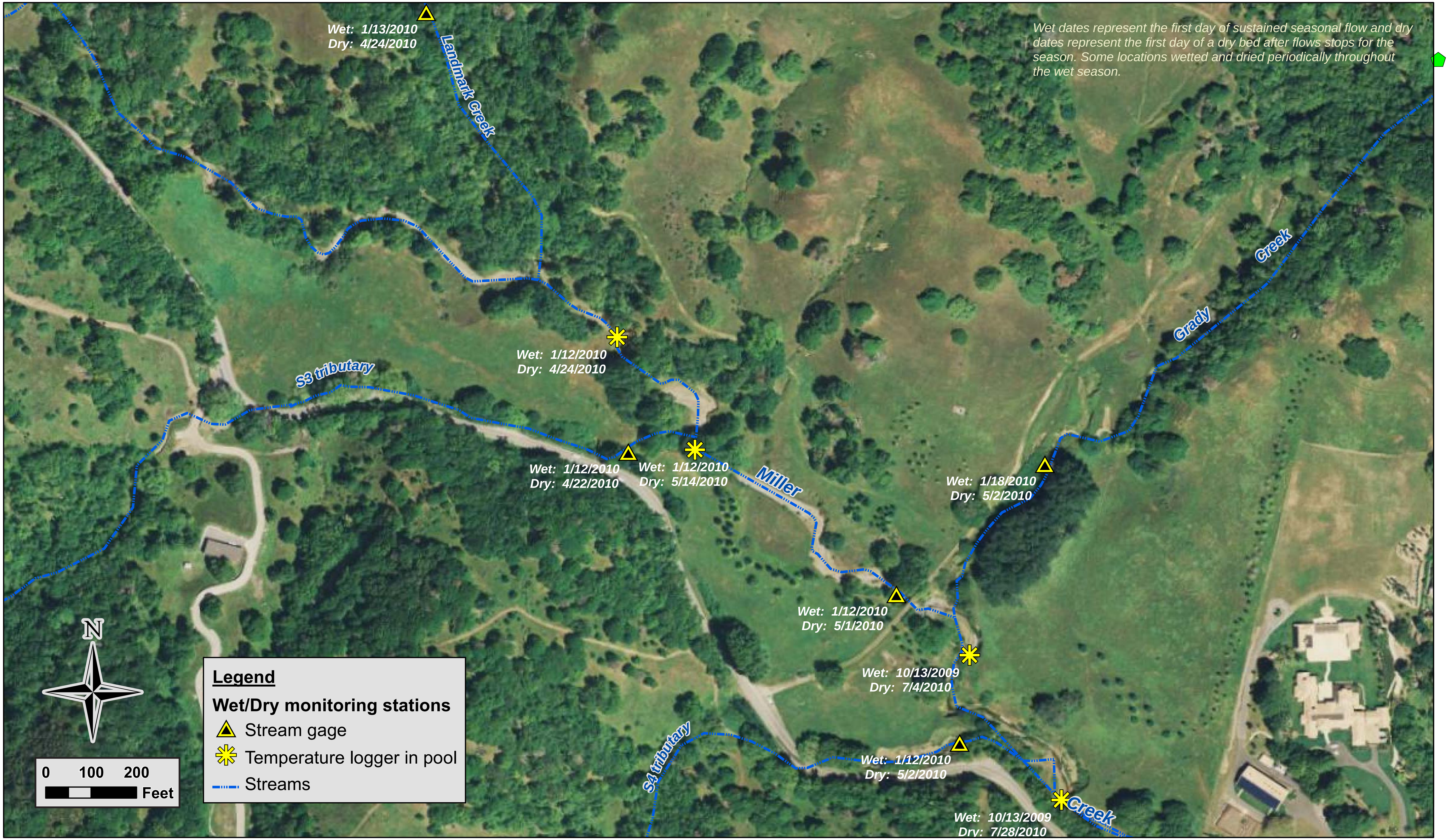
Figure 9. Annual hydrograph for S4 Tributary, water year 2010, Marin County, California. The channel briefly wetted following the first significant early-season October 13th storm. Flows were sustained from January 12th through May 1st.

Data preliminary and subject to revision



Wet dates represent the first day of sustained seasonal flow and dry dates represent the first day of a dry bed after flows stops for the season. Some locations wetted and dried periodically throughout the wet season.

Aerial photo source: Digital Globe, dated 4-1-09.

Balance Hydrologics, Inc.

208164 water temperature pools.mxd

Figure 10. Wet and dry dates for Miller Creek and its tributaries on Grady Ranch, water year 2010, Marin County, California. Miller Creek below Grady Bridge wetted up 3 months before Miller Creek above Grady Bridge and dried down 2 months after Miller Creek above Grady Bridge.

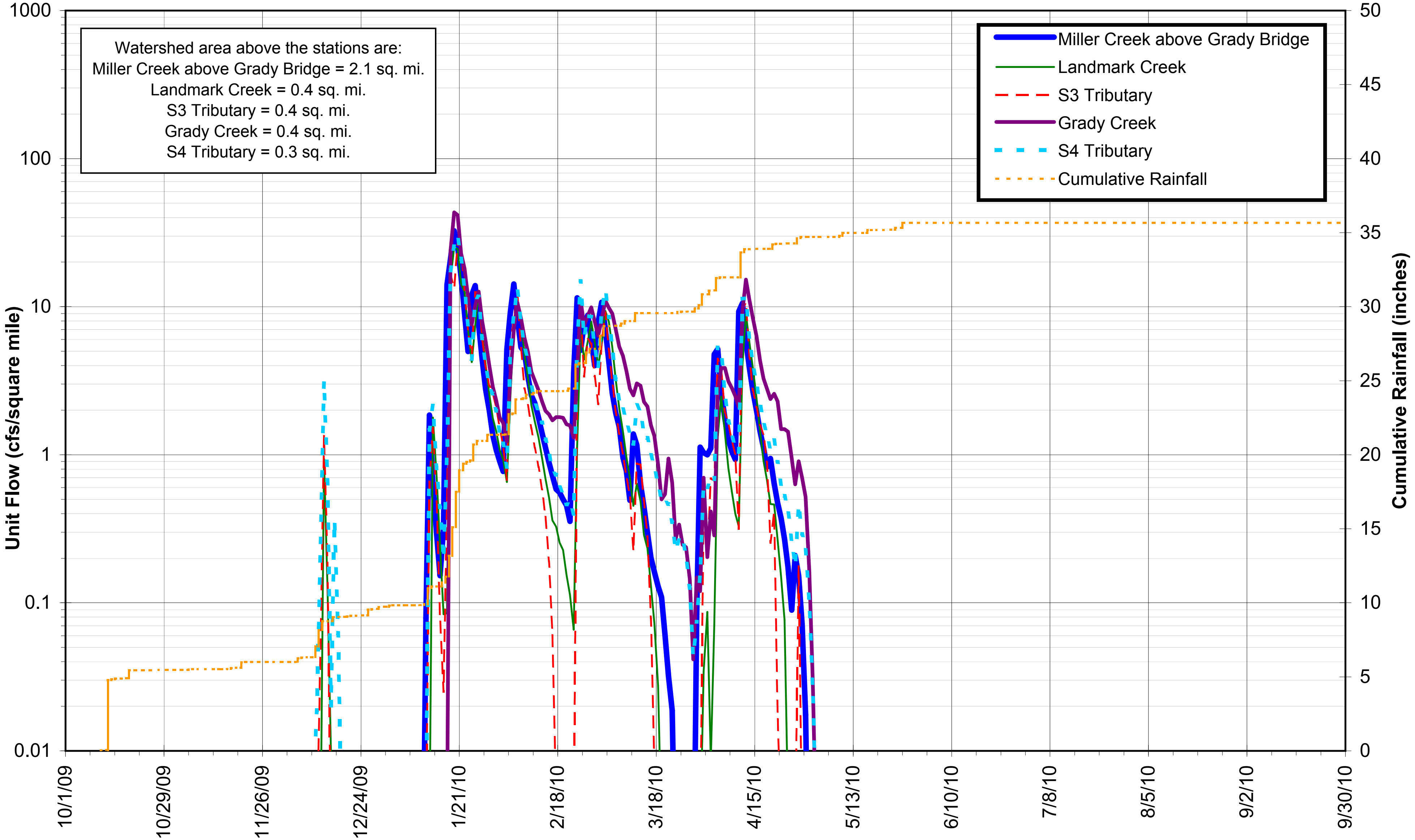


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Figure 11. Annual unit hydrographs at Grady Ranch, water year 2010, Marin County, California. Unit flow is calculated by normalizing flow by watershed area. Note that Grady Creek and S4 Tributary have continuous flow throughout the wet season and noticeably higher falling limb flows than other streams in March and April.

Data preliminary and subject to revision

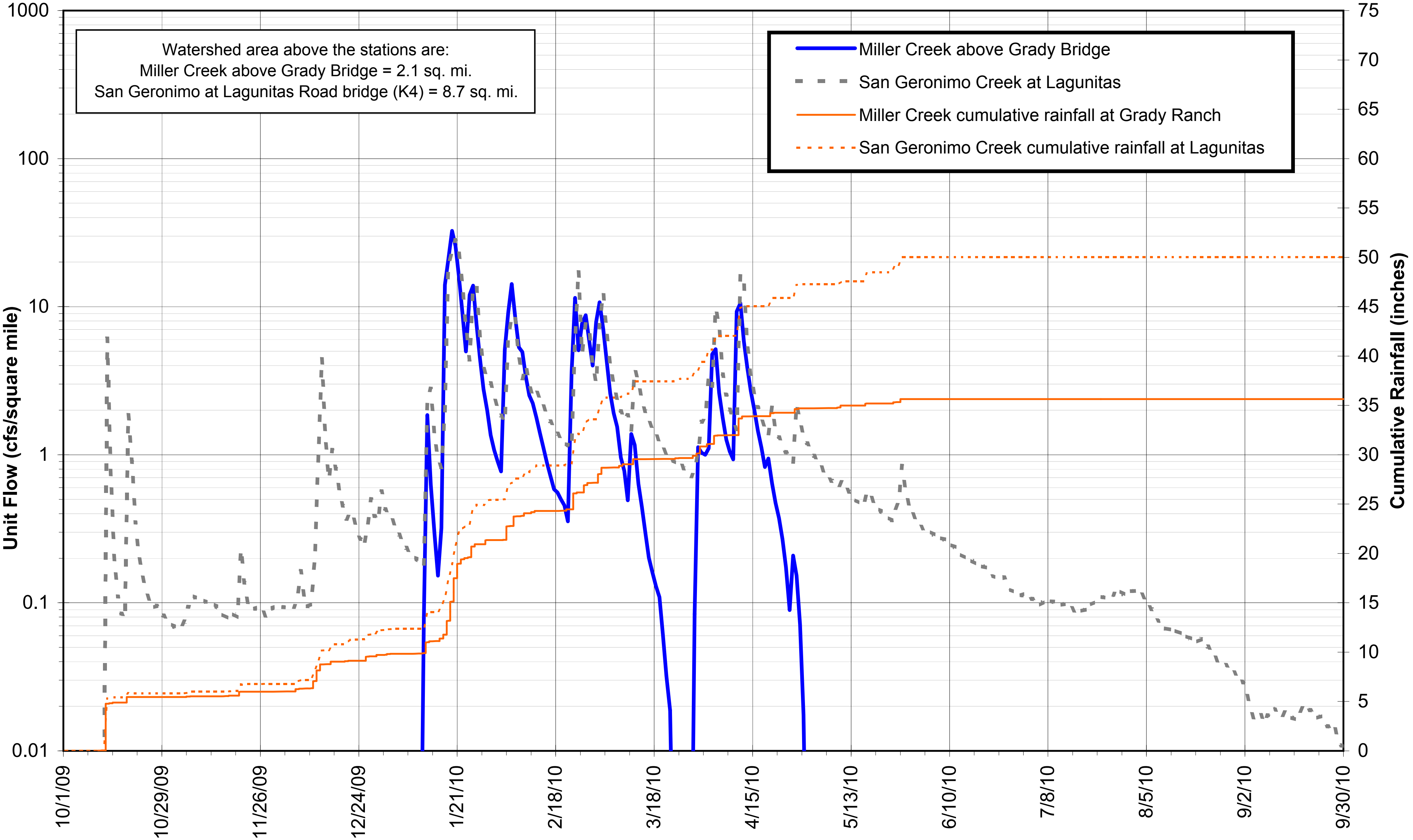

Figure 12. Annual unit hydrographs for Miller Creek and San Geronimo Creek, water year 2010, Marin County, California. The Miller Creek above Grady Bridge station is higher in its watershed with deeper alluvium than the San Geronimo Creek gage. The Miller Creek gage is also at the incision knickpoint which drains groundwater and depletes streamflow. Thus, the Miller Creek station was dry for more than 8 months of the year. In contrast, San Geronimo at Lagunitas Road is a bedrock-dominated channel, which had continuous flow.

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Data preliminary and subject to revision

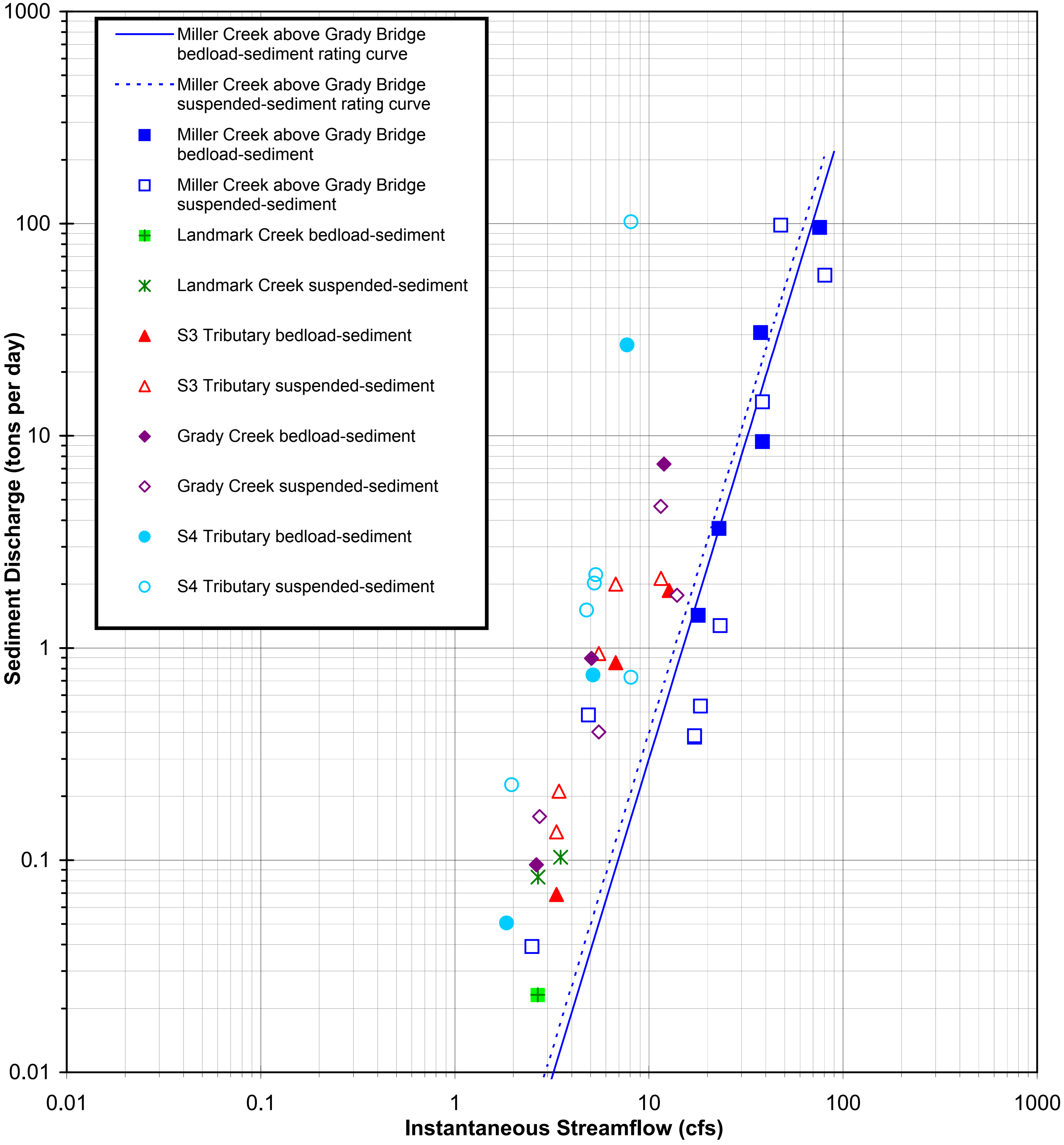

Figure 13. Sediment-discharge measurements for Miller Creek and tributaries water year 2010, Grady Ranch, Marin County, California. These first-year measurements suggest that S4 tributary transports higher rates of sediment than the other tributaries, potentially when upstream banks fail. Preliminary rating curves are illustrated for the Miller Creek station.

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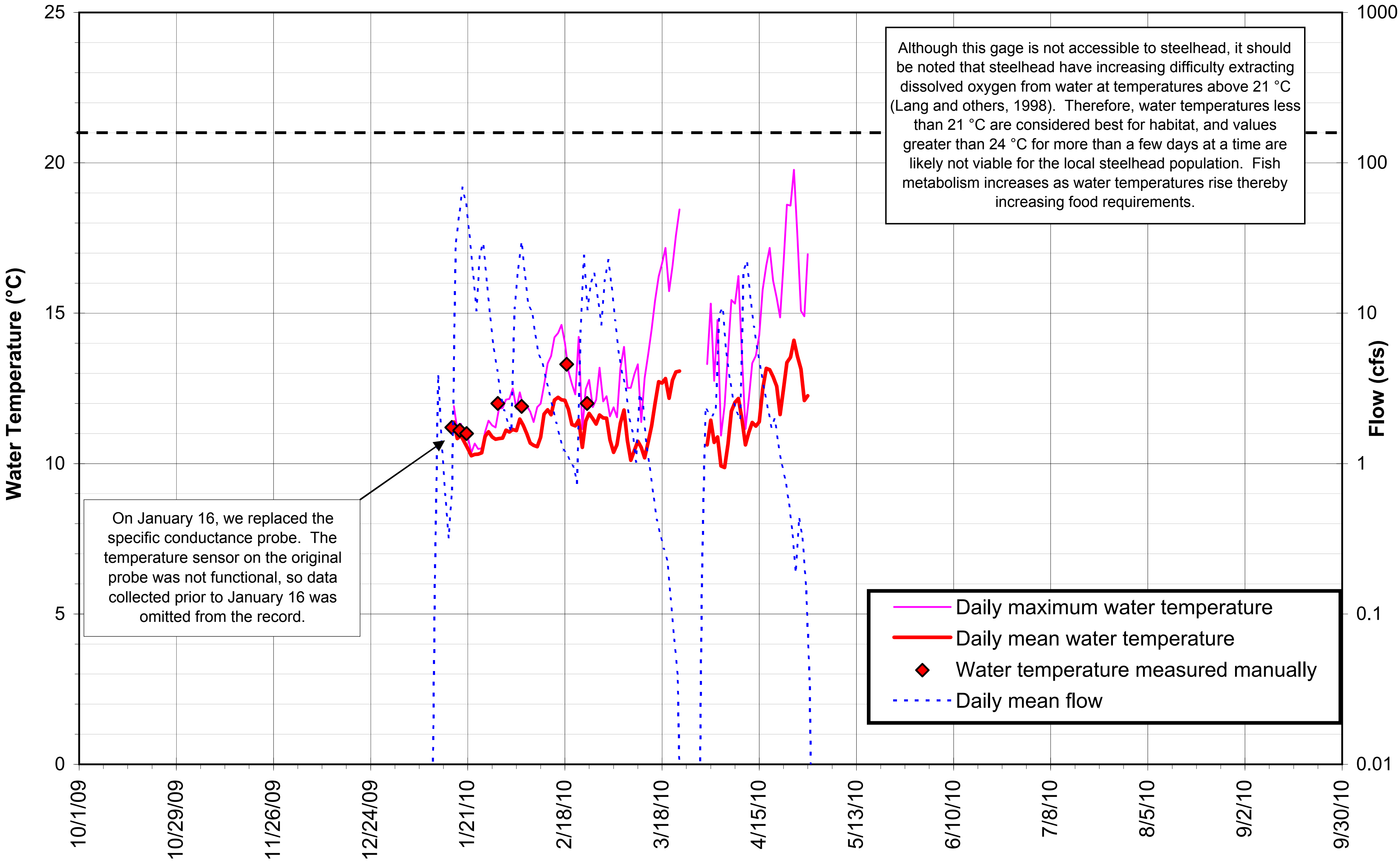
208164 sediment log and curves 3-6-11.xls

Data preliminary and subject to revision



Although this gage is not accessible to steelhead, it should be noted that steelhead have increasing difficulty extracting dissolved oxygen from water at temperatures above 21 °C (Lang and others, 1998). Therefore, water temperatures less than 21 °C are considered best for habitat, and values greater than 24 °C for more than a few days at a time are likely not viable for the local steelhead population. Fish metabolism increases as water temperatures rise thereby increasing food requirements.

On January 16, we replaced the specific conductance probe. The temperature sensor on the original probe was not functional, so data collected prior to January 16 was omitted from the record.

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Figure 14. Water temperature at the Miller Creek above Grady Bridge station, water year 2010, Marin County, California. Water temperatures were within the reported acceptable range for steelhead habitat. The flow record is plotted for reference.

Data preliminary and subject to revision

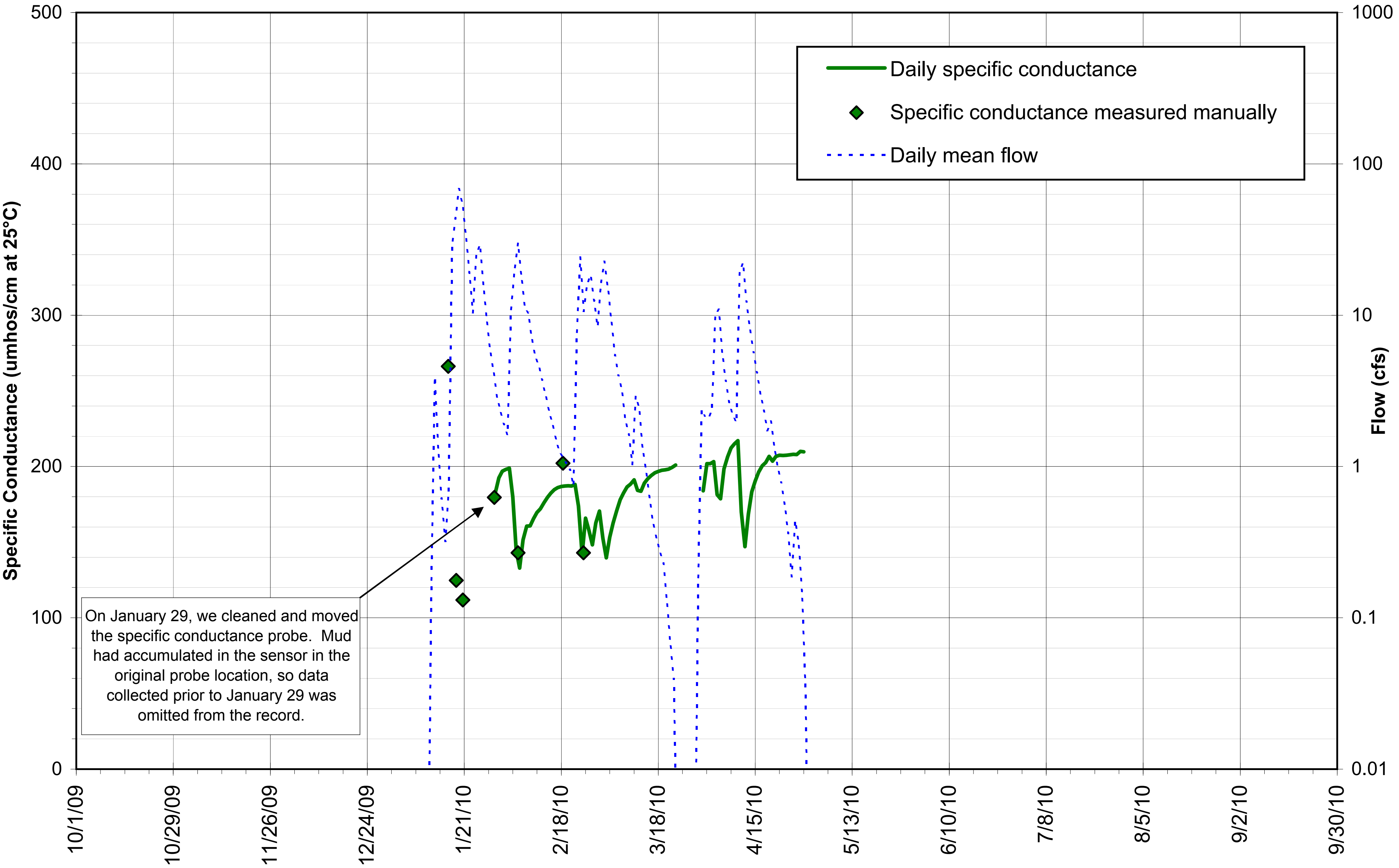

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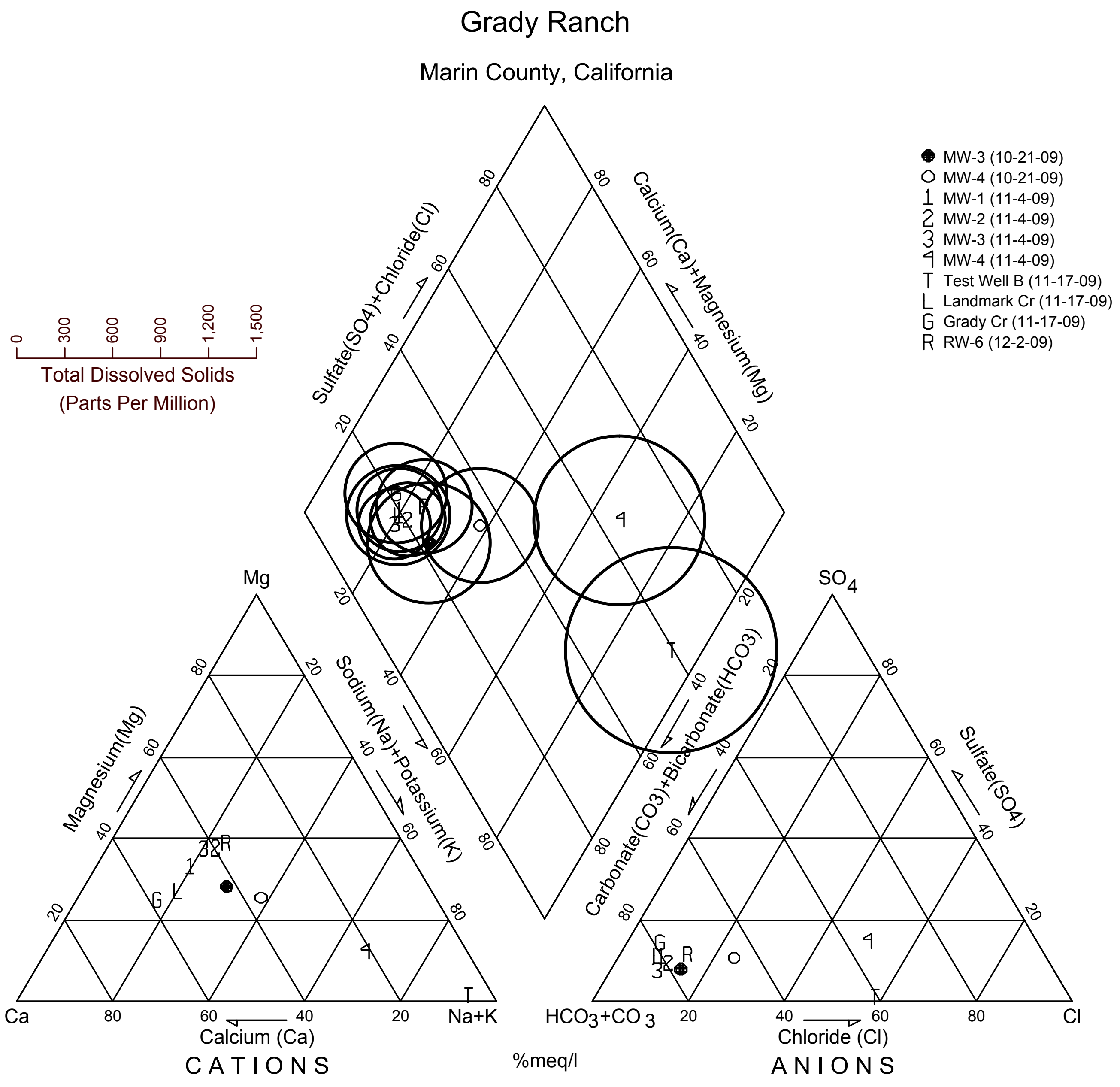
Figure 15. Specific conductance record at the Miller Creek above Grady Bridge station, water year 2010, Marin County, California. Specific conductance during baseflow recession is similar to other central Marin streams, such as San Geronimo Creek, suggesting that flow emanates from the alluvial aquifer rather than deeper bedrock sources. During storms, specific conductance recedes with runoff.

Data preliminary and subject to revision



This diagram shows cations in the ternary graph on the left and anions on the right graph. The diamond graph in the center illustrates both cations and anions. Hardness dominated water plots to the left and top of the diamond graph, soft monovalent-salt dominated water to the right, and soft alkaline water towards the bottom. The radius of circle around the plotted points represents the concentration of dissolved solids, calibrated to the scale shown.

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Figure 16. Piper diagram illustrating different ionic signatures of water samples collected from wells and surface waters on Grady Ranch, Marin County, California.

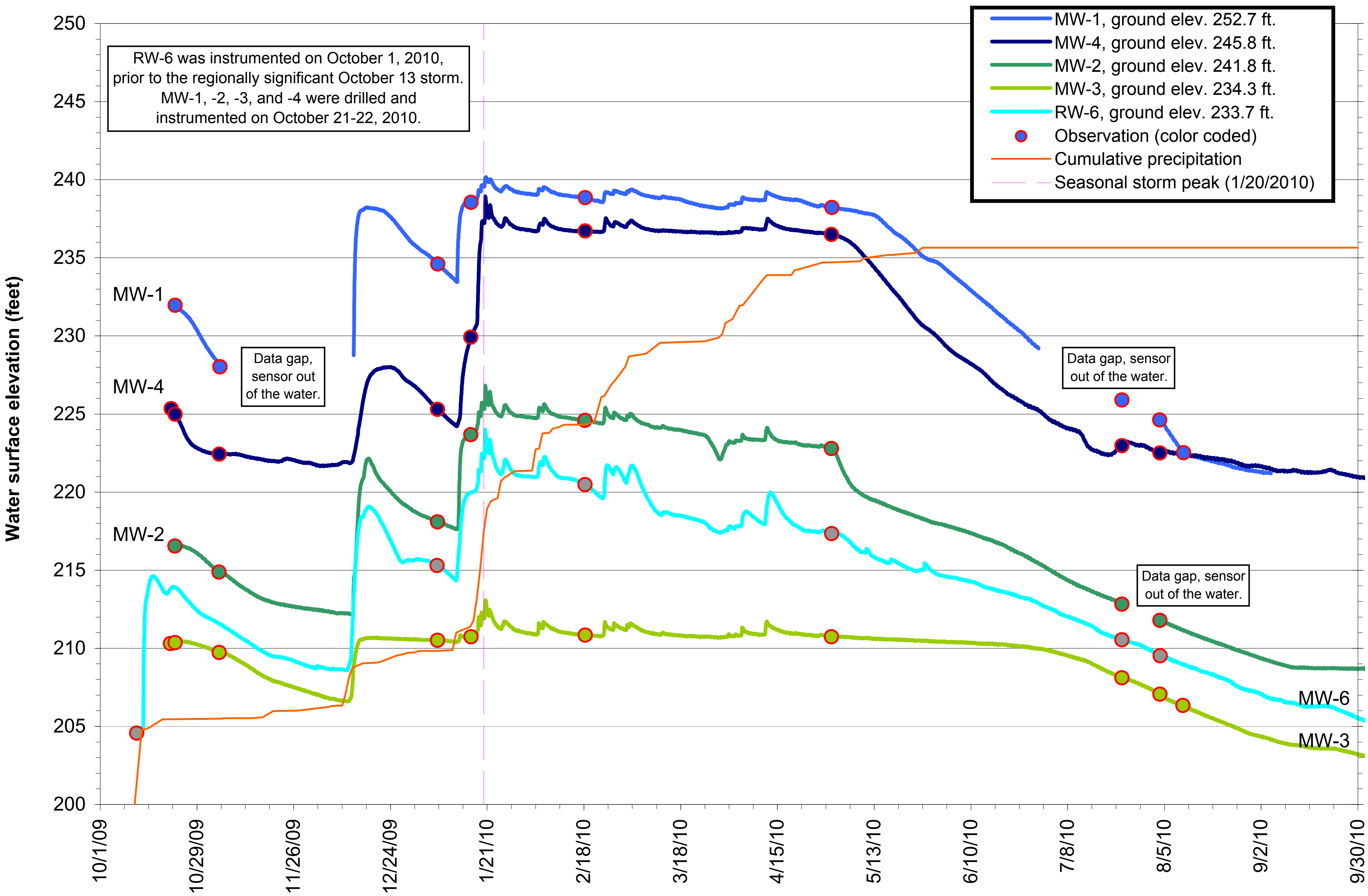

Figure 17. Groundwater elevations at Grady Ranch, water year 2010, Marin County, California. Water levels for MW-1, -3, and -4 remained relatively stable during the wet season, while MW-2 (closest to Grady Bridge knickpoint) and particularly RW-6 declined over time. RW-6 also showed largest strom rebound (see text for discussion). Dry-season recession began in May for all wells except MW-3, which began in July. MW-3 is overlain by mudflow deposits and shows the least recharge.

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208164 monitoring wells WL records 3-6-11.xlsWSE chart

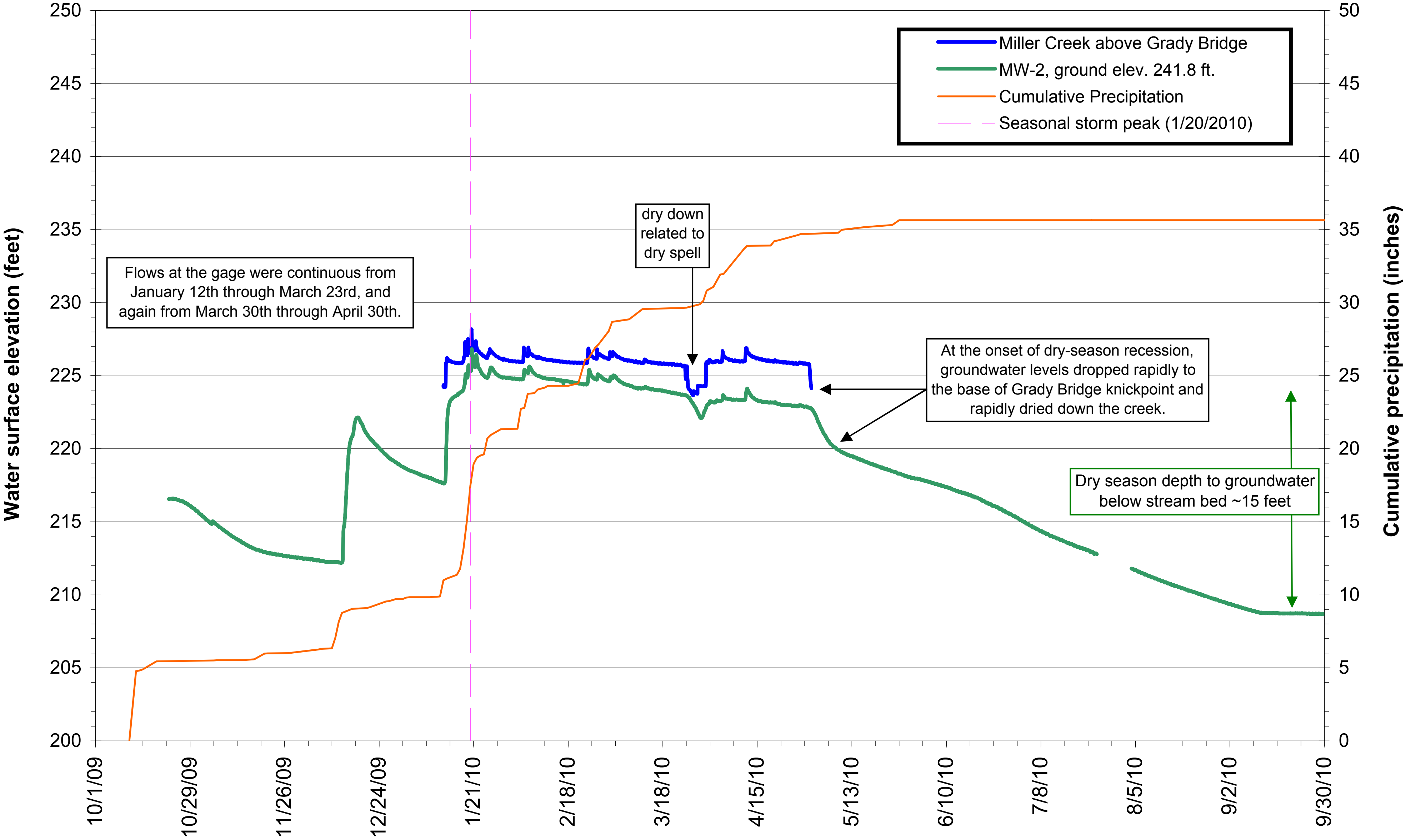

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Figure 18. Surface-groundwater interactions on Miller Creek above Grady Bridge, water year 2010, Marin County, California. Water-surface elevations show that the reach above Grady Bridge loses water to the alluvial aquifer. This groundwater recharge keeps groundwater levels high until a mid-winter dry spell or the onset of the dry season when streamflow recedes and relatively rapid groundwater discharge at the foot of the Grady Bridge knickpoint draws down groundwater and dries down the stream.

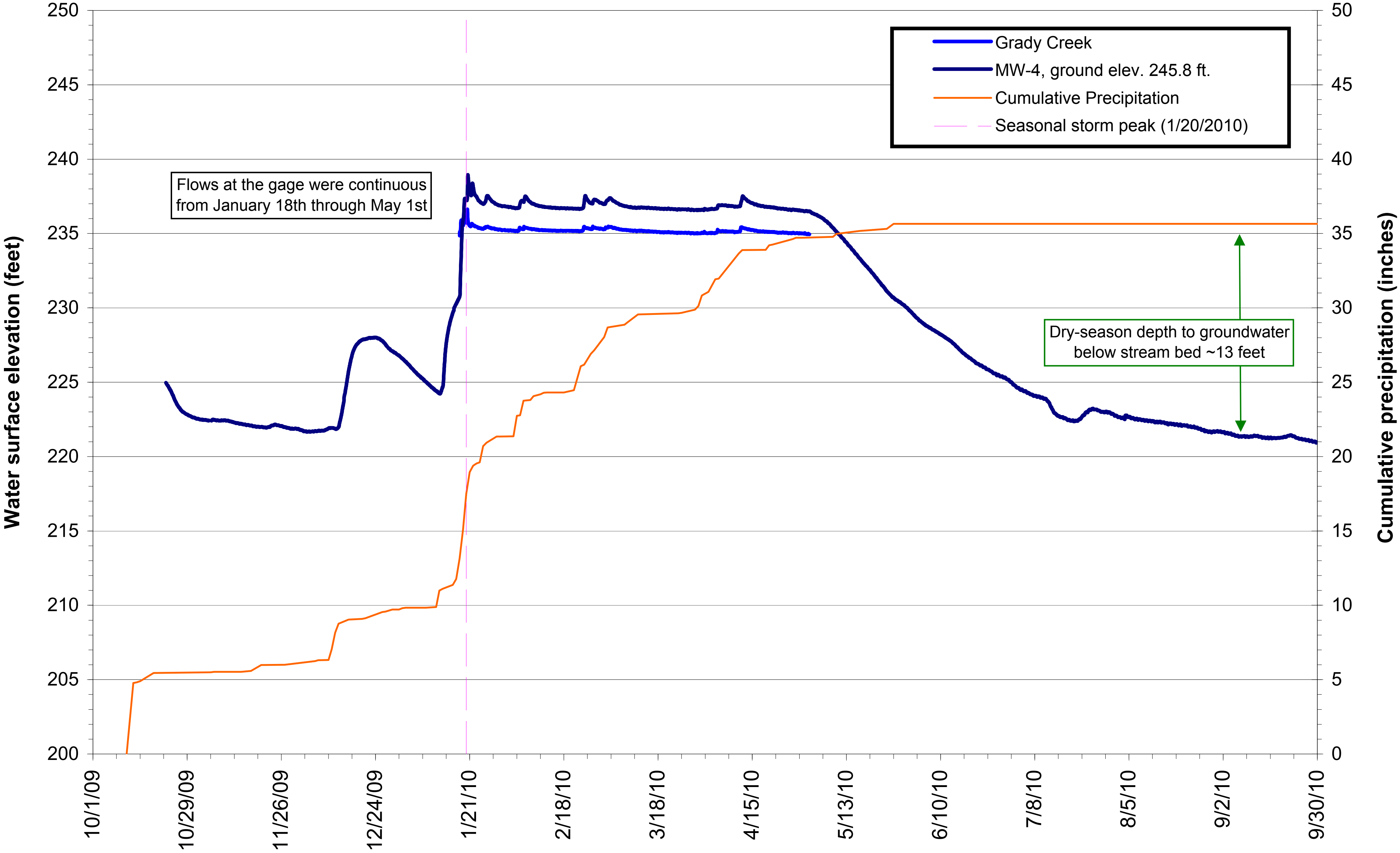

Figure 19. Surface-groundwater interactions on Grady Creek, water year 2010, Marin County, California. Water-surface elevations show that Grady Creek gains water from the aquifer and dries back along with receding groundwater levels.

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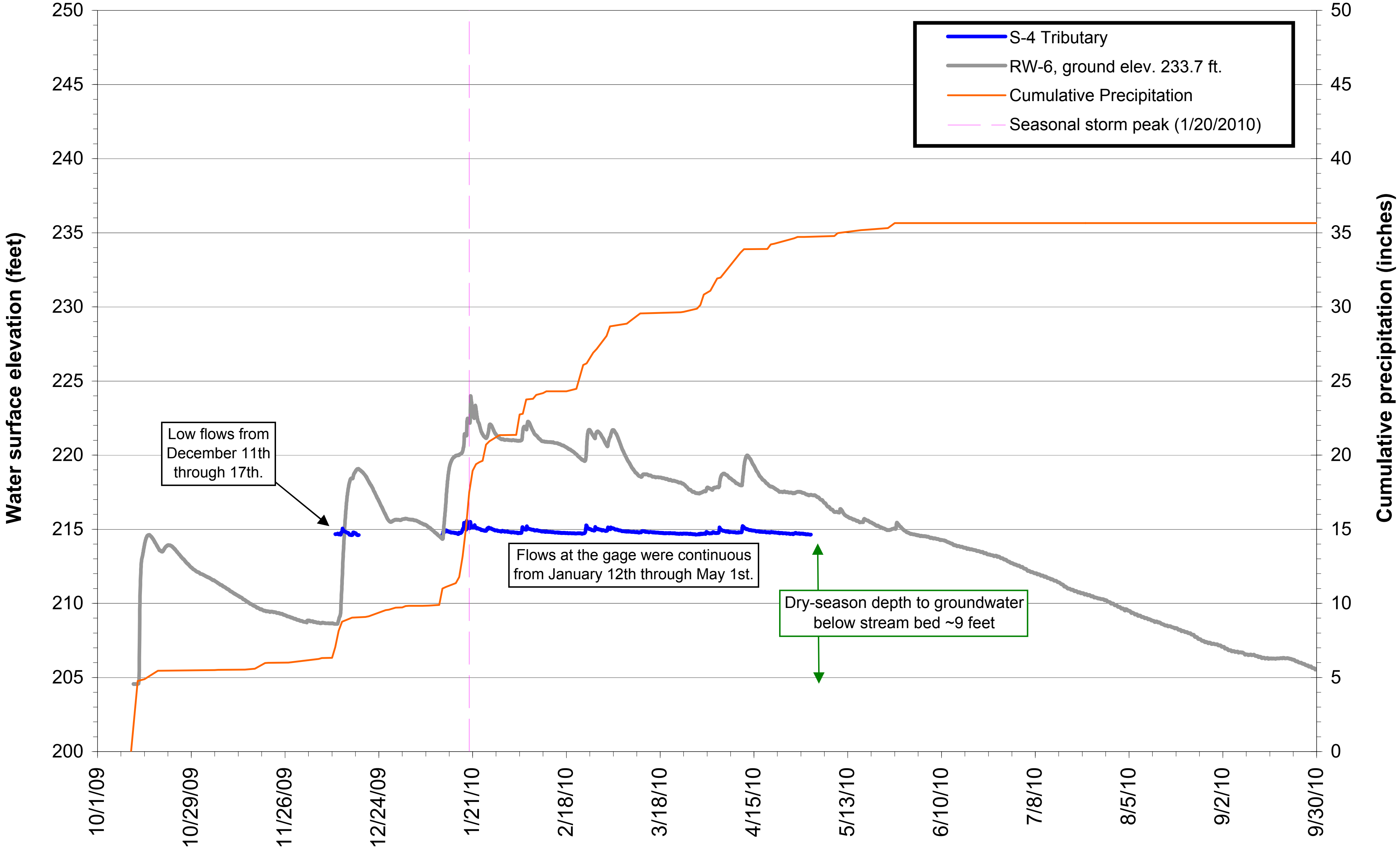

Figure 20. Surface-groundwater interactions on Grady Creek, water year 2010, Marin County, California. Water-surface elevations show that S4 Tributary gains water from the aquifer and dries back along with receding groundwater levels.

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FORMS

Form 1. Annual Rainfall Record: Miller Creek Upper Watershed

Water Year:	**2010**
Watershed:	Miller Creek
Station:	Grady Ranch
County, State:	Marin County, CA

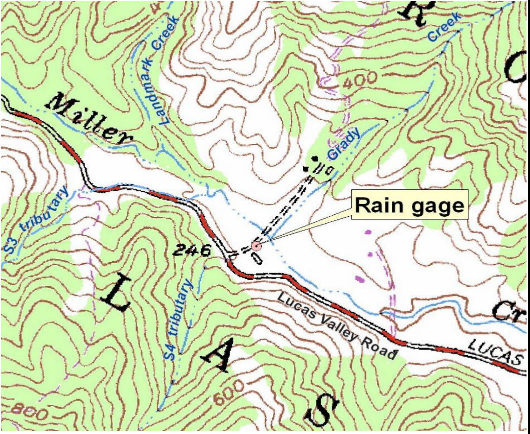
Station Location / Watershed Descriptors

Located on old dairy trough 165 ft northwest of the property gate
on access road to Grady Ranch
Latitude: 38°2'21.24"N, Longitude: 122°36'9.69"W (WGS84)
Elevation: 237 feet (WGS84)

Period of Record

Tipping-bucket rain gage installed 10/11/2009
Sponsored by Skywalker Properties, Ltd.

Station Location Map:



Peak Daily Rainfall (period of record)

Date	Inches	Date	Inches	Date	Inches	Date	Inches
10/13/09	4.74	-	-	-	-	-	-
1/20/10	2.38	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Water Year 2010 Daily Total Rainfall (inches)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.02	0.00	0.89	0.25	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.02	0.65	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	1.37	0.00	0.84	0.00	0.00	0.00	0.00	0.00
5	0.00	0.05	0.00	0.00	0.04	0.00	0.05	0.00	0.00	0.00	0.00	0.00
6	0.00	0.02	0.25	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.01	0.05	0.17	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.26	0.17	0.00	0.07	0.00	0.00	0.00	0.00
10	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00
11	0.03	0.00	0.72	0.05	0.12	0.00	1.69	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	1.10	1.10	0.12	0.53	0.23	0.00	0.00	0.00	0.00	0.00
13	4.74	0.00	0.61	0.12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.28	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.06	0.00	0.40	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	1.40	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
19	0.56	0.00	0.00	1.94	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
20	0.00	0.39	0.04	2.38	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00
21	0.00	0.01	0.05	1.46	0.16	0.00	0.04	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.14	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.08	0.10	0.08	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	1.09	0.00	0.02	0.00	0.13	0.00	0.00	0.00	0.00
26	0.00	0.00	0.41	0.23	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.01	0.03	0.00	0.24	0.00	0.38	0.33	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.14	0.41	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.01	--	0.24	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00	--	0.01	0.00	--	0.71	--	0.00	--	0.00	0.00	--
Total	5.45	0.55	3.72	11.63	5.80	3.68	3.88	0.94	0.00	0.00	0.00	0.00
Max	4.74	0.39	1.10	2.38	1.61	0.89	1.69	0.33	0.00	0.00	0.00	0.00

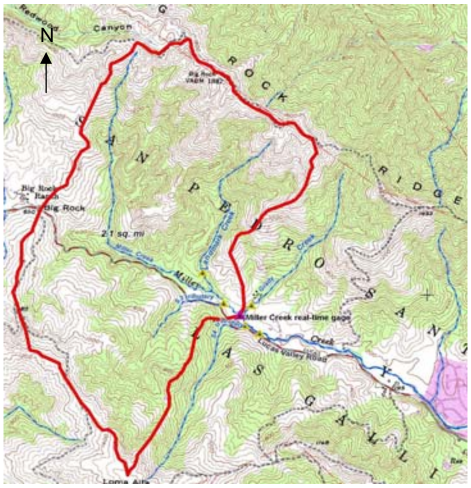
Water Year 2010

Total Annual	35.65	(inches)
Maximum Daily Total	4.74	(inches)

Form 2. Annual Hydrologic Record: Miller Creek above Grady Bridge

Water Year:	**2010**
Stream:	Miller Creek
Station:	above Grady Bridge
County, State:	Marin County, CA

Station Location Map



Station Location / Watershed Descriptors

Approximately 20 feet upstream Grady Bridge (right bank)
Latitude: 38°2'22.58"N, Longitude: 122°36'9.31"W (WGS84)
Drainage area is 1344 acres or 2.10 square miles.
Regulation: County open space

Period of Record

Gage was installed on 11/4/09 by Balance Hydrologics.
Record 11/24/09 through 9/30/10.
Gaging sponsored by Skywalker Properties, Ltd.

Mean Flows

Monthly mean flows are presented below.

Seasonal Peak Flows (period of record)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
1/20/10	9:00	4.43	198.80				

Water Year Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	no data	no data	0.00	0.00	2.27	8.41	2.17	0.00	0.00	0.00	0.00	0.00
2	no data	no data	0.00	0.00	1.89	16.53	2.10	0.00	0.00	0.00	0.00	0.00
3	no data	no data	0.00	0.00	1.62	22.53	2.32	0.00	0.00	0.00	0.00	0.00
4	no data	0.00	0.00	0.00	10.77	14.79	10.01	0.00	0.00	0.00	0.00	0.00
5	no data	0.00	0.00	0.00	19.21	8.96	10.86	0.00	0.00	0.00	0.00	0.00
6	no data	0.00	0.00	0.00	29.84	5.46	5.50	0.00	0.00	0.00	0.00	0.00
7	no data	0.00	0.00	0.00	17.89	4.00	3.69	0.00	0.00	0.00	0.00	0.00
8	no data	0.00	0.00	0.00	11.18	3.24	2.66	0.00	0.00	0.00	0.00	0.00
9	no data	0.00	0.00	0.00	10.40	2.01	2.21	0.00	0.00	0.00	0.00	0.00
10	no data	0.00	0.00	0.00	7.08	1.63	1.95	0.00	0.00	0.00	0.00	0.00
11	no data	0.00	0.00	0.00	5.29	1.03	19.47	0.00	0.00	0.00	0.00	0.00
12	no data	0.00	0.00	0.17	4.68	2.90	22.15	0.00	0.00	0.00	0.00	0.00
13	no data	0.00	0.00	3.90	3.73	2.44	12.26	0.00	0.00	0.00	0.00	0.00
14	no data	0.00	0.00	1.32	2.94	1.33	8.10	0.00	0.00	0.00	0.00	0.00
15	no data	0.00	0.00	0.62	2.35	0.93	5.67	0.00	0.00	0.00	0.00	0.00
16	no data	0.00	0.00	0.32	1.87	0.62	4.16	0.00	0.00	0.00	0.00	0.00
17	no data	0.00	0.00	0.67	1.52	0.42	3.03	0.00	0.00	0.00	0.00	0.00
18	no data	0.00	0.00	29.47	1.23	0.34	2.34	0.00	0.00	0.00	0.00	0.00
19	no data	0.00	0.00	43.86	1.17	0.27	1.74	0.00	0.00	0.00	0.00	0.00
20	no data	0.00	0.00	68.27	1.05	0.23	1.98	0.00	0.00	0.00	0.00	0.00
21	no data	0.00	0.00	53.87	0.95	0.13	1.34	0.00	0.00	0.00	0.00	0.00
22	no data	0.00	0.00	33.13	0.74	0.07	0.99	0.00	0.00	0.00	0.00	0.00
23	no data	0.00	0.00	18.94	7.55	0.04	0.78	0.00	0.00	0.00	0.00	0.00
24	no data	0.00	0.00	10.46	24.08	0.00	0.56	0.00	0.00	0.00	0.00	0.00
25	no data	0.00	0.00	25.21	10.65	0.00	0.37	0.00	0.00	0.00	0.00	0.00
26	no data	0.00	0.00	29.12	16.09	0.00	0.19	0.00	0.00	0.00	0.00	0.00
27	no data	0.00	0.00	15.88	18.41	0.00	0.44	0.00	0.00	0.00	0.00	0.00
28	no data	0.00	0.00	9.29	12.43	0.00	0.32	0.00	0.00	0.00	0.00	0.00
29	no data	0.00	0.00	5.82	...	0.00	0.15	0.00	0.00	0.00	0.00	0.00
30	no data	0.00	0.00	4.18	...	0.18	0.04	0.00	0.00	0.00	0.00	0.00
31	no data	...	0.00	2.85	...	2.36	...	0.00	...	0.00	0.00	...
MEAN	NA	0.00	0.00	11.53	8.17	3.25	4.32	0.00	0.00	0.00	0.00	0.00
MAX. DAY	NA	0.00	0.00	68.27	29.84	22.53	22.15	0.00	0.00	0.00	0.00	0.00
MIN. DAY	NA	0.00	0.00	0.00	0.74	0.00	0.04	0.00	0.00	0.00	0.00	0.00
cfs days	NA	0.00	0.00	357.33	228.85	100.87	129.55	0.00	0.00	0.00	0.00	0.00
ac-ft	NA	0.00	0.00	708.77	453.92	200.07	256.96	0.00	0.00	0.00	0.00	0.00

Monitor's Comments

1. Multiple stage shifts were applied to the rating equation for local scour or fill.
2. Daily values with more than 2 to 3 significant figures result from calculations. No additional precision is implied.
3. Minor runoff may have occurred during the rains of mid-October, prior to installation of the gages. We believe such flows are negligible, and have computed mean daily flow for the year without adding any flows for those dates.

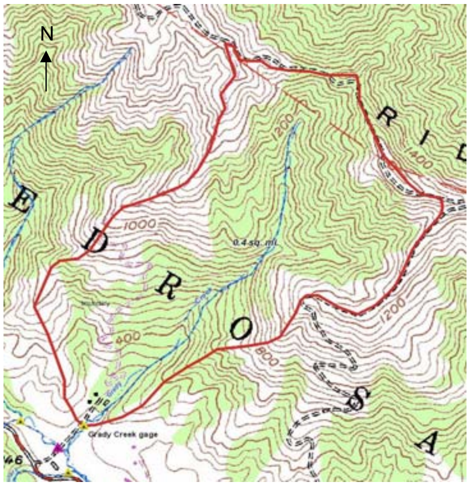
Water Year Summary

Mean daily discharge	2.24	(cfs)
Max. daily discharge	68.3	(cfs)
Min. daily discharge	0.00	(cfs)
Total	817	(cfs-days)
Total Volume	1620	(ac-ft)

Data preliminary and subject to revision

Form 3. Annual Hydrologic Record: Grady Creek

Water Year: 2010
Stream: Grady Creek
Station: …
County, State: Marin County, CA
Station Location Map



Station Location / Watershed Descriptors

Approximately 350 feet upstream of the confluence with Miller Creek (left bank)
Latitude: 38°2'25.49"N, Longitude: 122°36'5.44"W (WGS84)
Drainage area is 256 acres or 0.40 square miles.
Regulation: County open space

Period of Record

Gage was installed on 11/4/09 by Balance Hydrologics.
Preliminary record 11/4/09 through 9/30/10.
Gaging sponsored by Skywalker Properties, Ltd.

Mean Flows

Monthly mean flows are presented below.

Seasonal Peak Flows (period of record)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
1/20/10	8:15	8.55	34.60				

Water Year Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	no data	no data	0.00	0.00	0.71	2.55	0.08	0.01	0.00	0.00	0.00	0.00
2	no data	no data	0.00	0.00	0.66	3.30	0.17	0.00	0.00	0.00	0.00	0.00
3	no data	no data	0.00	0.00	0.49	4.39	0.11	0.00	0.00	0.00	0.00	0.00
4	no data	0.00	0.00	0.00	1.37	3.93	1.05	0.00	0.00	0.00	0.00	0.00
5	no data	0.00	0.00	0.00	2.79	3.60	1.54	0.00	0.00	0.00	0.00	0.00
6	no data	0.00	0.00	0.00	4.29	2.81	1.54	0.00	0.00	0.00	0.00	0.00
7	no data	0.00	0.00	0.00	3.34	2.15	1.25	0.00	0.00	0.00	0.00	0.00
8	no data	0.00	0.00	0.00	2.47	1.86	1.13	0.00	0.00	0.00	0.00	0.00
9	no data	0.00	0.00	0.00	1.98	1.48	1.00	0.00	0.00	0.00	0.00	0.00
10	no data	0.00	0.00	0.00	1.45	1.12	0.84	0.00	0.00	0.00	0.00	0.00
11	no data	0.00	0.00	0.00	1.26	1.01	3.75	0.00	0.00	0.00	0.00	0.00
12	no data	0.00	0.00	0.00	1.09	1.21	6.09	0.00	0.00	0.00	0.00	0.00
13	no data	0.00	0.00	0.00	0.92	1.17	4.45	0.00	0.00	0.00	0.00	0.00
14	no data	0.00	0.00	0.00	0.79	0.91	3.34	0.00	0.00	0.00	0.00	0.00
15	no data	0.00	0.00	0.00	0.75	0.85	2.52	0.00	0.00	0.00	0.00	0.00
16	no data	0.00	0.00	0.00	0.68	0.63	1.73	0.00	0.00	0.00	0.00	0.00
17	no data	0.00	0.00	0.00	0.72	0.54	1.31	0.00	0.00	0.00	0.00	0.00
18	no data	0.00	0.00	9.46	0.72	0.34	1.12	0.00	0.00	0.00	0.00	0.00
19	no data	0.00	0.00	17.36	0.71	0.20	0.95	0.00	0.00	0.00	0.00	0.00
20	no data	0.00	0.00	16.64	0.64	0.22	1.03	0.00	0.00	0.00	0.00	0.00
21	no data	0.00	0.00	9.15	0.63	0.38	0.92	0.00	0.00	0.00	0.00	0.00
22	no data	0.00	0.00	7.25	0.52	0.26	0.60	0.00	0.00	0.00	0.00	0.00
23	no data	0.00	0.00	4.64	1.41	0.11	0.60	0.00	0.00	0.00	0.00	0.00
24	no data	0.00	0.00	3.02	4.40	0.14	0.57	0.00	0.00	0.00	0.00	0.00
25	no data	0.00	0.00	4.06	2.98	0.10	0.38	0.00	0.00	0.00	0.00	0.00
26	no data	0.00	0.00	5.05	3.48	0.09	0.25	0.00	0.00	0.00	0.00	0.00
27	no data	0.00	0.00	3.20	3.97	0.06	0.36	0.00	0.00	0.00	0.00	0.00
28	no data	0.00	0.00	2.34	3.17	0.02	0.28	0.00	0.00	0.00	0.00	0.00
29	no data	0.00	0.00	1.60	...	0.06	0.21	0.00	0.00	0.00	0.00	0.00
30	no data	0.00	0.00	1.16	...	0.05	0.07	0.00	0.00	0.00	0.00	0.00
31	no data	...	0.00	0.93	...	0.28	...	0.00	...	0.00	0.00	...
MEAN	NA	0.00	0.00	2.77	1.73	1.15	1.31	0.00	0.00	0.00	0.00	0.00
MAX. DAY	NA	0.00	0.00	17.36	4.40	4.39	6.09	0.01	0.00	0.00	0.00	0.00
MIN. DAY	NA	0.00	0.00	0.00	0.49	0.02	0.07	0.00	0.00	0.00	0.00	0.00
cfs days	NA	0.00	0.00	85.88	48.39	35.79	39.23	0.01	0.00	0.00	0.00	0.00
ac-ft	NA	0.00	0.00	170.35	95.99	70.99	77.82	0.02	0.00	0.00	0.00	0.00

Monitor's Comments

1. Multiple stage shifts were applied to the rating equation for local scour or fill.
2. Daily values with more than 2 to 3 significant figures result from calculations. No additional precision is implied.
3. Minor runoff may have occurred during the rains of mid-October, prior to installation of the gages. We believe such flows are negligible, and have computed mean daily flow for the year without adding any flows for those dates.
4. The bank adjacent to the gage slumped on March 2 and buried the sensors. The sensors continued to operate, but flow values are approximate. The sensors were dug out on April 30.

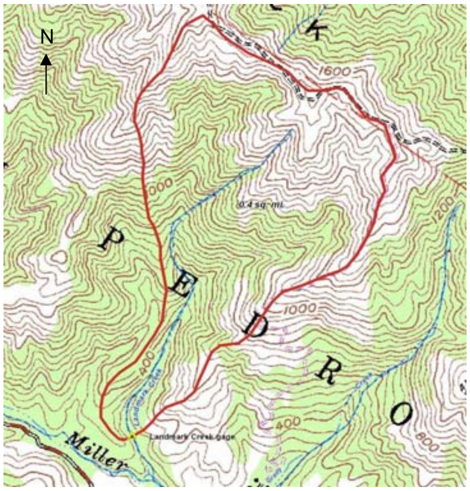
Water Year Summary

Mean daily discharge	0.57	(cfs)
Max. daily discharge	17.4	(cfs)
Min. daily discharge	0.00	(cfs)
Total	209	(cfs-days)
Total Volume	415	(ac-ft)

Data preliminary and subject to revision

Form 4. Annual Hydrologic Record: Landmark Creek

Water Year: **2010**
Stream: Landmark Creek
Station: ...
County, State: Marin County, CA
Station Location Map



Station Location / Watershed Descriptors

Approximately 250 feet downstream road crossing (500 feet upstream Miller Creek)
Latitude: 38°2'34.59"N, Longitude: 122°36'23.98"W (WGS84)
Drainage area is 256 acres or 0.40 square miles.
Regulation: County open space

Period of Record

Gage was installed on 11/16/09 by Balance Hydrologics.
Preliminary record 11/16/09 through 9/30/10.
Gaging sponsored by Skywalker Properties, Ltd.

Mean Flows

Monthly mean flows are presented below.

Seasonal Peak Flows (period of record)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
1/20/10	8:00	8.51	23.65				

Water Year Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	no data	no data	0.00	0.00	0.43	1.58	0.03	0.00	0.00	0.00	0.00	0.00
2	no data	no data	0.00	0.00	0.37	2.22	0.00	0.00	0.00	0.00	0.00	0.00
3	no data	no data	0.00	0.00	0.26	3.73	0.03	0.00	0.00	0.00	0.00	0.00
4	no data	no data	0.00	0.00	0.97	3.17	0.53	0.00	0.00	0.00	0.00	0.00
5	no data	no data	0.00	0.00	2.94	2.12	0.99	0.00	0.00	0.00	0.00	0.00
6	no data	no data	0.00	0.00	4.49	1.27	0.56	0.00	0.00	0.00	0.00	0.00
7	no data	no data	0.00	0.00	3.26	0.82	0.32	0.00	0.00	0.00	0.00	0.00
8	no data	no data	0.00	0.00	1.90	0.57	0.23	0.00	0.00	0.00	0.00	0.00
9	no data	no data	0.00	0.00	1.33	0.38	0.16	0.00	0.00	0.00	0.00	0.00
10	no data	no data	0.00	0.00	0.86	0.28	0.13	0.00	0.00	0.00	0.00	0.00
11	no data	no data	0.00	0.00	0.67	0.18	1.63	0.00	0.00	0.00	0.00	0.00
12	no data	no data	0.00	0.00	0.52	0.26	3.57	0.00	0.00	0.00	0.00	0.00
13	no data	no data	0.37	0.71	0.38	0.19	2.29	0.00	0.00	0.00	0.00	0.00
14	no data	no data	0.05	0.29	0.28	0.11	1.55	0.00	0.00	0.00	0.00	0.00
15	no data	no data	0.00	0.10	0.21	0.09	0.96	0.00	0.00	0.00	0.00	0.00
16	no data	0.00	0.00	0.03	0.14	0.05	0.58	0.00	0.00	0.00	0.00	0.00
17	no data	0.00	0.00	0.03	0.13	0.03	0.36	0.00	0.00	0.00	0.00	0.00
18	no data	0.00	0.00	6.11	0.10	0.01	0.27	0.00	0.00	0.00	0.00	0.00
19	no data	0.00	0.00	10.08	0.09	0.00	0.19	0.00	0.00	0.00	0.00	0.00
20	no data	0.00	0.00	9.80	0.06	0.00	0.18	0.00	0.00	0.00	0.00	0.00
21	no data	0.00	0.00	5.67	0.05	0.00	0.11	0.00	0.00	0.00	0.00	0.00
22	no data	0.00	0.00	5.04	0.03	0.00	0.06	0.00	0.00	0.00	0.00	0.00
23	no data	0.00	0.00	2.79	0.46	0.00	0.03	0.00	0.00	0.00	0.00	0.00
24	no data	0.00	0.00	1.69	2.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	no data	0.00	0.00	2.98	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	no data	0.00	0.00	4.94	2.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	no data	0.00	0.00	2.68	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	no data	0.00	0.00	1.63	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	no data	0.00	0.00	1.03	...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	no data	0.00	0.00	0.71	...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	no data	...	0.00	0.57	...	0.01	...	0.00	...	0.00	0.00	...
MEAN	NA	NA	0.01	1.84	1.15	0.55	0.49	0.00	0.00	0.00	0.00	0.00
MAX. DAY	NA	NA	0.37	10.08	4.49	3.73	3.57	0.00	0.00	0.00	0.00	0.00
MIN. DAY	NA	NA	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
cfs days	NA	NA	0.46	56.89	32.26	17.11	14.76	0.00	0.00	0.00	0.00	0.00
ac-ft	NA	NA	0.91	112.84	63.98	33.93	29.27	0.00	0.00	0.00	0.00	0.00

Monitor's Comments

1. A stage shift were applied to the rating equation for local fill following the Jan. 20 event.
2. Daily values with more than 2 to 3 significant figures result from calculations. No additional precision is implied.
3. Minor runoff may have occurred during the rains of mid-October, prior to installation of the gages. We believe such flows are negligible, and have computed mean daily flow for the year without adding any flows for those dates.

Water Year Summary

Mean daily discharge	0.33	(cfs)
Max. daily discharge	10.1	(cfs)
Min. daily discharge	0.00	(cfs)
Total	121	(cfs-days)
Total Volume	241	(ac-ft)

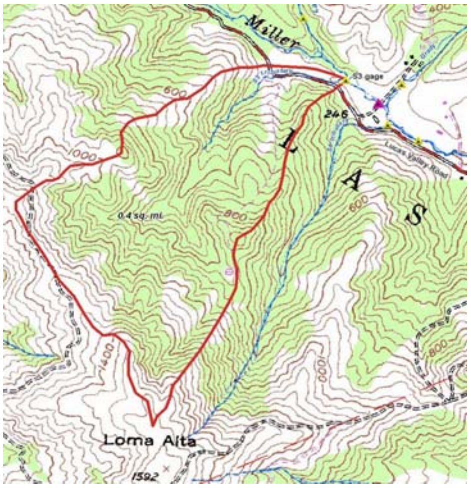
Data preliminary and subject to revision

Form 5. Annual Hydrologic Record: S3 Tributary

Water Year: 2010

Stream:	S3 Tributary
Station:	below Lucas Valley Road
County, State:	Marin County, CA

Station Location Map



Station Location / Watershed Descriptors

Approximately 150 feet upstream of the confluence with Miller Creek (right bank)
Latitude: 38°2'25.55"N, Longitude: 122°36'16.66"W (WGS84)
Drainage area is 256 acres or 0.40 square miles.
Regulation: County open space

Period of Record

Gage was installed on 11/16/09 by Balance Hydrologics.
Record 11/16/09 through 9/30/10.
Gaging sponsored by Skywalker Properties, Ltd.

Mean Flows

Monthly mean flows are presented below.

Seasonal Peak Flows (period of record)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
1/20/10	8:45	8.64	40.67				

Water Year Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	no data	no data	0.00	0.00	0.61	0.88	0.08	0.00	0.00	0.00	0.00	0.00
2	no data	no data	0.00	0.00	0.46	2.31	0.28	0.00	0.00	0.00	0.00	0.00
3	no data	no data	0.00	0.00	0.27	3.65	0.27	0.00	0.00	0.00	0.00	0.00
4	no data	no data	0.00	0.00	2.25	2.04	1.78	0.00	0.00	0.00	0.00	0.00
5	no data	no data	0.00	0.00	3.23	1.23	1.51	0.00	0.00	0.00	0.00	0.00
6	no data	no data	0.00	0.00	5.07	0.78	0.77	0.00	0.00	0.00	0.00	0.00
7	no data	no data	0.00	0.00	2.11	0.55	0.65	0.00	0.00	0.00	0.00	0.00
8	no data	no data	0.00	0.00	1.12	0.40	0.49	0.00	0.00	0.00	0.00	0.00
9	no data	no data	0.00	0.00	0.87	0.28	0.41	0.00	0.00	0.00	0.00	0.00
10	no data	no data	0.00	0.00	0.60	0.21	0.13	0.00	0.00	0.00	0.00	0.00
11	no data	no data	0.00	0.00	0.44	0.09	3.85	0.00	0.00	0.00	0.00	0.00
12	no data	no data	0.02	0.26	0.33	0.35	4.22	0.00	0.00	0.00	0.00	0.00
13	no data	no data	0.54	0.61	0.23	0.34	1.83	0.00	0.00	0.00	0.00	0.00
14	no data	no data	0.08	0.20	0.15	0.20	1.08	0.00	0.00	0.00	0.00	0.00
15	no data	no data	0.00	0.03	0.08	0.11	0.83	0.00	0.00	0.00	0.00	0.00
16	no data	0.00	0.00	0.01	0.03	0.03	0.63	0.00	0.00	0.00	0.00	0.00
17	no data	0.00	0.00	0.19	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00
18	no data	0.00	0.00	6.56	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00
19	no data	0.00	0.00	5.39	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
20	no data	0.00	0.00	10.54	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00
21	no data	0.00	0.00	9.94	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
22	no data	0.00	0.00	5.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	no data	0.00	0.00	2.75	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	no data	0.00	0.00	1.84	3.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	no data	0.00	0.00	5.01	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	no data	0.00	0.00	5.02	2.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	no data	0.00	0.00	2.39	2.25	0.00	0.07	0.00	0.00	0.00	0.00	0.00
28	no data	0.00	0.00	1.57	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	no data	0.00	0.00	1.17	...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	no data	0.00	0.00	1.03	...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	no data	...	0.00	0.84	...	0.20	...	0.00	...	0.00	0.00	...
MEAN	NA	NA	0.02	1.95	1.09	0.44	0.67	0.00	0.00	0.00	0.00	0.00
MAX. DAY	NA	NA	0.54	10.54	5.07	3.65	4.22	0.00	0.00	0.00	0.00	0.00
MIN. DAY	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
cfs days	NA	NA	0.66	60.51	30.52	13.66	20.06	0.00	0.00	0.00	0.00	0.00
ac-ft	NA	NA	1.32	120.02	60.53	27.10	39.79	0.00	0.00	0.00	0.00	0.00

Monitor's Comments

1. Multiple stage shifts were applied to the rating equation for local scour or fill.
2. Daily values with more than 2 to 3 significant figures result from calculations. No additional precision is implied.
3. Minor runoff may have occurred during the rains of mid-October, prior to installation of the gages. We believe such flows are negligible, and have computed mean daily flow for the year without adding any flows for those dates.

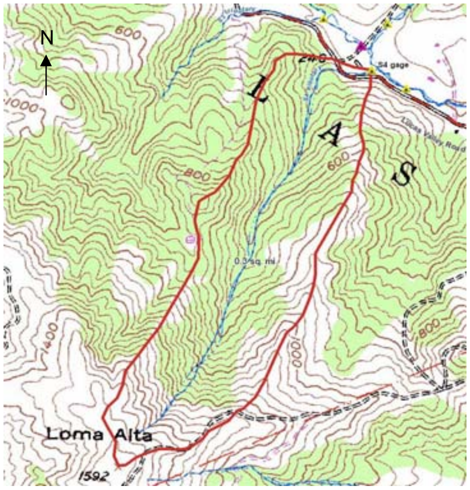
Water Year Summary

Mean daily discharge	0.34	(cfs)
Max. daily discharge	10.5	(cfs)
Min. daily discharge	0.00	(cfs)
Total	125	(cfs-days)
Total Volume	249	(ac-ft)

Data preliminary and subject to revision

Form 6. Annual Hydrologic Record: S4 Tributary

Water Year: 2010
Stream: S4 Tributary
Station: below Lucas Valley Road
County, State: Marin County, CA
Station Location Map



Station Location / Watershed Descriptors

Approximately 225 feet upstream of confluence with Miller Creek (right bank)
Latitude: 38°2'18.92"N, Longitude: 122°36'9.98"W (WGS84)
Drainage area is 192 acres or 0.30 square miles.
Regulation: County open space

Period of Record

Gage was installed on 11/16/09 by Balance Hydrologics.
Preliminary record 11/16/09 through 9/30/10.
Gaging sponsored by Skywalker Properties, Ltd.

Mean Flows

Monthly mean flows are presented below.

Seasonal Peak Flows (period of record)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
1/20/10	8:15	7.65	22.43				

Water Year Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	no data	no data	0.00	0.00	0.43	1.15	0.18	0.01	0.00	0.00	0.00	0.00
2	no data	no data	0.00	0.00	0.36	2.85	0.21	0.00	0.00	0.00	0.00	0.00
3	no data	no data	0.00	0.00	0.25	3.88	0.20	0.00	0.00	0.00	0.00	0.00
4	no data	no data	0.00	0.00	1.44	2.56	1.59	0.00	0.00	0.00	0.00	0.00
5	no data	no data	0.00	0.00	2.66	1.62	1.53	0.00	0.00	0.00	0.00	0.00
6	no data	no data	0.00	0.00	4.00	0.97	0.77	0.00	0.00	0.00	0.00	0.00
7	no data	no data	0.00	0.00	2.40	0.71	0.51	0.00	0.00	0.00	0.00	0.00
8	no data	no data	0.00	0.00	1.58	0.61	0.41	0.00	0.00	0.00	0.00	0.00
9	no data	no data	0.00	0.00	1.34	0.50	0.34	0.00	0.00	0.00	0.00	0.00
10	no data	no data	0.00	0.00	0.88	0.43	0.31	0.00	0.00	0.00	0.00	0.00
11	no data	no data	0.01	0.00	0.67	0.35	3.39	0.00	0.00	0.00	0.00	0.00
12	no data	no data	0.07	0.44	0.60	0.65	3.44	0.00	0.00	0.00	0.00	0.00
13	no data	no data	0.93	0.64	0.50	0.59	1.86	0.00	0.00	0.00	0.00	0.00
14	no data	no data	0.21	0.24	0.38	0.42	1.24	0.00	0.00	0.00	0.00	0.00
15	no data	no data	0.01	0.13	0.31	0.39	0.90	0.00	0.00	0.00	0.00	0.00
16	no data	0.00	0.11	0.06	0.24	0.30	0.66	0.00	0.00	0.00	0.00	0.00
17	no data	0.00	0.02	0.30	0.22	0.25	0.49	0.00	0.00	0.00	0.00	0.00
18	no data	0.00	0.00	5.26	0.18	0.19	0.41	0.00	0.00	0.00	0.00	0.00
19	no data	0.00	0.00	7.67	0.17	0.15	0.33	0.00	0.00	0.00	0.00	0.00
20	no data	0.00	0.00	8.82	0.14	0.15	0.38	0.00	0.00	0.00	0.00	0.00
21	no data	0.00	0.00	6.35	0.15	0.14	0.27	0.00	0.00	0.00	0.00	0.00
22	no data	0.00	0.00	3.95	0.12	0.10	0.19	0.00	0.00	0.00	0.00	0.00
23	no data	0.00	0.00	2.25	1.76	0.07	0.16	0.00	0.00	0.00	0.00	0.00
24	no data	0.00	0.00	1.33	4.46	0.08	0.13	0.00	0.00	0.00	0.00	0.00
25	no data	0.00	0.00	3.30	1.87	0.08	0.08	0.00	0.00	0.00	0.00	0.00
26	no data	0.00	0.00	3.50	2.60	0.06	0.05	0.00	0.00	0.00	0.00	0.00
27	no data	0.00	0.00	1.83	2.56	0.04	0.14	0.00	0.00	0.00	0.00	0.00
28	no data	0.00	0.00	1.21	1.59	0.01	0.09	0.00	0.00	0.00	0.00	0.00
29	no data	0.00	0.00	0.86	...	0.02	0.07	0.00	0.00	0.00	0.00	0.00
30	no data	0.00	0.00	0.77	...	0.05	0.03	0.00	0.00	0.00	0.00	0.00
31	no data	...	0.00	0.59	...	0.19	...	0.00	...	0.00	0.00	...
MEAN	NA	NA	0.04	1.60	1.21	0.63	0.68	0.00	0.00	0.00	0.00	0.00
MAX. DAY	NA	NA	0.93	8.82	4.46	3.88	3.44	0.01	0.00	0.00	0.00	0.00
MIN. DAY	NA	NA	0.00	0.00	0.12	0.01	0.03	0.00	0.00	0.00	0.00	0.00
cfs days	NA	NA	1.38	49.51	33.85	19.56	20.35	0.01	0.00	0.00	0.00	0.00
ac-ft	NA	NA	2.74	98.21	67.14	38.79	40.36	0.02	0.00	0.00	0.00	0.00

Monitor's Comments

1. Multiple stage shifts were applied to the rating equation for local scour or fill.
2. Daily values with more than 2 to 3 significant figures result from calculations. No additional precision is implied.
3. Minor runoff may have occurred during the rains of mid-October, prior to installation of the gages. We believe such flows are negligible, and have computed mean daily flow for the year without adding any flows for those dates.

Water Year Summary

Mean daily discharge	0.34	(cfs)
Max. daily discharge	8.82	(cfs)
Min. daily discharge	0.00	(cfs)
Total	125	(cfs-days)
Total Volume	247	(ac-ft)

Data preliminary and subject to revision

Water Year: 2010
Stream: Miller Creek
Station: Above Grady Bridge
County: Marin County, CA

Form 7. Annual Sediment-Discharge Record

Daily Suspended-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	no data	no data	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
2	no data	no data	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	no data	no data	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	
4	no data	0.0	0.0	0.0	7.5	1.4	2.7	0.0	0.0	0.0	0.0	0.0	
5	no data	0.0	0.0	0.0	3.5	0.3	0.6	0.0	0.0	0.0	0.0	0.0	
6	no data	0.0	0.0	0.0	15.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
7	no data	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	no data	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	no data	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10	no data	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11	no data	0.0	0.0	0.0	0.1	0.0	11.2	0.0	0.0	0.0	0.0	0.0	
12	no data	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	
13	no data	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	
14	no data	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	
15	no data	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
16	no data	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17	no data	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
18	no data	0.0	0.0	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19	no data	0.0	0.0	68.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
20	no data	0.0	0.0	323	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
21	no data	0.0	0.0	85.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	no data	0.0	0.0	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
23	no data	0.0	0.0	3.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	no data	0.0	0.0	0.5	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
25	no data	0.0	0.0	11	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	no data	0.0	0.0	10.6	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	no data	0.0	0.0	1.8	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
28	no data	0.0	0.0	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	no data	0.0	0.0	0.1	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	no data	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
31	no data	...	0.0	0.0	...	0.0	...	0.0	...	0.0	0.0	...	**Annual**
TOTAL	0	0	0	555	53	10	21	0	0	0	0	0	**639**
Max.day	0	0	0	323	15	5	11	0	0	0	0	0	**323**

Daily Bedload-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	no data	no data	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
2	no data	no data	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
3	no data	no data	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	
4	no data	0.0	0.0	0.0	5.6	1.1	2.0	0.0	0.0	0.0	0.0	0.0	
5	no data	0.0	0.0	0.0	2.7	0.2	0.5	0.0	0.0	0.0	0.0	0.0	
6	no data	0.0	0.0	0.0	11.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
7	no data	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	no data	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	no data	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10	no data	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11	no data	0.0	0.0	0.0	0.0	0.0	8.4	0.0	0.0	0.0	0.0	0.0	
12	no data	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	
13	no data	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	
14	no data	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	
15	no data	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
16	no data	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17	no data	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
18	no data	0.0	0.0	26.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19	no data	0.0	0.0	51.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
20	no data	0.0	0.0	242	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
21	no data	0.0	0.0	64.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	no data	0.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
23	no data	0.0	0.0	2.3	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	no data	0.0	0.0	0.4	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
25	no data	0.0	0.0	7.9	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	no data	0.0	0.0	7.9	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	no data	0.0	0.0	1.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
28	no data	0.0	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	no data	0.0	0.0	0.1	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	no data	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
31	no data	...	0.0	0.0	...	0.0		0.0	...	0.0	0.0	...	**Annual**
TOTAL	0	0	0	416	40	8	16	0	0	0	0	0	**480**
Max.day	0	0	0	242	11	4	8	0	0	0	0	0	**242**

Monitor's Comments

1. Daily values are based on calculations of sediment discharge at 15-minute intervals.
2. Daily values with more than 2 to 3 significant figures result from electronic calculations. No additional precision is implied.

Total annual sediment discharge
(suspended plus bedload sediment)
WY 2010: 1,119 *tons*

Balance Hydrologics, Inc. 101 Lucas Valley Rd., Suite 229, San Rafael, CA 94903 (415) 472-7584
Balance Hydrologics, Inc. 800 Bancroft Way, Suite 101, Berkeley, CA 94710 (510) 704-1000; fax: (510) 704-1001; www.balancehydro.com

Data preliminary and subject to revision

APPENDICES

APPENDIX A

Log of hydrologic observations

Appendix A. Summary of hydrologic monitoring results for Water Year 2010, Grady Ranch, Marin County, California

Site Conditions		Groundwater			Streamflow						High-water Marks		Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water	WSE elevation (NGVD 29)	Depth below ground surface	Gage Height	WSE elevation (NGVD 29)	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Estimated stage at staff plate	Inferred dates?	Temperature	Specific Conductance	Specific Conductance	Additional sampling?	
		(ft)	(ft)	(ft)	(ft)		(cfs)	(cfs)	(AA/PY)	(e/g/f/p)			(°C)	(µmhos)	at 25 (°C)	(Qbed, etc.)	
GROUND WATER MONITORING POINTS																	
MW-1 (Tterrace S of Miller Cr, 400 ft u/s of S3 trib, near Landmark Cr)																	
Latitude:	38.04121° N																
Longitude:	122.60544° W																
Depth to bottom (from GS) =	30.00																
Depth to bottom (from RP) =	32.75																
Reference point (RP) elevation =	255.61																
Stickup of RP =	2.92																
Ground surface elevation =	252.69																
10/22/09 17:35	mw	23.65	231.96	20.73													installed F30 #2157 at 27 feet bgs
11/4/09 16:17	sr, tb	27.58	228.03	24.66													Measured initial DTW and then set pump ~2 ft above bottom of well and turned on at max rate.
11/4/09 16:40	sr, tb	27.60	228.01	24.68									15.1	290.3	357.4		Purged 7.5 gal (0.85 gal = 1 well casing). Water was initially very brown/turbid and cleared around 4 gal, such that it was faintly brown/turbid. Measured SCT in 2nd (last) 5-gal bucket. Sampled for irrigation suitability analysis. Downloaded and relaunched.
1/6/10 16:52	sr	21.01	234.60	18.09													F15 may not be sufficient (water level fluc. 2-13 ft from Nov to present). Pulled up levelogger 1.4 ft so that it was 5 ft below water surface.
1/16/10 8:17	tb	17.07	238.54	14.15													swapped the F15 for the F30, string length unchanged.
2/18/10 9:52	sr	16.76	238.85	13.84													Downloaded data and relaunched; string length unchanged.
4/30/10 18:23	sr, jo	17.40	238.21	14.48													Downloaded data and relaunched (changed to continuous logging); string length unchanged.
7/23/10 18:07	sr	29.72	225.89	26.80													Downloaded
8/3/10 16:00	gp	31.00	224.61	28.08													Lengthened string (25.7 ft --> 34.0 ft).
8/10/10 13:15	bh	33.10	222.51	30.18													Downloaded
10/7/10 17:27	sr, tb	32.75	222.86	29.83													
MW-2 (Terrace N of Miller Cr, 100 ft u/s of Grady bridge)																	
Latitude:	38.04002° N																
Longitude:	122.60269° W																
Depth to bottom (from GS) =	35.00																
Depth to bottom (from RP) =	38.25																
Reference point (RP) elevation =	241.79																
Stickup of RP =	3.35																
Ground surface elevation =	238.44																
10/22/09 16:00	mw	25.25	216.54	21.90													installed F30 # 2185 at 29.3 feet from RP
11/4/09 9:18	sr, tb	26.91	214.88	23.56									15.30	259.6	319.20		Measured initial DTW and SCT. SCT measured at top of water column. No more measurements of SCT will be made in well because a) reading represents well water, not GW and b) SCT increases with depth. Instead measure SCT after purging. Set pump ~2 ft abov
11/4/09 9:56	sr, tb	27.05	214.74	23.70									15.2	261.5	322.0		Purged 10 gal (1.85 gal = 1 well casing). Water was initially very brown/turbid and cleared around 5 gal, such that water was faintly brown/turbid. Measured SCT in 2nd (last) 5-gal bucket. Sampled for irrigation suitability analysis. Downloaded and relau
1/6/10 16:11	sr	23.70	218.09	20.35													F15 may not be sufficient (water level fluc. 2-13 ft from Nov to present). Pulled up levelogger 0.6 ft so that it was 5 ft below water surface.
1/16/10 7:08	tb	18.12	223.67	14.77													swapped the F15 for the F30, string length unchanged.
2/18/10 8:48	sr	17.21	224.58	13.86													Downloaded data and relaunched; string length unchanged.
4/30/10 16:00	sr, jo	19.01	222.78	15.66													Downloaded data and relaunched (changed to continuous logging); string length unchanged.
7/23/10 17:31	sr	28.97	212.82	25.62													Downloaded
8/3/10 17:50	gp	30.00	211.79	26.65													Lengthened string (28.6 ft --> 36.0 ft).
10/7/10 17:12	sr, tb	33.10	208.69	29.75													Downloaded
WW-2 (Near MW-2)																	
Latitude:	38.___° N																
Longitude:	122.___° W																

Site Conditions		*Groundwater*			*Streamflow*						*High-water Marks*		*Water Quality Observations*				*Remarks*
Date/Time	Observer	Top-of-casing to water	WSE elevation (NGVD 29)	Depth below ground surface	Gage Height	WSE elevation (NGVD 29)	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Estimated stage at staff plate	Inferred dates?	Temperature	Specific Conductance	Specific Conductance	Additional sampling?	
		(ft)	*(ft)*	*(ft)*	*(ft)*		*(cfs)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*			*(°C)*	*(µmhos)*	*at 25 (°C)*	*(Qbed, etc.)*	
Depth to bottom (from GS) =	307.70																
Depth to bottom (from RP) =	310.00																
Reference point (RP) elevation =	Not surveyed																
Stickup of RP =	2.30																
Ground surface elevation =	?																
10/19/10 15:22	gp	25.40	?	?													Well instrumented with F30 levelogger, SN 31019270, Bal# 1833. LL is 36.65 ft. from RP.(or 36.0 ft. from top of internal 4" casing)
MW-3 (Terrace N of Miller Cr, 350 ft d/s of Grady bridge, near S4 trib)																	
Latitude:	38.03901° N																
Longitude:	122.60150° W																
Depth to bottom (from GS) =	40.00																
Depth to bottom (from RP) =	42.33																
Reference point (RP) elevation =	236.26																
Stickup of RP =	1.99																
Ground surface elevation =	234.27																
10/21/09 8:07	sr, gp	25.97	210.29	23.98									15.0	220	…		SC measured at top of water column
10/21/09 8:07	sr, gp												9.0	360	…		SC measured at bottom of water column
10/21/09 10:41	sr	26.10	210.16	24.11													After bailing 1 well casing, water still brown/turbid; sampled for general mineral analysis
10/22/09 16:50	mw	25.90	210.36	23.91													installed F30 #2159 at 30 feet below RP
11/4/09 11:23	sr, tb	26.53	209.73	24.54													Measured initial DTW and then set pump ~2 ft above bottom of well and turned on at max rate.
11/4/09 11:50	sr, tb	26.91	209.35	24.92									15.3	250.4	306.8		Purged 10 gal (2.56 gal = 1 well casing). Water was initially very brown/turbid and cleared around 3 gal, such that water was faintly brown/turbid. Measured SCT in 2nd (last) 5-gal bucket. Sampled for irrigation suitability analysis. Downloaded and relau
1/6/10 15:01	sr	25.76	210.50	23.77													F15 seems sufficient (water level fluc. 3-8 ft from Nov to present).
1/16/10 7:47	tb	25.52	210.74	23.53													swapped the F15 for the F30, string length unchanged.
2/18/10 9:22	sr	25.42	210.84	23.43													Downloaded data and relaunched; string length unchanged.
4/30/10 15:39	sr, jo	25.52	210.74	23.53													Downloaded data and relaunched (changed to continuous logging); string length unchanged.
7/23/10 17:08	sr	28.16	208.10	26.17													Downloaded
8/3/10 16:49	gp	29.20	207.06	27.21													Lengthened string (30.2 ft --> 38.0 ft).
8/10/10 9:45	bh	29.93	206.33	27.94													Downloaded
10/7/10 16:24	sr, tb	33.23	203.03	31.24													
MW-4 (Terrace E of Grady Cr, 400 ft u/s of Miller Cr, near ranch rd ford)																	
Latitude:	38.04049° N																
Longitude:	122.60134° W																
Depth to bottom (from GS) =	30.00																
Depth to bottom (from RP) =	33.17																
Reference point (RP) elevation =	248.99																
Stickup of RP =	3.17																
Ground surface elevation =	245.82																
10/21/09 13:50	sr	23.65	225.34	20.48									15.5	401.4	491		SC measured in 4th 5-gal bucket bailed (5 5-gal buckets ~ 1 well casing); Bailed 3.5 buckets (drillers ready to seal well); water still brown/turbid; sampled for general mineral analysis
10/22/09 16:30	mw	24.02	224.97	20.85													installled F30 #2160 at 28 feet from RP
11/4/09 12:05	sr, tb	26.57	222.42	23.40													Measured initial DTW and then set pump ~2 ft above bottom of well and turned on at max rate.
11/4/09 12:25	sr, tb	28.02	220.97	24.85													Purged 1 gal (1.10 gal = 1 well casing). Water was initially very brown/turbid. Pump stopped working in the well. Pump worked in the bucket, but perhaps too much sediment in the water to work in the well? DTW indicates there is still water in the well.
11/4/09 15:41	sr, tb	27.10	221.89	23.93													Measured DTW and then began bailing.
11/4/09 15:55	sr, tb	30.10	218.89	26.93													Bailed 2.5 gal. Water very brown/turbid with fine sand in it. Bailer was not filling up. Bottom of well is 31.21 ft. Well casing turns when spun from the top (doesn't feel as secure as other wells). Left well to recover.

Site Conditions		Groundwater			Streamflow						High-water Marks		Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water	WSE elevation (NGVD 29)	Depth below ground surface	Gage Height	WSE elevation (NGVD 29)	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Estimated stage at staff plate	Inferred dates?	Temperature	Specific Conductance	Specific Conductance	Additional sampling?	
		(ft)	(ft)	(ft)	(ft)		(cfs)	(cfs)	(AA/PY)	(e/g/f/p)			(°C)	(µmhos)	at 25 (°C)	(Qbed, etc.)	
11/4/09 17:08	sr, tb	28.37	220.62	25.20													MW asked us to sample without any more bailing. Sampled for irrigation suitability analysis.
1/6/10 15:24	sr	23.69	225.30	20.52													F15 seems sufficient (water level fluc. 3-10 ft from Nov to present).
1/16/10 7:35	tb	19.07	229.92	15.90													swapped the F15 for the F30, string length unchanged.
2/18/10 9:08	sr	12.28	236.71	9.11													Downloaded data and relaunched; string length unchanged.
4/30/10 15:25	sr, jo	12.50	236.49	9.33													Downloaded data and relaunched (changed to continuous logging); string length unchanged.
7/23/10 16:48	sr	26.02	222.97	22.85													Downloaded
8/3/10 17:15	gp	26.49	222.50	23.32													Lengthened string (28 ft --> 30.0 ft).
10/7/10 16:31	sr, tb	28.05	220.94	24.88													Downloaded
RW-6 (Terrace W Miller Cr; 250 ft S bridge, near S-4)																	
Latitude:	38.03878° N																
Longitude:	122.60247° W																
Depth to bottom (from GS) =	52.00																
Reference point (RP) elevation =	236.16																
Stickup of RP =	2.46																
Ground surface elevation =	233.70																
10/11/09 14:30	mw	31.60	204.56	29.14													installed F30 #1829 at 35 feet bgs; installed barologger #1965; installed hobo rain gage on old cattle trough
1/6/10 12:51	sr	20.86	215.30	18.40													F30 seems sufficient (water level fluc. 3-18 ft from Nov to present).
2/18/10 8:16	sr	15.69	220.47	13.23													Downloaded data and relaunched; string length unchanged.
4/30/10 18:00	sr, jo	18.83	217.33	16.37													Downloaded data and relaunched (changed to continuous logging); string length unchanged.
7/23/10 17:45	sr	25.63	210.53	23.17													Downloaded
8/3/10 18:46	gp	26.65	209.51	24.19													Lengthened string 36 ft --> 51 ft).
10/7/10 16:13	sr, tb	30.75	205.41	28.29													Downloaded, downloaded and moved barologger from RW-6 to S3
SURFACE WATER MONITORING POINTS																	
Miller Creek above Grady bridge																	
Latitude:	38.03958° N																
Longitude:	122.60253° W																
Reference point (RP) elevation =	224.01																
Ground surface elevation =	225.81																
11/4/09 14:30	mw, tb																Installed datalogger (TB - see inventory for #) and solar panel (Bal #1152) into pool u/s Grady bridge (real-time station).
1/6/10 8:15	sr				…	…	dry	…	…	…	…	…	…	…	…	…	No flow at gage; Trouble-shooted SCT probe (checked wiring, cables -- didn't find any problems) and called SB to look into program/real-time data
1/16/10 9:37	tb				1.84	225.85	0.279	…	PY	f	2.50	01/12/10	11.2	197.1	266.2	…	Flow measurement on concrete in very shallow water, may be underestimate, water clear.
1/18/10 16:05	gp, mw				3.03	227.04	…	60.00	…	p	3.70	Not specified	11.1	91.7	124.8	1 Qbed, 1 Qss	Storm duty - Headphones broke so no flow meas.
1/20/10 14:38	gp, mw				3.24	227.25	73.9	…	AA	e/g	4.15	01/20/10	11.0	80.0	111.8	1Qbed	
1/29/10 16:15	mw				2.11	226.12	5.49	…	PY	…	3.50	Not specified	12.0	132.0	179.6	1 Qss	I removed the SCT probe from the still well, brushed out the mud, and placed it in the creek outside of the casing somewhat in the current so it would not accumulate mud within the sensor.
2/3/10 15:00	mw				1.94	225.95	…	…	…	…	…	…	…	…	…	…	measured Q at S3, S4 and Landmark but only read a GH at Miller Cr
2/5/10 12:15	sr, tb				2.40	226.41	17.01	20.00	PY	g	3.40	02/04/10	11.9	107	142.9	2 Qbed, 2 Qss	Rained ~1.6" last night - left bank has small trib running more turbid than Miller Ck u/s meas.; Miller Ck is as turbid S3, though much more bedload moving in Miller Ck than S3.
2/18/10 12:15	sr				1.89	225.90	1.15	1.00	PY	g	2.40	2/6-2/7	13.3	157	202.2	…	Gage pool filled in so that bed is now at GH 1.86; water clear, flow through both sides of bridge
2/24/10 9:45	mw				2.50	226.51	…	…	…	…	2.80	2/18/10	12.0	105	143.0	1 Qbed, 1 Qss	wake at staff dipping down to 1.48
2/26/10 14:48	gp				3.12	227.13	…	70	…	…	…	…	…	…	…	1 Qbed, 1 Qss	Approximate time of Qss is 15:50
2/26/10 16:14	gp				2.78	226.79	…	…	…	…	…	…	…	…	…	…	
4/30/10 17:00	sr, jo				…	…	0.46	…	PY	g	2.10	Mar-Apr 2010	15.6	182	222.0	…	No flow at gage (pool completely filled in with sediment), but water in adjacent LB pool. Dug down to 1.4 on staff plate - moist water but no ponded water. Walked us to upper side of straight reach (adj. to unnamed LB trib - not flowing) to minimize effects of losing reach (measured 0.46 cfs). Water clear.

Site Conditions		Groundwater			Streamflow						High-water Marks		Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water	WSE elevation (NGVD 29)	Depth below ground surface	Gage Height	WSE elevation (NGVD 29)	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Estimated stage at staff plate	Inferred dates?	Temperature	Specific Conductance	Specific Conductance	Additional sampling?	
		(ft)	(ft)	(ft)	(ft)		(cfs)	(cfs)	(AA/PY)	(e/g/f/p)			(°C)	(µmhos)	at 25 (°C)	(Qbed, etc.)	
7/23/10 12:25	sr				…	…	…	…	…	…	…	…	…	…	…	…	Dry at gage (bed = 1.85), no repairs needed. Gage pool filled in, pool us along LB. Downloaded and relaunched temp loggers d/s Grady Bridge, d/s S3, d/s Landmark Ck.
10/7/10 13:00	sr, tb				…	…	…	…	…	…	…	…	…	…	…	…	Moved real-time gage to LB pool just u/s previous location (left stilling well in case bed conditions change).
S4 Tributary																	
Latitude:	38.03871° N																
Longitude:	122.60323° W																
Reference point (RP) elevation =	207.94																
Ground surface elevation =	214.64																
11/16/09 13:40	mw, sr				…	…	…	…	…	…	…	…	…	…	…	…	Installed Levelogger (Bal #1894) into S-4 - No flow
1/6/10 12:06	sr				…	…	dry	…	…	…	…	…	…	…	…	…	No flow at gage; No isolated pools betw gage and road; Slight flow out of gravels at confluence with Miller Ck (lower 6')
1/16/10 11:22	tb				6.78	214.72	0.03	…	PY	g	7.05	01/12/10	10.4	155.3	215.7	…	water very slightly cloudy, bed silty and sandy with small cobbles.
1/18/10 17:10	gp, mw				7.17	215.11	…	…	…	…	7.70	Not specified	…	…	…	…	Storm duty - Headphones broke so no flow meas.
1/20/10 14:30	gp, mw				7.25	215.19	9.03	…	AA	…	7.80	01/20/10	10.5	78.0	110.5	1 Qbed, 1 Qss	
2/3/10 18:00	mw				6.80	214.74	0.24	…	PY	f	…	…	11.5	120.0	165.5	…	
2/5/10 14:15	sr, tb				7.02	214.96	2.00	1.50	PY	g	7.80	02/04/10	11.4	95.1	128.3	1 Qbed, 2 Qss	Observer may be artificially elevating the water level. Downloaded levelogger and relaunched.
2/18/10 14:00	sr				6.78	214.72	0.18	0.10	PY	g	7.25	02/06/10	12.6	134.2	176	…	Water clear, downloaded levelogger (but didn't stop and relaunch).
2/26/10 16:43	gp				7.17	215.11	…	…	…	…	…	…	…	…	…	1 Qbed, 1 Qss	Also 1 Qss sample taken slightly u/s of Lucas Valley Rd.
4/30/10 13:30	sr, jo				6.71	214.65	0.02	0.03	PY	f	7.50	Jan. 2010	17.3	178.0	210	…	Water was turbid for first half-hour (upstream erosion), but then cleared up. Found juevenile resident trout/steelhead in small pool ~5' us confluence with Miller Ck (S4 not flowing into Miller Ck - soaking into gravels). Base of stilling well was above lowest possible water level, so pushed 0.06 ft. at 13:50. Downloaded data and relaunched (changed to continuous logging).
7/23/10 10:00	sr				…	…	…	…	…	…	…	…	…	…	…	…	Dry at gage (bed = 6.5), no repairs needed, though stilling well is slightly above bottom of bed (gage = 6.6). Downloaded.
Grady Creek																	
Latitude:	38.04052° N																
Longitude:	122.60103° W																
Reference point (RP) elevation =	228.21																
Ground surface elevation =	235.06																
10/22/09 17:15	mw				…	…	…	…	…	…	…	…	15.0	330	415	…	installed temp logger in bedrock pool; flow further downstream ~100 ft than before 10/13 storm
11/4/09 12:39	mw, tb				…	…	…	…	…	…	…	…	…	…	…	…	Installed Levelogger F15 Gold (Bal #1783) into Grady Ck
1/6/10 15:44	sr				…	…	dry	…	…	…	…	…	…	…	…	…	No flow at gage; Isolated pool at base of canyon
1/16/10 7:33	tb				…	…	dry	…	…	…	…	…	…	…	…	…	no water, no sign of recent flow.
1/18/10 17:37	gp, mw				7.50	235.71	…	…	…	…	…	…	…	…	…	…	Storm duty - Headphones broke so no flow meas.
1/20/10 17:15	gp, mw				7.42	235.63	10.69	…	AA	…	8.40	01/20/10	11.0	90.0	125.8	1 Qbed, 1 Qss	
2/3/10 17:00	mw				6.97	235.18	0.51	…	PY	f	7.70	poor	13.0	178.0	235.8		
2/5/10 16:00	sr, tb				7.10	235.31	3.034	2.75	PY	e/g	8.00	02/04/10	12.6	130.5	170.9	1 Qbed, 1 Qss	Water clear -- can see bed through Q meas. Fresh sand deposited at tail end of pool. Downloaded levelogger and relaunched.
2/18/10 15:30	sr				6.96	235.17	0.729	0.40	PY	e	7.15	02/06/10	13.9	174.0	221.2	…	Water clear, downloaded levelogger and relaunched because levelogger time and PC time were very off.
2/26/10 17:17	gp				7.16	235.37	…	…	…	…	…	…	…	…	…	1 Qbed, 1 Qss	
2/26/10 17:30	gp				7.16	235.37	…	…	…	…	…	…	…	…	…	…	
4/30/10 15:00	sr, jo				6.85	235.06	0.06	0.10	PY	g	6.95, 7.45, 8.65	4/27/2010, Feb 2010, Jan-2010	16.4	199.0	238.0	…	Water clear. Bank failed on gage. JO removed dirt and reconnected gage with wse in stream. Downloaded data and relaunched (changed to continuous logging). LL gained time during this period (extra 15 min., which is only half-min. per day; I deleted last 15 min. record rather than adjust by such a small amt). Bank failure may have triggered issue, regardless time resynched so moving forward should be okay.
7/23/10 10:30	sr				…	…	…	…	…	…	…	…	…	…	…	…	Dry at gage (bed = 6.8), connected to channel despite large bank failure u/s gage. Downloaded and relaunched (this levelogger gains time?). GPS first flow u/s gage (increased from 0.25 to 1 gpm moving further u/s) and deployed new temp logger with MW (old one gone).
Grady Creek (u/S gage)																	

Site Conditions		Groundwater			Streamflow						High-water Marks		Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water	WSE elevation (NGVD 29)	Depth below ground surface	Gage Height	WSE elevation (NGVD 29)	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Estimated stage at staff plate	Inferred dates?	Temperature	Specific Conductance	Specific Conductance	Additional sampling?	
		(ft)	(ft)	(ft)	(ft)		(cfs)	(cfs)	(AA/PY)	(e/g/f/p)			(°C)	(µmhos)	at 25 (°C)	(Qbed, etc.)	
Latitude:	38.___° N																
Longitude:	122.___° W																
Reference point (RP) elevation =	228.21																
Ground surface elevation =	235.06																
10/19/10 15:00	gp, mw				Dry	…	…	…	…	…	…	…	…	…	…	…	Staff plate range 3.33 to 6.66 installed. 9.00 on the old staff plate equals 6.52 on the new one. F15 levelogger SN 21045668, Bal # 2179. LL start time 10/10/10 15:00 PDT; sample rate is 15 min.; continuous loging mode.
S3 Tributary																	
Latitude:	38.04049° N																
Longitude:	122.60454° W																
Reference point (RP) elevation =	227.49																
Ground surface elevation =	234.29																
11/16/09 13:40	mw, sr				…	…	…	…	…	…	…	…	…	…	…	…	Installed Levelogger (Bal #???) into S-3 - No flow
1/6/10 13:44	sr				…	…	dry	…	…	…	…	…	…	…	…	…	No flow at gage; No isolated pools betw gage and road
1/16/10 8:11	tb				…	…	dry	…	…	…	7.25	01/12/10	…	…	…	…	No flow at gage.
1/20/10 15:30	gp, mw				7.90	235.39	11.63	…	AA	…	…	…	11.0	78.0	109.0	1Qbed	
2/5/10 10:45	sr, tb				7.56	235.05	3.22	2.00	PY	e/g	8.00	02/04/10	10.9	97.3	133.2	1 Qbed, 1 Qss	At threshold for bedload transport. Downloaded levelogger and relaunched.
2/12/10 15:05	mw				7.11	234.60	0.25	…	PY	g	…	…	12.0	133.0	181.0	…	
2/18/10 10:30	sr				…	…	dry	…	…	…	7.00	02/06/10	…	…	…	…	No flow at gage (bed GH ~6.8), pool downstream flowing ~2 gpm, but NOT into Miller Ck (SC 175.8 us @ 12.0C, 234.9 us @ 25C). Downloaded levelogger (but didn't stop and relaunch).
2/26/10 15:30	gp				7.81	235.30	…	…	…	…	…	…	…	…	…	1 Qbed, 1 Qss	Also 1 Qss sample taken slightly u/s of Lucas Valley Rd.
4/30/10 17:19	sr, jo				…	…	dry	…	…	…	8, 8.65	Jan. 2010	…	…	…	…	No flow at gage (bed GH at 6.76). Downloaded data and relaunched (changed to continuous logging).
7/23/10 12:15	sr				…	…	…	…	…	…	…	…	…	…	…	…	Dry at gage (bed = 6.7), no repairs needed. Downloaded.
Landmark Creek																	
Latitude:	38.04357° N																
Longitude:	122.60661° W																
Reference point (RP) elevation =	255.84																
Ground surface elevation =	262.64																
11/16/09 10:00	mw, sr																Installed Levelogger (Bal #1895) into Landmark Ck - No flow
1/6/10 14:00	sr				…	…	dry	…	…	…	…	…	10.0	222.9	311.8	…	No flow at gage; Flow just upstream road crossing (visual est 0.05 cfs; SCT values taken here); Didn't download temp logger
1/16/10 10:48	tb				7.28	263.12	0.07	…	float	f	8.00	01/12/10	10.5	182.3	252.3	…	small flow test among cobbles and roots, water clear
2/3/10 16:00	mw				7.44	263.28	0.26	…	PY	f	8.00	poor	12.0	150.0	204.0	…	
2/5/10 17:30	sr, tb				7.68	263.52	2.72	…	AA	e	8.30	02/04/10	12.2	107.7	142.6	1 Qbed, 1 Qss	Water clear (clearest of all stations visited today). Downloaded levelogger and relaunched.
2/12/10 15:45	mw				7.48	263.32	0.46	…	AA	g/f			12.0	150.0	204.0	…	
2/18/10 16:45	sr				7.38	263.22	0.10	0.10	PY	g	8.00	02/06/10	12.8	162.7	212.1	…	Created weir to focus flow (had to remove cobbles to minimize turbulence); water clear; downloaded levelogger (but didn't stop and relaunch).
2/26/10 17:58	gp				7.73	263.57	…	…	…	…	…	…	…	…	…	1 Qss	
4/30/10 16:15	sr, jo				…	…	dry	…	…	…	8.00	Jan. 2010	…	…	…	…	No flow at gage (bed GH at 6.6). Leaves in bottom of pools suggest no flow has occurred recently. Downloaded data and relaunched (changed to continuous logging).
7/23/10 12:45	sr				…	…	…	…	…	…	…	…	…	…	…	…	Dry at gage (bed = 6.7), no repairs needed. Downloaded.
Miller Creek at property line																	
Latitude:	38.03811° N																
Longitude:	122.60085° W																
Reference point (RP) elevation =	Not surveyed																
Ground surface elevation =	?																
10/21/09 17:23	mw, gp, sr				1.42	…	…	20 gpm	visual est.	med.	…	…	…	…	…	…	

Site Conditions		Groundwater			Streamflow						High-water Marks		Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water	WSE elevation (NGVD 29)	Depth below ground surface	Gage Height	WSE elevation (NGVD 29)	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Estimated stage at staff plate	Inferred dates?	Temperature	Specific Conductance	Specific Conductance	Additional sampling?	
		(ft)	*(ft)*	*(ft)*	*(ft)*		*(cfs)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*			*(°C)*	*(µmhos)*	*at 25 (°C)*	*(Qbed, etc.)*	
1/6/10 11:00	sr				1.49	…	0.20	…	PY	g	…	…	12.3	212.7	280.7	…	Flow measured 20' upstream gage (not sufficient flow in pool adj. to dancefloor); Created weir and removed rocks from section prior to meas. to approx. laminar flow; No HWMs visible on gage (algae growing on staff plate and stilling well); Sediment erodi
1/16/10 12:08	tb				1.62	…	1.18	…	PY	g	1.7-1.8	01/12/10	12.9	199.8	259.8	…	signs of sediment from road drainage pipe at staff plate, flow measuerment upstream in sandy run.
1/18/10 16:30	gp, mw				…		…	…	…	…	…	…	…	…	…	…	Gage blew out sometime before our visit.
4/30/10 12:37	sr, jo				NA		1.07	…	PY	g	wse +.1, + 1.1	4/27/2010, Jan. 2010	16.0	174	210	…	Water clear, "dancefloor" covered with sand, gravels, and cobbles, pool filled in with coarse sediment in the bottom, with a sand patch in the lee bedrock. "Bath tub" ring marks this year's HWM. Bed seems armored d/s bridge - fines winnowed away.
7/23/10 9:45	sr				…		…	…	…	…	…	…	…	…	…	…	Dry at gage, deployed temp logger (no rock). Observed several isolated pools with tadpoles on the way down to this gage -- deployed 2 temp loggers with MW later in the afternoon.
10/7/10 14:30	sr, tb				…		…	…	…	…	…	…	…	…	…	…	Installed levelogger (BAL #1975) into pool just u/s previous location -- stilling well mounted into bedrock - continuous logging. Pool dry. No staff plate; observer will need to take laser level to shoot benchmark and then WSE relative to benchmark. All temp loggers downloaded and relaunched (currently 4 d/s MC bridge, 2 u/s bridge, and 1 in Grady Ck pool).

Notes:

Observer Key: mw = Mark Woyshner; gp = Gustavo Porras; sr = Sarah Richmond, tb = Travis Baggett

Stage: Water level observed at staff plate

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B), or uncertain (U).

Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual (V).

Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) estimated percent accuracy given

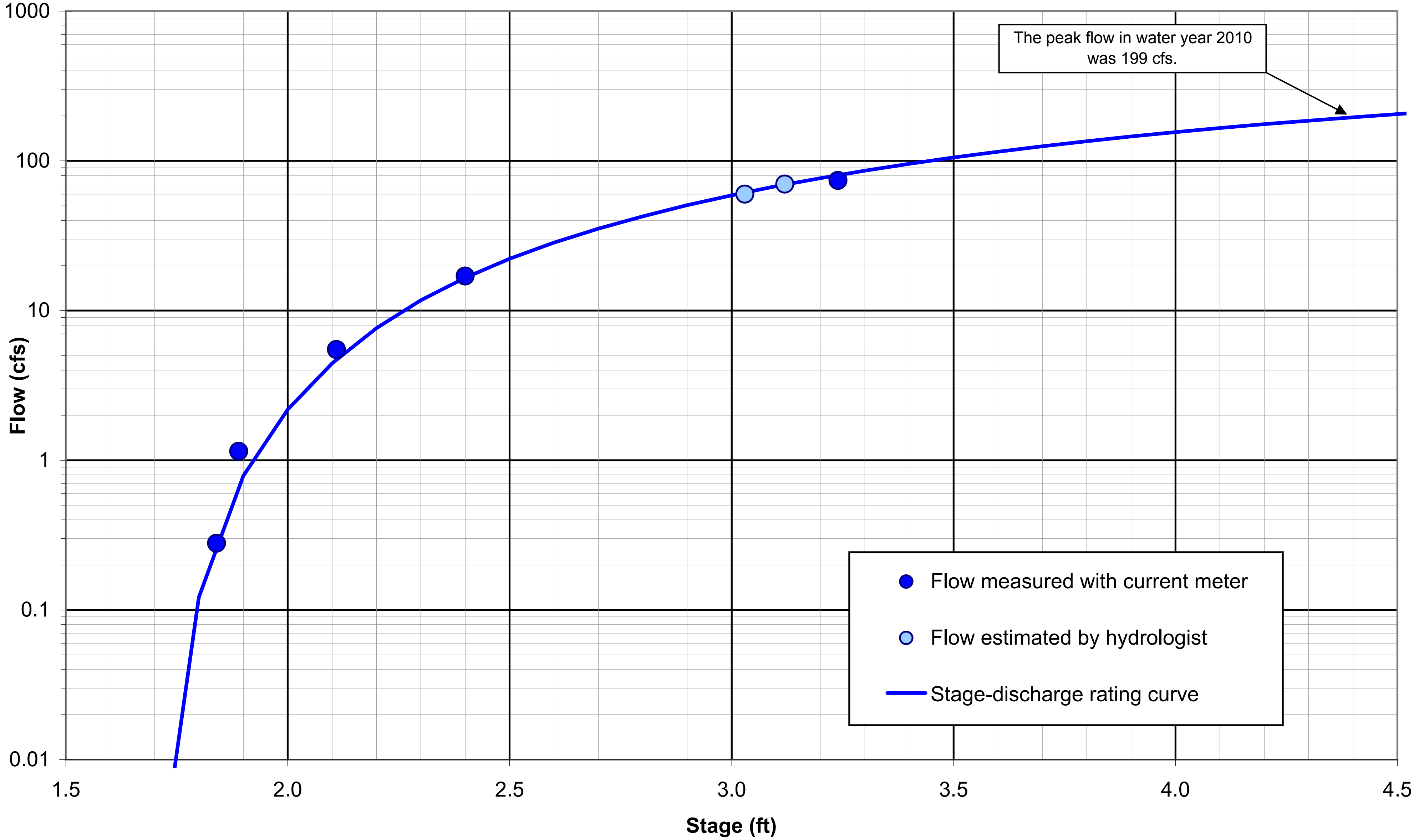
High-water mark (HWM): Measured or estimated at location of the staff plate

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, Nutr = nutrients; other symbols as appropriate

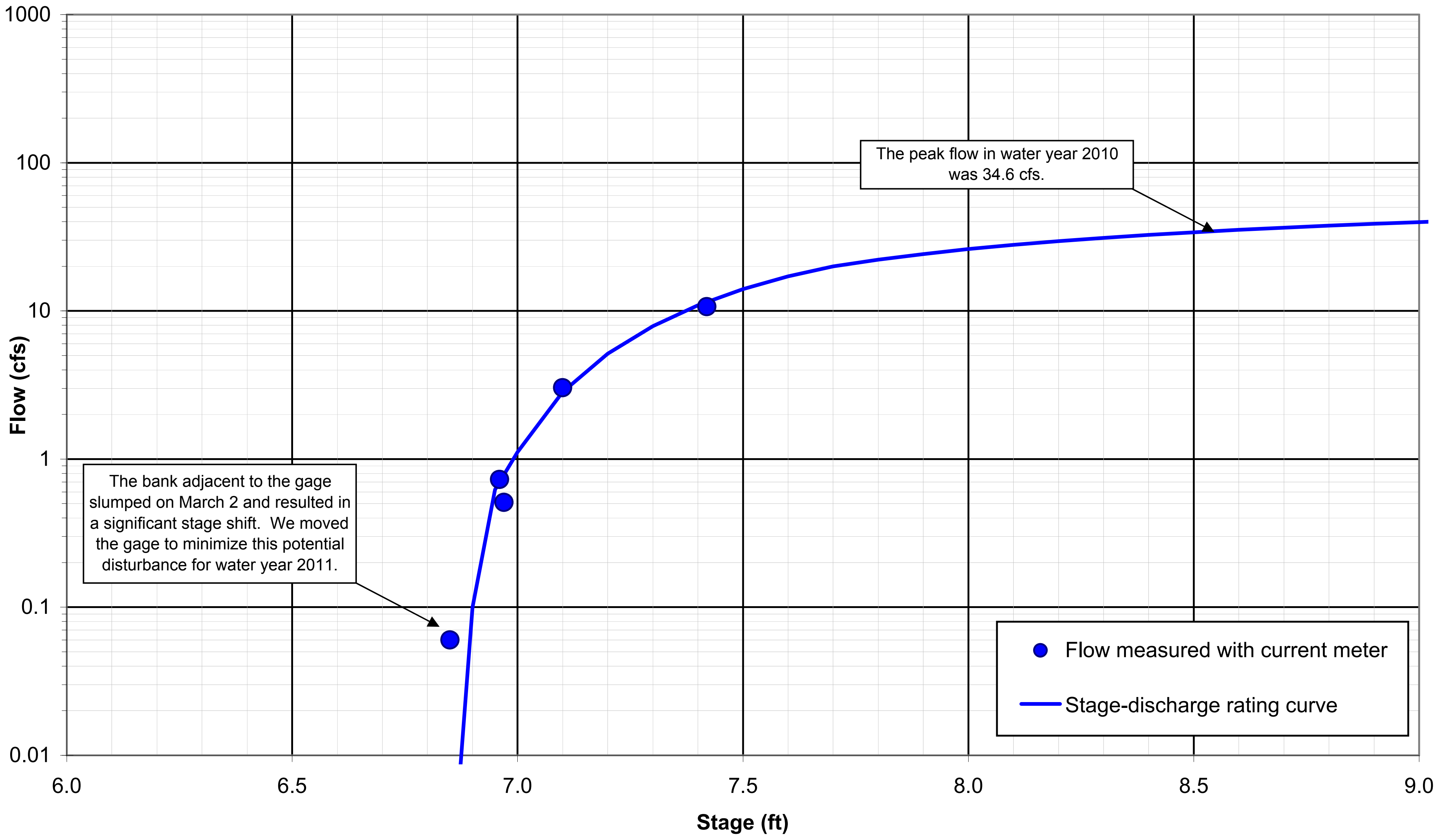
APPENDIX B

Stage-to-discharge rating curves



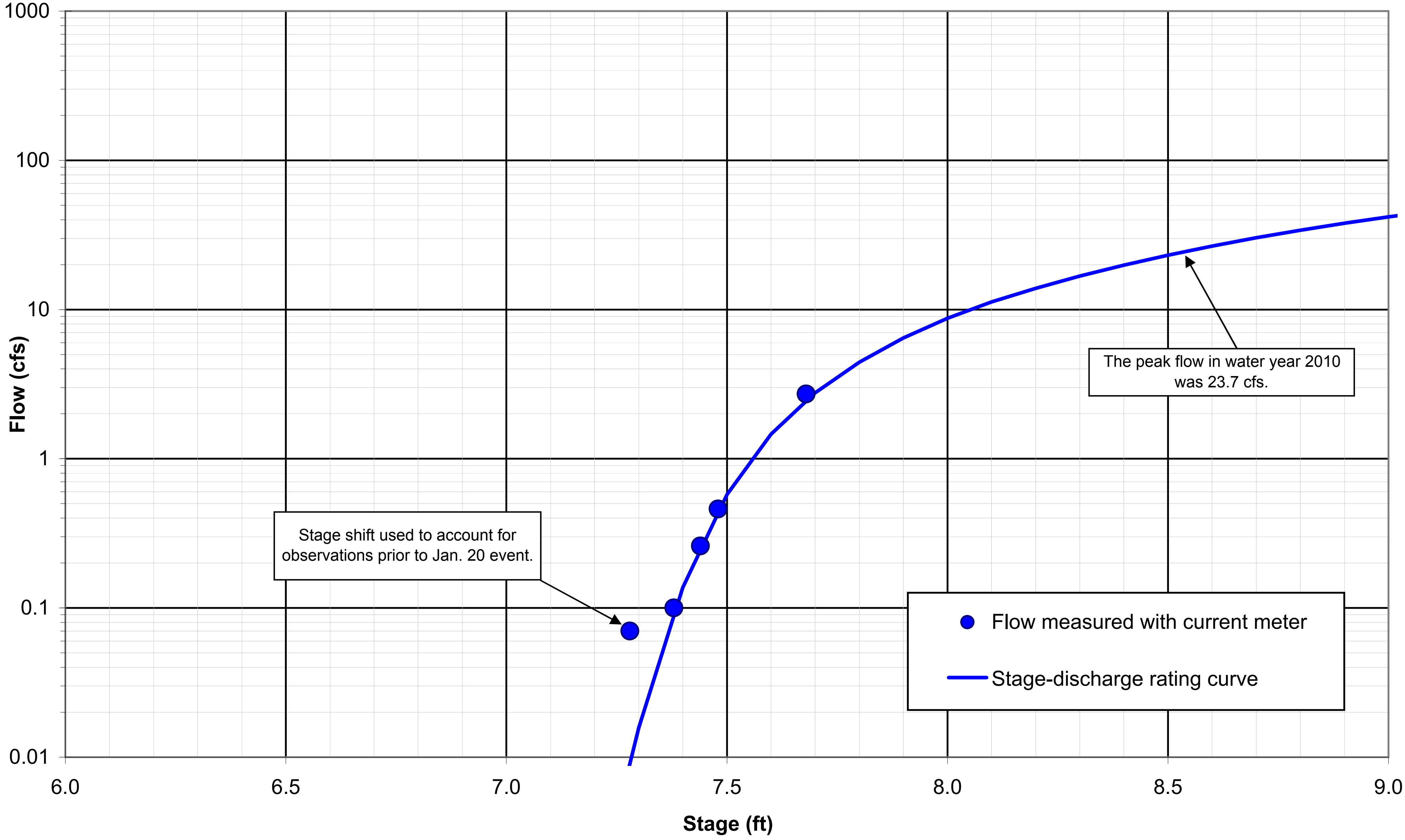
Balance Hydrologics, Inc.®

Stage-discharge rating curve: Miller Creek above Grady Bridge, water year 2010, Grady Ranch, Marin County, California.



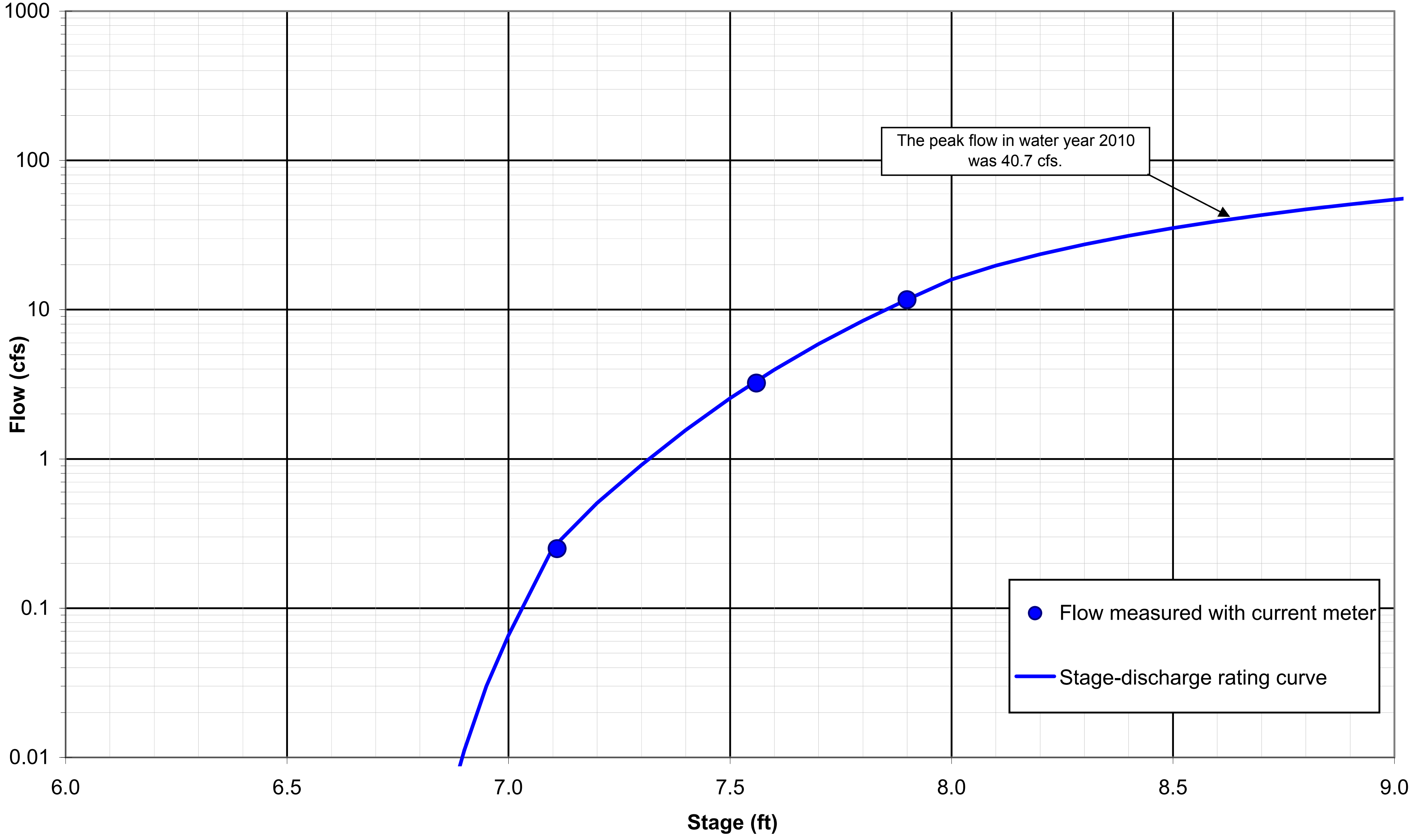
Balance Hydrologics, Inc.®

Stage-discharge rating curve: Grady Creek, water year 2010, Grady Ranch, Marin County, California.



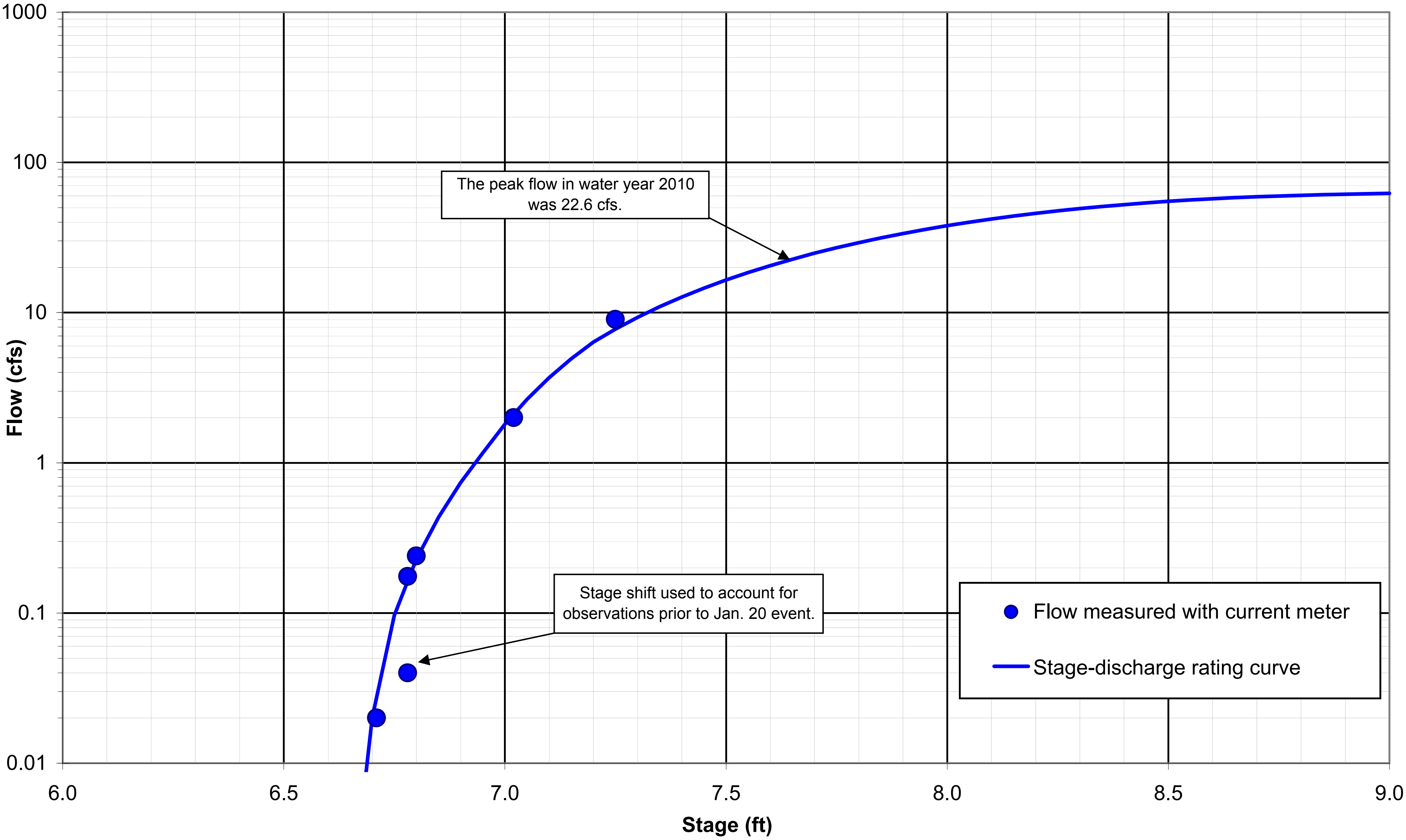
Balance Hydrologics, Inc.®

Stage-discharge rating curve: Landmark Creek, water year 2010, Grady Ranch, Marin County, California.



Balance Hydrologics, Inc.®

Stage-discharge rating curve: S3 Tributary, water year 2010, Grady Ranch, Marin County, California.



Balance Hydrologics, Inc.®

Stage-discharge rating curve: S4 Tributary, water year 2010, Grady Ranch, Marin County, California.

APPENDIX C

Sediment-discharge measurements

Appendix C. Sediment-discharge measurements, Grady Ranch, water year 2010, Marin County, California

Site Conditions						*Bedload Sampling Details*						*Sediment Transport*			
Location	**Sample**	**Observer(s)**	**Gage Height**	**Streamflow Discharge**	**Stream Condition**	**Active Bed Width**	**Sampler Width**	**No. of Verts.**	**Time/Vert.**	**Total Time**	**Sample Dry Weight**	**Bedload-Sediment Discharge Rate**	**Bedload-Sediment Discharge Rate**	**Suspended-Sediment Concentration**	**Suspended-Sediment Discharge Rate**
	Date:Time		*(ft)*	*(cfs)*	*R,F,B,U*	*(ft)*	*(ft)*		*(sec)*	*(sec)*	*(gm)*	*(lb/sec)*	*(tons/day)*	*(mg/l)*	*(tons/day)*
Landmark Ck	100205:1720	sr, tb	7.69	2.67	F	2	0.25	2	60	120	4	0.001	0.0	…	…
Landmark Ck	100205:1700	sr, tb	7.69	2.68	F	…	…	…	…	…	…	…	…	11.5	0.1
Landmkark Ck	100226:1758	gp	7.75	3.51	F									10.9	0.1
S3 trib	100120:1530	mw, gp	7.91	12.72	F	4	0.25	3	60	180	220	0.043	2	…	…
S3 trib	100205:1018	sr, tb	7.56	3.34	F	4	0.25	4	60	240	11	0.002	0	…	…
S3 trib	100226:1530	gp	7.74	6.74	R	6.5	0.25	5	30	150	52	0.020	1		
S3 trib	100120:1545	mw, gp	7.90	11.53	F	…	…	…	…	…	…	…	…	68.4	2.1
S3 trib	100205:1010	sr, tb	7.56	3.34	F	…	…	…	…	…	…	…	…	15.1	0.1
S3 trib	100205:1057	sr, tb	7.57	3.44	F	…	…	…	…	…	…	…	…	22.8	0.2
S3 trib	100226:1540	gp	7.71	6.74	R									110.0	2.0
S3 trib (across road, offsite)	100226:1600	gp	7.68	5.51	R									63.3	1
Miller Ck above Grady Bridge	100118:1615	mw, gp	2.74	38.50	F	10	0.25	5	60	300	739	0.217	9.4	…	…
Miller Ck above Grady Bridge	100120:1415	mw, gp	3.19	75.78	F	17	0.25	7	30	210	3108	2.219	95.8	…	…
Miller Ck above Grady Bridge	100205:1145	sr, tb	2.41	17.97	F	11	0.25	6	60	360	122	0.033	1.4	…	…
Miller Ck above Grady Bridge	100205:1226	sr, tb	2.39	17.17	F	6	0.25	4	60	240	40	0.009	0.4	…	…
Miller Ck above Grady Bridge	100218:1215	sr	1.88	1.06	F	Visual observation of no bedload transport						…	0.0		
Miller Ck above Grady Bridge	100224:1000	mw	2.47	22.99	F	10	0.25	5	60	300	288	0.085	3.7		
Miller Ck above Grady Bridge	100226:1550	gp	2.69	37.59	F	18	0.25	5	30	150	670	0.709	30.6		
Miller Ck above Grady Bridge	100118:1610	mw, gp	2.74	38.50	F	…	…	…	…	…	…	…	…	139.0	14.4
Miller Ck above Grady Bridge	100120:1330	mw, gp	3.24	80.77	F	…	…	…	…	…	…	…	…	262.0	57.1
Miller Ck above Grady Bridge	100129:1600	mw	2.10	4.88	F	…	…	…	…	…	…	…	…	36.7	0.5
Miller Ck above Grady Bridge	100201:0930	mw	2.00	2.50	F	…	…	…	…	…	…	…	…	5.8	0.0
Miller Ck above Grady Bridge	100205:1120	sr, tb	2.41	18.42	F	…	…	…	…	…	…	…	…	10.7	0.5
Miller Ck above Grady Bridge	100205:1235	sr, tb	2.39	17.17	F	…	…	…	…	…	…	…	…	8.3	0.4
Miller Ck above Grady Bridge	100224:0940	gp	2.48	23.27	F									20.3	1.3
Miller Ck above Grady Bridge	100226:1510	gp	2.83	47.85	F									762.0	98.3
Grady Ck	100120:1706	mw, gp	7.43	11.94	F	4	0.25	3	60	180	869	0.170	7	…	…
Grady Ck	100205:1535	sr, tb	7.10	2.63	F	4.5	0.25	3	60	180	10	0.002	0	…	…
Grady Ck	100226:1717	gp	7.21	5.05	F	3	0.25	5	60	300	235	0.021	1		
Grady Ck	100118:1737	mw, gp	7.50	13.95	F	…	…	…	…	…	…	…	…	47.1	1.8
Grady Ck	100120:1706	mw, gp	7.43	11.49	F	…	…	…	…	…	…	…	…	150.0	4.6
Grady Ck	100205:1515	sr, tb	7.10	2.73	F	…	…	…	…	…	…	…	…	21.8	0.2
Grady Ck	100226:1720	gp	7.16	5.52	F									27.0	0.4
S4 trib	100120:1645	mw, gp	7.26	7.72	F	4	0.25	3	20	60	1057	0.621	27	…	…
S4 trib	100205:1347	sr, tb	7.02	1.85	F	4.5	0.25	3	60	180	5	0.001	0	…	…
S4 trib	100226:1700	gp	7.18	5.16	F	3	0.25	5	40	200	131	0.017	1		
S4 trib	100118:1705	mw, gp	7.19	4.78	F	…	…	…	…	…	…	…	…	117.0	1.5
S4 trib	100120:1613	mw, gp	7.29	8.09	F	…	…	…	…	…	…	…	…	4680.0	102.1
S4 trib	100205:1331	sr, tb	7.03	8.09	F	…	…	…	…	…	…	…	…	33.3	0.7
S4 trib	100205:1439	sr, tb	7.06	1.96	F	…	…	…	…	…	…	…	…	42.9	0.2
S4 trib	100226:1650	gp	7.18	5.24	F									143.0	2.0
S4 trib (across road, offsite)	100226:1630	gp	7.18	5.33	F									154.0	2.2

Notes:

Observer Key: mw = Mark Woyshner; gp = Gustavo Porras; sr = Sarah Richmond; tb = Travis Baggett

Streamflow discharge is the measured or estimated instantaneous flow when sediment was sampled, and usually differs from the mean flow for the day.

Stream Condition: R = rising, F = falling, B = baseflow, U = uncertain

Values for sediment discharge having more than two to three digits displayed are the result of calculations; increased precision is not implied.

Active Bed Width: The width thought by the field observer to be transporting significant amounts of bedload based on observations and/or measurements.

Sampler Width and Type: 0.25 = 3-inch Helley Smith; 0.50 = 6-inch Helley Smith

Bedload Discharge (lbs/sec) = [active bed width (ft) * sample dry weight (gm) * 0.002205 (lbs)]/ [sampler width (ft) * sampling time (sec)]

Bedload Discharge (tons/day) = [active bed width (ft) * sample dry weight (gm) * 86,400 (sec)]/ [sampler width (ft) * sampling time (sec) * 907,200 (gm)]

When water is very clear we generally do not take a suspended-sediment sample, because from past experience, those clear samples are below the detection limit.

APPENDIX D

Borehole logs and monitoring well construction

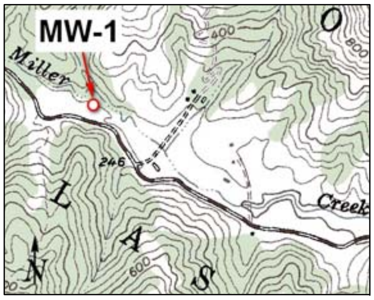
Balance Hydrologics, Inc.

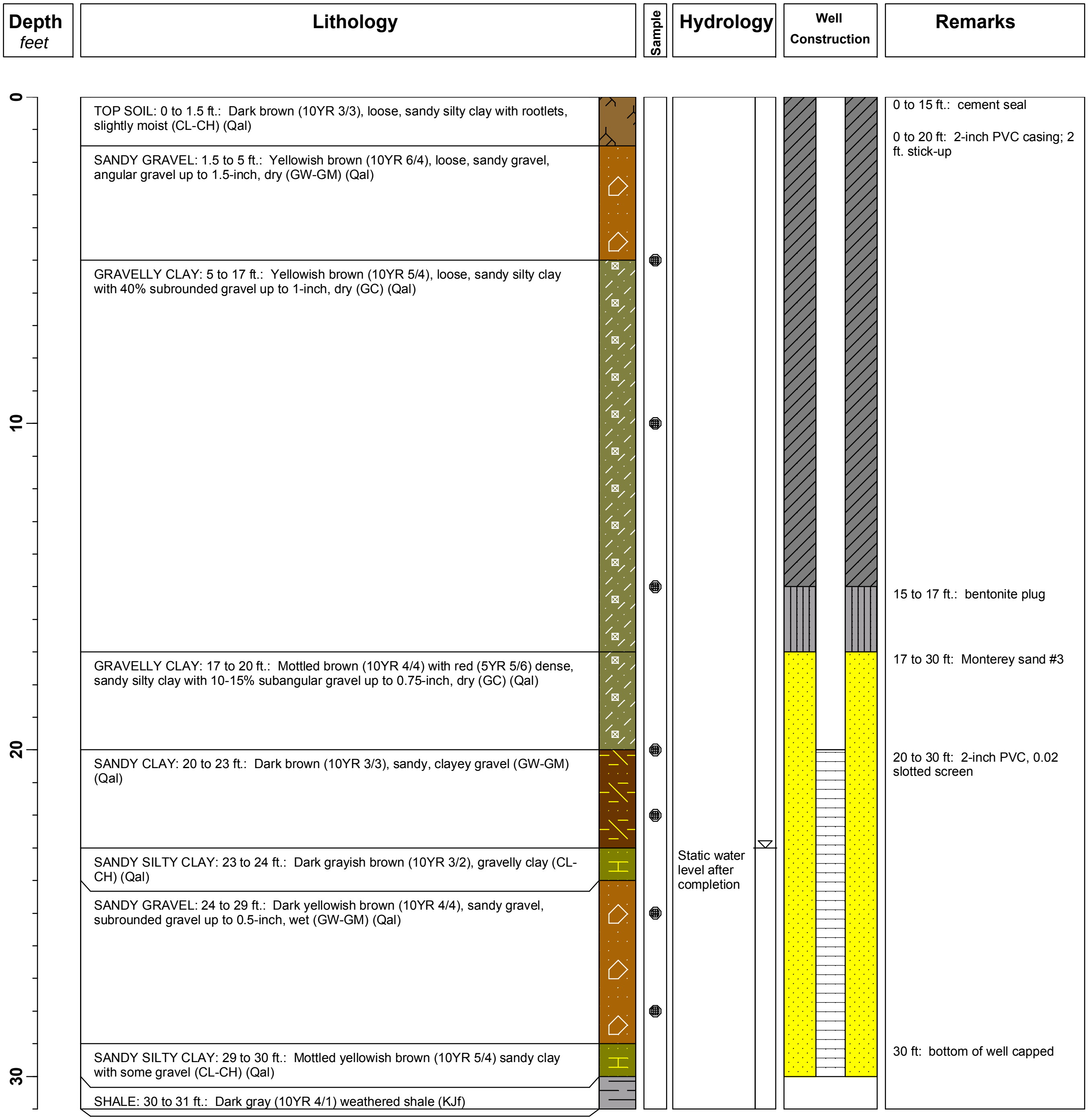
Log of boring and well construction of MW-1, Grady Ranch, Marin County, California

Property Owner and Mailing Information
Skywalker Properties, Ltd.
5858 Lucas Valley Road
Nicasio, CA 94946

Client:
Skywalker Properties Ltd.

Site location:	**Vega upper terrace S of Miller Cr. about 400 ft u/s of S3 trib, near Landmark Cr.**
APN:	**164-310-15, -17, and -19**
Latitude, Longitude:	**N38.04121°, W122.60544°**
Ground surface elevation:	**252 feet**
Start drilling date:	**October 21, 2009**
Well completion date:	**October 21, 2009**
Borehole geologist:	**Gustavo Porras**
Drilling company:	**Taber Consultants**
Driller:	**Andrew Elbon**
Drilling rig:	**Track mounted CME-55**
Driling equipment:	**8-inch hollow stem auger**
Depth of borehole:	**31 feet**
Depth of casing:	**30 feet**
Diameter of casing:	**2-inch**





TOP SOIL: 0 to 1.5 ft.: Dark brown (10YR 3/3), loose, sandy silty clay with rootlets, slightly moist (CL-CH) (Qal)

SANDY GRAVEL: 1.5 to 5 ft.: Yellowish brown (10YR 6/4), loose, sandy gravel, angular gravel up to 1.5-inch, dry (GW-GM) (Qal)

GRAVELLY CLAY: 5 to 17 ft.: Yellowish brown (10YR 5/4), loose, sandy silty clay with 40% subrounded gravel up to 1-inch, dry (GC) (Qal)

GRAVELLY CLAY: 17 to 20 ft.: Mottled brown (10YR 4/4) with red (5YR 5/6) dense, sandy silty clay with 10-15% subangular gravel up to 0.75-inch, dry (GC) (Qal)

SANDY CLAY: 20 to 23 ft.: Dark brown (10YR 3/3), sandy, clayey gravel (GW-GM) (Qal)

SANDY SILTY CLAY: 23 to 24 ft.: Dark grayish brown (10YR 3/2), gravelly clay (CL-CH) (Qal)

SANDY GRAVEL: 24 to 29 ft.: Dark yellowish brown (10YR 4/4), sandy gravel, subrounded gravel up to 0.5-inch, wet (GW-GM) (Qal)

SANDY SILTY CLAY: 29 to 30 ft.: Mottled yellowish brown (10YR 5/4) sandy clay with some gravel (CL-CH) (Qal)

SHALE: 30 to 31 ft.: Dark gray (10YR 4/1) weathered shale (KJf)

Static water level after completion

0 to 15 ft.: cement seal

0 to 20 ft: 2-inch PVC casing; 2 ft. stick-up

15 to 17 ft.: bentonite plug

17 to 30 ft: Monterey sand #3

20 to 30 ft: 2-inch PVC, 0.02 slotted screen

30 ft: bottom of well capped

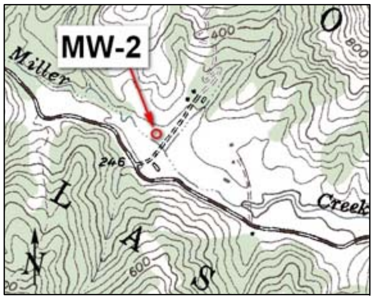
Balance Hydrologics Project Number: **208164**

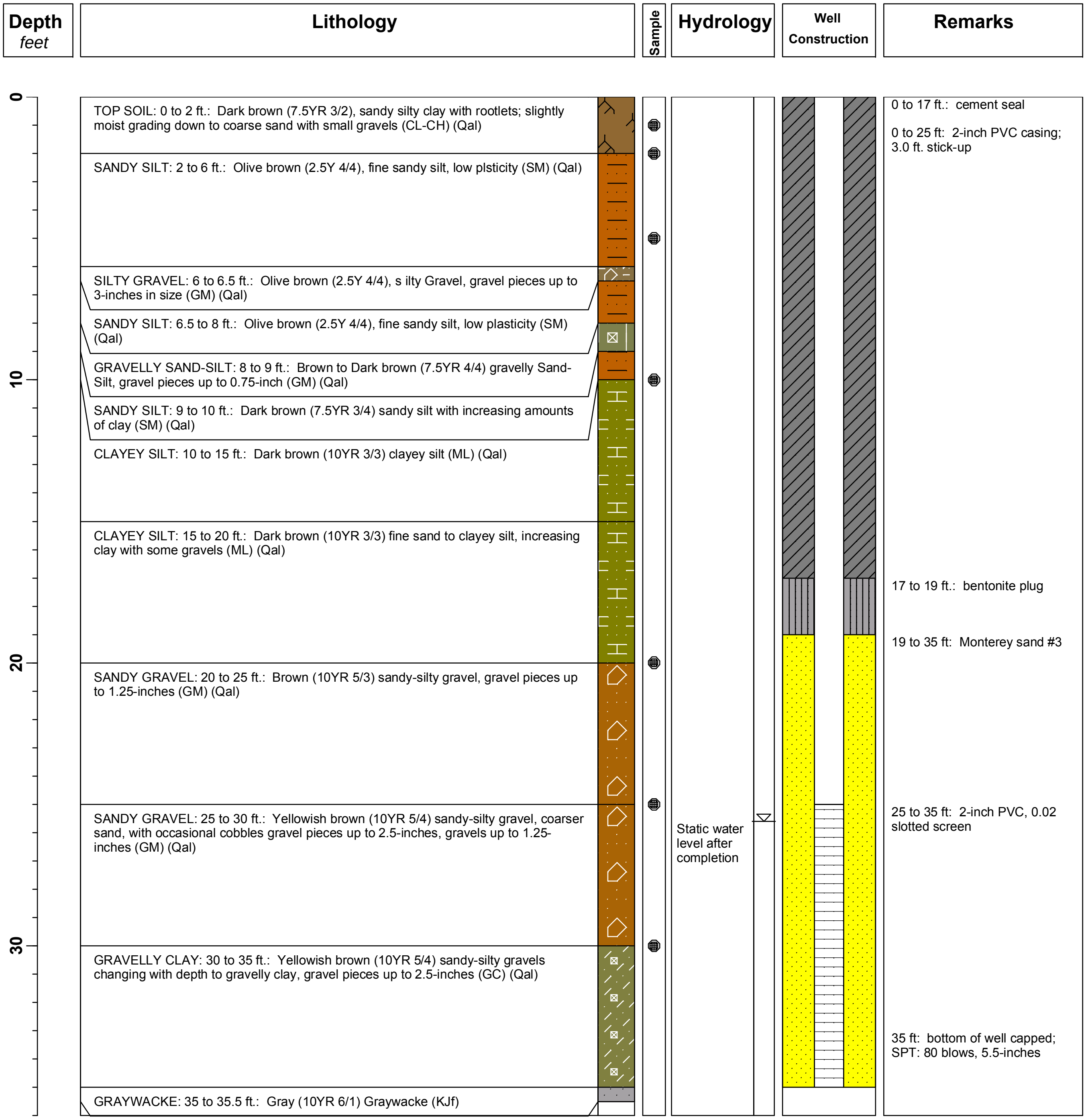
Preliminary Data Subject To Revision

Balance Hydrologics, Inc.

Log of boring and well construction of MW-2, Grady Ranch, Marin County, California

Property Owner and Mailing Information	Skywalker Properties, Ltd. 5858 Lucas Valley Road Nicasio, CA 94946
Client:	**Skywalker Properties, Ltd.**
Site location:	**Vega upper terrace N of Miller Cr about 100 ft u/s of Grady bridge**
APN:	**164-310-15, -17, and -19**
Latitude, Longitude:	**N38.04002°, W122.60269°**
Ground surface elevation:	**239 feet**
Start drilling date:	**October 20, 2009**
Well completion date:	**October 20, 2009**
Borehole geologist:	**Gustavo Porras**
Drilling company:	**Taber Consultants**
Driller:	**Andrew Elbon**
Drilling rig:	**Track mounted CME-55**
Driling equipment:	**8-inch hollow stem auger**
Depth of borehole:	**35.5**
Depth of casing:	**35**
Diameter of casing:	**2-inch**





Lithology

TOP SOIL: 0 to 2 ft.: Dark brown (7.5YR 3/2), sandy silty clay with rootlets; slightly moist grading down to coarse sand with small gravels (CL-CH) (Qal)

SANDY SILT: 2 to 6 ft.: Olive brown (2.5Y 4/4), fine sandy silt, low plsticity (SM) (Qal)

SILTY GRAVEL: 6 to 6.5 ft.: Olive brown (2.5Y 4/4), s ilty Gravel, gravel pieces up to 3-inches in size (GM) (Qal)

SANDY SILT: 6.5 to 8 ft.: Olive brown (2.5Y 4/4), fine sandy silt, low plasticity (SM) (Qal)

GRAVELLY SAND-SILT: 8 to 9 ft.: Brown to Dark brown (7.5YR 4/4) gravelly Sand-Silt, gravel pieces up to 0.75-inch (GM) (Qal)

SANDY SILT: 9 to 10 ft.: Dark brown (7.5YR 3/4) sandy silt with increasing amounts of clay (SM) (Qal)

CLAYEY SILT: 10 to 15 ft.: Dark brown (10YR 3/3) clayey silt (ML) (Qal)

CLAYEY SILT: 15 to 20 ft.: Dark brown (10YR 3/3) fine sand to clayey silt, increasing clay with some gravels (ML) (Qal)

SANDY GRAVEL: 20 to 25 ft.: Brown (10YR 5/3) sandy-silty gravel, gravel pieces up to 1.25-inches (GM) (Qal)

SANDY GRAVEL: 25 to 30 ft.: Yellowish brown (10YR 5/4) sandy-silty gravel, coarser sand, with occasional cobbles gravel pieces up to 2.5-inches, gravels up to 1.25-inches (GM) (Qal)

GRAVELLY CLAY: 30 to 35 ft.: Yellowish brown (10YR 5/4) sandy-silty gravels changing with depth to gravelly clay, gravel pieces up to 2.5-inches (GC) (Qal)

GRAYWACKE: 35 to 35.5 ft.: Gray (10YR 6/1) Graywacke (KJf)

Remarks

0 to 17 ft.: cement seal

0 to 25 ft: 2-inch PVC casing; 3.0 ft. stick-up

17 to 19 ft.: bentonite plug

19 to 35 ft: Monterey sand #3

25 to 35 ft: 2-inch PVC, 0.02 slotted screen

35 ft: bottom of well capped; SPT: 80 blows, 5.5-inches

Balance Hydrologics Project Number: **208164**

Balance Hydrologics, Inc.

Preliminary Data Subject To Revision

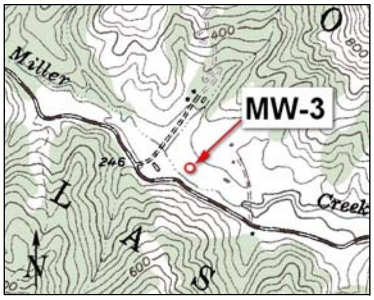
Log of boring and well construction of MW-3, Grady Ranch, Marin County, California

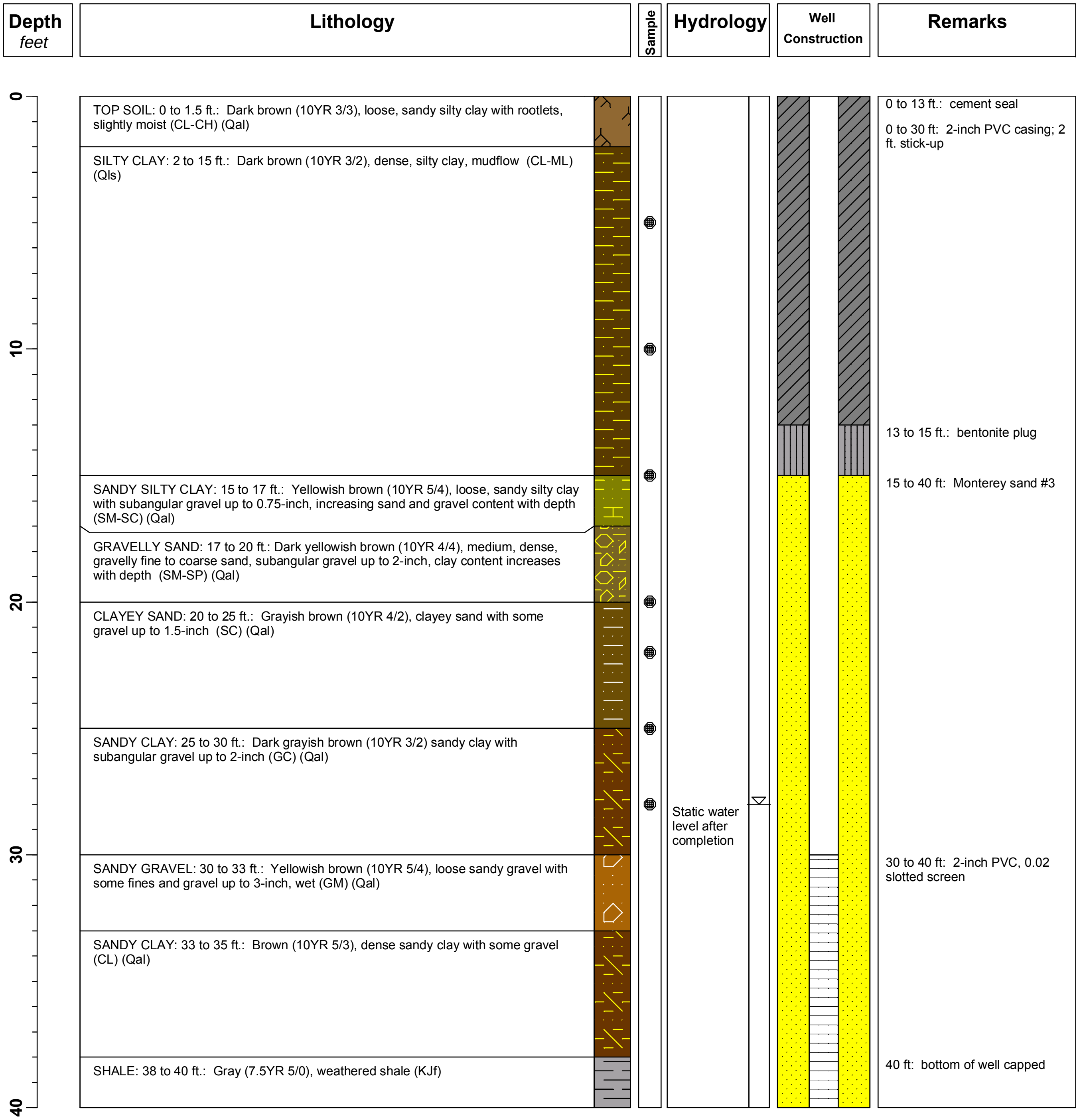
Property Owner and Mailing Information
Skywalker Properties, Ltd.
5858 Lucas Valley Road
Nicasio, CA 94946

Client:
Skywalker Properties, Ltd.

Site location: **Vega upper terrace N of Miller Cr about 350 ft d/s of Grady bridge, near S4 trib**
APN: **164-310-15, -17, and -19**
Latitude, Longitude: **N38.0391°, W122.60150°**
Ground surface elevation: **234 feet**
Start drilling date: **October 20, 2009**

Well completion date: **October 20, 2009**
Borehole geologist: **Gustavo Porras**
Drilling company: **Taber Consultants**
Driller: **Andrew Elbon**
Drilling rig: **Track mounted CME-55**
Driling equipment: **8-inch hollow stem auger**
Depth of borehole: **40**
Depth of casing: **40**
Diameter of casing: **2-inch**





TOP SOIL: 0 to 1.5 ft.: Dark brown (10YR 3/3), loose, sandy silty clay with rootlets, slightly moist (CL-CH) (Qal)

SILTY CLAY: 2 to 15 ft.: Dark brown (10YR 3/2), dense, silty clay, mudflow (CL-ML) (Qls)

SANDY SILTY CLAY: 15 to 17 ft.: Yellowish brown (10YR 5/4), loose, sandy silty clay with subangular gravel up to 0.75-inch, increasing sand and gravel content with depth (SM-SC) (Qal)

GRAVELLY SAND: 17 to 20 ft.: Dark yellowish brown (10YR 4/4), medium, dense, gravelly fine to coarse sand, subangular gravel up to 2-inch, clay content increases with depth (SM-SP) (Qal)

CLAYEY SAND: 20 to 25 ft.: Grayish brown (10YR 4/2), clayey sand with some gravel up to 1.5-inch (SC) (Qal)

SANDY CLAY: 25 to 30 ft.: Dark grayish brown (10YR 3/2) sandy clay with subangular gravel up to 2-inch (GC) (Qal)

SANDY GRAVEL: 30 to 33 ft.: Yellowish brown (10YR 5/4), loose sandy gravel with some fines and gravel up to 3-inch, wet (GM) (Qal)

SANDY CLAY: 33 to 35 ft.: Brown (10YR 5/3), dense sandy clay with some gravel (CL) (Qal)

SHALE: 38 to 40 ft.: Gray (7.5YR 5/0), weathered shale (KJf)

Static water level after completion

0 to 13 ft.: cement seal

0 to 30 ft: 2-inch PVC casing; 2 ft. stick-up

13 to 15 ft.: bentonite plug

15 to 40 ft: Monterey sand #3

30 to 40 ft: 2-inch PVC, 0.02 slotted screen

40 ft: bottom of well capped

Balance Hydrologics Project Number: **208164**

Preliminary Data Subject To Revision

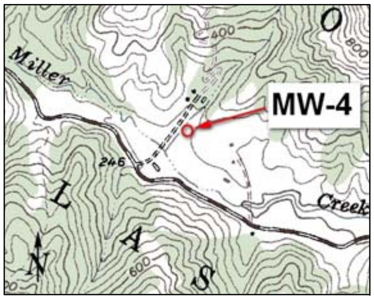
Balance Hydrologics, Inc.

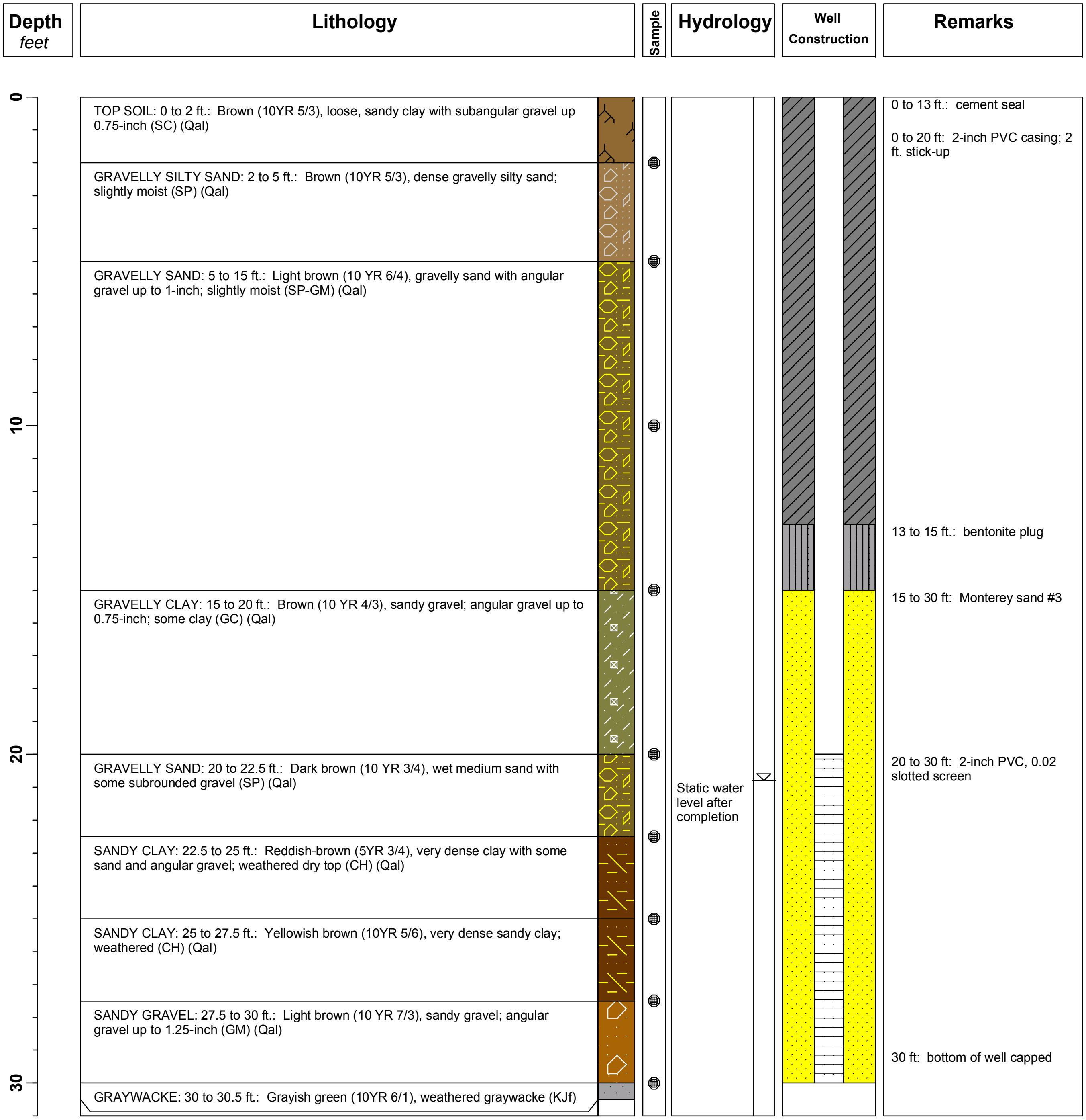
Log of boring and well construction of MW-4, Grady Ranch, Marin County, California

Property Owner and Mailing Information
Skywalker Properties, Ltd.
5858 Lucas Valley Road
Nicasio, CA 94946

Client:
Skywalker Properties, Ltd.

Site location:	**Upper terrace E of Grady Cr. about 400 ft u/s of Miller Cr., near ranch road ford**
APN:	**164-310-15, -17, and -19**
Latitude, Longitude:	**N38.04049°, W122.60134°**
Ground surface elevation:	**244 feet**
Start drilling date:	**October 20, 2009**
Well completion date:	**October 20, 2009**
Borehole geologist:	**Gustavo Porras**
Drilling company:	**Taber Consultants**
Driller:	**Andrew Elbon**
Drilling rig:	**Track mounted CME-55**
Driling equipment:	**8-inch hollow stem auger**
Depth of borehole:	**30.5**
Depth of casing:	**30**
Diameter of casing:	**2-inch**





TOP SOIL: 0 to 2 ft.: Brown (10YR 5/3), loose, sandy clay with subangular gravel up 0.75-inch (SC) (Qal)

GRAVELLY SILTY SAND: 2 to 5 ft.: Brown (10YR 5/3), dense gravelly silty sand; slightly moist (SP) (Qal)

GRAVELLY SAND: 5 to 15 ft.: Light brown (10 YR 6/4), gravelly sand with angular gravel up to 1-inch; slightly moist (SP-GM) (Qal)

GRAVELLY CLAY: 15 to 20 ft.: Brown (10 YR 4/3), sandy gravel; angular gravel up to 0.75-inch; some clay (GC) (Qal)

GRAVELLY SAND: 20 to 22.5 ft.: Dark brown (10 YR 3/4), wet medium sand with some subrounded gravel (SP) (Qal)

SANDY CLAY: 22.5 to 25 ft.: Reddish-brown (5YR 3/4), very dense clay with some sand and angular gravel; weathered dry top (CH) (Qal)

SANDY CLAY: 25 to 27.5 ft.: Yellowish brown (10YR 5/6), very dense sandy clay; weathered (CH) (Qal)

SANDY GRAVEL: 27.5 to 30 ft.: Light brown (10 YR 7/3), sandy gravel; angular gravel up to 1.25-inch (GM) (Qal)

GRAYWACKE: 30 to 30.5 ft.: Grayish green (10YR 6/1), weathered graywacke (KJf)

0 to 13 ft.: cement seal

0 to 20 ft: 2-inch PVC casing; 2 ft. stick-up

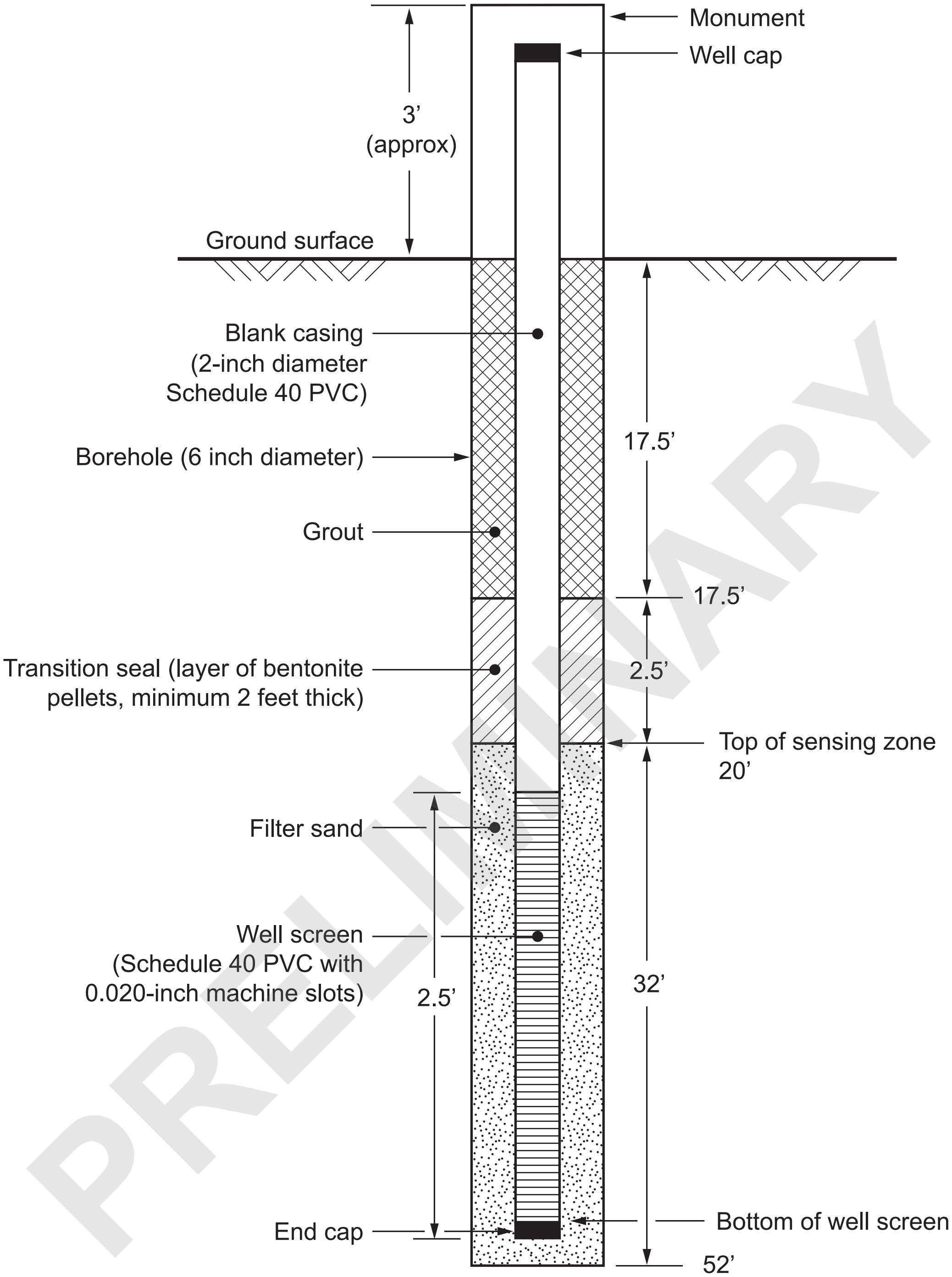
13 to 15 ft.: bentonite plug

15 to 30 ft: Monterey sand #3

20 to 30 ft: 2-inch PVC, 0.02 slotted screen

30 ft: bottom of well capped

Balance Hydrologics Project Number: **208164**



Not to scale

MONITORING WELL RW-6(P)
CONSTRUCTION DIAGRAM
Grady Ranch Development

By: __	Date: 08/24/2009	Project No. 14648.000

AMEC Geomatrix

Figure **A3-1**

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PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-6(P)

BORING LOCATION:	Road realignment	ELEVATION AND DATUM: 232	
DRILLING CONTRACTOR:	Taber Consultants	DATE STARTED: 8/6/2009	DATE FINISHED: 8/6/2009
DRILLING EQUIPMENT:	Track mounted CME-55	TOTAL DEPTH (feet): 52	MEASURING POINT: Ground Surface
DRILLING METHOD:	4-inch diameter auger	DEPTH TO FREE WATER FIRST ENCOUNTERED:	
SAMPLING METHOD:	See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:	
HAMMER WEIGHT: 140 lbs.	HAMMER DROP: 30 inches (Auto Hammer)	LOGGED BY: C. Johnson	

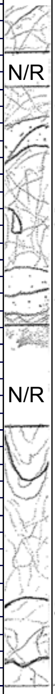
DEPTH (feet)	SAMPLES Sample No.	Sample	Blows/ foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	Dry Density (pcf)	Other
0				SILTY SAND (SM) loose, dark yellowish brown (10YR 4/4), dry, sand is fine to coarse, includes local subrounded gravel up to 1" max. diameter, coarse sand is rounded [ALLUVIUM]			11:50 AM start no liners sample bagged
1-2	1		15				S1 13"/18" PP at 2.5= 1; <0.25; <0.25 (tsf) (sample crumbling)
2-4	2		2				S2: 12"/18"
4.5				CLAYEY SAND (SC) loose, very dark grayish brown (10YR 3/2), moist to wet, sand is fine, fines have medium plasticity and medium toughness, scattered gravels up to 1/2" max. diameter [ALLUVIUM]			
5-6.5	3		2				S3: 14"/18" PP at 6'= 0.75; 1; 1 (tsf)
6.5-8	4		0				S4: 13"/18" sample pushed 18"
10				10': Local red and strong brown, friable sandstone up to ~1/4" diameter			
10-11.5	5		6				S5: 11"/18" PP at 11'= 0.25; <0.25; 0.5; 0.5 (tsf)
11.5				11.5': Sand is mostly very fine, fines content increases			
11.5-13	6		3				S6: 18"/18"
15.5				CLAYEY SAND with Gravel (SC) medium dense, dark brown (10YR 3/3), moist to slightly wet, sand mostly fine to medium, gravel mostly subrounded to rounded, variably weathered sandstone up to 1.5" max. diameter [ALLUVIUM]			
15-16.5	7		17				S7: 16.5"/18" PP at 15.5'= 1; 1.25; >4.5 (tsf) (gravels)
16.5-18	8		19				S8: 13"/18"

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-6(P) cont.

DEPTH (feet)	SAMPLES Sample No.	SAMPLES Sample	SAMPLES Blows/ foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	LABORATORY TESTS Dry Density (pcf)	LABORATORY TESTS Other
18	8			CLAYEY SAND with Gravel (SC) (cont.)			
19							
20							S9: 14.5"/18" PP at 21'= 1; 1; 0.5; 0.5 (tsf)
21	9		21	20': Fines content decreases slightly, medium to coarse sand content increases, becomes mostly dark yellowish brown (10YR 4/4)			S10: 18"/18"
22	10		15				
23							
24				CLAYEY GRAVEL with Sand (GC) medium dense, dark yellowish brown (10YR 4/4), wet, gravel is rounded to subrounded sandstone and shale clasts up to 1" max. diameter [ALLUVIUM]			
25							S11: 15.5"/18" PP at 26'= >4.5 (tsf) (gravels)
26	11		20				S12: 18"/18"
27	12		10	CLAYEY SAND (SC) medium dense, dark yellowish brown (10YR 3/4), moist, sand is fine, includes medium plasticity clay bed/layer 27.2-27.8' [ALLUVIUM]			
28							
29							
30				30': Increase in coarse sand includes rounded gravel up to 1.5" diameter			S13: 18"/18" PP at 31.5'= 2.5; 2.5; 2; 2.25; 1.5 (tsf)
31	13		22	SANDY CLAY (CL) firm, dark yellowish brown (10YR 3/4), moist, sand is fine, fines have medium platicity and medium to high toughness, includes local black organic flecks, locally mottled with strong brown [ALLUVIUM]			S14: 18"/18"
32	14		8				
33							
34				SANDSTONE dark olive gray (5Y 3.2), moderately hard, moderately strong, dark oxide-staining on fracture surfaces [FRANCISCAN (KJf)]			
35	15		62/11"				S15: 7"/11"
36	16		50*/4"	Continued on rock log			S16= 4"/4"
37							
38							
39							

PROJECT: Grady Ranch Development Marin County, California	**Log of Boring No. RW-5**
BORING LOCATION: Planned fill mound	ELEVATION AND DATUM: 236
DRILLING CONTRACTOR: Taber Consultants	DATE STARTED: 8/6/2009 — DATE FINISHED: 8/6/2009
DRILLING EQUIPMENT: Track mounted CME-55	TOTAL DEPTH (feet): 50 — MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter rotary wash	DEPTH TO FREE WATER FIRST ENCOUNTERED: 31.0feet (9:00 AM 8/6/2009)
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:
HAMMER WEIGHT: -- — HAMMER DROP: --	LOGGED BY: C. Johnson

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
38											
39											
40											
41											
42	1	60	0	VC	So	Fr	Se-Mo	SHALE (continued) crushed, soft, friable, moderately weathered, locally interbedded with sandstone			Run 1: 42-43' 10:15-10:19 AM
				NR	NR	NR	NR		N/R		
43	2	70	0	VC	So	Fr	Se-Mo	43.4': Includes dark gray, very fine sandstone bed 6" thick		Jo 60, Op, Pl -Jo, 40. ss/sh contact	Run 2: 43-47' 10:26-10:33 AM
44										-altered, chloritized nodule	
45								45.2': Includes greenstone(?) bed or inclusion 0.4' thick		Jo 30, Op, Pl.	
46				NR	NR	NR	NR		N/R		
47	3	100	0	VC	So	Fr	Se-Mo	47-47.8': Shear zone(?), slickensides perpendicular to shear plane, waxy green chloritized shale or serpentinite		Sh, 70, Pl, Po	Run 3: 47-50' 10:37-10:42 AM
48											
49					Lo	We				Jo? 50, Ir, Ro Mc	
50								Bottom of boring 50.0'			
51											
52											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HA RDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHE RING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Ste pped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-6

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PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-6(P) cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
51	4	100	0	Cl-Mo	Lo	Mo	Fr	INTERBEDDED SANDSTONE and SHALE (cont.)		Jo 70 op Pl Sl	
52								Bottom of boring 52.0'			
53											
54											
55											
56											
57											
58											
59											
60											
61											
62											
63											
64											
65											
66											
67											
68											

RT-2 (3/03)

GEES-ROCK 3/03 GRADY_ROCK_LOGS.GPJ GES32003-7.GDT 8/18/09

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-7 Cont.

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APPENDIX E

Maximum daily water temperature in Miller Creek and Grady Greek

Appendix E. Maximum daily water temperature in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Day	Miller Creek above Grady Bridge (at gage) (°C)	Grady Creek[1] (1,250 feet upstream Grady Creek gage) (°C)	Miller Creek below Grady Creek (150 feet downstream Grady Bridge) (°C)
Water Year 2010			
1-Oct	dry	no data	no data
2-Oct	dry	no data	no data
3-Oct	dry	no data	no data
4-Oct	dry	no data	no data
5-Oct	dry	no data	no data
6-Oct	dry	no data	no data
7-Oct	dry	no data	no data
8-Oct	dry	no data	no data
9-Oct	dry	no data	no data
10-Oct	dry	no data	no data
11-Oct	dry	no data	no data
12-Oct	dry	no data	no data
13-Oct	dry	no data	no data
14-Oct	dry	no data	no data
15-Oct	dry	no data	no data
16-Oct	dry	no data	no data
17-Oct	dry	no data	no data
18-Oct	dry	no data	no data
19-Oct	dry	no data	no data
20-Oct	dry	no data	no data
21-Oct	dry	no data	15.748
22-Oct	dry	no data	15.676
23-Oct	dry	no data	15.652
24-Oct	dry	no data	15.533
25-Oct	dry	no data	15.485
26-Oct	dry	no data	15.247
27-Oct	dry	no data	14.385
28-Oct	dry	no data	13.594
29-Oct	dry	no data	14.266
30-Oct	dry	no data	14.745
31-Oct	dry	no data	14.697
1-Nov	dry	no data	14.888
2-Nov	dry	no data	14.768
3-Nov	dry	no data	14.601
4-Nov	dry	no data	14.098
5-Nov	dry	no data	17.272
6-Nov	dry	no data	18.747
7-Nov	dry	no data	12.775
8-Nov	dry	no data	12.147
9-Nov	dry	no data	15.724
10-Nov	dry	no data	16.63
11-Nov	dry	no data	17.796
12-Nov	dry	no data	11.516
13-Nov	dry	no data	13.016
14-Nov	dry	no data	10.222
15-Nov	dry	no data	9.977

Appendix E. Maximum daily water temperature in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Day	Miller Creek above Grady Bridge (at gage) (°C)	Grady Creek[1] (1,250 feet upstream Grady Creek gage) (°C)	Miller Creek below Grady Creek (150 feet downstream Grady Bridge) (°C)
16-Nov	dry	no data	8.792
17-Nov	dry	no data	15.629
18-Nov	dry	no data	9.139
19-Nov	dry	no data	7.795
20-Nov	dry	no data	12.703
21-Nov	dry	no data	7.87
22-Nov	dry	no data	14.409
23-Nov	dry	no data	8.045
24-Nov	dry	no data	8.668
25-Nov	dry	no data	10.149
26-Nov	dry	no data	12.268
27-Nov	dry	no data	14.625
28-Nov	dry	no data	11.783
29-Nov	dry	no data	9.41
30-Nov	dry	no data	8.22
1-Dec	dry	no data	8.965
2-Dec	dry	no data	7.645
3-Dec	dry	no data	8.717
4-Dec	dry	no data	6.661
5-Dec	dry	no data	8.668
6-Dec	dry	no data	8.891
7-Dec	dry	no data	7.192
8-Dec	dry	no data	8.045
9-Dec	dry	no data	3.88
10-Dec	dry	no data	9.139
11-Dec	dry	no data	6.458
12-Dec	dry	no data	13.04
13-Dec	dry	no data	14.05
14-Dec	dry	no data	11.394
15-Dec	dry	no data	13.642
16-Dec	dry	no data	14.146
17-Dec	dry	no data	14.721
18-Dec	dry	no data	14.816
19-Dec	dry	no data	14.481
20-Dec	dry	no data	14.481
21-Dec	dry	no data	15.031
22-Dec	dry	no data	13.81
23-Dec	dry	no data	13.69
24-Dec	dry	no data	13.522
25-Dec	dry	no data	13.353
26-Dec	dry	no data	13.377
27-Dec	dry	no data	13.618
28-Dec	dry	no data	13.642
29-Dec	dry	no data	13.233
30-Dec	dry	no data	13.522
31-Dec	dry	no data	13.666

Appendix E. Maximum daily water temperature in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Day	Miller Creek above Grady Bridge (at gage) (°C)	Grady Creek[1] (1,250 feet upstream Grady Creek gage) (°C)	Miller Creek below Grady Creek (150 feet downstream Grady Bridge) (°C)
1-Jan	dry	no data	13.666
2-Jan	dry	no data	13.906
3-Jan	dry	no data	13.185
4-Jan	dry	no data	13.209
5-Jan	dry	no data	12.92
6-Jan	dry	no data	13.016
7-Jan	dry	no data	12.799
8-Jan	dry	no data	12.92
9-Jan	dry	no data	12.968
10-Jan	dry	no data	12.534
11-Jan	dry	no data	12.799
12-Jan	no data	no data	13.257
13-Jan	no data	no data	12.727
14-Jan	no data	no data	12.509
15-Jan	no data	no data	12.654
16-Jan	11.73	no data	12.799
17-Jan	11.91	no data	12.582
18-Jan	11.14	no data	11.248
19-Jan	11.32	no data	11.662
20-Jan	10.91	no data	11.516
21-Jan	10.91	no data	10.98
22-Jan	10.36	no data	10.663
23-Jan	10.67	no data	11.662
24-Jan	10.49	no data	11.005
25-Jan	10.51	no data	11.102
26-Jan	11.06	no data	11.492
27-Jan	11.43	no data	12.219
28-Jan	11.27	no data	11.686
29-Jan	11.2	no data	11.856
30-Jan	11.83	no data	12.001
31-Jan	11.85	no data	12.122
1-Feb	12.13	no data	12.461
2-Feb	12.15	no data	12.509
3-Feb	12.5	no data	12.654
4-Feb	11.83	no data	12.171
5-Feb	12.37	no data	12.437
6-Feb	11.91	no data	12.001
7-Feb	11.92	no data	12.001
8-Feb	11.73	no data	11.953
9-Feb	11.38	no data	11.686
10-Feb	11.88	no data	12.074
11-Feb	11.99	no data	12.074
12-Feb	12.6	no data	12.727
13-Feb	13.33	no data	13.257
14-Feb	13.57	no data	13.305
15-Feb	14.2	no data	13.738

Appendix E. Maximum daily water temperature in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Day	Miller Creek above Grady Bridge (at gage) (°C)	Grady Creek[1] (1,250 feet upstream Grady Creek gage) (°C)	Miller Creek below Grady Creek (150 feet downstream Grady Bridge) (°C)
16-Feb	14.34	no data	13.69
17-Feb	14.61	no data	13.954
18-Feb	14.02	no data	13.546
19-Feb	13.07	no data	12.944
20-Feb	12.65	no data	12.678
21-Feb	12.3	no data	12.461
22-Feb	14.21	no data	13.329
23-Feb	11.15	no data	11.88
24-Feb	12.47	no data	12.534
25-Feb	12.78	no data	12.871
26-Feb	11.88	no data	11.953
27-Feb	12.12	no data	12.243
28-Feb	13.19	no data	13.185
1-Mar	12.07	no data	12.243
2-Mar	12.24	no data	12.316
3-Mar	11.57	no data	11.71
4-Mar	11.87	no data	12.001
5-Mar	11.54	no data	11.783
6-Mar	13.17	no data	13.209
7-Mar	13.88	no data	13.762
8-Mar	12.52	no data	12.461
9-Mar	12.52	no data	12.485
10-Mar	12.98	no data	12.799
11-Mar	13.3	no data	13.401
12-Mar	11.38	no data	11.662
13-Mar	12.84	no data	12.775
14-Mar	13.65	no data	13.377
15-Mar	14.47	no data	13.954
16-Mar	15.42	no data	14.673
17-Mar	16.22	no data	15.008
18-Mar	16.66	no data	15.055
19-Mar	17.17	no data	15.031
20-Mar	15.73	no data	14.218
21-Mar	16.56	no data	14.673
22-Mar	17.58	no data	14.792
23-Mar	18.45	no data	14.792
24-Mar	dry	no data	14.792
25-Mar	dry	no data	14.481
26-Mar	dry	no data	14.816
27-Mar	dry	no data	14.936
28-Mar	dry	no data	15.008
29-Mar	dry	no data	13.834
30-Mar	21.29	no data	14.721
31-Mar	13.31	no data	14.05

Appendix E. Maximum daily water temperature in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Day	Miller Creek above Grady Bridge (at gage) (°C)	Grady Creek[1] (1,250 feet upstream Grady Creek gage) (°C)	Miller Creek below Grady Creek (150 feet downstream Grady Bridge) (°C)
1-Apr	15.32	no data	15.055
2-Apr	12.75	no data	13.016
3-Apr	14.78	no data	14.792
4-Apr	10.93	no data	11.783
5-Apr	11.93	no data	12.316
6-Apr	13.69	no data	13.762
7-Apr	15.44	no data	15.127
8-Apr	15.32	no data	14.912
9-Apr	16.24	no data	15.414
10-Apr	13.69	no data	13.161
11-Apr	11.15	no data	11.394
12-Apr	12.16	no data	12.243
13-Apr	13.34	no data	13.473
14-Apr	13.59	no data	13.618
15-Apr	14.27	no data	14.17
16-Apr	15.78	no data	15.438
17-Apr	16.59	no data	15.986
18-Apr	17.17	no data	16.415
19-Apr	16.09	no data	15.438
20-Apr	15.51	no data	15.008
21-Apr	14.86	no data	14.577
22-Apr	16.64	no data	15.843
23-Apr	18.61	no data	16.63
24-Apr	18.58	no data	16.296
25-Apr	19.77	no data	16.558
26-Apr	17.62	no data	15.223
27-Apr	15.08	no data	14.601
28-Apr	14.9	no data	14.649
29-Apr	16.96	no data	15.247
30-Apr	17.66	no data	15.438
1-May	dry	no data	15.629
2-May	dry	no data	16.034
3-May	dry	no data	16.201
4-May	dry	no data	15.963
5-May	dry	no data	15.867
6-May	dry	no data	16.249
7-May	dry	no data	16.511
8-May	dry	no data	16.201
9-May	dry	no data	15.652
10-May	dry	no data	14.936
11-May	dry	no data	16.606
12-May	dry	no data	16.892
13-May	dry	no data	16.82
14-May	dry	no data	17.13
15-May	dry	no data	17.463

Appendix E. Maximum daily water temperature in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Day	Miller Creek above Grady Bridge (at gage) (°C)	Grady Creek[1] (1,250 feet upstream Grady Creek gage) (°C)	Miller Creek below Grady Creek (150 feet downstream Grady Bridge) (°C)
16-May	dry	no data	16.368
17-May	dry	no data	13.714
18-May	dry	no data	15.867
19-May	dry	no data	15.963
20-May	dry	no data	17.486
21-May	dry	no data	16.487
22-May	dry	no data	16.796
23-May	dry	no data	17.772
24-May	dry	no data	16.534
25-May	dry	no data	13.666
26-May	dry	no data	18.438
27-May	dry	no data	18.723
28-May	dry	no data	16.915
29-May	dry	no data	19.651
30-May	dry	no data	20.055
31-May	dry	no data	18.628
1-Jun	dry	no data	19.246
2-Jun	dry	no data	20.246
3-Jun	dry	no data	20.793
4-Jun	dry	no data	19.365
5-Jun	dry	no data	21.795
6-Jun	dry	no data	21.652
7-Jun	dry	no data	20.674
8-Jun	dry	no data	20.103
9-Jun	dry	no data	20.198
10-Jun	dry	no data	20.579
11-Jun	dry	no data	21.819
12-Jun	dry	no data	22.944
13-Jun	dry	no data	23.472
14-Jun	dry	no data	22.298
15-Jun	dry	no data	20.365
16-Jun	dry	no data	19.793
17-Jun	dry	no data	19.579
18-Jun	dry	no data	17.772
19-Jun	dry	no data	17.772
20-Jun	dry	no data	18.39
21-Jun	dry	no data	18.937
22-Jun	dry	no data	19.008
23-Jun	dry	no data	18.081
24-Jun	dry	no data	16.225
25-Jun	dry	no data	19.508
26-Jun	dry	no data	20.007
27-Jun	dry	no data	21.485
28-Jun	dry	no data	22.776
29-Jun	dry	no data	21.819
30-Jun	dry	no data	20.865

Appendix E. Maximum daily water temperature in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Day	Miller Creek above Grady Bridge (at gage) (°C)	Grady Creek[1] (1,250 feet upstream Grady Creek gage) (°C)	Miller Creek below Grady Creek (150 feet downstream Grady Bridge) (°C)
1-Jul	dry	no data	20.793
2-Jul	dry	no data	22.657
3-Jul	dry	no data	25.453
4-Jul	dry	no data	dry
5-Jul	dry	no data	dry
6-Jul	dry	no data	dry
7-Jul	dry	no data	dry
8-Jul	dry	no data	dry
9-Jul	dry	no data	dry
10-Jul	dry	no data	dry
11-Jul	dry	no data	dry
12-Jul	dry	no data	dry
13-Jul	dry	no data	dry
14-Jul	dry	no data	dry
15-Jul	dry	no data	dry
16-Jul	dry	no data	dry
17-Jul	dry	no data	dry
18-Jul	dry	no data	dry
19-Jul	dry	no data	dry
20-Jul	dry	no data	dry
21-Jul	dry	no data	dry
22-Jul	dry	no data	dry
23-Jul	dry	17.08	dry
24-Jul	dry	16.44	dry
25-Jul	dry	15.82	dry
26-Jul	dry	14.39	dry
27-Jul	dry	15.15	dry
28-Jul	dry	15.75	dry
29-Jul	dry	15.99	dry
30-Jul	dry	16.11	dry
31-Jul	dry	16.06	dry
1-Aug	dry	16.30	dry
2-Aug	dry	16.20	dry
3-Aug	dry	16.37	dry
4-Aug	dry	16.08	dry
5-Aug	dry	15.70	dry
6-Aug	dry	15.99	dry
7-Aug	dry	16.27	dry
8-Aug	dry	16.08	dry
9-Aug	dry	16.23	dry
10-Aug	dry	15.94	dry
11-Aug	dry	15.20	dry
12-Aug	dry	15.99	dry
13-Aug	dry	16.15	dry
14-Aug	dry	15.61	dry
15-Aug	dry	15.51	dry

Appendix E. Maximum daily water temperature in Miller Creek and tributaries, Grady Ranch, Marin County, California.

Day	Miller Creek above Grady Bridge (at gage) (°C)	Grady Creek[1] (1,250 feet upstream Grady Creek gage) (°C)	Miller Creek below Grady Creek (150 feet downstream Grady Bridge) (°C)
16-Aug	dry	16.20	dry
17-Aug	dry	15.96	dry
18-Aug	dry	16.20	dry
19-Aug	dry	16.70	dry
20-Aug	dry	16.34	dry
21-Aug	dry	14.98	dry
22-Aug	dry	15.96	dry
23-Aug	dry	17.44	dry
24-Aug	dry	18.82	dry
25-Aug	dry	19.98	dry
26-Aug	dry	18.11	dry
27-Aug	dry	16.65	dry
28-Aug	dry	15.01	dry
29-Aug	dry	15.13	dry
30-Aug	dry	15.03	dry
31-Aug	dry	16.20	dry
1-Sep	dry	17.39	dry
2-Sep	dry	18.56	dry
3-Sep	dry	17.96	dry
4-Sep	dry	17.15	dry
5-Sep	dry	16.75	dry
6-Sep	dry	17.23	dry
7-Sep	dry	16.46	dry
8-Sep	dry	15.25	dry
9-Sep	dry	15.37	dry
10-Sep	dry	15.94	dry
11-Sep	dry	16.49	dry
12-Sep	dry	16.11	dry
13-Sep	dry	15.41	dry
14-Sep	dry	15.51	dry
15-Sep	dry	15.10	dry
16-Sep	dry	16.49	dry
17-Sep	dry	16.51	dry
18-Sep	dry	16.51	dry
19-Sep	dry	16.39	dry
20-Sep	dry	16.27	dry
21-Sep	dry	15.39	dry
22-Sep	dry	14.63	dry
23-Sep	dry	15.18	dry
24-Sep	dry	16.06	dry
25-Sep	dry	17.03	dry
26-Sep	dry	18.79	dry
27-Sep	dry	18.01	dry
28-Sep	dry	18.75	dry
29-Sep	dry	20.46	dry
30-Sep	dry	18.06	dry

Notes;

1. Temperature logger installed in November 2009 was later not found and a replaced in July 2010. Data shows that there was flow in the pool year-round.

APPENDIX F

Analytical laboratory reports

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Balance Hydrologics - San Rafael
101 Lucas Valley Road - Suite 229
San Rafael, CA 94901
Attn: Mark Woyshner

Work Order #: 9100688
Reporting Date: November 2, 2009

Date Received:	October 23, 2009
Project # / Name:	208164 / Grady Ranch
Water System #:	NA
Sample Identification:	MW-3, sampled 10/21/2009 11:10:00AM
Sampler Name / Co.:	Sarah Richmond / Balance Hydrologics
Matrix:	Water
Laboratory #:	9100688-01

	Results	Units	RL	State Drinking Water Limits[1]	Analysis Method	Date Analyzed	Flags
General Mineral							
pH	7.1	pH Units	0.1	-	EPA 150.1	10/23/09	
Specific Conductance (EC)	450	uS/cm	1.0	1600	EPA 120.1	10/23/09	
Hydroxide as OH	ND	mg/L	2.5	-	EPA 310.1	10/23/09	
Carbonate as CO3	ND	mg/L	2.5	-	EPA 310.1	10/23/09	
Bicarbonate as HCO3	250	mg/L	2.5	-	EPA 310.1	10/23/09	
Total Alkalinity as CaCO3	210	mg/L	2.5	-	EPA 310.1	10/23/09	
Hardness	160	mg/L	5.0	-	SM 2340 B	10/30/09	
Total Dissolved Solids	250	mg/L	10	1000	EPA 160.1	10/27/09	
Nitrate as NO3	2.6	mg/L	1.0	45	EPA 300.0	10/24/09	
Chloride	27	mg/L	1.0	500	EPA 300.0	10/24/09	
Sulfate as SO4	20	mg/L	1.0	500	EPA 300.0	10/24/09	
Fluoride	0.24	mg/L	0.10	2	EPA 300.0	10/24/09	
Calcium	37	mg/L	0.50	-	EPA 200.7	10/30/09	
Magnesium	15	mg/L	0.50	-	EPA 200.7	10/30/09	
Potassium	5.0	mg/L	0.50	-	EPA 200.7	10/30/09	
Sodium	27	mg/L	5.0	-	EPA 200.7	10/30/09	
* Iron	310	ug/L	50	300	EPA 200.7	10/30/09	
* Manganese	190	ug/L	20	50	EPA 200.7	10/30/09	
Copper	ND	ug/L	50	1000	EPA 200.7	10/30/09	
Zinc	ND	ug/L	50	5000	EPA 200.7	10/30/09	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.
State Drinking Water Limits[1] - as listed by California Administrative Code, Title 22.
* - a * in the left hand margin of the report means that particular constituent is above the California Drinking Water Limits.

Mike Galloway

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

TEL: 831-724-5422
FAX: 831-724-3188

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

Balance Hydrologics - San Rafael
101 Lucas Valley Road - Suite 229
San Rafael, CA 94901
Attn: Mark Woyshner

Work Order #: 9100688
Reporting Date: November 2, 2009

Date Received: October 23, 2009
Project # / Name: 208164 / Grady Ranch
Water System #: NA
Sample Identification: MW-4, sampled 10/21/2009 1:52:00PM
Sampler Name / Co.: Sarah Richmond / Balance Hydrologics
Matrix: Water
Laboratory #: 9100688-02

	Results	Units	RL	State Drinking Water Limits[1]	Analysis Method	Date Analyzed	Flags
General Mineral							
pH	6.9	pH Units	0.1	-	EPA 150.1	10/23/09	
Specific Conductance (EC)	490	uS/cm	1.0	1600	EPA 120.1	10/23/09	
Hydroxide as OH	ND	mg/L	2.5	-	EPA 310.1	10/23/09	
Carbonate as CO3	ND	mg/L	2.5	-	EPA 310.1	10/23/09	
Bicarbonate as HCO3	200	mg/L	2.5	-	EPA 310.1	10/23/09	
Total Alkalinity as CaCO3	170	mg/L	2.5	-	EPA 310.1	10/23/09	
Hardness	140	mg/L	5.0	-	SM 2340 B	10/30/09	
Total Dissolved Solids	260	mg/L	10	1000	EPA 160.1	10/27/09	
Nitrate as NO3	5.1	mg/L	1.0	45	EPA 300.0	10/24/09	
Chloride	43	mg/L	1.0	500	EPA 300.0	10/24/09	
Sulfate as SO4	26	mg/L	1.0	500	EPA 300.0	10/24/09	
Fluoride	0.24	mg/L	0.10	2	EPA 300.0	10/24/09	
Calcium	33	mg/L	0.50	-	EPA 200.7	10/30/09	
Magnesium	14	mg/L	0.50	-	EPA 200.7	10/30/09	
Potassium	6.3	mg/L	0.50	-	EPA 200.7	10/30/09	
Sodium	36	mg/L	5.0	-	EPA 200.7	10/30/09	
Iron	ND	ug/L	50	300	EPA 200.7	10/30/09	
* Manganese	55	ug/L	20	50	EPA 200.7	10/30/09	
Copper	ND	ug/L	50	1000	EPA 200.7	10/30/09	
Zinc	ND	ug/L	50	5000	EPA 200.7	10/30/09	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.
State Drinking Water Limits[1] - as listed by California Administrative Code, Title 22.
* - a * in the left hand margin of the report means that particular constituent is above the California Drinking Water Limits.

Mike Galloway

MONTEREY BAY ANALYTICAL SERVICES
PRECISION ● ACCURACY ● DEPENDABILITY
4 Justin Court Suite D, Monterey, CA 93940
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montereybayanalytical@usa.net
ELAP Certification Number: 2385

Tuesday, December 01, 2009

Balance Hydrologics
Mark Woyshner
841 Folger Ave
Berkeley, CA 94710

Lab Number: **AA61876**

Collection Date/Time:	11/4/2009	16:32	Sample Collector:	RICHMOND, S
Submittal Date/Time:	11/5/2009	11:00	Sample ID	

Sample Description: MW1

Analyte	Method	Unit	**Result**	Qual	PQL	Date Analyzed
Alkalinity, Total (as CaCO3)	2320B	mg/L	**140**		2	11/5/2009
Bicarbonate (as HCO3-)	2320B	mg/L	**171**		10	11/6/2009
Boron	4500B-B	mg/L	**0.05**		0.05	11/23/2009
Calcium	3111B	mg/L	**35**		1	11/13/2009
Chloride	300.0	mg/L	**11**		1	11/6/2009
Magnesium	3111B	mg/L	**15**		1	11/13/2009
Nitrate as NO3	300.0	mg/L	**1**		1	11/6/2009
Nitrite as NO2-N	300.0	mg/L	**Not detected**		0.1	11/6/2009
o-Phosphate-P	300.0	mg/L	**Not detected**		0.05	11/6/2009
pH (Laboratory)	4500-H+B	STD. Units	**6.8**			11/5/2009
Potassium	3111B	mg/L	**1.0**		0.5	11/13/2009
QC Anion Sum x 100	Calculaltion	%	**101%**			11/13/2009
QC Anion-Cation Balance	Calculaltion	%	**2**			11/29/2009
QC Cation Sum x 100	Calculaltion	%	**106%**			11/29/2009
QC Ratio TDS/SEC	Calculation		**0.7**			11/30/2009
SAR (Sodium Adsorption Ratio)	Suarez, 1981		**0.6**			11/13/2009
SAR, Adjusted	Suarez, 1981		**0.5**			11/30/2009
Sodium	3111B	mg/L	**16**		1	11/13/2009
Specific Conductance (E.C)	2510B	umhos/cm	**349**		1	11/5/2009
Sulfate	300.0	mg/L	**19**		1	11/6/2009
Total Diss. Solids	2540C	mg/L	**243**		10	11/11/2009

Sample Comments:

Report Approved by:

David Holland, Laboratory Director

mg/L: Milligrams per liter (=ppm)
ug/L : Micrograms per liter (=ppb)
PQL : Practical Quantitation Limit
H = Analyzed ouside of hold time
E = Analysis performed by External Laboratory; See External Laboratory Report attachments.
J = Result is less than PQL

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ELAP Certification Number: 2385

Tuesday, December 01, 2009

Balance Hydrologics
Mark Woyshner
841 Folger Ave
Berkeley, CA 94710

Lab Number: **AA61877**

Collection Date/Time: 11/4/2009 9:57 Sample Collector: RICHMOND, S
Submittal Date/Time: 11/5/2009 11:00 Sample ID

Sample Description: MW2

Analyte	Method	Unit	**Result**	Qual	PQL	Date Analyzed
Alkalinity, Total (as CaCO3)	2320B	mg/L	**121**		2	11/5/2009
Bicarbonate (as HCO3-)	2320B	mg/L	**148**		10	11/6/2009
Boron	4500B-B	mg/L	**0.06**		0.05	11/23/2009
Calcium	3111B	mg/L	**26**		1	11/13/2009
Chloride	300.0	mg/L	**12**		1	11/6/2009
Magnesium	3111B	mg/L	**15**		1	11/13/2009
Nitrate as NO3	300.0	mg/L	**3**		1	11/6/2009
Nitrite as NO2-N	300.0	mg/L	**Not detected**		0.1	11/6/2009
o-Phosphate-P	300.0	mg/L	**Not detected**		0.05	11/6/2009
pH (Laboratory)	4500-H+B	STD. Units	**6.9**			11/5/2009
Potassium	3111B	mg/L	**1.4**		0.5	11/13/2009
QC Anion Sum x 100	Calculaltion	%	**98%**			11/13/2009
QC Anion-Cation Balance	Calculaltion	%	**3**			11/13/2009
QC Cation Sum x 100	Calculaltion	%	**103%**			11/29/2009
QC Ratio TDS/SEC	Calculation		**0.66**			11/30/2009
SAR (Sodium Adsorption Ratio)	Suarez, 1981		**0.6**			11/13/2009
SAR, Adjusted	Suarez, 1981		**0.5**			11/30/2009
Sodium	3111B	mg/L	**16**		1	11/13/2009
Specific Conductance (E.C)	2510B	umhos/cm	**317**		1	11/5/2009
Sulfate	300.0	mg/L	**14**		1	11/6/2009
Total Diss. Solids	2540C	mg/L	**210**		10	11/11/2009

Sample Comments:

Report Approved by:

David Holland, Laboratory Director

mg/L: Milligrams per liter (=ppm)
ug/L : Micrograms per liter (=ppb)
PQL : Practical Quantitation Limit
H = Analyzed ouside of hold time
E = Analysis performed by External Laboratory; See External Laboratory Report attachments.
J = Result is less than PQL

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ELAP Certification Number: 2385

Balance Hydrologics
Mark Woyshner
841 Folger Ave
Berkeley, CA 94710

Tuesday, December 01, 2009

Lab Number: **AA61878**

Collection Date/Time: 11/4/2009 11:50 Sample Collector: RICHMOND, S
Submittal Date/Time: 11/5/2009 11:00 Sample ID

Sample Description: MW3

Analyte	Method	Unit	**Result**	Qual	PQL	Date Analyzed
Alkalinity, Total (as CaCO3)	2320B	mg/L	**122**		2	11/5/2009
Bicarbonate (as HCO3-)	2320B	mg/L	**149**		10	11/6/2009
Boron	4500B-B	mg/L	**0.06**		0.05	11/23/2009
Calcium	3111B	mg/L	**26**		1	11/13/2009
Chloride	300.0	mg/L	**10**		1	11/6/2009
Magnesium	3111B	mg/L	**14**		1	11/13/2009
Nitrate as NO3	300.0	mg/L	**2**		1	11/6/2009
Nitrite as NO2-N	300.0	mg/L	**Not detected**		0.1	11/6/2009
o-Phosphate-P	300.0	mg/L	**Not detected**		0.05	11/6/2009
pH (Laboratory)	4500-H+B	STD. Units	**7.0**			11/5/2009
Potassium	3111B	mg/L	**2.1**		0.5	11/13/2009
QC Anion Sum x 100	Calculaltion	%	**97%**			11/13/2009
QC Anion-Cation Balance	Calculaltion	%	**1**			11/29/2009
QC Cation Sum x 100	Calculaltion	%	**99%**			11/29/2009
QC Ratio TDS/SEC	Calculation		**0.71**			11/30/2009
SAR (Sodium Adsorption Ratio)	Suarez, 1981		**0.5**			11/13/2009
SAR, Adjusted	Suarez, 1981		**0.4**			11/30/2009
Sodium	3111B	mg/L	**13**		1	11/13/2009
Specific Conductance (E.C)	2510B	umhos/cm	**309**		1	11/5/2009
Sulfate	300.0	mg/L	**11**		1	11/6/2009
Total Diss. Solids	2540C	mg/L	**218**		10	11/11/2009

Sample Comments:

Report Approved by:

David Holland, Laboratory Director

mg/L: Milligrams per liter (=ppm) ug/L : Micrograms per liter (=ppb) PQL : Practical Quantitation Limit
H = Analyzed ouside of hold time E = Analysis performed by External Laboratory; See External Laboratory Report attachments.
J = Result is less than PQL

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ELAP Certification Number: 2385

Tuesday, December 01, 2009

Balance Hydrologics
Mark Woyshner
841 Folger Ave
Berkeley, CA 94710

Lab Number: **AA61879**

Collection Date/Time:	11/4/2009	17:09	Sample Collector:	RICHMOND, S
Submittal Date/Time:	11/5/2009	11:00	Sample ID	

Sample Description: MW4

Analyte	Method	Unit	**Result**	Qual	PQL	Date Analyzed
Alkalinity, Total (as CaCO3)	2320B	mg/L	**139**		2	11/6/2009
Bicarbonate (as HCO3-)	2320B	mg/L	**170**		10	12/1/2009
Boron	4500B-B	mg/L	**0.26**		0.05	11/23/2009
Calcium	3111B	mg/L	**34**		1	11/13/2009
Chloride	300.0	mg/L	**140**		1	11/6/2009
Magnesium	3111B	mg/L	**12**		1	11/13/2009
Nitrate as NO3	300.0	mg/L	**1**		1	11/6/2009
Nitrite as NO2-N	300.0	mg/L	**Not detected**		0.1	11/6/2009
o-Phosphate-P	300.0	mg/L	**Not detected**		0.05	11/6/2009
pH (Laboratory)	4500-H+B	STD. Units	**8.2**			11/5/2009
Potassium	3111B	mg/L	**5.0**		0.5	11/13/2009
QC Anion Sum x 100	Calculaltion	%	**91%**			12/1/2009
QC Anion-Cation Balance	Calculaltion	%	**1**			12/1/2009
QC Cation Sum x 100	Calculaltion	%	**93%**			12/1/2009
QC Ratio TDS/SEC	Calculation		**0.6**			11/30/2009
SAR (Sodium Adsorption Ratio)	Suarez, 1981		**4.5**			12/1/2009
SAR, Adjusted	Suarez, 1981		**4.7**			12/1/2009
Sodium	3111B	mg/L	**120**		1	11/13/2009
Specific Conductance (E.C)	2510B	umhos/cm	**866**		1	11/5/2009
Sulfate	300.0	mg/L	**56**		1	11/6/2009
Total Diss. Solids	2540C	mg/L	**518**		10	11/11/2009

Sample Comments:

Report Approved by:

David Holland, Laboratory Director

mg/L: Milligrams per liter (=ppm)
ug/L : Micrograms per liter (=ppb)
PQL : Practical Quantitation Limit
H = Analyzed ouside of hold time
E = Analysis performed by External Laboratory; See External Laboratory Report attachments.
J = Result is less than PQL

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ELAP Certification Number: 2385

Tuesday, December 15, 2009

Balance Hydrologics
Mark Woyshner
841 Folger Ave
Berkeley, CA 94710

Lab Number: **AA62174**

Collection Date/Time:	11/17/2009	16:00	Sample Collector:	WOYSHNER, M
Submittal Date/Time:	11/18/2009	14:00	Sample ID	208164

Sample Description: Landmark Cr.

Analyte	Method	Unit	**Result**	Qual	PQL	Date Analyzed
Alkalinity, Total (as CaCO3)	2320B	mg/L	**171**		2	11/18/2009
Bicarbonate (as HCO3-)	2320B	mg/L	**209**		10	11/19/2009
Boron	4500B-B	mg/L	**0.06**		0.05	12/2/2009
Calcium	3111B	mg/L	**45**		1	12/4/2009
Chloride	300.0	mg/L	**12**		1	11/19/2009
Magnesium	3111B	mg/L	**14**		1	12/4/2009
Nitrate as NO3	300.0	mg/L	**Not detected**		1	11/19/2009
Nitrite as NO2-N	300.0	mg/L	**Not detected**		0.1	11/19/2009
o-Phosphate-P	300.0	mg/L	**Not detected**		0.1	11/19/2009
pH (Laboratory)	4500-H+B	STD. Units	**7.7**			11/18/2009
Potassium	3111B	mg/L	**0.8**		0.5	12/4/2009
QC Anion Sum x 100	Calculaltion	%	**105%**			12/14/2009
QC Anion-Cation Balance	Calculaltion	%	**0**			12/14/2009
QC Cation Sum x 100	Calculaltion	%	**105%**			12/14/2009
QC Ratio TDS/SEC	Calculation		**0.62**			12/2/2009
SAR (Sodium Adsorption Ratio)	Suarez, 1981		**0.6**			12/4/2009
SAR, Adjusted	Suarez, 1981		**0.7**			12/4/2009
Sodium	3111B	mg/L	**19**		1	12/4/2009
Specific Conductance (E.C)	2510B	umhos/cm	**405**		1	11/18/2009
Sulfate	300.0	mg/L	**23**		1	11/19/2009
Total Diss. Solids	2540C	mg/L	**250**		10	11/30/2009

Sample Comments:

Report Approved by:

David Holland, Laboratory Director

mg/L: Milligrams per liter (=ppm)
ug/L : Micrograms per liter (=ppb)
PQL : Practical Quantitation Limit
H = Analyzed ouside of hold time
E = Analysis performed by External Laboratory; See External Laboratory Report attachments.
J = Result is less than PQL

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ELAP Certification Number: 2385

Tuesday, December 15, 2009

Balance Hydrologics
Mark Woyshner
841 Folger Ave
Berkeley, CA 94710

Lab Number: **AA62175**

Collection Date/Time:	11/17/2009	16:30	Sample Collector:	WOYSHNER, M
Submittal Date/Time:	11/18/2009	14:00	Sample ID	208164

Sample Description: Test Well B

Analyte	Method	Unit	**Result**	Qual	PQL	Date Analyzed
Alkalinity, Total (as CaCO3)	2320B	mg/L	**190**		2	11/18/2009
Bicarbonate (as HCO3-)	2320B	mg/L	**232**		10	12/14/2009
Boron	4500B-B	mg/L	**8.38**		0.05	12/11/2009
Calcium	3111B	mg/L	**10**		1	12/4/2009
Chloride	300.0	mg/L	**194**		1	11/19/2009
Magnesium	3111B	mg/L	**2**		1	12/4/2009
Nitrate as NO3	300.0	mg/L	**1**		1	11/19/2009
Nitrite as NO2-N	300.0	mg/L	**Not detected**		0.1	11/19/2009
o-Phosphate-P	300.0	mg/L	**Not detected**		0.1	11/19/2009
pH (Laboratory)	4500-H+B	STD. Units	**8.5**			11/18/2009
Potassium	3111B	mg/L	**4.4**		0.5	12/4/2009
QC Anion Sum x 100	Calculaltion	%	**91%**			12/14/2009
QC Anion-Cation Balance	Calculaltion	%	**3**			12/14/2009
QC Cation Sum x 100	Calculaltion	%	**97%**			12/4/2009
QC Ratio TDS/SEC	Calculation		**0.62**			12/2/2009
SAR (Sodium Adsorption Ratio)	Suarez, 1981		**16.0**			12/4/2009
SAR, Adjusted	Suarez, 1981		**15.5**			12/14/2009
Sodium	3111B	mg/L	**212**		1	12/4/2009
Specific Conductance (E.C)	2510B	umhos/cm	**1033**		1	11/18/2009
Sulfate	300.0	mg/L	**5**		1	11/19/2009
Total Diss. Solids	2540C	mg/L	**638**		10	11/30/2009

Sample Comments:

Report Approved by:

David Holland, Laboratory Director

mg/L: Milligrams per liter (=ppm)
ug/L : Micrograms per liter (=ppb)
PQL : Practical Quantitation Limit
H = Analyzed ouside of hold time
E = Analysis performed by External Laboratory; See External Laboratory Report attachments.
J = Result is less than PQL

MBAS
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831.375.MBAS
montereybayanalytical@usa.net
ELAP Certification Number: 2385

Tuesday, December 15, 2009

Balance Hydrologics
Mark Woyshner
841 Folger Ave
Berkeley, CA 94710

Lab Number: **AA62176**

Collection Date/Time:	11/17/2009	17:00	Sample Collector:	WOYSHNER, M
Submittal Date/Time:	11/18/2009	14:00	Sample ID	208164

Sample Description: Grady Cr.

Analyte	Method	Unit	**Result**	Qual	PQL	Date Analyzed
Alkalinity, Total (as CaCO3)	2320B	mg/L	**163**		2	11/18/2009
Bicarbonate (as HCO3-)	2320B	mg/L	**199**		10	11/19/2009
Boron	4500B-B	mg/L	**0.14**		0.05	12/2/2009
Calcium	3111B	mg/L	**50**		1	12/4/2009
Chloride	300.0	mg/L	**10**		1	11/19/2009
Magnesium	3111B	mg/L	**13**		1	12/4/2009
Nitrate as NO3	300.0	mg/L	**1**		1	11/19/2009
Nitrite as NO2-N	300.0	mg/L	**Not detected**		0.1	11/19/2009
o-Phosphate-P	300.0	mg/L	**Not detected**		0.1	11/19/2009
pH (Laboratory)	4500-H+B	STD. Units	**8.2**			11/18/2009
Potassium	3111B	mg/L	**0.8**		0.5	12/4/2009
QC Anion Sum x 100	Calculaltion	%	**106%**			12/4/2009
QC Anion-Cation Balance	Calculaltion	%	**1**			12/14/2009
QC Cation Sum x 100	Calculaltion	%	**109%**			12/14/2009
QC Ratio TDS/SEC	Calculation		**0.57**			12/14/2009
SAR (Sodium Adsorption Ratio)	Suarez, 1981		**0.5**			12/4/2009
SAR, Adjusted	Suarez, 1981		**0.6**			12/4/2009
Sodium	3111B	mg/L	**16**		1	12/4/2009
Specific Conductance (E.C)	2510B	umhos/cm	**394**		1	11/18/2009
Sulfate	300.0	mg/L	**29**		1	11/19/2009
Total Diss. Solids	2540C	mg/L	**225**		10	11/30/2009

Sample Comments:

Report Approved by:

David Holland, Laboratory Director

mg/L: Milligrams per liter (=ppm)
ug/L : Micrograms per liter (=ppb)
PQL : Practical Quantitation Limit
H = Analyzed ouside of hold time
E = Analysis performed by External Laboratory; See External Laboratory Report attachments.
J = Result is less than PQL

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Balance Hydrologics
Mark Woyshner
841 Folger Ave
Berkeley, CA 94710

ELAP Certification Number: 2385

Page 1 of 1 Wednesday, December 23, 2009

Lab Number: **AA62502**

Collection Date/Time:	12/2/2009	13:00	Sample Collector:	WOYSHNER, M
Submittal Date/Time:	12/3/2009	12:50	Sample ID	208164

Sample Description: RW-6

Analyte	Method	Unit	**Result**	Qual	PQL	Date Analyzed
Alkalinity, Total (as CaCO3)	2320B	mg/L	**148**		2	12/3/2009
Bicarbonate (as HCO3-)	2320B	mg/L	**181**		10	12/14/2009
Boron	4500B-B	mg/L	**0.30**		0.05	12/11/2009
Calcium	3111B	mg/L	**31**		1	12/8/2009
Chloride	300.0	mg/L	**20**		1	12/3/2009
Magnesium	3111B	mg/L	**20**		1	12/8/2009
Nitrate as NO3	300.0	mg/L	**0.2**		1	12/3/2009
Nitrite as NO2-N	300.0	mg/L	**Not detected**		0.1	12/3/2009
o-Phosphate-P	300.0	mg/L	**Not detected**		0.1	12/3/2009
pH (Laboratory)	4500-H+B	STD. Units	**7.3**			12/3/2009
Potassium	3111B	mg/L	**2.4**		0.5	12/8/2009
QC Anion Sum x 100	Calculaltion	%	**98%**			12/14/2009
QC Anion-Cation Balance	Calculaltion	%	**3**			12/14/2009
QC Cation Sum x 100	Calculaltion	%	**103%**			12/14/2009
QC Ratio TDS/SEC	Calculation		**0.62**			12/11/2009
SAR (Sodium Adsorption Ratio)	Suarez, 1981		**0.8**			12/14/2009
SAR, Adjusted	Suarez, 1981		**0.7**			12/14/2009
Sodium	3111B	mg/L	**22**		1	12/8/2009
Specific Conductance (E.C)	2510B	umhos/cm	**407**		1	12/3/2009
Sulfate	300.0	mg/L	**22**		1	12/3/2009
Total Diss. Solids	2540C	mg/L	**253**		10	12/4/2009

Sample Comments:

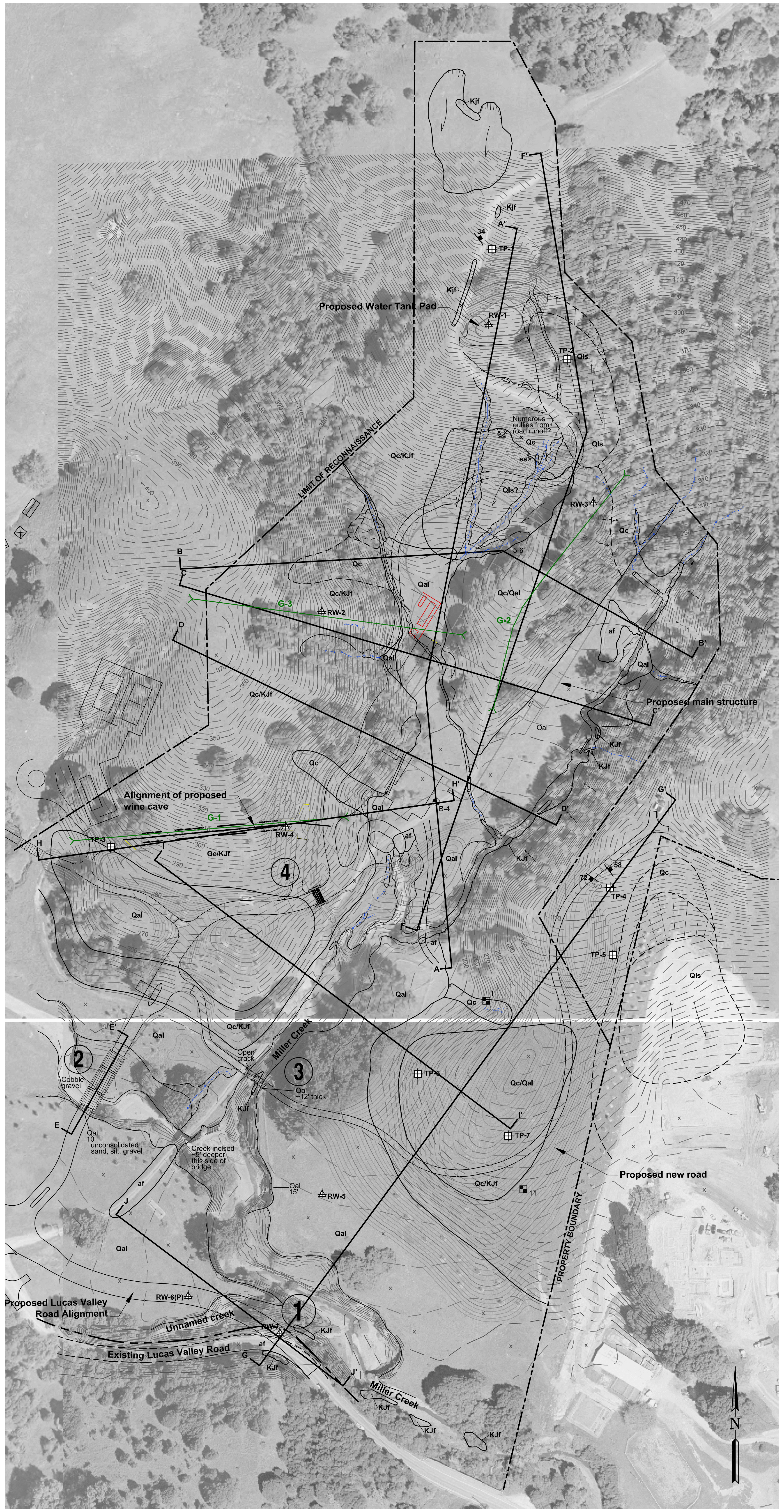
Report Approved by:

David Holland
Laboratory Director

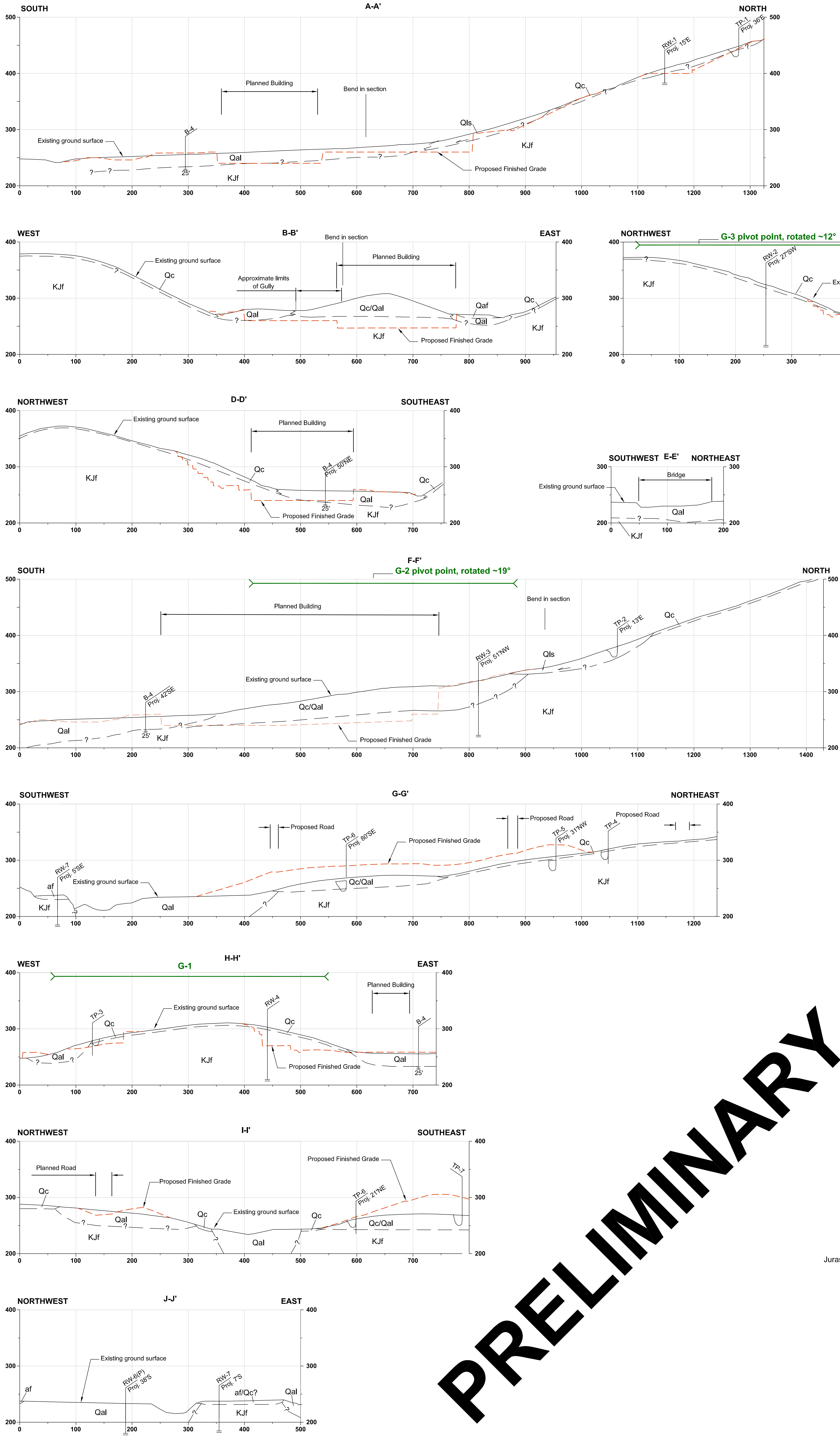
mg/L: Milligrams per liter (=ppm) ug/L : Micrograms per liter (=ppb) PQL : Practical Quantitation Limit
H = Analyzed ouside of hold time E = Analysis performed by External Laboratory; See External Laboratory Report attachments.
D = Method deviates from standard method due to insufficient sample for MS/MSD J = Result is less than PQL

APPENDIX G

Geology Plate (AMEC Geomatrix, November 2008), boring logs (August 2009), and supplemental seismic refraction lines (October 2009)



GEOLOGIC MAP, SITE PLAN, GRADING PLAN



CROSS-SECTIONS

EXPLANATION

—— —?	Geologic contact; dashed where approximate; queried where uncertain
	Erosion scarp; dashed where approximate
	Proposed finished grades by CSW|ST2
	Shallow erosion gully
(4-6)	Deep erosion gully, with depth in feet
ˣˣss	Small bedrock outcrop (ss = sandstone)
	Creeping soil
A A'	Cross section location
B-4	Approximate location of test boring (Harlan Tait Associates, 1993)
1	Approximate location of test pit (Harlan Tait Associates, 1993)
RW-2	Rotary wash boring; (P) indicates piezometer constructed in boring
⊞ TP-4	Test pit location, this study
G-3	Seismic refraction line
39	Strike and dip of fracture
B-4 25'	Boring, with depth in feet (from Harlan Tait Associates, 1993)
	Landslide: hachures indicated scarp; arrows show general direction of movement
④	Proposed bridge locations (CSW|ST2, 2008)
Quatemary af	Artifical fill
Qc	Colluvium
Qal?	Alluvium; includes channel and terrace deposits; queried where questionable
Qls?	Landslide deposit; queried where questionable
Jurassic - Cretaceous KJf?	Franciscan Complex bedrock; queried where questionable

NOTES:

1. Geologic interpretations shown on C1.1A are based on C1.1 presented in "Geotecnical Evaluation: Grady Ranch Development, Marin County, Califronia." AMEC Geomatrix, November 2008. Modifications are based on additional surficial exploration for this addendum.
2. Topographic base provided by CSWST2, August 3, 2009.

C S W | S T 2
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fax: 510.663.4141
CONTACT: JIM FRENCH, PE, GE

Rev	Date	Description	Designed	Drawn	Checked
	1/21/09	RESPONSE TO CLIENT COMMENTS			
-	11/21/08	SUBMITTAL FOR CLIENT REVIEW			

GRADY RANCH PRECISE DEVELOPMENT PLAN

SITE GEOLOGY, CROSS SECTIONS, AND SLOPE STABILIZATION PLAN (1 OF 2)

Skywalker Properties Ltd.

County Of
Marin

State Of
California

Prepared Under the Direction of:

James B. French
No. 2018
EXP. 06/30/2010

James B French

Sheet
C1.1A

Scale: 1" = 100'
Date: November 21, 2008
File: 5.875.20 N 5.875.21 P
Plan File: D-4868 N DP-0748-.18 P

S:\14600\14648\14648.000\task_3\08_1017_ger_fig_C-1.1A.dwg, 8/28/2009 - 02:59 PM, dave.oshea, 1:1

LEGEND

━━━	SEISMIC REFRACTION PROFILE (10/2009 SURVEY)
- - -	SEISMIC REFRACTION PROFILE (07/2009 SURVEY)

NOTE: BASE MAP PROVIDED BY AMEC GEOMATRIX

SCALE

0 75 150 300

(1 inch = 150 feet)

NORCAL

JOB #: 09-325.55

DATE: OCT. 2009

SITE LOCATION MAP
GRADY RANCH

LOCATION: LUCAS VALLEY, CALIFORNIA

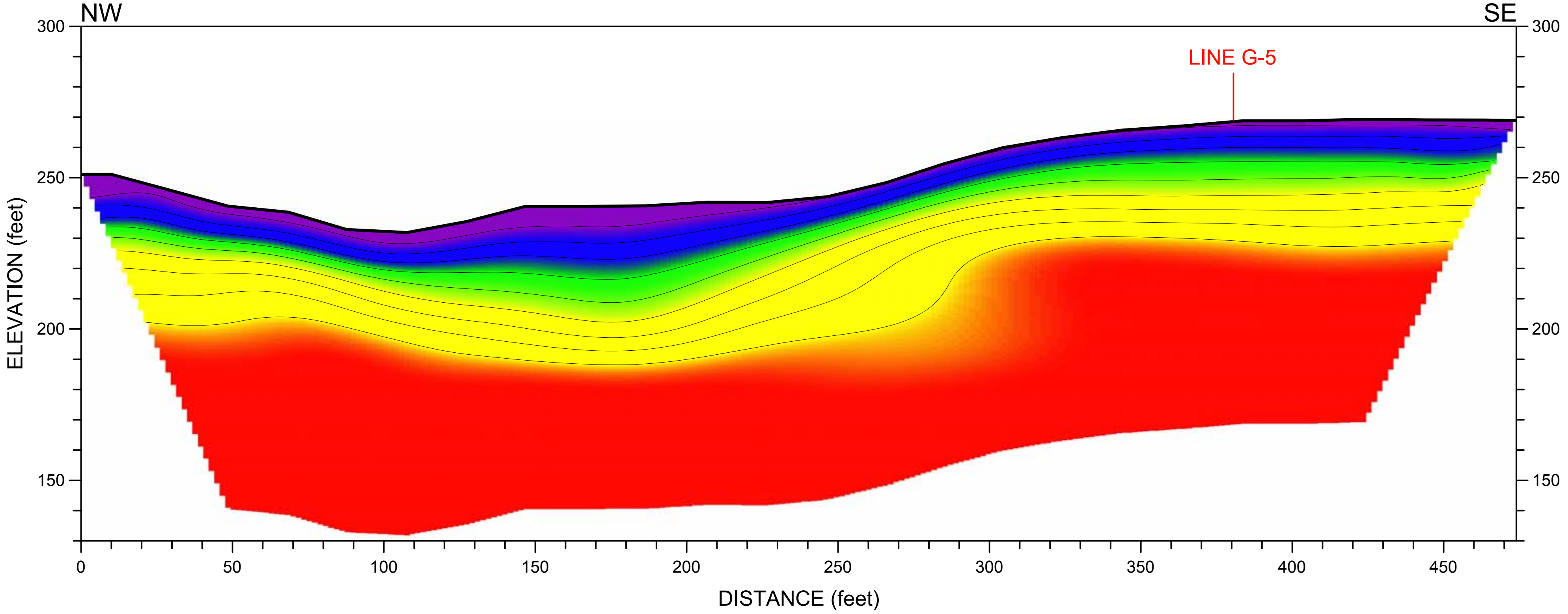
CLIENT: AMEC GEOMATRIX

NORCAL GEOPHYSICAL CONSULTANTS INC.

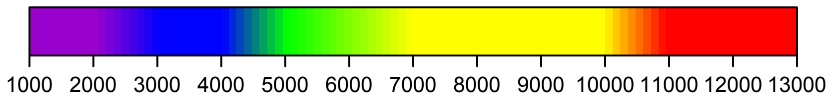
DRAWN BY: G.RANDALL

APPROVED BY: DJK

PLATE
1

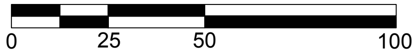


SEISMIC VELOCITY



(feet/second)

SCALE



(1 inch = 50 feet)

NORCAL

SEISMIC REFRACTION PROFILE
LINE G-4
GRADY RANCH

LOCATION: LUCAS VALLEY, CALIFORNIA

CLIENT: AMEC GEOMATRIX

JOB #: 09-325.55

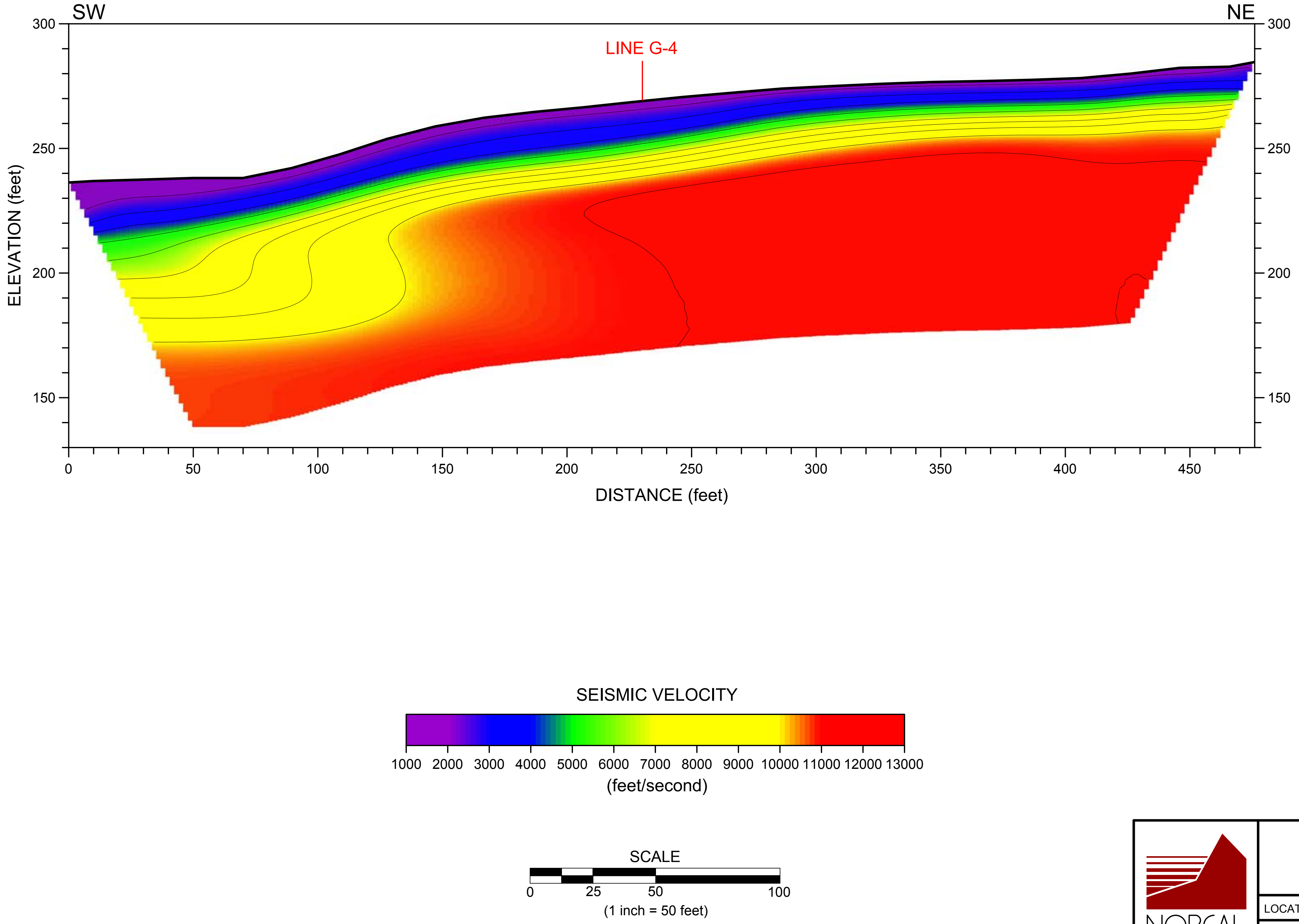
NORCAL GEOPHYSICAL CONSULTANTS INC.

DATE: OCT. 2009

DRAWN BY: G.RANDALL

APPROVED BY: DJK

PLATE
2



NORCAL

SEISMIC REFRACTION PROFILE
LINE G-5
GRADY RANCH

LOCATION: LUCAS VALLEY, CALIFORNIA

CLIENT: AMEC GEOMATRIX

JOB #: 09-325.55

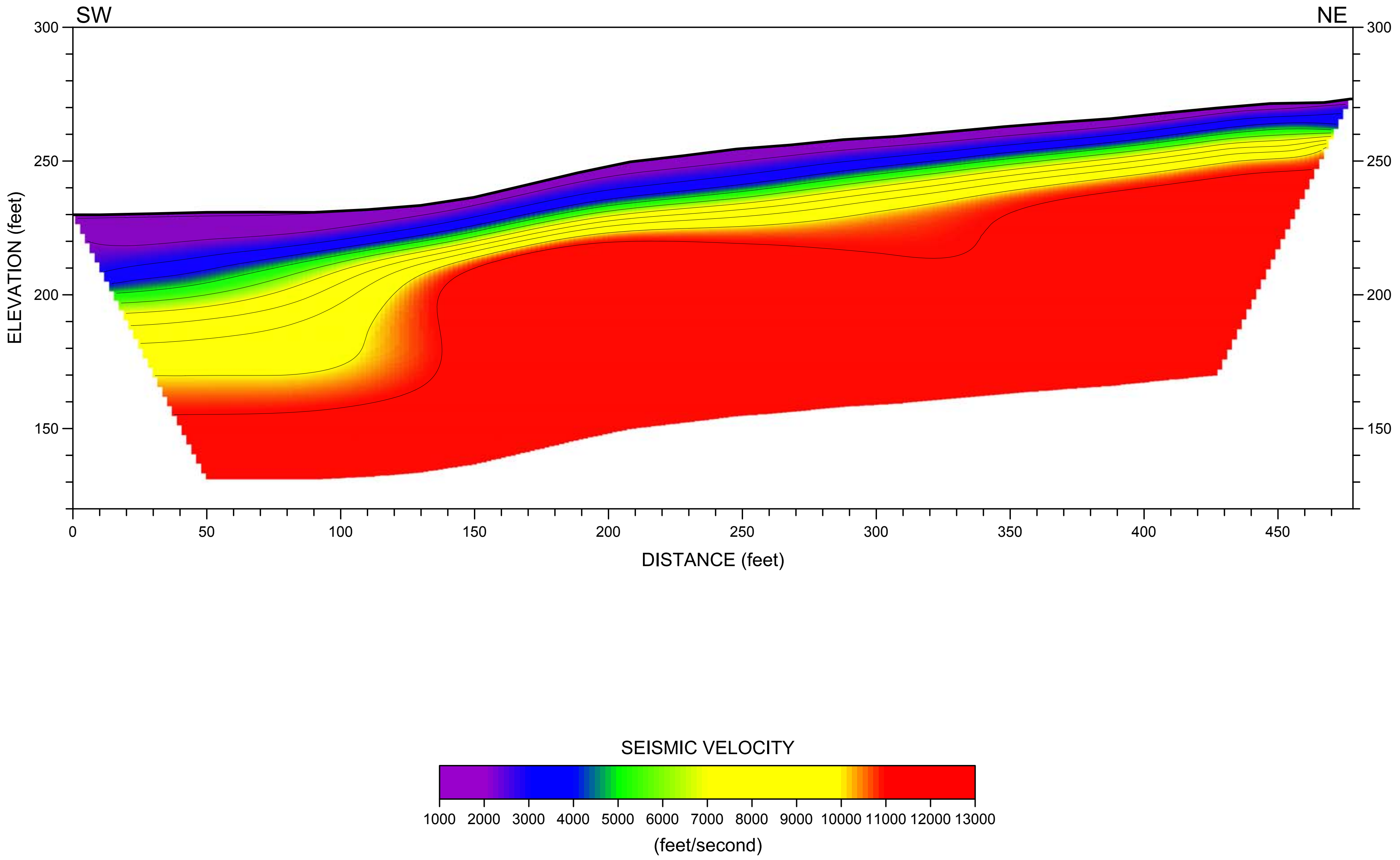
NORCAL GEOPHYSICAL CONSULTANTS INC.

DATE: OCT. 2009

DRAWN BY: G.RANDALL

APPROVED BY: DJK

PLATE
3



SCALE

0 25 50 100

(1 inch = 50 feet)

NORCAL

SEISMIC REFRACTION PROFILE
LINE G-6
GRADY RANCH

LOCATION: LUCAS VALLEY, CALIFORNIA

CLIENT: AMEC GEOMATRIX

JOB #: 09-325.55

NORCAL GEOPHYSICAL CONSULTANTS INC.

DATE: OCT. 2009

DRAWN BY: G.RANDALL

APPROVED BY: DJK

PLATE 4

PROJECT: Grady Ranch Development
Marin County, California

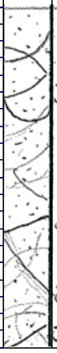
Log of Boring No. RW-1

BORING LOCATION:	Planned water tank	ELEVATION AND DATUM: 408	
DRILLING CONTRACTOR:	Taber Consultants	DATE STARTED: 8/5/2009	DATE FINISHED: 8/5/2009
DRILLING EQUIPMENT:	Track mounted CME-55	TOTAL DEPTH (feet): 26	MEASURING POINT: Ground Surface
DRILLING METHOD:	4-inch diameter auger	DEPTH TO FREE WATER FIRST ENCOUNTERED:	
SAMPLING METHOD:	See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:	
HAMMER WEIGHT: 140 lbs.	HAMMER DROP: 30 inches (Auto Hammer)	LOGGED BY: C. Johnson	

DEPTH (feet)	SAMPLES			MATERIAL DESCRIPTION	LABORATORY TESTS		
	Sample No.	Sample	Blows/ foot		Moisture Content (%)	Dry Density (pcf)	Other
1				CLAYEY SAND (SC) dark yellowish brown (10YR 3/4), dry, loose to medium dense, sand is fine, contains abundant rootlets, includes scattered coarse sand/fine gravel-sized clasts of friable red and yellowish brown sandstone [COLLUVIUM]			~3:30 PM start
2	1	⧗	10				S1 14.5"/18" PP at 2'= 2.0; >4.5; >4.5; 3.5 (tsf) PP at 2.5'= >4.5; 3.75; 2.5 (tsf)
3	2	▯	13	SANDSTONE dark yellowish brown (10YR 3/4), soft, friable, severely weathered, local rootlets, local weathered clay fractures(?), locally oxidized to strong brown, slightly silty [FRANCISCAN (KJf)]			S2 15.5"/18"
4							
5							S3 15"/18" PP at 5.5'= 3.25; >4.5 (tsf)
6	3	⧗	20				S4 16"/18"
7	4	▯	26	6.5': Rootlets grade out			
8							
9							
10	5	⧗	50				S5 5"/5" S6 12/11"
11	6	▯	73/11"				Switch to mud rotary
12				Continued on rock log			
13							
14							
15							
16							
17							

GT-1 (12/03)

PROJECT: Grady Ranch Development Marin County, California	**Log of Boring No. RW-1**
BORING LOCATION: Planned water tank	ELEVATION AND DATUM: 408
DRILLING CONTRACTOR: Taber Consultants	DATE STARTED: 8/5/2009 — DATE FINISHED: 8/5/2009
DRILLING EQUIPMENT: Track mounted CME-55	TOTAL DEPTH (feet): 26 — MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter rotary wash	DEPTH TO FREE WATER FIRST ENCOUNTERED:
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:
HAMMER WEIGHT: -- — HAMMER DROP: --	LOGGED BY: C. Johnson

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
											5" diameter casing driven to 5 feet
1											
2											
3											
4											
5											
6											
7											
8											
9											
10								Continued from soil log			
11	1	120	0	Cl	So	Fr	Se	SANDSTONE (continued) mostly dark yellowish brown (10YR 4/4) 11.5': Sand becomes fine to medium, increase in strength and hardness, includes local black shaley coarse sand		Jo,70,Fi,clay-lined Jo,40,Op,Pl,Sl Jo 55,Op,Pl Jo,70,Fi,Pl,Clay-lined	Run 1: 11-11.5' 4:16-4:18 PM Run 2: 11.5-16.5' 4:32-4:26 PM
12											
13										Jo 20, Op,Pl,Sl, Mg-ox stained	
14	2	82	8	Cl	Lo	We	Mo-Se			Jo(Ve?),55,Fi,clay 0.1" thick Jo, 30, Op, Pl, Sm, Mg-ox staine	
15											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HA RDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHE RING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Ste pped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-2

Geomatrix Consultants

RT-1 (3/03)

GEES-ROCK 3/03 GRADY_ROCK_LOGS.GPJ GES32003-7.GDT 8/18/09

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-1 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
	2							SANDSTONE (cont.)			
16				NR	NR	NR	NR		N/R		
17										Jo 30 Fi Pl clay-lined	Run 3: 16.5-21.5' 4:31-4:37 PM
18										Jo 30, Op Pl Sm Jo 20,Op Pl	
19	3	84	0	Cl-VC	Lo	We	Mo-Se			Jo 40 op Pl Be,30	
20								19.5': Becomes mostly olive brown (2.5Y 4/4)		Jo,65,op,Pl,Sm, Mg-ox Jo,5,op Pl Mg-ox	
21				NR	NR	NR	NR		N/R		
22										Me Jo,40,Op,Pl,Sm	Run 4: 21.5-26' 4:39-4:44 PM
23										Jo,40,op,Pl,Sm,Mg-ox Staine Jo 50 op Pl. Jo 30 Op Pl	
24	4	84	0	Cl-VC	Lo	We	Mo-Se				
25										Jo 60 op Pl Sm Jo 65. Op Pl Mg-ox staine	
				NR	NR	NR	NR		N/R		
26								Bottom of boring 26.0'			
27											
28											
29											
30											
31											
32											
33											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-2 Cont.

PROJECT: Grady Ranch Development Marin County, California	**Log of Boring No. RW-2**
BORING LOCATION: Building cut slope - West	ELEVATION AND DATUM: 324
DRILLING CONTRACTOR: Taber Consultants	DATE STARTED: 8/4/2009 — DATE FINISHED: 8/4/2009
DRILLING EQUIPMENT: Track mounted CME-55	TOTAL DEPTH (feet): 107.5 — MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter auger	DEPTH TO FREE WATER FIRST ENCOUNTERED:
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:
HAMMER WEIGHT: 140 lbs. — HAMMER DROP: 30 inches (Auto Hammer)	LOGGED BY: C. Johnson

DEPTH (feet)	SAMPLES			MATERIAL DESCRIPTION	LABORATORY TESTS		
	Sample No.	Sample	Blows/ foot		Moisture Content (%)	Dry Density (pcf)	Other
1		⧗		CLAYEY SAND (SC) medium dense, olive brown (2.5Y 4/3), dry sand is fine to medium, fines have medium plasticity, trace gravel up to 3/4" max diameter [COLLUVIUM]			7:29 start S1 15.5"/18"
2	1	⧗	64	SHALE very dark gray (2.5Y 3/1), crushed, low hardness, weak, moderately weathered, locally oxidized along fractures, local clay films on fracture surfaces [FRANCISCAN (KJf)]			S2 6"/11"
3	2	▯	81/11"				
4							
5	3	⧗	94/9"	5': Locally severely weathered and friable; interbedded with dark gray, friable to weak, fine-grained sandstone			S3 5"/9" S4 0"/3" some fragments collected
6	4	▯	50*/3"	Continued on rock log			
7							Switch to mud rotary 8:00 AM
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							

PROJECT: Grady Ranch Development Marin County, California	**Log of Boring No. RW-2**
BORING LOCATION: Building cut slope - West	ELEVATION AND DATUM: 324
DRILLING CONTRACTOR: Taber Consultants	DATE STARTED: 8/4/2009 — DATE FINISHED: 8/4/2009
DRILLING EQUIPMENT: Track mounted CME-55	TOTAL DEPTH (feet): 107.5 — MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter rotary wash	DEPTH TO FREE WATER FIRST ENCOUNTERED:
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:
HAMMER WEIGHT: -- — HAMMER DROP: --	LOGGED BY: C. Johnson

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
0–6								Continued from soil log		
6	1	100	0	Cl	Lo	Mo	Mo	SANDSTONE dark olive gray (5Y 3/2), local clay-lined fractures, slightly oxidized fracture surfaces, includes local blocks/blebs of shale up to 1.5" long [FRANCISCAN (KJf)]	Jo, 50, Op, Pl, Mo Jo, 30, Op, Pl, Sl Jo 50, Fi, Pl, Sl, clay-lined Jo, 40, Fi, Pl, Sl, Mg-OX	Run 1: 6-7.5' 8:19-8:24 AM
7.5	2	96	20						Jo, 50, Fi, Pl-Ir, Mo, Mg-ox Jo, 30, Fi, Pl, clay-lined Jo, 50, Fi, Pl, clay-lined Jo, 50, Fi, Pl, Sl, clay & Mg-OX Me	Run 2: 7.5-12.5' 8:31-8:38 AM
9.5				VC-Cl	So/Lo	We		INTERBEDDED SANDSTONE & SHALE black (5Y 2.5/2) to very dark grayish brown (10YR 3/2), very closely spaced fractures, moderately weathered, sandstone is fine to very fine grained, generally low hardness and weak, shale is generally friable to weak and in beds up to 6" thick, may be slightly sheared [FRANCISCAN (KJf)]	Be, 45, ss/sh contact Be, 40, Pl Jo, 50, Fi, Pl, Clay-lined	
12.4				NR	NR	NR	NR			
12.5–15	3	94	34	VC	Lo	We	Mo	12.5-17.2': Primarily sandstone, mostly crushed	Jo, 35, Fi, Pl, Clay-lined >Be, 40, V. fine ss. Jo, 10, Fi, Pl, clay — vein	Run 3: 12.5-17.5' 8:43-8:50 AM

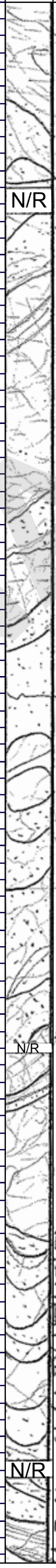
FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 14648.000

Figure A2-3

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-2 cont.



DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
16 17	3	94	34	VC	Lo	We	Mo	INTERBEDDED SANDSTONE and SHALE (cont.)		~ block ss Jo 55 op, Pl, Sm/Po Jo 35 op, Pl, Sm	
				NR	NR	NR	NR		N/R		
18 19 20	4	100	24		Lo So	We Fr		18-20.9': Primarily shale, includes local blocks (beds?) of very fine black sandstone up to 1/4" across		Jo, 60, Op, Pl, Sm Be, 70, ss/sh contact Be(?), 50 Be(?), 45, sh/ss contact	Run 4: 17.5-20.9' 8:54-8:59 AM
21 22	5	100	0							Be(?), 80, sh/ss contact	Run 5: 20.9-22.5' 9:03-9:06 AM
23 24 25 26 27	6	98	52	VC	Lo	We	Sl	22.4-24': Sandstone, includes local medium sand beds 24-24.5': Very fine-grained sandstone and shale 24.5-27.5': Mostly sandstone with interbeds of shale up to 1" thick, grain size of sand increases with depth		Be, 70, med ss/fine ss Me Be, 60, SH bed 1/4" thick Jo, 50, Pl Be, 50, Be, 50; Jo, 45, Op, Pl Jo, 40, Op, Pl-Ir Be, 30, sh bed 0.1" thick Be, 45, ss/sh contact	Run 6: 22.5-27.5' 9:08-9:14 AM
				NR	NR	NR	NR		N/R		
28 29 30 31 32	7	96	0	VC	So Lo	Fr We	Sl	27.5-29.5': Mostly shale, includes local sandstone beds up to 1" thick 29.5-32.3': Mostly sandstone, sand is very fine, includes 0.6' thick low hardness, weak shale bed		Be, 50 Be, 50, ss bed 1" thick Be, 60, sh/ss contact Be, 60, Jo 50 op Pl Sm Jo 50 Op Pl Sm Jo 60 Op Pl, Sm Be 50, ss/sh contact Jo, 50, Op, Pl Jo, 50, Fi, Pl, qtz/calcite	Run 7: 27.5-32.5' 9:34-9:38 AM
				NR	NR	NR	NR		N/R		
33								32.8-35.4': Mostly shale with local sandstone beds		> Be, 25, sh bed 1" thick Be, 50, ss/sh contact Jo, 45, Op, Pl, Sm	Run 8: 32.5-37.5' 10:20-10:30 AM

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HA RDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHE RING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wav y), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
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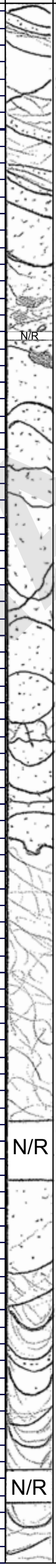
Figure A2-3 Cont.

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-2 cont.



DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
34								INTERBEDDED SANDSTONE and SHALE (cont.)		Jo,30,Op.Pl Be,45, ss bed 1" thick	
35	8	98	24	VC-Cl	Lo-So	We-Fr	Sl			Be,40, ss bed 0.1" thick Jo 50,Op Be 40, ss bed 0.1" thick - ss bed 40°, 1" thick	
36										- ss bed Be,45,sh bed 1" thick Jo,45,Op,Pl,Sm Jo,50,Op,Pl,Sl	
37				NR	NR	NR	NR		N/R	sh nodules	
38								37.5-42.5': Fine-grained, dark gray sandstone			Run 9: 37.5-42.5' 10:36-10:39 AM
39										Jo 65, Fi, Pl, Sm, clay-lined. Be, 50, grain-size variation Me Jo 50, Op, Pl-Ir,	
40	9	100	56	Mo	Lo-Mo	We-Mo				Jo 60, Op, Pl, Sm	
41										Be, 60, grain-size variation	
42							Fr			Ve, 40 calcite Jo, 40, Op Pl Sm Me Ve, 60, Fi, qtz/calcite	
43										Jo, 40, Fi, Pl, qtz/calcite Jo, 25 Op Pl Sm Jo, 20 Op Pl Sm-Sl ss/sh contact	Run 10: 42.5-47.5' 10:42-10:51 AM
44								43.5-46.8': Shale, generally crushed			
45	10	86	36	VC	So-Lo	Fr-We					
46											
47				NR	NR	NR	NR		N/R		
48				Wi	Mo	Mo		47.5-48.5': Sandstone			Run 11: 47.5-51.3' 10:58-11:09 AM
49	11	89	29	VC-Cl	So-Lo	Fr-We	Fr	48.5-50.9': Shale, includes very thin sandstone beds (<0.1" thick) and beds 1.2" thick		Be, 55, ss/sh contact Jo, 40, Op, Pl, Sm Be, 70 Be, 65, ss bed 1.2" thick	
50										Jo 50 Op Pl Sm Jo 40, Op Pl Be 70	
51				NR	NR	NR	NR		N/R		
52	12	83	83	VC	Lo	We	Fr	51.3': Shale		Be, 60, ss bed ½" thick Jo, 40, Op, Pl, Sm	Run 12: 51.3-52.5'

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HA RDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHE RING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wav y), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-3 Cont.

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-2 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
	12			NR	NR	NR	NR	INTERBEDDED SANDSTONE and SHALE (cont.)	N/R		11:22-11:27 AM
53				VC	So	Fr-We		52.5-53.3': Crushed shale		Me	Run 13: 52.5-57.5' 11:30-11:38 AM
54								53.5-57.5': Sandstone, sand is very fine to 56.4' then sand becomes mostly fine and lighter gray			
55	13	100	58	Cl	Lo	We-Mo				Jo,50,Op,Pl,Sm-Sl	
56										Jo 45 Fi, Pl, Sm, qtz/calcite Jo 50, Op, Pl, Sm Be 60	
57							Fr			Be 55 Jo 40, Fi, Pl, Sl, qtz/calcite	
58								57.5-62': Shale with very thin interbeds of fine sandstone throughout, dipping at ~50°		Be, 50, ss/sh contact	Run 14: 57.5-62.5' 11:44 AM-12:02 PM
59											
60	14	90	0	VC-Cl	So-Lo	Fr-We				Jo 40 Op Pl Sm Jo 40 Op Pl Sm	
61										Be 50, ss bed 1" thick	
62				NR	NR	NR	NR		N/R		
63				Cl	Lo	We		62.5-66.5': Shale as above, shale contains minor amounts of very fine sand to 63.8'		Jo 45, Op, Ir, Ro Me	Run 15: 62.5-67.5' 12:08 PM Start
64				VC	So	Fr					
65	15	80	20	Cl	Lo-Mo	We	Fr			Jo 40, Op, Ir, Sl Be, 40, ss bed 1/4" thick Jo 45 Op, Pl, Sm Be 50 ss bed 1" thick Jo 40, Op Pl Sm	
66										Jo 40, Op, Pl, Sm-Sl	
67				NR	NR	NR	NR		N/R		
68					So	Fr		67.5-67.9': Shale as above 67.9-69.8': Fine-grained gray sandstone, includes local blebs of quartz		Be, Ir, Sh/ss contact ~Qtz	Run 16: 67.5-72.5' 12:26-12:36 PM
69	16	98	76	VC	Lo	We-Mo	Fr			Bc, 50	
70								69.8-72.4': Shale, includes some very fine sand		Be 50, ss/sh contacts Me	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-3 Cont.

PROJECT: Grady Ranch Development
Marin County, California

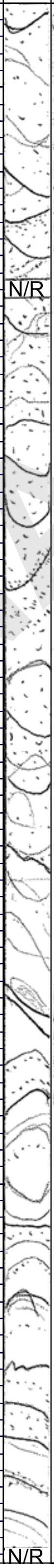
Log of Boring No. RW-2 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
71 72	16	98	76	VC	Lo	We-Mo	Fr	INTERBEDDED SANDSTONE and SHALE (cont.)		Jo 45, Op Pl, Ro Be, 60, ss bed ½" thick	
				NR	NR	NR	NR		N/R		
73 74 75 76 77	17	94	20	VC-Cl	Lo-So	Mo-Fr	Fr	72.6-77.2': Shale with very fine sand, local green sandstone beds		Jo 55, Op, Pl, Po Be 60, ss bed 1" thick Jo 40 Op Pl Po Be, 50 ss bed ¼" thick Jo 50, Op Pl	Run 17: 72.5-77.5' 12:40-12:58 PM
				NR	NR	NR	NR		N/R		
78 79 80 81 82	18	100	0	VC-Cl	Lo-So	Mo-Fr	Fr	77.5-82.5': Shale as above		Jo, 50, Op, Pl – qtz blebs	Run 18: 77.5-82.5' 1:40-1:52 PM
83 84 85 86 87	19	100	32					82.5-84.5': Very fine-grained sandstone 84.5-87.5': Shale with minor fine sand		Me Jo 60, Op. Pl, Sm Ve 40, Fi, qtz/calcite Jo, 60, Op, Pl, Po	Run 19: 82.5-87.5' 1:56-2:08 PM
88	20	96	72	Cl	Lo	Mo		87.5-92.5': Sandstone, very fine-grained		Me? Jo 60 Op Pl Sm Jo 60 Fi Pl qtz/calci	Run 20: 87.5-92.5' 2:14-2:25 PM

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-2 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
								INTERBEDDED SANDSTONE and SHALE (cont.)		Jo 30 op Pl Sm	
90											
	20	96	72	Cl	Lo	Mo	Fr				
91										Jo 30 Fi qtz/calcite Be 40	
92										Jo 50 Fi qtz/calcite	
				NR	NR	NR	NR		N/R		
								92.5-99.2': Sandstone, very fine-grained, local quartz/calcite veins			Run 21: 92.5-97.5' 2:28-2:39 PM
93										Jo 30 Fi qtz/calcite	
94										Me	
95	21	100	66							Jo 60 Fi qt/calcite Jo 60 Fi qtz/calcite Be 70	
96											
97										Jo 30 Fi qtz/calcite	
											Run 22: 97.5-102.5' 2:46-2:59 PM
98										Jo 65 Op Pl Sm Jo 50, Op Pl Sm	
99										Be(?), Ir, ss/sh contact	
								99.2-107.5': Mostly shale, includes abundant thin (0.1" thick and less) sandstone interbeds, local smooth to polished fracture surfaces dipping at ~50°			
100	22	100	44	Cl	Lo	Mo	Fr				
101										Be 40 friable ^ bed 3/4" thick	
102										Jo 50 Op Pl Sl	
											Run 23: 102.5-107.5' 3:05-3:21 PM
103										Me	
104										Be 40 Be 40 ss bed 1/2" thick	
105	23	96	70							me	
106										> Be 20, ss bed 0.4' thic	
107										Be 35° ss bed 3/4" thick	
				NR	NR	NR	NR		N/R		

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HA RDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHE RING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wav y), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-3 Cont.

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-3

BORING LOCATION: Building cut slope - North

ELEVATION AND DATUM: 314

DRILLING CONTRACTOR: Taber Consultants

DATE STARTED: 8/5/2009

DATE FINISHED: 8/5/2009

DRILLING EQUIPMENT: Track mounted CME-55

TOTAL DEPTH (feet): 97

MEASURING POINT: Ground Surface

DRILLING METHOD: 4-inch diameter auger

DEPTH TO FREE WATER FIRST ENCOUNTERED:

SAMPLING METHOD: See Boring Log Explanation, Figure A2-1

DEPTH TO FREE WATER AT COMPLETION:

HAMMER WEIGHT: 140 lbs.

HAMMER DROP: 30 inches (Auto Hammer)

LOGGED BY: C. Johnson

DEPTH (feet)	SAMPLES			MATERIAL DESCRIPTION	LABORATORY TESTS		
	Sample No.	Sample	Blows/ foot		Moisture Content (%)	Dry Density (pcf)	Other
1				SILTY SAND (SM) medium dense, dark brown (10YR 3/3), dry, sand is fine, includes abundant roots and rootlets [COLLUVIUM]			7:23 AM start S1 16"/18" recovered
2	1	⧗	30	CLAYEY SAND (SC) medium dense, dark yellowish brown (10YR 4/6), dry to slightly moist, sand fine to medium, fines have medium plasticity, includes local rootlets and abundant degraded sandstone gravels that are dark yellowish brown to dark red and up to 1" max. diameter [COLLUVIUM]			S2 17"/18" PP at 4'=>4.5 (tsf)
3	2	▯	20				
4							
5				5': Includes local light gray clayey pockets 1"-2" thick			S3 16"/18"
6	3	⧗	61				S4 18"/18"
7	4	▯	38	6.0': Increase in dark red degraded friable sandstone, becomes yellowish red (5YR 4/6), rootlets grade out, becomes dense 6.5': Abundantly mottled strong brown, yellowish red, and light grayish brown			
8							
9							
10				10': Fines content increases, becomes moist and mostly dark brown (7.5YR 3/4), includes local moderately hard very fine sandstone clasts in fragments up to 1/2" max. diameter			S5 15"/18" PP at 11.5'=>4.5 (tsf)
11	5	⧗	57				S6 18"/18"
12	6	▯	36				
13							
14							
15				15': Fines content decreases slightly relative to above, includes local friable shale clasts up to 1/2" max. diameter			S7 14.5"/18" PP at 16.5=>4.5 (tsf)
16	7	⧗	70				S8 18"/18"
17	8	▯	28				

PROJECT: Grady Ranch Development
Marin County, California

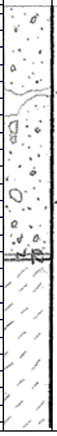
Log of Boring No. RW-3 cont.

DEPTH (feet)	SAMPLES: Sample No.	Sample	Blows/ foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	Dry Density (pcf)	Other
	8			CLAYEY SAND (SC) (cont.)			
18							
19							
20				20': Increase in dark yellowish brown, friable sandstone gravels up to 2" max diameter			S9 15"/18" PP at 21.4=>4.5 (tsf)
21	9		89/10.5"				S10 18"/18"
				21.4': Becomes medium dense			
22	10		28				
23							
24							
25				25': Includes fine-grained sandstone gravels up to 1.5" max diameter that are subangular, weak, and covered with dark brown clay films			S11 14.5"/18"
26	11		77				S12 0"/18"
	12		50*/4"	26.5': No recoverey, slough material includes dark yellowish brown, friable sandstone and clayey sand similar to above			
27							
28							28.5' Driller noted that the drilling became gradually harder and got drilling refusal with auger at 28.5'
29				Continued on rock log			
30							9:00 AM switch to mud rotary and HQ coring
31							
32							
33							
34							
35							
36							
37							
38							
39							

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-3

BORING LOCATION: Building cut slope - North
ELEVATION AND DATUM: 314
DRILLING CONTRACTOR: Taber Consultants
DATE STARTED: 8/5/2009
DATE FINISHED: 8/5/2009
DRILLING EQUIPMENT: Track mounted CME-55
TOTAL DEPTH (feet): 97
MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter rotary wash
DEPTH TO FREE WATER FIRST ENCOUNTERED:
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1
DEPTH TO FREE WATER AT COMPLETION:
HAMMER WEIGHT: --
HAMMER DROP: --
LOGGED BY: C. Johnson

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
19											
20											
21											
22											
23											
24											
25											
26											
27											
28									Continued from soil log			
29									CLAYEY SAND (SC) (continued) sand is fine to coarse, mostly fine to medium		More clayey, gray zone	Run 1: 28.5-31.5' 9:45-9:48 AM 29' PP: >4.5 (tsf)
30	1	97		NA	NA	NA	NA			Quartzose gravels	
31				NR	NR	NR	NR		NR		
32								31.5-33.5': SANDY CLAY (CL), dark yellowish brown (10YR 3/4) to grayish brown (2.5Y 5/2), fines have medium plasticity			Run 2: 31.5-36.5' 10:20-10:25 AM
	2	92		NA	NA	NA	NA			CL	
33											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HA RDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHE RING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Ste pped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

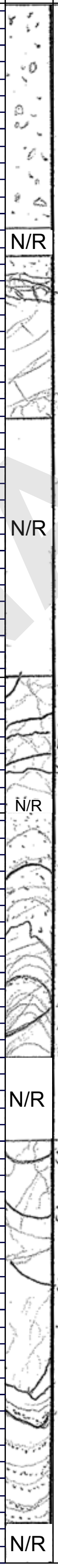
Project No.
14648.000

Figure A2-4

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-3 cont.



DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
34 35 36	2	92		NA	NA	NA	NA	CLAYEY SAND (SC) (cont.)			
				NR	NR	NR	NR		N/R		
37 38	3	38		NA	NA	NA	NA	36.9-38.4: Metamorphic boulder (?), crushed, polished, clay-lined fractures dipping 30°, local oxidized staining on fracture surfaces, shoe contains dark red sandstone clast and clay			Run 3: 36.5-41.5' 10:31-10:43 AM Driller noted no major changes in drilling
39 40 41				NR	NR	NR	NR		N/R		
42	4	94	0	VC	So/ Lo	We- Mo	Sl	SHALE (META MUDSTONE?) very dark gray (2.5Y 3/1), crushed, soft to low hardness, weak to moderate strength, slightly weathered [FRANCISCAN (KJf)]		Jo, 60, Op, Pl, Sm Jo Me 30 Fi, Pl-Ir, clay-lined Jo Me 40 Fi Pl clay-lined	Run 4: 41.5-43.1' 10:55-11:01 AM
43				NR	NR	NR	NR		N/R		
44	5	74	23	VC	Lo	We	Sl	INTERBEDDED SANDSTONE and SHALE very dark greenish gray (10GY 3/) to black (10YR 2/1), variable bed thickness, mostly crushed to closely spaced fractures 43.1-44.6': Sandstone/greenstone?		Be, 50	Run 5: 43.1-47' 11:06-11:19 AM
45					So	Fr		44.6-46': Shale		Be, 50, Ir, ss/sh contact Be, 60, ss bed 0.1" thick Jo, 50, Op, Pl, Sm	
46				NR	NR	NR	NR		N/R		
47 48 49 50 51	6	90	30	VC- Cl	So- Lo	Fr	Sl	47-53.4': Shale; includes scattered anastamosing quartz/calcite veinlets throughout, increase in sand and fine sandstone interbeds with depth		Jo 70 Op Pl Sm Jo, 45, Op, Pl, Sm Jo 65 Fi Pl clay-lined Me (?) Be 50, ss bed 1/4" thick	Run 6: 47-52' 11:23-11:33 AM
52				NR	NR	NR	NR		N/R		

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
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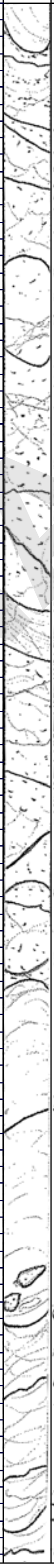
Figure A2-4 Cont.

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-3 cont.



DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
52-53	7	100	16	VC-Cl	Lo	We	Sl-Fr	INTERBEDDED SANDSTONE and SHALE (cont.)	Be 70, ss bed ½" thick Me	Run 7: 52-57' 11:38-11:39 AM and 11:51-11:58 AM
53						Mo		53.4-63.7': Sandstone, very dark gray (N 3/), abundant quartz/calcite veinlets throughout	Be, 55°, sh/ss contact	
54									Jo 50 Fi qtz/calcite Jo, 45 Fi, clay-lined	
55									Jo, 40 Fi qtz/calcite	
56									Jo, 65, Op, Pl, Sl	
57	8	100	42	Cl			Fr		Me	Run 8: 57-62' 12:02-12:09 PM
58									Vc 70, qtz/calcite ~1mm thic	
59					So	Fr			Be, 50, Ir Be, 55, Pl	
60					Lo	Mo				
61									Jo 40 Op Pl Sm Jo 30 op Pl Sl	
62	9	100	22						Jo 50 Fi Pl qtz/calc. Me	Run 9: 62-67' 12:12-12:21 PM
63				VC	So	Fr		63.7-72': Shale, local quartz/calcite nodules and veinlets	Jo 55, Op Pl Sm Be, 70, ss/sh contact	
64									Jo 50, Op Pl Sl	
65										
66										
67	10	96	44					67-69.5': Shale has local sandstone includsions up to 2" in diameter	>ss inclusions Jo, 40, Op, Pl-Wa, Po	Run 10: 67-72' 12:29-12:40 PM
68									Jo, 40, Op, Ir, Sm	
69					Lo	We		69.5-71.8': Shale includes some very fine sand, becomes slightly harder and stronger	Me(?) Be(?) Jo 60, Op Pl Sm	
70									Me	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HA RDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHE RING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wav y), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-4 Cont.

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-3 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
71	10	96	44					INTERBEDDED SANDSTONE and SHALE (cont.)	Me	
72				NR	NR	NR	NR			Run 11: 72-77' 12:55-1:02 PM
				VC	Lo	We-Fr				
73								72.5-82': Sandstone	Be,45. sh/ss contact	
74									Me	
	11	100	70							
75										
76									Me	
									Jo,25,Op,Pl, Sl	
77										Run 12: 77-82' 1:10-1:17 PM
78									Jo 40,Op Pl Sl Jo (Me?),10,op,Pl,Ro	
79									Jo60, Op. Pl, Sl	
	12	100	44	Cl-Wi	Mo	Mo	Fr		Jo,15,Fi qtz/calcite	
80										
81									Jo 60,Fi, clay-lined Jo,40,op,Pl-Ir,Ro —qtz/calcite inclusion	
82								82-90': Sandstone, includes quartz or calcite veins up to 1/2" thick		Run 13: 82-87' 1:22-1:28 PM
83									Jo 30 Op Pl, Ro	
84										
	13	96	78						Ve 55 qtz/calcite 1/2" thi	
85									Jo 25,Op Pl Sl	
									Jo 70,	
86									Ve 50 qtz/calcite Jo 40 Op, Pl,Sl	
87				NR	NR	NR	NR			Run 14: 87-92' 1:59-2:07 PM
88	14	94	8	Cl-VC	Mo	Mo	Fr		Jo,15,Op,Pl,Sm	
89									Jo 55, op Pl Sm	

GRAPHIC LOG

RT-2 (3/03)

GEES-ROCK 3/03 GRADY_ROCK_LOGS.GPJ GES32003-7.GDT 8/18/09

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-4 Cont.

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-3 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
	14	94	8	Cl-VC			Fr	INTERBEDDED SANDSTONE and SHALE (cont.)			
90					So-Lo	Fr-We		90-91.7': Shale		Be 45, ss/sh contact	
91										Jo,35,op,Pl,Ro	
				NR	NR	NR	NR		N/R		
92	15	100	0	Cl	Mo	Mo	Fr	92-93.2': Fine-grained sandstone			Run 15: 92-97' 2:10-2:19 PM
93				VC	So	Fr		93.2-97': Shale, abundant polished fracture or bedding surfaces			
94										Jo 70 op,Ir,	
95											
96											
97								Bottom of boring 97.0'			
98											
99											
100											
101											
102											
103											
104											
105											
106											
107											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-4 Cont.

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-4

BORING LOCATION: Proposed wine cave - East
ELEVATION AND DATUM: 304
DRILLING CONTRACTOR: Taber Consultants
DATE STARTED: 8/3/2009
DATE FINISHED: 8/3/2009
DRILLING EQUIPMENT: Track mounted CME-55
TOTAL DEPTH (feet): 92.5
MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter auger
DEPTH TO FREE WATER FIRST ENCOUNTERED:
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1
DEPTH TO FREE WATER AT COMPLETION:
HAMMER WEIGHT: 140 lbs.
HAMMER DROP: 30 inches (Auto Hammer)
LOGGED BY: C. Johnson

DEPTH (feet)	SAMPLES Sample No.	Sample	Blows/ foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	Dry Density (pcf)	Other
				SILTY SAND (SM) medium dense, dark yellowish brown (10YR 3/4), dry to slightly moist, sand is fine to medium, includes abundant rootlets in upper 1' [COLLUVIUM]			
1							8:05 AM start S1 15"/18"
	1		13				
2				2': Becomes mostly strong brown (7.5YR 4/6), includes local severely weathered sandstone clasts up to 1/2" max. diameter, includes abundant decomposing rootlets and local charcoal bits			S2 18"/18"
3	2		17				
4							
5				5': Locally mottled with dark yellowish brown, becomes very dense			S3 14.5"/18"
6	3		56	SANDSTONE yellowish brown (10YR 5/6), soft, friable, moderately to severely weathered, locally weathered to strong brown, local black oxidized fracture surfaces, slightly silty [FRANCISCAN (KJf)]			S4 19"/18"
7	4		56				
8							
9							
10	5		50* 1.5"				S5 0"/1.5" Switch to mud rotary at 8:50 AM
				Continued on rock log			
11							
12							
13							
14							
15							
16							
17							

GEES-SOIL 12/03 GRADY_SOIL_LOGS.GPJ GES32003-7.GDT 8/18/09

GT-1 (12/03)

PROJECT: Grady Ranch Development Marin County, California		**Log of Boring No. RW-4**	
BORING LOCATION:	Proposed wine cave - East	ELEVATION AND DATUM: 304	
DRILLING CONTRACTOR:	Taber Consultants	DATE STARTED: 8/3/2009	DATE FINISHED: 8/3/2009
DRILLING EQUIPMENT:	Track mounted CME-55	TOTAL DEPTH (feet): 92.5	MEASURING POINT: Ground Surface
DRILLING METHOD:	4-inch diameter rotary wash	DEPTH TO FREE WATER FIRST ENCOUNTERED:	
SAMPLING METHOD:	See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:	
HAMMER WEIGHT: --	HAMMER DROP: --	LOGGED BY: C. Johnson	

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
1											
2											
3											
4											
5											
6											
7											
8											
9											
10								Continued from soil log			
11	1	63	40	Mo	So-Lo	Fr-We	Mo	SANDSTONE yellowish brown (10YR 5/6), local clay-lined fractures, fracture surfaces oxidized to dark brown, sand is fine and mostly quartz [FRANCISCAN (KJf)]		Mc Jo, 30, Fi, Pl, Sl, clay-lined Jo, 50, Fi, Pl, Mo, Clay-lined Jo, 35, Fi, Pl, Sl, clay-lined.	Run 1: 10.1-12.5' 9:06-9:10 AM
12				NR	NR	NR	NR		N/R		
13	2	96	0	Cl	Lo-So	Fr	Mo			Jo, 35, Fi, Pl, Sl-Mo, Mg-ox Jo, 40, Fi, Pl, Sl, Mg-ox Jo, 80, Fi, Pl, Sm, Mg-ox Me Jo, 70, Op, Pl, Sm-Sl Jo, 65, Op, Ir, Sl-Ro. Jo, 45, Fi, Pl, Sm, Cla	Run 2: 12.5-17.5' 9:12-9:17 AM
14											
15											

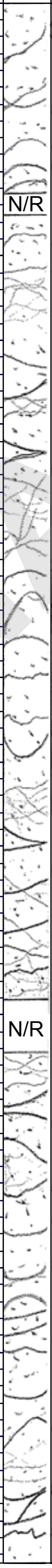
FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-5

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-4 cont.



DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
16 17	2	96	0	Cl	Lo-So	Fr	Mo	SANDSTONE (cont.)		Jo,65,Fi,Pl,Sl, Mg-ox Jo,55,Fi,Ir, Sl-Mo, Mg-ox Jo,40,Fi,Pl,Sm, Mg-ox Jo,60,Fi,Pl,Sm-Sl, Mg-ox Jo,50,Fi,Pl,Sm, Mg-ox Jo,45,Fi,Pl,Sm,Mg-ox	
				NR	NR	NR	NR		N/R		
18 19 20 21 22	3	100	0	Cl	Lo	Mo-We	Mo	18': Becomes olive gray (5Y 5/2), strength and hardness increase, includes local crushed zones up to 0.6' thick		Jo,50,Fi,Pl,Sm,Mg-ox Jo,10,Fi,Ir,Ro,Mg-ox Jo,40,Fi,Pl,Sm-Sl,Mg-ox Jo,50,Fi,Pl,Sl-Mo, clay-lined Jo,40,Fi,Pl,Sm, Mg-ox Jo,35,Fi,Pl,Sm,Mg-ox Jo,40,Fi,Pl-Wa,Sm-Sl,Mg-ox Jo,80,Fi,Pl,Sm,Mg-ox	Run 3: 17.5-22.5' 9:22-9:28 AM Driller noted bottom foot dropped from barrel; recovered in following run
23 24 25 26	4	100	0							Jo,35,Fi,Pl,Sm-Sl,Mg-ox Me Jo,Op,Ir, Mo Jo,50, Fi,Pl,Mo, 0.1" strong brown clay Jo,45,Fi,Pl,Sm,Mg-ox Jo,40,Fi,Pl,Sm,Mg-ox Jo,35,Fi,Pl,Sm,Mg-ok Jo,40,Fi,Pl,Sm,Mg-ox Me	Run 4: 22.5-26.5' 9:32-9:34 AM
27	5	40	0	NR	NR	NR	NR		N/R		Run 5: 26.5-27.5'
28 29	6	100	26	Cl	Lo	Mo-We	Mo			Jo,20,Fi,Pl,Sl, clay-filled Jo,30,Fi,Pl,Sl-Mo, clay Jo,40,Fi,Pl,Sm, Mg-ox Jo,55, Fi,Ir, Mo, clay	Run 6: 27.5-32.5' 10:15-10:22 AM
30 31 32					Mo	Mo-St	Mo-Sl	29.3': Becomes dark bluish gray (10B 4/), strength and hardness increase		Jo,20,Fi,Pl,Sl,Mg-ox Jo,45,Fi,Pl,Sm,Mg-ox Jo,50,Fi,Pl,Sm,Clay Jo,10,Fi,Pl,Sm Jo,20,Fi,Pl,Sm Me Jo,20,Fi,Pl,Mo Jo,20,Fi,Pl,Sm-Sl,Mg-ox	
33										Jo,30,Fi,Pl,Sl-Mo,clay/Mg-ox Ve,60,Fi,Pl,qtz/calcite 0.1" thi Jo,20,Op,Ir,Ro Me	Run 7: 32.5-37.5' 10:28-10:36 AM

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-5 Cont.

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-4 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
34				Cl	Mo	Mo-St	Mo-Sl	SANDSTONE (cont.)		Jo,50,Fi,Pl,Sl,clay-lined Me Jo,30,Fi,Pl-Ir,Mo clay	
35	7	46	20								
36				NR	NR	NR	NR		N/R		
37											
38											Run 8: 37.5-40' 10:41-10:48 AM Some gravel-sized fragments recovered; saved in bag
39	8	0	0	NR	NR	NR	NR		N/R		
40				Cl	Mo	St	Sl	40': Includes local blebs of quartz/calcite up to 1/2" long		Me	Run 9: 40-42.5' Core has been pushing inner barrel up; collected in bucket - up direction?
41	9	28	16	NR	NR	NR	NR		N/R		
42											
43								42.5': Becomes mostly dark bluish gray (10B 4/)		Jo,45,Fi,Pl,clay-lined Jo 30,Fi,Pl Jo 30,Pl Jo 25,Pl	Run 10: 42.5-47.5' 11:36-11:43 AM
44										Ve,60,Fi,Pl,Sl,Qtz/calcite Me	
45	10	100	64		Mo	St	Sl			Jo,50,Fi,Pl,Sl,clay	
46											
47				Mo						Jo,60,Op,Pl,Sl Jo,60,Op,Pl,Sm	
48								47.5': Grades stronger and harder		Jo,40.Op,Pl,Sm Jo,40,Op,Pl,Sl Ve,Ir,Qtz/calcite Jo,50,Op,Pl,Sl	Run 11: 47.5-52.5' 11:47 AM Start
49										Jo,40,Op,Pl,Ro	
50	11	100	96		Ha	St	Fr			Jo,80,Fi,Qtz/calcite Me	
51											
52											

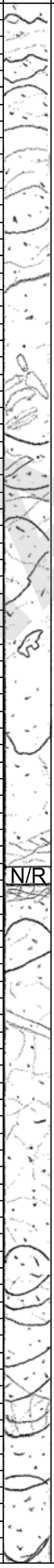
FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-5 Cont.

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-4 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
	11							SANDSTONE (cont.)		Me Me	
53										Be.40 Me	Run 12: 52.5-57.5' 12:06-12:12 PM
54											
55	12	100	90	Mo						ve,50,qtz/calcite Jo,30,op.Pl,Sl	
56										-qtz/calcite blebs	
57					Ha	Mo	Fr			Jo,60.op,Pl,Sl -qtz/calcite	
58										Me Jo,20,Ti,Pl Jo.40,Ti,Pl	Run 13: 57.5-62.5' 12:17-12:19 PM and 12:36-12:42 PM
59										ve,50,Fi,Ir-Pl,qtz/calcit -qtz/calcite blebs	
60	13	96	48	Mo-Cl							
61										Jo,80,Op,Pl-Ir,RO	
62											
				NR	NR	NR	NR		N/R		
63										ve,60,Fi,Pl,qtz/calcite Jo,50,Tp,Pl 1/4" thick	Run 14: 62.5-67.5' 12:48-12:55 PM
64										Ve?,45,He,Pl Ve?,45,He,Pl	
65	14	100	62	Cl-Wi							
66					Ha	Mo	Fr				
67										Jo,50,op,Pl,Sm Jo,55,Op,Pl,Sm Jo,45 Op,Pl,Sl Jo,60 Op.Pl Mo	
68										Jo 50,Op,Pl,Sm Jo.50 Op,Pl,Sl Jo,30 op,Pl,Sm	Run 15: 67.5-72.5' 1:09-1:16 PM
69	15	94	52	Cl-Mo				68.9': Medium-grained sand increases		Jo;30 Op.Pl,Sm Jo,50,op.Pl,Sl Me,	
70										Jo,60,op,Pl,Sl	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
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Figure A2-5 Cont.

Geomatrix Consultants

PROJECT:	Grady Ranch Development Marin County, California

Log of Boring No. RW-5

BORING LOCATION:	Planned fill mound	ELEVATION AND DATUM: 236	
DRILLING CONTRACTOR:	Taber Consultants	DATE STARTED: 8/6/2009	DATE FINISHED: 8/6/2009
DRILLING EQUIPMENT:	Track mounted CME-55	TOTAL DEPTH (feet): 50	MEASURING POINT: Ground Surface
DRILLING METHOD:	4-inch diameter auger	DEPTH TO FREE WATER FIRST ENCOUNTERED: 31.0 feet (9:00 AM 8/6/2009)	
SAMPLING METHOD:	See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:	
HAMMER WEIGHT: 140 lbs.	HAMMER DROP: 30 inches (Auto Hammer)	LOGGED BY: C. Johnson	

DEPTH (feet)	SAMPLES Sample No.	Sample	Blows/ foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	Dry Density (pcf)	Other
1 2	1		12	SAND with Silt and Gravel (SP-SM) loose to medium dense, very dark grayish brown (10YR 3/2), dry to slightly moist, sand fine to coarse, mostly fine, gravel is subangular to subrounded dark gray and brownish gray sandstone up to 2" max diameter, local rootlets [COLLUVIUM]			7:21 AM start S1 10"/18" PP at 2.5'=3.5; 2.0; 1.75; 3.75 (tsf) S2 8.5"/18"
3 4	2		12	2.5': Includes local shale gravels up to 1.2" max diameter, some sandstone oxidized to strong brown, rootlets grade out			
5 6	3		4	SILTY SAND (SM) loose, mostly dark brown (10YR 3/3), wet from driller adding water, sand fine to coarse, mostly fine to medium, some fine gravels that are rounded to subangular [ALLUVIUM]			Driller added some water to hole S3 11.5"/18" PP at 5'= 0.25; 0.5; <0.25; 0.5 (tsf) higher number of gravels
7 8	4		2				S4 11"/18" abundant fine gravels
9 10 11	5		11	SAND with Clay and Gravel (SW-SC) loose, brown (10YR 4/3), moist, sand is well-graded, gravel is fine and mostly subrounded to rounded sandstone and quartzose volcanic clasts up to 1.5" max diameter [ALLUVIUM]			S5 15.5"/18" PP at 11'=1.0; 1.0; 1.2 (tsf) S6 15"/18"
12 13 14	6		2	SILTY SAND (SM) loose, dark brown (10YR 3/3), moist, to slightly wet, sand is fine, some coarse sand and scattered fine gravel [ALLUVIUM]			
15	7		8	15': Fines content decreases			S7 15"/18" PP at 15.5'= 0.75; 1.0; 0.5; 1.25 (tsf) PP at 16.5'= 2.5; 2.5; 2.0; 3.0 (tsf) S8 13"/18"
16 17	8		12	SAND with Silt and Gravel (SP-SM) medium dense, dark brown (10YR 3/3), slightly wet, sand fine to coarse, mostly medium, gravel rounded to subangular up to 3/4" max diameter [ALLUVIUM]			

GT-1 (12/03)

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-5 cont.

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/ foot	MATERIAL DESCRIPTION		LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Other
	8			16.5': Coarse sand increases				
18								
19								
20				20': Abundant dark red, dark yellowish brown, and gray gravels, up to 1.5" max diameter				S9 15.5"/18" PP at 21'=4.0; 3.5; >4.5 (tsf)
21	9		19					S10 11"/18"
22	10		22	21.5': Includes chert gravel and sandstone gravel broken up by sampler to angular fragments up to 1.5" max diameter, becomes moist				
23								
24								
25								S11 14"/18" PP at 26.5'= >4.5; >4.5; 4.25; 3.0 (tsf) (gravels)
26	11		28					
27	12		22	26.5': Grades to dark yellowish brown (10YR 4/4)				
28								
29				CLAYEY SAND with Gravel (SC) medium dense, olive brown (2.5Y 4/4), moist to wet, sand is fine to coarse, mostly medium, gravel is subrounded to subangular sandstone, with minor chert, shale, and quartzose volcanic clasts up to 1.5" max diameter [ALLUVIUM]				
30								S13 14"/18" PP at 30.5'= >4.5 (tsf) (gravels)
31	13		19		ATD ▽			S14 13"/18"
32	14		24					
33								
34								
35				35':Includes abundant gravels, degraded dark yellowish brown sandstone clast 2" diameter, becomes dense				S15 16"/18" PP at 36.5'= >4.5 (tsf) (gravels)
36	15		98					S16 14.5"/18"
37	16		41					Driller noted harder drilling at 38.5'; refusal at 39.5'
38								
				SHALE				
39								

PROJECT: Grady Ranch Development
Marin County, California

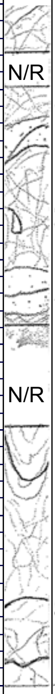
Log of Boring No. RW-5 cont.

DEPTH (feet)	SAMPLES Sample No.	 Sample	 Blows/foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	 Dry Density (pcf)	 Other
40	17	⧗	82/9"	SHALE dark olive gray (5Y 3/2) to black (5Y 2.5/1), crushed, soft, weak, moderately weathered, abundant polished bedding or fracture surfaces, sheared, contains nodules of more competent shale surrounded by more friable material, locally pale olive [FRANCISCAN (KJf)]			S17 14"/15" PP at 40.75'= >4.5 (tsf)
41	18	▯	76/11"				S18 15.5"/11" driller set sampler prior to counting blows
42				Continued on rock log			
43							
44							
45							
46							
47							
48							
49							
50							

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-5

BORING LOCATION: Planned fill mound	ELEVATION AND DATUM: 236
DRILLING CONTRACTOR: Taber Consultants	DATE STARTED: 8/6/2009 DATE FINISHED: 8/6/2009
DRILLING EQUIPMENT: Track mounted CME-55	TOTAL DEPTH (feet): 50 MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter rotary wash	DEPTH TO FREE WATER FIRST ENCOUNTERED: 31.0feet (9:00 AM 8/6/2009)
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:
HAMMER WEIGHT: -- HAMMER DROP: --	LOGGED BY: C. Johnson

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
38											
39											
40											
41											
42	1	60	0	VC	So	Fr	Se-Mo	SHALE (continued) crushed, soft, friable, moderately weathered, locally interbedded with sandstone			Run 1: 42-43' 10:15-10:19 AM
				NR	NR	NR	NR		N/R		
43	2	70	0	VC	So	Fr	Se-Mo	43.4': Includes dark gray, very fine sandstone bed 6" thick		Jo 60, Op, Pl -Jo, 40. ss/sh contact	Run 2: 43-47' 10:26-10:33 AM
44										-altered, chloritized nodule	
45								45.2': Includes greenstone(?) bed or inclusion 0.4' thick		Jo 30, Op, Pl.	
46				NR	NR	NR	NR		N/R		
47	3	100	0	VC	So	Fr	Se-Mo	47-47.8': Shear zone(?), slickensides perpendicular to shear plane, waxy green chloritized shale or serpentinite		Sh, 70, Pl, Po	Run 3: 47-50' 10:37-10:42 AM
48											
49					Lo	We				Jo? 50, Ir, Ro Mc	
50								Bottom of boring 50.0'			
51											
52											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
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Figure A2-6

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-6(P)

BORING LOCATION: Road realignment

ELEVATION AND DATUM: 232

DRILLING CONTRACTOR: Taber Consultants

DATE STARTED: 8/6/2009

DATE FINISHED: 8/6/2009

DRILLING EQUIPMENT: Track mounted CME-55

TOTAL DEPTH (feet): 52

MEASURING POINT: Ground Surface

DRILLING METHOD: 4-inch diameter auger

DEPTH TO FREE WATER FIRST ENCOUNTERED:

SAMPLING METHOD: See Boring Log Explanation, Figure A2-1

DEPTH TO FREE WATER AT COMPLETION:

HAMMER WEIGHT: 140 lbs.

HAMMER DROP: 30 inches (Auto Hammer)

LOGGED BY: C. Johnson

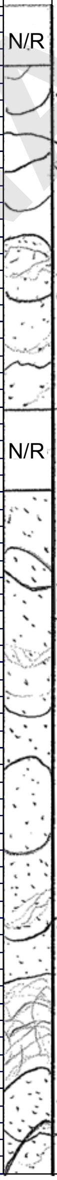
DEPTH (feet)	SAMPLES			MATERIAL DESCRIPTION	LABORATORY TESTS		
	Sample No.	Sample	Blows/ foot		Moisture Content (%)	Dry Density (pcf)	Other
1				SILTY SAND (SM) loose, dark yellowish brown (10YR 4/4), dry, sand is fine to coarse, includes local subrounded gravel up to 1" max. diameter, coarse sand is rounded [ALLUVIUM]			11:50 AM start no liners sample bagged S1 13"/18" PP at 2.5= 1; <0.25; <0.25 (tsf) (sample crumbling) S2: 12"/18"
2	1		15				
3	2		2				
4							
5				CLAYEY SAND (SC) loose, very dark grayish brown (10YR 3/2), moist to wet, sand is fine, fines have medium plasticity and medium toughness, scattered gravels up to 1/2" max. diameter [ALLUVIUM]			S3: 14"/18" PP at 6'= 0.75; 1; 1 (tsf)
6	3		2				S4: 13"/18" sample pushed 18"
7	4		0				
8							
9							
10				10': Local red and strong brown, friable sandstone up to ~1/4" diameter			S5: 11"/18" PP at 11'= 0.25; <0.25; 0.5; 0.5 (tsf)
11	5		6				S6: 18"/18"
12	6		3	11.5': Sand is mostly very fine, fines content increases			
13							
14							
15				CLAYEY SAND with Gravel (SC) medium dense, dark brown (10YR 3/3), moist to slightly wet, sand mostly fine to medium, gravel mostly subrounded to rounded, variably weathered sandstone up to 1.5" max. diameter [ALLUVIUM]			S7: 16.5"/18" PP at 15.5'= 1; 1.25; >4.5 (tsf) (gravels)
16	7		17				S8: 13"/18"
17	8		19				

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-6(P) cont.

DEPTH (feet)	SAMPLES Sample No.	SAMPLES Blows/ foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	LABORATORY TESTS Dry Density (pcf)	LABORATORY TESTS Other
18	8		CLAYEY SAND with Gravel (SC) (cont.)			
20						S9: 14.5"/18" PP at 21'= 1; 1; 0.5; 0.5 (tsf)
21	9	21	20': Fines content decreases slightly, medium to coarse sand content increases, becomes mostly dark yellowish brown (10YR 4/4)			S10: 18"/18"
22	10	15				
24			CLAYEY GRAVEL with Sand (GC) medium dense, dark yellowish brown (10YR 4/4), wet, gravel is rounded to subrounded sandstone and shale clasts up to 1" max. diameter [ALLUVIUM]			
25						S11: 15.5"/18" PP at 26'= >4.5 (tsf) (gravels)
26	11	20				S12: 18"/18"
27	12	10	CLAYEY SAND (SC) medium dense, dark yellowish brown (10YR 3/4), moist, sand is fine, includes medium plasticity clay bed/layer 27.2-27.8' [ALLUVIUM]			
30			30': Increase in coarse sand includes rounded gravel up to 1.5" diameter			S13: 18"/18" PP at 31.5'= 2.5; 2.5; 2; 2.25; 1.5 (tsf)
31	13	22	SANDY CLAY (CL) firm, dark yellowish brown (10YR 3/4), moist, sand is fine, fines have medium platicity and medium to high toughness, includes local black organic flecks, locally mottled with strong brown [ALLUVIUM]			S14: 18"/18"
32	14	8				
34			SANDSTONE dark olive gray (5Y 3.2), moderately hard, moderately strong, dark oxide-staining on fracture surfaces [FRANCISCAN (KJf)]			
35	15	62/11"				S15: 7"/11"
36	16	50*/4"				S16= 4"/4"
37			Continued on rock log			
39						

PROJECT: Grady Ranch Development Marin County, California	**Log of Boring No. RW-6(P)**
BORING LOCATION: Road realignment	ELEVATION AND DATUM: 232
DRILLING CONTRACTOR: Taber Consultants	DATE STARTED: 8/6/2009 DATE FINISHED: 8/6/2009
DRILLING EQUIPMENT: Track mounted CME-55	TOTAL DEPTH (feet): 52 MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter rotary wash	DEPTH TO FREE WATER FIRST ENCOUNTERED:
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1	DEPTH TO FREE WATER AT COMPLETION:
HAMMER WEIGHT: -- HAMMER DROP: --	LOGGED BY: C. Johnson



DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
36								Continued from soil log			
	1	0	0	NR	NR	NR	NR	INTERBEDDED SANDSTONE and SHALE shale is generally black, crushed, soft to low hardness and friable to weak, locally beds are softer/harder; sandstone is dark gray (N 4/), with closely spaced fractures, low hardness, and weak to moderately strong [FRANCISCAN (KJf)]	N/R		Run 1: 36.3-37' 1:50-1:52 PM
37 38	2	82	50	VC	So-Lo	Fr-We	Fr	37-39.1': Shale with abundant very thin (~0.1" thick) sandstone interbeds, cross-bedding locally		Jo 70 Op Pl Sl Bc(?) 40 Jo 25 Fi, clay-lined Be, 50, cross-bedding 40°bed	Run 2: 37-42' 1:55-2:04 PM
39 40 41				Cl	Lo	We-Mo		39.1-41.1': Sandstone, includes abundant quartz/calcite veinlets		Be? 40 Sh/ss contact Jo 55, Op, Pl-Ir, Sl Me	
				NR	NR	NR	NR		N/R		
42 43 44 45 46	3	100	74	Cl-Mo	Lo	Mo	Fr	42-47.8': Dark greenish gray sandstone		Ve, 40, qtz/calcite Jo, 40, Fi, Pl-Ir, Ro, qtz-line Jo, 70, Op, Pl, Ro Jo, 45, Op, Pl, Sl Jo, 50, Fi, thin shale bed, polished	Run 3: 42-47' 2:08-2:13 PM
47	4	100	0							Be 40, shale bed 1/2" thick Be? Ir, Sh/sh contact	Run 4: 47-52' 2:16-2:21 PM
48				VC	So	Fr		47.8-49': Friable, soft shale		Be 50, sh/ss contact	
49 50				Cl-Mo	Lo	Mo				Me Be 55	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HA RDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHE RING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Ste pped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A2-7

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-6(P) cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
51	4	100	0	Cl-Mo	Lo	Mo	Fr	INTERBEDDED SANDSTONE and SHALE (cont.)		Jo 70 op Pl Sl	
52								Bottom of boring 52.0'			
53											
54											
55											
56											
57											
58											
59											
60											
61											
62											
63											
64											
65											
66											
67											
68											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-7 Cont.

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-7

BORING LOCATION: Lucas Valley Road (shoulder)

ELEVATION AND DATUM: 236

DRILLING CONTRACTOR: Taber Consultants

DATE STARTED: 8/7/2009

DATE FINISHED: 8/7/2009

DRILLING EQUIPMENT: Track mounted CME-55

TOTAL DEPTH (feet): 52.5

MEASURING POINT: Ground Surface

DRILLING METHOD: 4-inch diameter auger

DEPTH TO FREE WATER FIRST ENCOUNTERED:

SAMPLING METHOD: See Boring Log Explanation, Figure A2-1

DEPTH TO FREE WATER AT COMPLETION:

HAMMER WEIGHT: 140 lbs.

HAMMER DROP: 30 inches (Auto Hammer)

LOGGED BY: C. Johnson

DEPTH (feet)	SAMPLES			MATERIAL DESCRIPTION	LABORATORY TESTS		
	Sample No.	Sample	Blows/ foot		Moisture Content (%)	Dry Density (pcf)	Other
				GRAVEL ROAD FILL			
1							7:49 AM start driller noted "crunchy gravel" down to 1.5'
2	1		33	SILTY SAND (SM) medium dense, dark brown (10YR 3/3), dry to slightly moist local rootlets and degraded sandstone gravels up to 2" max diameter, sand is mostly fine [FILL?]			S1: 14.5"/18" PP at 2.5'= >4.5 (tsf) S2: 12"/18"
3							
4	2		15				
5				5.0': Gravel content increases, includes some rounded sandstone clasts up to ~1/2" max diameter, may be colluvium?			S3: 6"/18" PP at 6'= >4.5 (tsf) (gravels)
6	3		8				S4: 4"/18"
7	4		19	6.5': Increasing dark yellowish brown, severely weathered sandstone clasts/fragments			
8							
9				SANDSTONE? No recovery [FRANCISCAN (KJf)]			
10	5		50* 1.25"				S5: 0"/1.25" switch to mud rotary 8:12 AM
11				Continued on rock log			
12							
13							
14							
15							
16							
17							

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-7

BORING LOCATION: Lucas Valley Road (shoulder)

ELEVATION AND DATUM:
236

DRILLING CONTRACTOR: Taber Consultants

DATE STARTED:
8/7/2009

DATE FINISHED:
8/7/2009

DRILLING EQUIPMENT: Track mounted CME-55

TOTAL DEPTH (feet):
52.5

MEASURING POINT:
Ground Surface

DRILLING METHOD: 4-inch diameter rotary wash

DEPTH TO FREE WATER FIRST ENCOUNTERED:

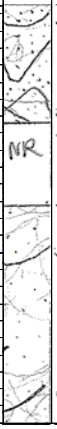
SAMPLING METHOD: See Boring Log Explanation, Figure A2-1

DEPTH TO FREE WATER AT COMPLETION:

HAMMER WEIGHT: --

HAMMER DROP: --

LOGGED BY:
C. Johnson

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
1 2 3 4 5 6 7 8 9 10								Continued from soil log			
11	1	58	0	Cl	Lo	Fr-We	Se-Mo	SANDSTONE olive brown (2.5Y 4/4), intensely fractured, Mg-oxide stained fractures abundant, sand is mostly fine [FRANCISCAN (KJf)]		Jo 40, Op Pl Sl Jo 80 Fi, Pl, Sl, Mg-OX Jo 75 Fi Pl Sm Mg-OX Jo 50 Fi Pl Sm Mg-OX	Run 1: 10.1-12.5' 8:29-8:33 AM
12				NR	NR	NR	NR				
13 14 15	2	64	0	VC	So-Lo	Fr-We	Se	12.5-15.4': Variably weathered, includes 1/4" diameter root and soft, clayey, mottled zone surrounding it, locally oxidized to strong brown		Jo 70, Fi Pl, Sm, Mg-OX -1/4" diam. root Jo 75 Op Pl Sm.	Run 2: 12.5-17' 8:39-8:44 AM

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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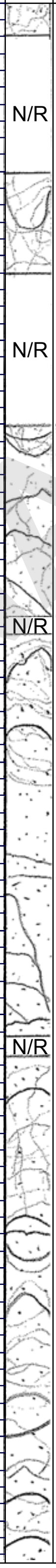
Figure A2-8

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-7 cont.



DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
				VC	So	Fr	Se	SANDSTONE (cont.)			
16	2	64	0	NR	NR	NR	NR		N/R		
17				VC	Lo	We	Se-Mo	17-18.2': Sandstone, generally crushed and pulverized by coring		Jo 85, Fi, Pl, clay-lined	Run 3: 17-20' 8:49-8:56 AM
18	3	40	0								
19				NR	NR	NR	NR		N/R		
20								20': Sandstone becomes slightly harder and stronger than above		Jo 80 Op Pl Sm Jo 50 Fi clay-lined	Run 4: 20-22.5' 8:59-9:05 AM
21	4	92	16	Cl	Lo	We	Mo			Me, 25 Jo, 55 Op, Pl-Ir, Sl, Mg-ox	
22										Jo 70, Op, Pl, Sm, Mg-ox	
				NR	NR	NR	NR		N/R		
23										Jo 70, Fi, Clay-lined	Run 5: 22.5-27.5' 9:09-9:15 AM
24										Jo, 50, Fi, clay-lined	
25	5	96	14	Cl	Lo	We	Mo			Jo 25 Op Pl Ro Jo 25 Op Pl Ro	
26											
27										Me	
				NR	NR	NR	NR		N/R		
28								27.5': Grades to dark greenish gray (10Y 4/), less weathered, becomes slightly stronger		Jo 40 Op Pl Sl	Run 6: 27.5-32.5' 9:19-9:26 AM
29										Jo 50 Fi clay-lined Jo 30 Op, Ir, Ro Be, 35, 2" thick bed v. fine	
30	6	100	58	Cl	Lo	We	Sl			Jo, 70, Fi, clay-lined	
31											
32										Jo 30 Op Pl Sm Mg-ox Jo 25 Op Pl Sm	
33										Jo 40, Ti, Pl, Ro Jo, 30, Op Pl Sl	Run 7: 32.5-37.5' 9:56-10:01 AM Driller noted total fluid loss starting at ~32.5'

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-8 Cont.

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-7 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
34								SANDSTONE (cont.)	Jo 65 op Pl-Ir, Ro	
35	7	96	10	Cl	Lo	We-Mo	Sl			
36									Jo 60, Fi clay-lined Jo 75, Op Pl Sl Jo 65, Op Pl Sm Jo 65 Fi clay-lined	
37				NR	NR	NR	NR	37': Grades to dark greenish gray (10BG 4/)	Jo 50 Op Pl Sl	
38									Jo 70 Op Pl Sl Jo 45 op Pl Sl	Run 8: 37.5-42.5' 10:06-10:12 AM 10:20 AM: Driller has inner barrel stuck in casing rods; has to pull all out to retrieve
39										
40	8	96	18	Cl	Mo	Mo	Fr		Jo 50 Op Ir Sl	
41									Jo 40 Op Ir-Pl Sl Me	
42				NR	NR	NR	NR			
43								42.5-44.9': Sandstone is locally interbedded with black, friable shale beds up to 4" thick	Jo 70 Fi clay-lined Be 30 shale bed 3/4" th	Run 9: 42.5-45.4' 10:44-10:49 AM
44	9	83	21	Cl	Mo	Mo	Fr		Jo 70 Op Pl Ro Be 40 ss/sh contact	
45				NR	NR	NR	NR			
46	10	100	62		Mo-Lo	Mo-Fr		45.4-47.3': Includes abundant shale interbeds up to 3" thick	Be 80 3" thick SH bed Jo 50 op Pl Sm-Po	Run 10: 45.4-47.5' 10:53-10:59 AM
47					Lo	Fr		47.3-47.6': Shale, abundant polishes fracture/bedding surfaces	Be 30 ss/sh contact Jo 25 Op Pl Sm/Po	Run 11: 47.5-52.5' 11:03-11:12 AM
48									>trapped shale frags Jo 40 op Pl Sm	
49				Cl-Mo			Fr			
50	11	100	56		Mo	Mo		50': Sand becomes very fine	Be 45, sh bed 2" thick Be 30 SH bed 4" thick Jo 40 Op Pl Ro	
51									Be 30 soft shale bed 1" thic	
52									Jo 35 op Pl Sm	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me- Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

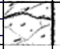
Project No.
14648.000

Figure A2-8 Cont.

Geomatrix Consultants

PROJECT: Grady Ranch Development
Marin County, California

Log of Boring No. RW-7 cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
	11							SANDSTONE (cont.)		Mc	
								Bottom of boring 52.5'			
53											
54											
55											
56											
57											
58											
59											
60											
61											
62											
63											
64											
65											
66											
67											
68											
69											
70											

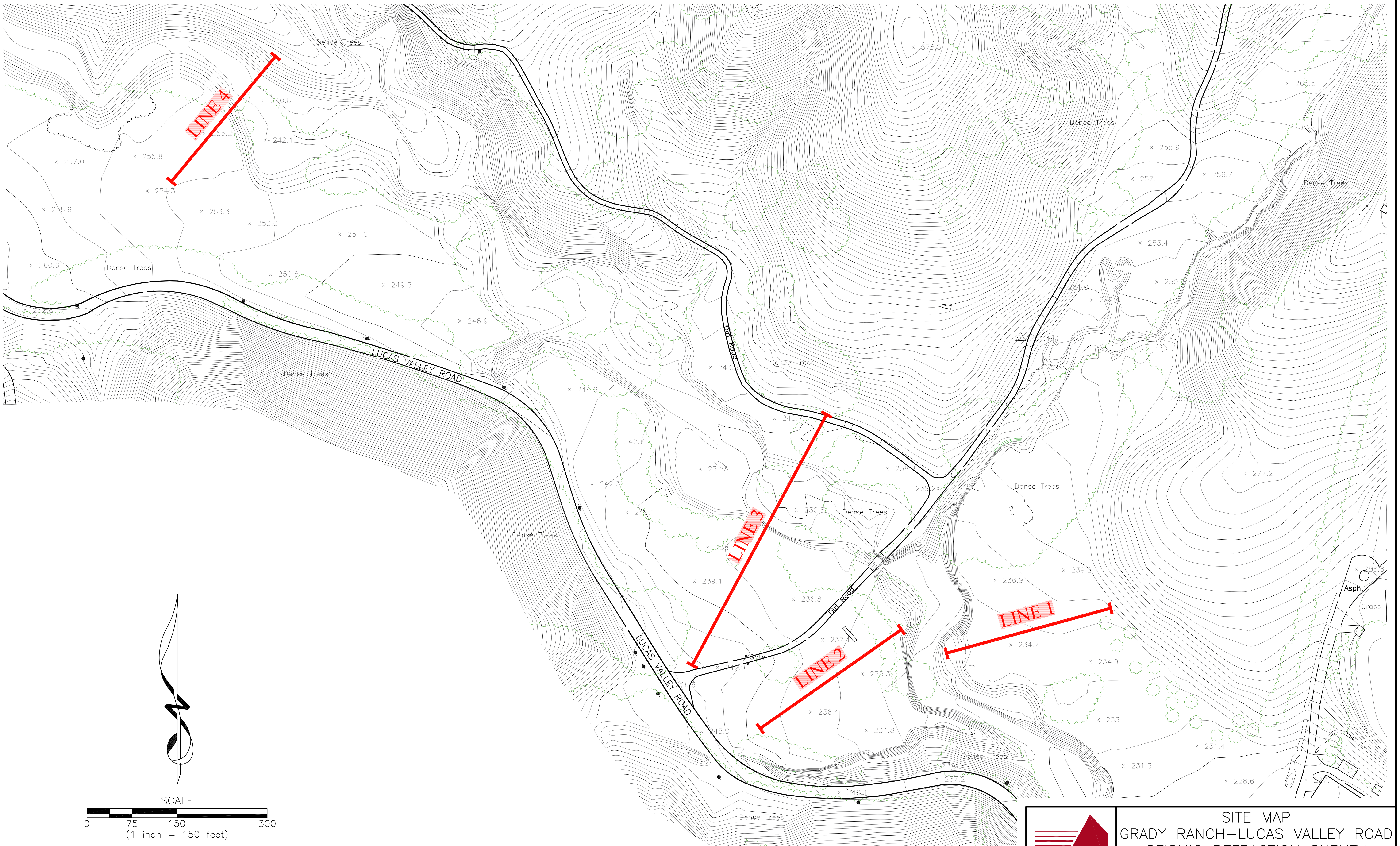
FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No.
14648.000

Figure A2-8 Cont.

APPENDIX H

Seismic refraction survey
(November 2009)



LEGEND

━	SEISMIC REFRACTION PROFILE

MAP REFERENCE: NORCAL, OCT. 2009, 09–325.55

NORCAL

JOB #: 09–732.02

DATE: NOV. 2009

SITE MAP
GRADY RANCH–LUCAS VALLEY ROAD
SEISMIC REFRACTION SURVEY

LOCATION: SAN RAFAEL, CALIFORNIA

CLIENT: BALANCE HYDRO

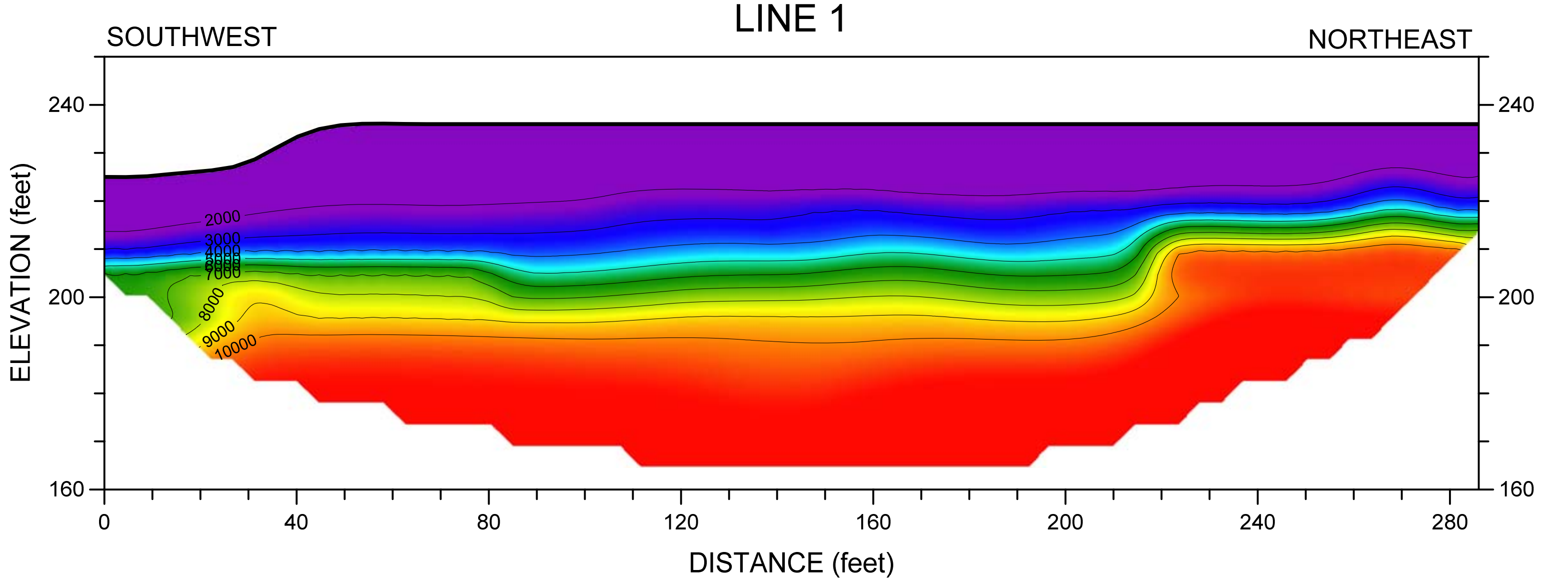
NORCAL GEOPHYSICAL CONSULTANTS INC.

DRAWN BY: G.RANDALL

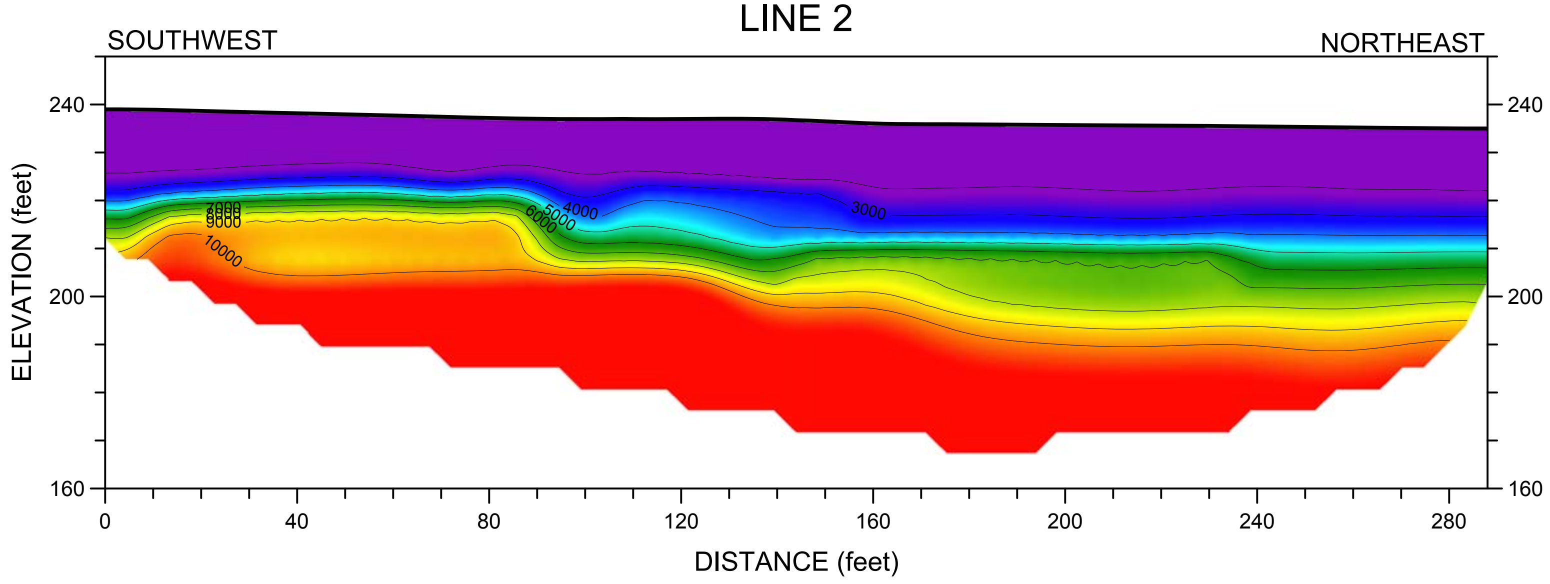
APPROVED BY: DTH

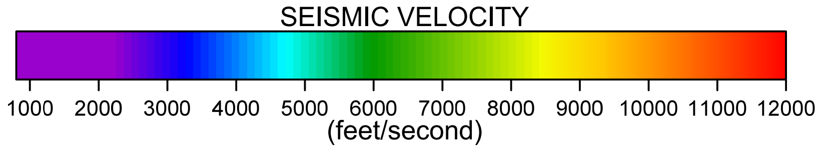
PLATE
1

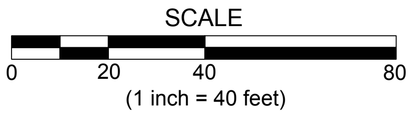
LINE 1



LINE 2







NORCAL

SEISMIC REFRACTION PROFILES
LINES 1 & 2
GRADY RANCH - LUCAS VALLEY ROAD

LOCATION: SAN RAFAEL, CALIFORNIA

CLIENT: BALANCE HYDRO

JOB #: 09-732.02

NORCAL GEOPHYSICAL CONSULTANTS INC.

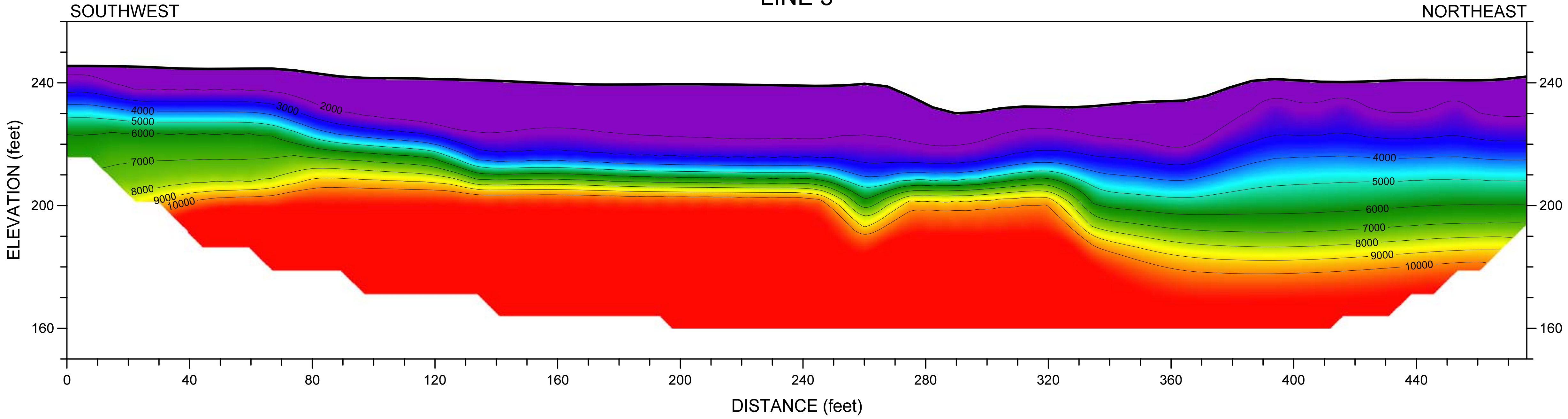
DATE: NOV. 2009

DRAWN BY: G.RANDALL

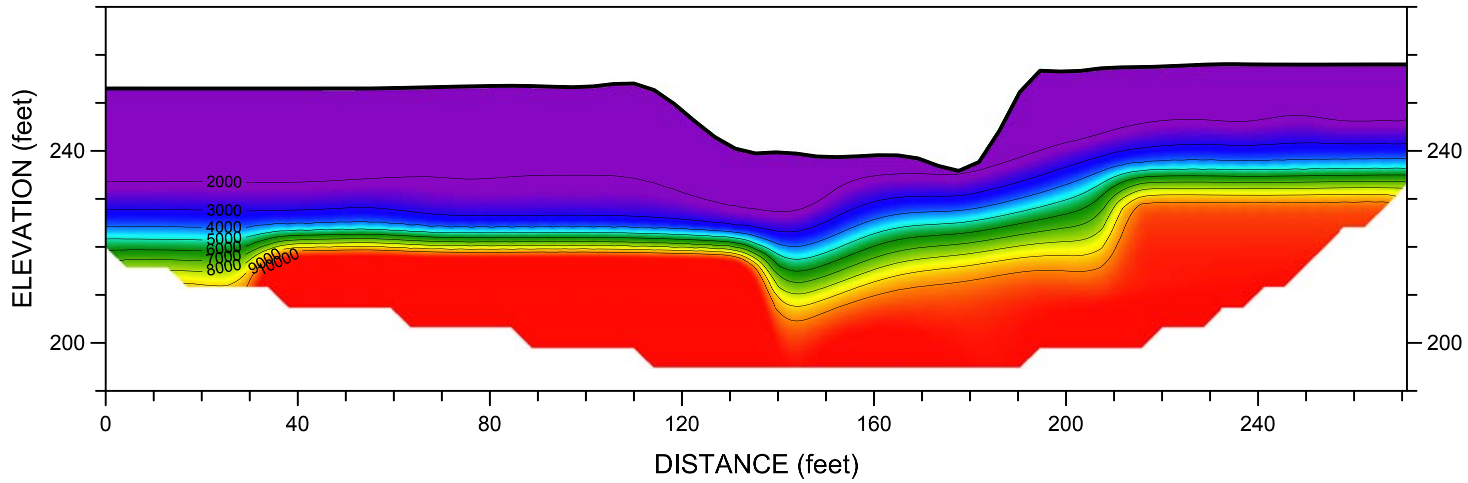
APPROVED BY: DTH

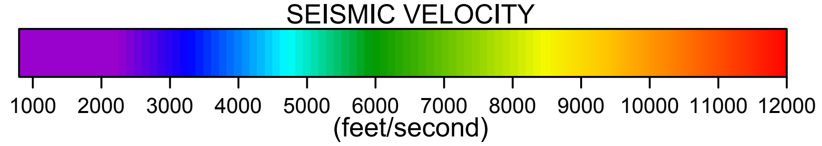
PLATE
2

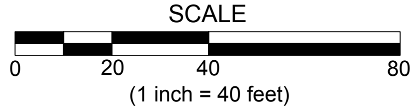
LINE 3



LINE 4







NORCAL

SEISMIC REFRACTION PROFILES
LINES 3 & 4
GRADY RANCH - LUCAS VALLEY ROAD

LOCATION: SAN RAFAEL, CALIFORNIA

CLIENT: BALANCE HYDRO

JOB #: 09-732.02

NORCAL GEOPHYSICAL CONSULTANTS INC.

DATE: NOV. 2009

DRAWN BY: G.RANDALL

APPROVED BY: DTH

PLATE
3

APPENDIX I

Electrical resistivity survey
(January 2010)

NORCAL GEOPHYSICAL CONSULTANTS, INC.

January 19, 2010

Mr. Gregg Grubin
CSW/ST2
45 Leveroni Court
Novato, CA 94949

Subject: Electrical Resistivity Survey
Grady Ranch Project, Marin County, CA
NORCAL Job # 09-732.03

Dear Mr. Grubin:

This letter presents the findings of an electrical resistivity (ER) survey performed by NORCAL Geophysical Consultants, Inc. at the Grady Ranch in Marin County, California. The survey was performed on December 29 and 30, 2009 by NORCAL California Professional Geophysicist Donald J. Kirker and Geophysical Technician Travis Black. Logistical support was provided by Lou Bouc of Lucasfilm Ltd. and Steve Korbay of Geokor.

1.0 SITE DESCRIPTION

The Grady Ranch Project is a proposed development located off of Lucas Valley Road northwest of San Rafael, CA. It is characterized by relatively steep hills covered with low grass and trees. The parcel is accessed by a gravel/dirt road that traverses the property along the east boundary. Outcropping rock is evident at various locations on the property. The local geology consists of Franciscan Complex bedrock overlain by Quaternary colluvium that includes stream deposits from Lucas Valley Creek. Past surveys in this area by NORCAL defined bedrock at depths of 20- to 35-ft. near the creek.

The ER survey was conducted along three lines, as determined by Lou Bouc and Steve Korbay. They are generally located across a wide drainage near the entrance to the property. These locations were selected due to the creek proximity and the possibility of water bearing stream deposits or deeper zones within the bedrock that may also be water-bearing. The locations of these lines, and the site topography, are shown on Plate 1. Surface elevations along these lines range from approximately 228 to over 290 feet above mean sea level (msl).

2.0 PURPOSE

The purpose of the ER survey is to measure variations in the electrical properties of the subsurface to aid in determining lithologic changes that may be related to relative permeability. We understand that this information will be used to aid in the placement of a water supply well.

3.0 FIELD INVESTIGATIONS

3.1 ELECTRICAL RESISTIVITY

The groundwater bearing potential for a given site can be dependent on inherent lithologic variations. These variations may be defined by characterizing the changes in specific electrical resistivity values both laterally and with depth. Generally, fine-grained low-permeable sedimentary deposits will exhibit low electrical resistivities, whereas coarser grained materials will have higher values and generally higher permeability. Therefore electrical resistivity surveys provide a means for defining increased permeability zones within a sedimentary section. Within a bedrock section, as the degree of weathering and fracturing increases, the electrical resistivity values will generally decrease. However, the actual rock lithology also influences the electrical resistivity values. Shear zones or lateral changes in rock characteristics may also manifest abrupt changes in resistivity. Therefore, characterizing the electrical properties both laterally and with depth can provide subsurface information that may be related to water-bearing potential both within the sedimentary and bedrock sections. Interpreted potential drill targets, however, are typically based on a qualitative assessment of the character and/or configuration of the modeled resistivity values, and not based on the detection of groundwater. Therefore there is no guarantee that water will be encountered, only that the chances of encountering water are increased due to the targeting of certain subsurface features.

For this investigation, we used the electrical resistivity (ER) method with the dipole-dipole electrode configuration. The dipole-dipole array consists of four electrodes that are placed in the ground in a collinear arrangement. One pair of adjacent electrodes is used to transmit electrical current into the earth. The second pair of electrodes is used to measure the resulting potential drop (voltage). This electrode configuration provides information on both the depth and lateral extent of subsurface electrical properties.

3.2 DATA ACQUISITION AND ANALYSIS

We obtained high resolution ER data along 3 profiles, as shown on Plate 1. They are designated as Lines 1 through 3 and are oriented either southwest to northeast or northwest to southeast. The dipole-dipole resistivity data were collected using an electrode spacing of 10-feet, resulting in total profile lengths of 550-ft. The positions of these lines were recorded using our hand-held portable Global Positioning System (GPS).

ER data were collected using a Supersting/Swift electrical resistivity system manufactured by Advanced Geoscience, Inc. (AGI) of Austin, Texas. This system was configured to collect ER data using an array of 56 stainless steel electrodes distributed in a collinear array. The electrodes were connected to the Swift switch-box by four multi-conductor cables with 14-connectors (take-outs) per cable. The Supersting was programmed to control the Swift switch-box to turn on and off specific electrodes (four at a time) while automatically collecting the ER data.

Upon completion of the ER survey, we downloaded the apparent resistivity data to a lap-top computer using the software ***AGI Administrator*** by Advanced Geoscience, Incorporated (AGI). We also used this software to convert the data to a format suitable for inversion. We then used the computer program ***EarthImager***, also by AGI, to invert the data and derive a model that provides an appropriate fit to the measured data. The computer program ***Surfer 9.0*** by Golden Software was then used to contour the calculated data, producing a 2-D model showing the variation of the electrical resistivity values both laterally and with depth. Further descriptions of the ER methodology, data acquisition, and analysis are provided in Appendix A.

4.0 RESULTS

The results of the ER survey are illustrated on Plates 1 through 3. Plate 1 is the Site Location Map showing the location of Lines 1 through 3, and the pertinent site features. Plates 2 and 3 contain model resistivity profiles showing variations of the electrical resistivity values both laterally and with depth along each line. The resistivity variations are manifested by contours and gradational color shading that represents specific resistivity values. A graduated scale relating resistivity to color is included at the bottom of each plate.

4.1 ELECTRICAL RESISTIVITY PROFILES AND INTERPRETATION

The resistivity profiles illustrate general variations in electrical resistivity to depths of about 110- to 115-ft below ground surface (bgs). The resistivities range from less than 5 ohm-m to over 700 ohm-m. Based on the distribution of values we have divided the resistivities into three ranges consisting of low, moderate, and high. Low resistivities range from 2- to 79-ohm meters and are represented by dark blue to light blue colors. Moderate resistivities range from 79- to 209-ohm meters and are represented by dark to light green colors. High resistivities range from 209- to over 700-ohm meters and are represented by yellow to red colors.

Specific resistivity values can be related to various soil types and bedrock conditions. Regarding soil types, low values (blue shading) are generally indicative of fine grained silts and clays. Moderate values (green shading) are typically indicative of poorly sorted sands with lesser fine grained materials. The highest resistivity values (yellow to red shading) are representative of coarse grained materials such as sands and gravels with minor amounts of fine grained materials.

The wide range of resistivity values along Lines 1 through 3 can also be manifested by variations in the character of bedrock. Rock formations that are deeply buried and not exposed to chemical weathering are generally impermeable, contain little water, and have a relatively high electrical resistivity. Conversely, highly weathered and fractured rock that contains moisture typically has a lower resistivity.

4.1.1 Alluvium and Bedrock Layering

Based on our review of this data and the general depth to bedrock as defined from our previous surveys in this area, we have made an interpretation of the electrical resistivity variations as they may relate to the alluvium and bedrock layers. This is shown as a hatched line and is referred to as 'Interpreted Bedrock Interface' on Plates 2 and 3.

The surface layer of alluvium varies in thickness from 10- to 33-ft and is generally thickest along Lines 1 and 2. It consists primarily of moderate and high resistivities with some isolated zones of low resistivity material. The high resistivity values (yellow to red) form small isolated zones at the northeast end of Line 1 and in the center of Lines 2 and 3. As mentioned above, these zones are indicative of coarse grained materials such as sand and gravel, and represent the most permeable material in the alluvium. The low resistivities (blue) throughout the center of Line 1 and at the northwest end of Line 3 are indicative of fine grained material and represent the least permeable material.

The bedrock is generally characterized by large alternating zones of moderate and low resistivity values. The moderate values (green) at the center of Line 1 and the northwest ends of Lines 2 and 3, probably represent more competent bedrock that is slightly weathered and/or fractured. The low resistivity bedrock (blue) may indicate an increase in the fracturing and moisture content of the bedrock.

4.1.2 Recommended Well Locations

Based on our interpretations of the character of the alluvium and bedrock, we have marked four areas as potential well locations. They are referred to as "Recommended Well Locations 1 through 4" on Plates 1 through 3. Location #1 is within the center of Line 1 and targets the thicker zone of alluvium and the underlying moderately high resistivity bedrock zone. Location #2 is at the southwest end of Line 1 and targets the very large zone of low resistivity values within the bedrock at a depth of 30- to 60-ft bgs. This zone may represent fractured rock that could be water bearing. Location #3 is located at a profile distance of 200 ft along Line 2 and targets both the shallow zone of higher resistivity alluvium and the underlying lateral bedrock change that may represent a variation in the bedrock weathering or fracturing characteristics. Location #4 is located at a profile distance of 245 ft along Line 3 and targets the zone of low resistivity values at a depth of 20- to 40-ft bgs. These values form a small zone in the shallow bedrock section that may represent a water bearing fracture zone. This location should be considered the lowest priority of the four recommended drill locations.

5.0 STANDARD OF CARE

The scope of NORCAL's services for this project consisted of using geophysical methods to characterize the subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the standard of care ordinarily exercised by members of the profession currently employing similar methods. No warranty, with respect to the performance of services or products delivered under this agreement, expressed or implied, is made by NORCAL.

We appreciate having the opportunity to provide you with this information.

Respectfully,

NORCAL Geophysical Consultants, Inc.

Donald J. Kirker

Donald J. Kirker
Geophysicist, PGp-997

DJK/tt

Enclosures: Plates 1 through 3

Appendix A

GEOPHYSICAL METHODOLOGY

Appendix A

ELECTRICAL RESISTIVITY SURVEYS

Rational

Electrical resistivity is the physical property of a material that resists the flow of electrical current. The electrical resistivity of earth materials is directly affected by moisture content and permeability. Typically, electrical resistivity decreases as permeability and moisture content increases. The resistivity of earth materials is also greatly affected by the concentration of dissolved salts or free ions in the saturating fluid. Generally, fine-grained materials such as clays have a lower electrical resistivity than coarse grained materials such as sands and gravels. The presence of fluids that have a high concentration of dissolved salts or free ions can significantly decrease the electrical resistivity of both fine and coarse-grained materials.

Electrical properties of rock can vary greatly depending upon degree of weathering and fracturing, as well as composition. Rock formations that are deeply buried and not exposed to chemical weathering are generally impermeable, contain little water, and have a relatively high electrical resistivity. Conversely, highly weathered and fractured rock that contains moisture typically has lower resistivity.

Based on the above relationships, geophysical methods that measure the electrical resistivity of the subsurface can be used to determine lateral changes due to possible faulting, the depth and/or lateral extent of possible water-bearing formations, and the depth to bedrock.

Methodology

The electrical resistivity of the subsurface is measured using a galvanic resistivity method. This consists of transmitting electrical current into the earth through a pair of grounded metal electrodes, and measuring the resulting potential drop across the second pair of grounded metal electrodes. There are a variety of electrode arrangements (arrays) that can be used. The dipole-dipole electrode configuration is typically used because it provides information on both the depth and lateral extent of subsurface electrical properties.

The dipole-dipole array consists of four electrodes that are placed in the ground in a collinear arrangement. One pair of adjacent electrodes is used to transmit current into the earth and is referred to as the current dipole. The second pair of electrodes is used to measure the resulting potential drop, and is referred to as the potential dipole. Both dipoles have the same length.

To begin a profile, a reading is taken with the dipoles separated by their common length. Subsequent readings are taken as the potential dipole is moved along the profile while the current dipole remains stationary. The separation between dipoles is always a multiple of the dipole length. As the separation between dipoles increases, so does the depth of investigation. Once the maximum separation is reached, the current dipole is moved along the profile one dipole length and the entire procedure is repeated.

For each reading, a value is calculated that represents the apparent resistivity of the volume of earth that the current flows through. The term, apparent, is used because the value represents the resistivity of a volume rather than an individual layer. The apparent resistivity values are then plotted in cross-section and contoured to form what is referred to as a "pseudo-section". The term "pseudo" is used because the vertical scale is not scalar but is proportional to the dipole separation. In addition, the resistivities are apparent rather than true. However, the pseudo-section can be inverted to generate a 2-D model showing the depth and true resistivity of subsurface layers.

Instrumentation

Apparent resistivity data is typically acquired using a SuperSting R1 Resistivity meter with the Swift automatic multi-electrode system. Both systems are manufactured by Advanced Geosciences Incorporated (AGI). The Sting is a self-contained unit that transmits current at outputs ranging from 1 to 500 milliamps (mA). The unit also measures the potential drop and converts the data to values of apparent resistivity for a number of electrode arrays. The data are stored in internal memory and can be downloaded to a computer for processing. The Swift consists of an electrode interface console, four cables, and 56 stainless steel electrodes. Each cable has 14 individual take-outs that can be connected to electrodes at intervals up to 10 meters (33 feet). Depending on the objective of the survey, the Swift can operate using 28 to 56 electrodes.

Data Acquisition

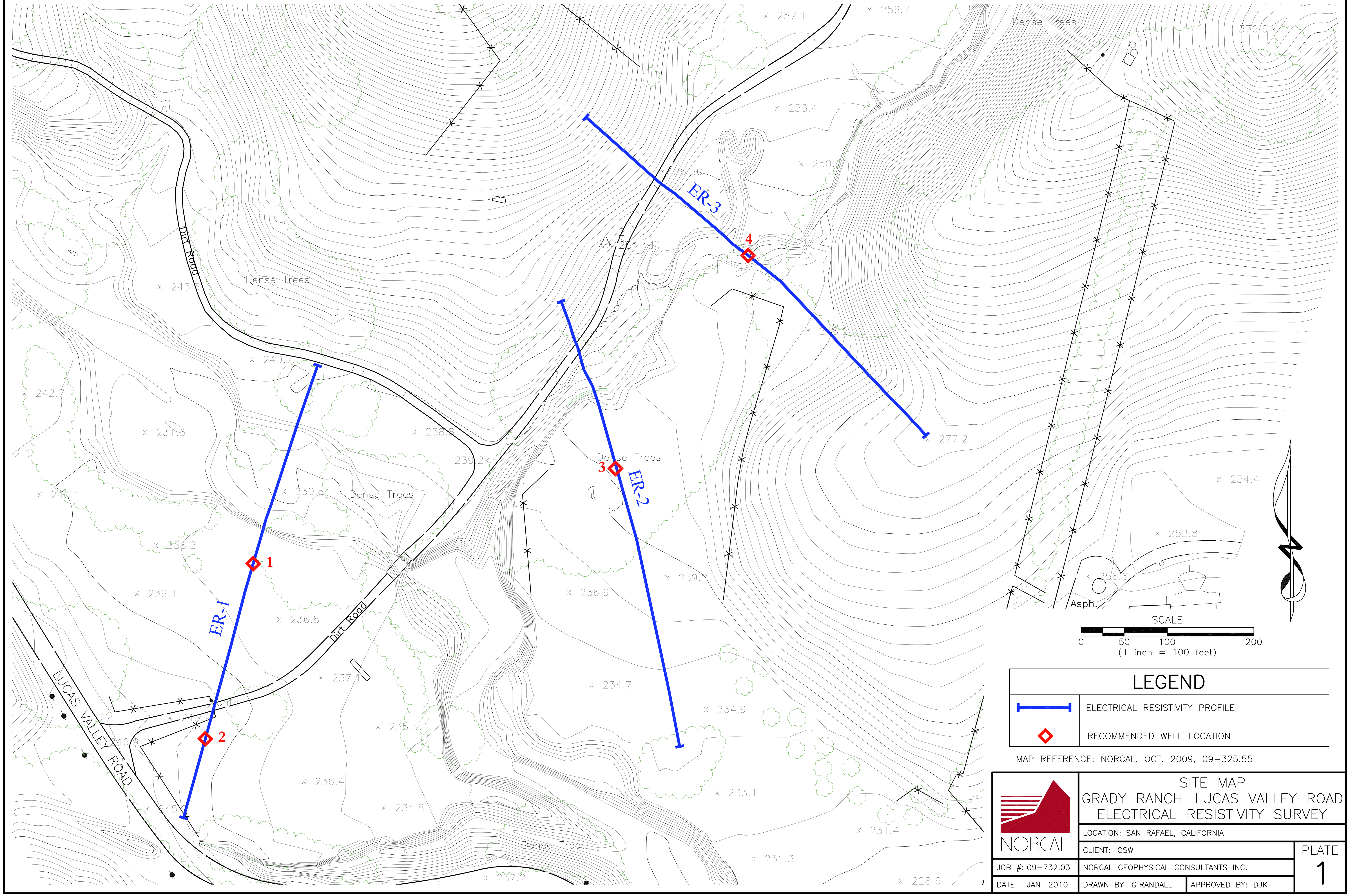
ER surveys using the Sting/Swift resistivity system are initiated by laying out the cables, end-to-end, along each profile. The Swift console is then connected between the two cables and to the Sting ER meter. At each take-out in the cable, stainless steel electrodes are driven into the ground and then fastened to the respective take-out. To begin the survey, the ER meter tests the contact resistance of each electrode. If any of the values are abnormally high, the electrode plant as well as the connection between the electrode and the switch is inspected, and if necessary, improved. The survey is begun once all of the electrode contacts tested satisfactory. To start out, readings are taken with the dipoles separated by their common length and moved along the length of the array. For example, if the length between two electrodes (referred to as a dipole) is 10 meters (33 feet), then the distance between the current and potential dipoles (two electrodes each) will also be 10 meters (33 feet). Since each of the switches are individually addressable by the Sting, the instrument is able to move this configuration down the array by turning the appropriate switches on and off, as necessary, to switch from one dipole to another. Subsequent readings are then taken by increasing the distance between dipoles, up to eight times the dipole separation, along the array. It then repeats the entire procedure using dipole lengths typically two to three times the length of the initial dipole. For example, if the initial dipole was 10 meters (33 feet), then the Sting/Swift system repeats the process using dipole lengths of 20 and 30 meters (66 and 98 feet).

Data Analysis

Upon completion of a dipole-dipole survey, apparent resistivity data are downloaded from the Sting to a lap-top computer using the program STINGDMP. The data are inverted to true resistivity versus depth and distance using the program EARTHIMAGER 2D. Both programs are written by AGI. The data generated by the EARTHIMAGER 2D program are then gridded and contoured using the computer program Surfer 9.0 by Golden Software to produce 2-D models.

Limitations

A common feature of all electrical methods is that the models derived from the electric profiling are not unique. That is, depending on the subsurface geo-electric structure, there may be many models that will produce essentially the same apparent resistivities. This is known as the *principal of equivalence*. To overcome this limitation, computer software programs include routines for evaluating the equivalence of a given model relative to the observed resistivity values, resulting in a model that provides the closest fit to the observed data.



SCALE

0 50 100 200

(1 inch = 100 feet)

LEGEND

━	ELECTRICAL RESISTIVITY PROFILE
◇	RECOMMENDED WELL LOCATION

MAP REFERENCE: NORCAL, OCT. 2009, 09-325.55

NORCAL

SITE MAP
GRADY RANCH–LUCAS VALLEY ROAD
ELECTRICAL RESISTIVITY SURVEY

LOCATION: SAN RAFAEL, CALIFORNIA

CLIENT: CSW

NORCAL GEOPHYSICAL CONSULTANTS INC.

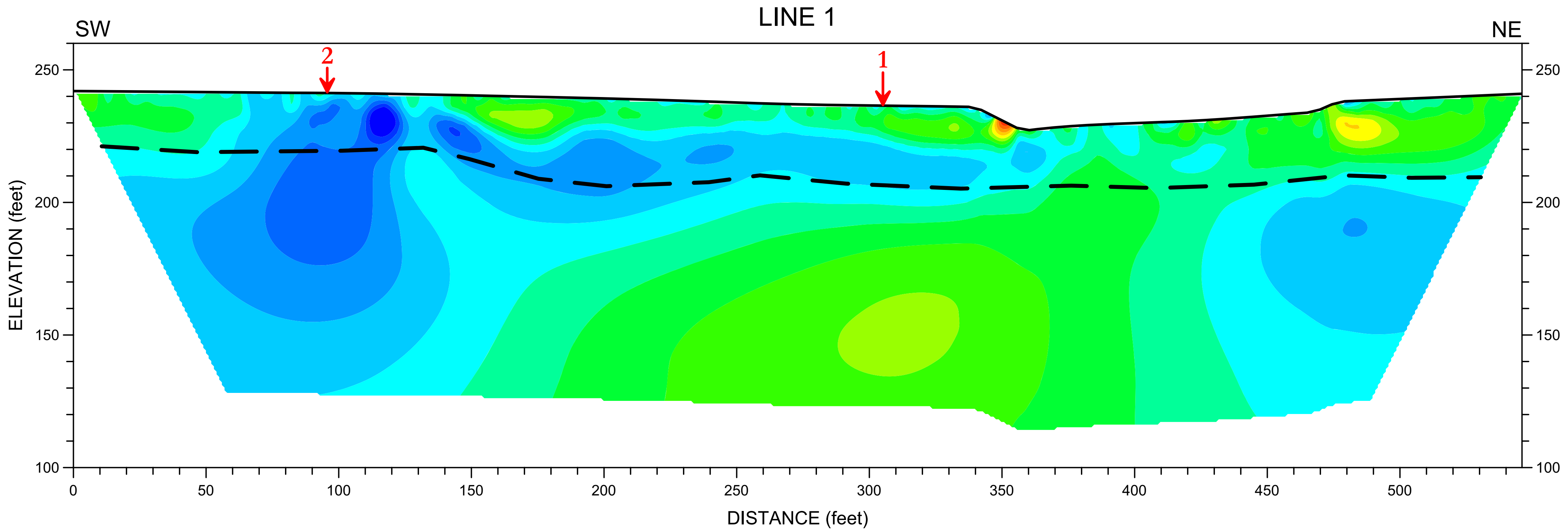
DRAWN BY: G.RANDALL

APPROVED BY: DJK

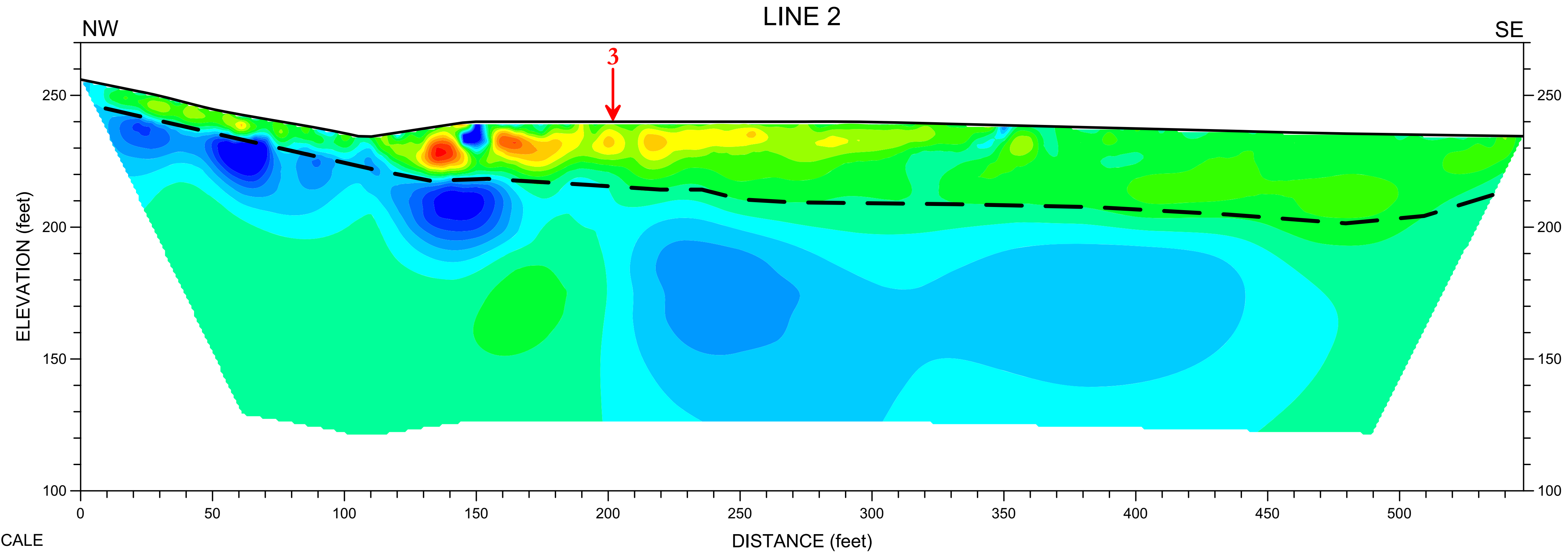
JOB #: 09-732.03

DATE: JAN. 2010

PLATE 1



LINE 1



LINE 2

SCALE

0 25 50 100

(1 inch = 50 feet)

LEGEND	
— —	INTERPRETED BEDROCK INTERFACE BASED ON ELECTRICAL RESISTIVITY & PREVIOUS SEISMIC REFRACTION SURVEYS (2009) CONDUCTED BY NORCAL
←	RECOMMENDED WELL LOCATION

ELECTRICAL RESISTIVITY

0 24 30 38 49 62 79 101 129 164 209 267 341 434 554 706

(Ohm-meters)

NORCAL

ELECTRICAL RESISTIVITY PROFILES
LINES 1 & 2
GRADY RANCH-LUCAS VALLEY ROAD

LOCATION: SAN RAFAEL, CALIFORNIA

CLIENT: CSW

PLATE 2

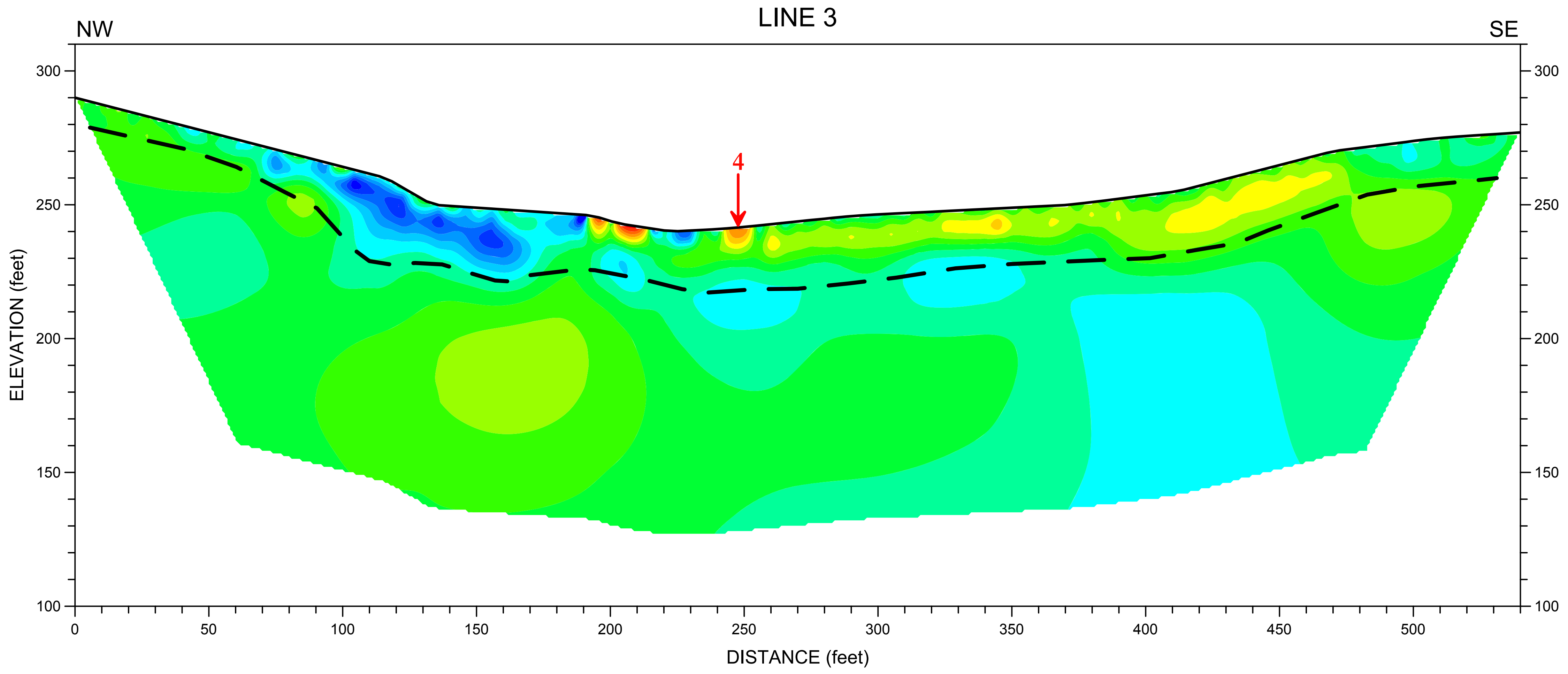
JOB #: 09-732.03

NORCAL GEOPHYSICAL CONSULTANTS INC.

DATE: JAN. 2010

DRAWN BY: G.RANDALL

APPROVED BY: DJK



SCALE

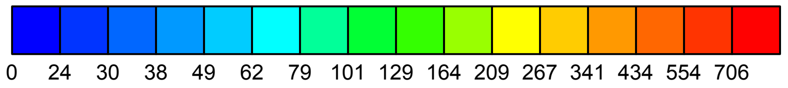
0 25 50 100

(1 inch = 50 feet)

LEGEND

— —	INTERPRETED BEDROCK INTERFACE BASED ON ELECTRICAL RESISTIVITY & PREVIOUS SEISMIC REFRACTION SURVEYS (2009) CONDUCTED BY NORCAL
←	RECOMMENDED WELL LOCATION

ELECTRICAL RESISTIVITY



(Ohm-meters)

NORCAL

ELECTRICAL RESISTIVITY PROFILE
LINE 3
GRADY RANCH-LUCAS VALLEY ROAD

LOCATION: SAN RAFAEL, CALIFORNIA

CLIENT: CSW

JOB #: 09-732.03

NORCAL GEOPHYSICAL CONSULTANTS INC.

DATE: JAN. 2010

DRAWN BY: G.RANDALL

APPROVED BY: DJK

PLATE
3

APPENDIX J

Bedrock well completion reports

Forster PUMP & Engineering inc.
Water Systems · Wells · Tanks · Drainage

FAX TRANSMISSION COVER SHEET

DATE: Dec 1, 10

FAX NO.: 662-1903

PLEASE DELIVER THE FOLLOWING PAGES TO:

To: Lou Bonc

THIS FASCIMILE IS BEING SENT BY: Bob Lerios

NUMBER OF PAGES: 20 INCLUDING COVER SHEET)

Grady Ranch Drillers logs And Flow TEST Reports for Well B.

IT Looks like The only other well cased is AT Site F. I DID not TEST THIS well yet. I'll Send EST.

If you have any questions to verify regarding this fax please call the number below.

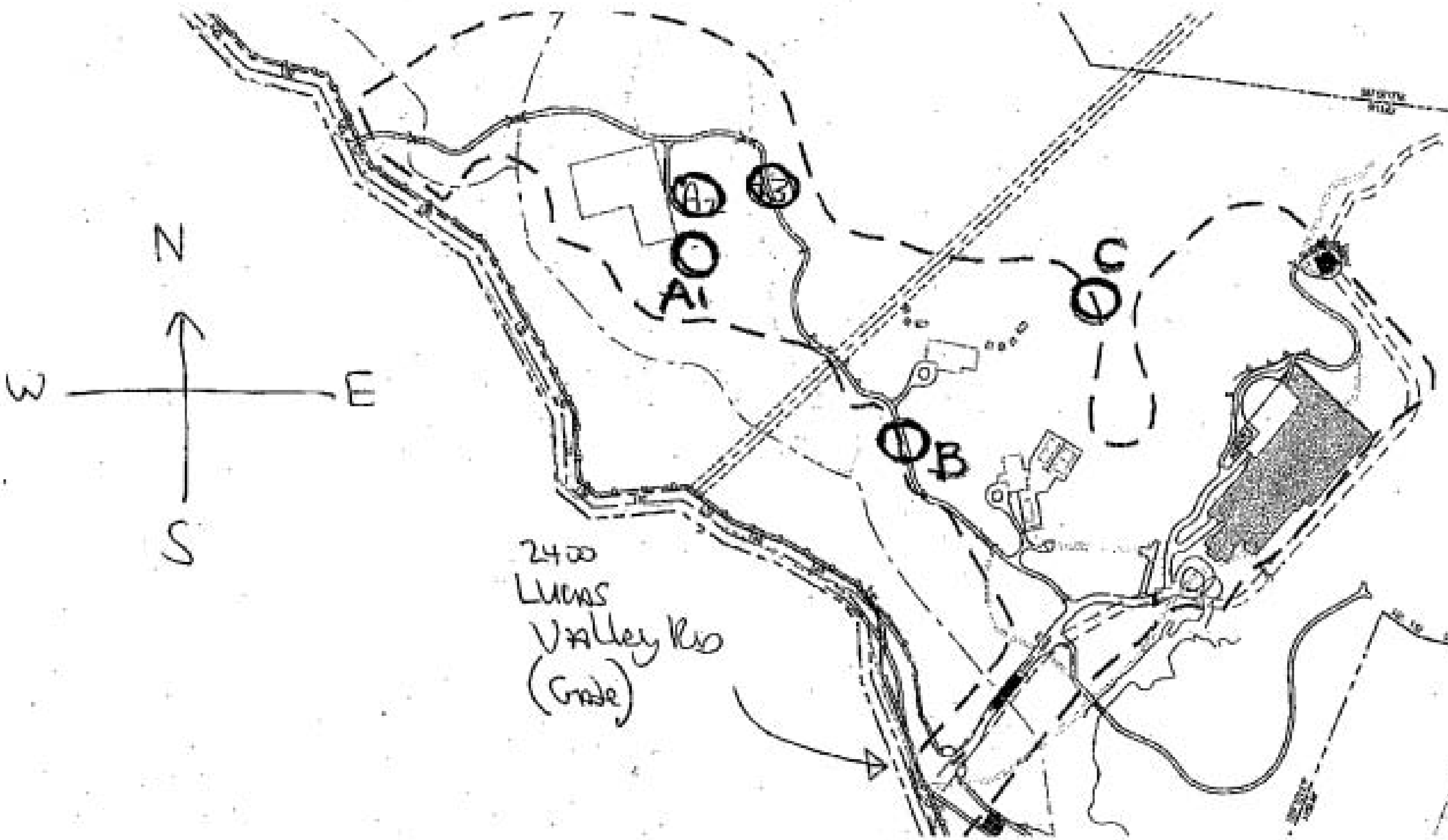
ORIGINAL

☐ Not being sent

☐ To follow via: ☐ Regular U.S. Mail ☐ Overnight Mail ☐ Federal Express

415 459-4770
56 Woodland Avenue, San Rafael, CA 94901-5344 * Lic. No. 426152
Fax 415 459-0607 * www.forsterpump.com

GRADY RANCH



DUPLICATE
Driller's Copy

Page ____ of ____ **A-1**

Owner's Well No. ____________

Date Work Began 11/12/09 Ended 11/12/09

Local Permit Agency MARIN COUNTY ENVIRONMENTAL HEALTH

Permit No. 09/10-19A (1) Permit Date 11/09/09

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0946213

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

CONFIDENTIAL

GEOLOGIC LOG

ORIENTATION (✓) ____ VERTICAL ____ HORIZONTAL ____ ANGLE ____ (SPECIFY)

DRILLING METHOD ____________ FLUID ____________

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	40	BROWN CLAY W/WEATHERED SANDSTONE
40	60	BROWN & BLUE CLAY
60	110	SANDSTONE, SHALE & CLAY
110	200	SANDSTONE
200	300	SANDSTONE, SHALE & CLAY
		TEST HOLE

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

WELL OWNER

Name SKYWALKER PROPERTIES LTD

Mailing Address P. O. BOX 10877

SAN RAFAEL CA 94903
CITY STATE ZIP

WELL LOCATION

Address 2400 LUCAS VALLEY ROAD

City NICASIO CA 94946

County MARIN COUNTY

APN Book 164 Page 340 Parcel 14

Township ____ Range ____ Section ____

Lat ____ ____ ____ N Long ____ ____ ____ W
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST

EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR

____ Deepen

____ Other (Specify)

____ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY

____ Domestic ____ Public

____ Irrigation ____ Industrial

MONITORING ____

TEST WELL ✓

CATHODIC PROTECTION ____

HEAT EXCHANGE ____

DIRECT PUSH ____

INJECTION ____

VAPOR EXTRACTION ____

SPARGING ____

REMEDIATION ____

OTHER (SPECIFY) ____

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ____ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL ____ (Ft.) & DATE MEASURED ____

ESTIMATED YIELD * ____ (GPM) & TEST TYPE ____

TEST LENGTH ____ (Hrs.) TOTAL DRAWDOWN ____ (Ft.)

* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	20		X BENTONITE		
20	BOTTOM			1/8X1/4	

ATTACHMENTS (✓)

____ Geologic Log

____ Well Construction Diagram

____ Geophysical Log(s)

____ Soil/Water Chemical Analyses

✓ Other MAP LOCATION OF WELL

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FORSTER PUMP & ENGINEERING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 56 WOODLAND AVE SAN RAFAEL CA 94901
CITY STATE ZIP

Signed Robert Jensen 11/19/09 426152
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy
Page ___ of ___ A-2
Owner's Well No. ___
Date Work Began 11/13/09 Ended 11/13/09
Local Permit Agency MARIN COUNTY ENVIRONMENTAL HEALTH
Permit No. 09/10-19A (1) Permit Date 11/09/09

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 0946215

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE
LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ___ FLUID ___

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	20	BROWN CLAY W/WEATHERED SANDSTONE
20	50	SANDSTONE & SHALE
50	100	SANDSTONE
100	140	SHALE & CLAY
140	160	SANDSTONE & SHALE
160	260	SANDSTONE, SHALE & CLAY
		TEST HOLE
		MELANGE

TOTAL DEPTH OF BORING 260 (Feet)
TOTAL DEPTH OF COMPLETED WELL 260 (Feet)

WELL OWNER

Name SKYWALKER PROPERTIES LTD
Mailing Address P. O. BOX 10877
SAN RAFAEL CA 94903
CITY STATE ZIP

WELL LOCATION

Address 2400 LUCAS VALLEY ROAD
City NICASIO CA 94946
County MARIN COUNTY
APN Book 164 Page 310 Parcel 11
Township ___ Range ___ Section ___
Lat ___ N Long ___ W
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH
WEST
EAST
see attached
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)
✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)
WATER SUPPLY
___ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ✓
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___
ESTIMATED YIELD * ___ (GPM) & TEST TYPE ___
TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	20		X BENTONITE		
20	BOTTOM		1/8 X1/8		

ATTACHMENTS (✓)
___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
✓ Other MAP-LOCATION OF WELL
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME FORSTER PUMP & ENGINEERING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS 56 WOODLAND AVE SAN RAFAEL CA 94901
CITY STATE ZIP
Signed ___ C-57 LICENSED WATER WELL CONTRACTOR
DATE SIGNED 11/19/09
C-57 LICENSE NUMBER 426152

DWR 188 REV. 05/03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy

Page ____ of ____ **A-3**

Owner's Well No. ____

Date Work Began 11/16/09 Ended 11/16/09

Local Permit Agency MARIN COUNTY ENVIRONMENTAL HEALTH

Permit No. 09/10-19A (1) Permit Date 11/09/09

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0946214

DWR USE ONLY – DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ____ FLUID ____

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	50	BROWN CLAY W/WEATHERED SANDSTONE
50	200	SANDSTONE & SHALE
200	300	SANDSTONE, SHALE & CLAY
		MELANGE
		TEST HOLE

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

WELL OWNER

Name SKYWALKER PROPERTIES LTD

Mailing Address P. O. BOX 10877

SAN RAFAEL CA 94903

CITY STATE ZIP

WELL LOCATION

Address 2400 LUCAS VALLEY ROAD

City NICASIO CA 94946

County MARIN COUNTY

APN Book 164 Page 310 Parcel 11

Township ____ Range ____ Section ____

Lat ____ N Long ____ W

DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST

See attached MAP

EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY

___ Domestic ___ Public

___ Irrigation ___ Industrial

MONITORING

TEST WELL ✓

CATHODIC PROTECTION

HEAT EXCHANGE

DIRECT PUSH

INJECTION

VAPOR EXTRACTION

SPARGING

REMEDIATION

OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ____ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL ____ (Ft.) & DATE MEASURED ____

ESTIMATED YIELD * ____ (GPM) & TEST TYPE ____

TEST LENGTH ____ (Hrs.) TOTAL DRAWDOWN ____ (Ft.)

** May not be representative of a well's long-term yield.*

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	CASING (S) TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

DEPTH FROM SURFACE Ft.	to Ft.	ANNULAR MATERIAL TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	20		X BENTONITE		
20	BOTTOM				1/8 X 1/4

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

☒ Other: MAP

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FORSTER PUMP & ENGINEERING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 56 WOODLAND AVE CITY SAN RAFAEL STATE CA ZIP 94901

Signed ____ 11/18/09 426152
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy
Page ___ of ___
Owner's Well No. #1 8
Date Work Began 11/11/09 , Ended 11/11/09
Local Permit Agency MARIN COUNTY ENVIRONMENTAL HEALTH
Permit No. 09/10-19A (1) Permit Date 11/09/09

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 0946211

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ___ FLUID ___

DEPTH FROM SURFACE Ft. to Ft.		DESCRIPTION Describe material, grain size, color, etc.
0	30	BROWN CLAY W/WEATHRERED SANDSTONE
30	100	SANDSTONE
100	120	SHALE
120	240	SANDSTONE & SHALE
240	300	SANDSTONE
300	400	SANDSTONE & SHALE

TOTAL DEPTH OF BORING 400 (Feet)
TOTAL DEPTH OF COMPLETED WELL 400 (Feet)

WELL OWNER

Name SKYWALKER PROPERTIES LTD
Mailing Address P. O. BOX 10877
SAN RAFAEL CA 94903
CITY STATE ZIP

WELL LOCATION

Address 2400 LUCAS VALLEY ROAD
City NICASIO CA 94946
County MARIN COUNTY
APN Book 164 Page 310 Parcel 11
Township ___ Range ___ Section ___
Lat ___ N Long ___ W
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH
WEST
See attached MAP
EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)
✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")
USES (✓)
WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 120 (Ft.) & DATE MEASURED 11/11/2009
ESTIMATED YIELD * 5 (GPM) & TEST TYPE AIR
TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 380 (Ft.)
* May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	80	10	X				PVC/F480	4 1/2		
80	160	7"	X				PVC/F480	4 1/2		
160	320	7"		X			PVC	4 1/2		032"
320	340	7"	X				PVC/F480	4 1/2		
340	400	7"		X			PVC	4 1/2		032"
					CAP ON BOTTOM					

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	60		X BENTONITE		
60	400			1/8 X1/4	

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
✓ Other MAP

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FORSTER PUMP & ENGINEERING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS 56 WOODLAND AVE CITY SAN RAFAEL STATE CA ZIP 94901
Signed Robert Forster
C-57 LICENSED WATER WELL CONTRACTOR
DATE SIGNED 11/19/09
C-57 LICENSE NUMBER 426152

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy
Page ____ of ____C
Owner's Well No. ____________

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 0946212

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

Date Work Began 11/17/09 Ended 11/17/09
Local Permit Agency MARIN COUNTY ENVIRONMENTAL HEALTH
Permit No. 09/10-19A (1) Permit Date 11/09/09

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ____________ FLUID ____________

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	10	BROWN CLAY
10	30	SHALE
30	60	SANDSTONE & SHALE
60	140	SHALE & CLAY
140	190	SANDSTONE & SHALE
190	315	SHALE
315	340	SANDSTONE
340	400	SANDSTONE & SHALE

TOTAL DEPTH OF BORING 400 (Feet)
TOTAL DEPTH OF COMPLETED WELL 400 (Feet)

WELL OWNER

Name SKYWALKER PROPERTIES LTD
Mailing Address P. O. BOX 10877
SAL RAFAEL CA 94903
CITY STATE ZIP

WELL LOCATION

Address 2400 LUCAS VALLEY ROAD
City NICASIO CA 94946
County MARIN COUNTY
APN Book 164 Page 310 Parcel 11
Township ______ Range ______ Section ______
Lat ____ ____ ____ N Long ____ ____ ____ W
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST EAST

See attached map

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)
WATER SUPPLY
___ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL X
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ________ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ________ (Ft.) & DATE MEASURED ________
ESTIMATED YIELD * ________ (GPM) & TEST TYPE ________
TEST LENGTH ________ (Hrs.) TOTAL DRAWDOWN ________ (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	20		X BENTONITE		
20	400				1/8 X 1/4

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
X Other MAP
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FORSTER PUMP & ENGINEERING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

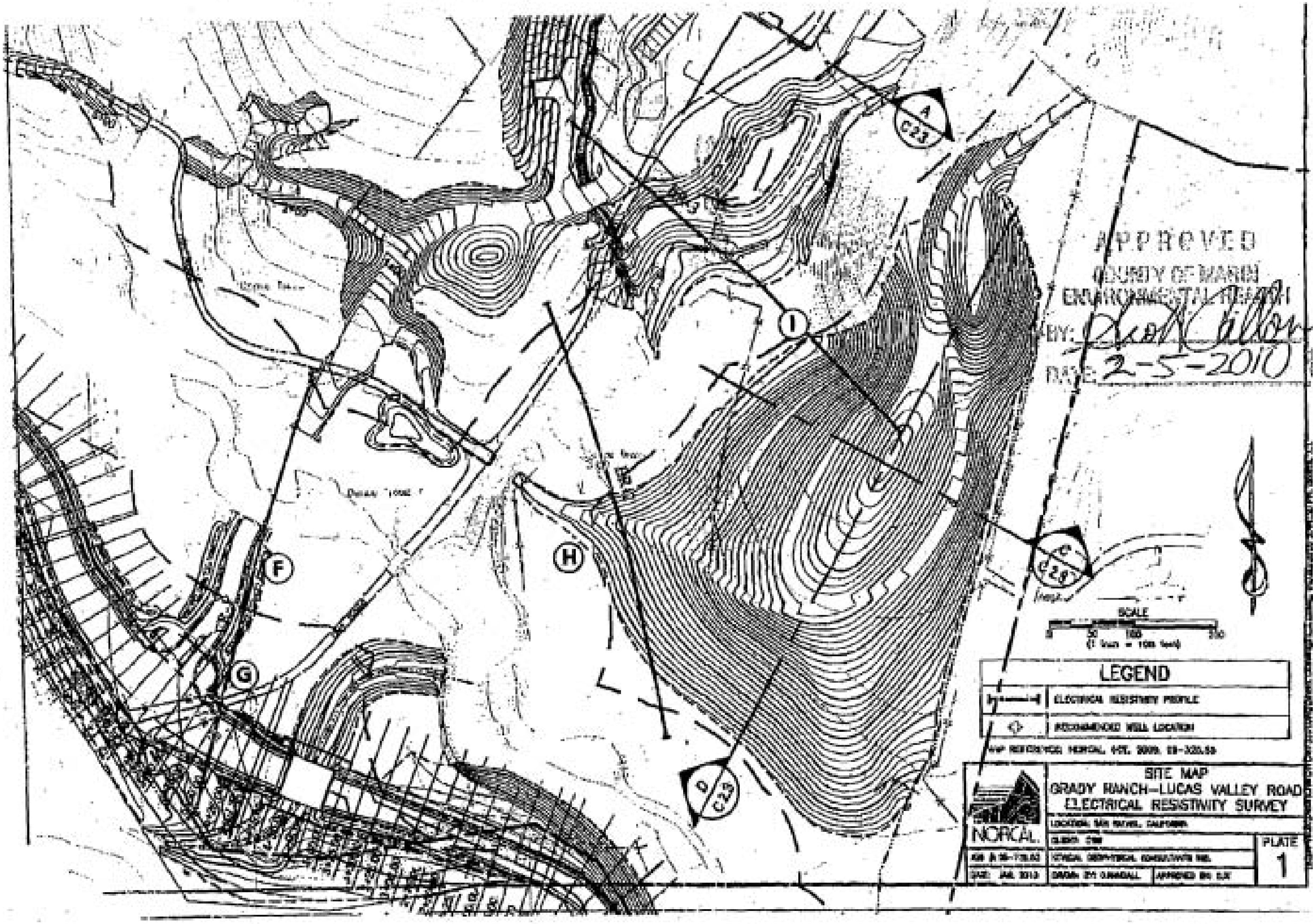
ADDRESS 56 WOODLAND AVE CITY SAN RAFAEL STATE CA ZIP 94901

Signed ____________ C-57 LICENSED WATER WELL CONTRACTOR
DATE SIGNED 11/19/09 C-57 LICENSE NUMBER 426152

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Grady Ranch Drill Sites – F, G, H, & I.



APPROVED
COUNTY OF MARIN
ENVIRONMENTAL HEALTH
BY:
DATE: 2-5-2010

DUPLICATE
Driller's Copy

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0946216

Page ___ of ___

Owner's Well No. Site F

Date Work Began 02/16/10, Ended 02/18/10

Local Permit Agency MARIN COUNTY ENVIRONMENTAL HEALTH

Permit No. 09/10-19A (2) Permit Date 02/05/10

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE

LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ___ FLUID ___

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	20	BROWN CLAY W/GRAVELS
20	40	WEATHERED SANDSTONE & BROWN CLAY
40	60	SANDSTONE & SHALE
60	80	SHALE & CLAY
80	300	SANDSTONE & SHALE

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

WELL OWNER

Name SKYWALKER PROPERTIES LTD

Mailing Address P.O. BOX 10877

SAL RAFAEL CA 94903

CITY STATE ZIP

WELL LOCATION

Address 2400 LUCAS VALLEY ROAD

City NICASIO CA 94946

County MARIN COUNTY

APN Book 164 Page 310 Parcel 11

Township ___ Range ___ Section ___

Lat ___ DEG. MIN. SEC. N Long ___ DEG. MIN. SEC. W

LOCATION SKETCH

NORTH

WEST

EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY

___ Domestic ___ Public

___ Irrigation ___ Industrial

MONITORING ___

TEST WELL ___

CATHODIC PROTECTION ___

HEAT EXCHANGE ___

DIRECT PUSH ___

INJECTION ___

VAPOR EXTRACTION ___

SPARGING ___

REMEDIATION ___

OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 40 (Ft.) & DATE MEASURED 02/18/2010

ESTIMATED YIELD * 5 (GPM) & TEST TYPE AIR

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 280 (Ft.)

* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	20	12	X				PVC/F480	8		
20	80	10"	X				PVC/F480	4 1/2		
80	300	7"		X			PVC	4 1/2		032"

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	50		X		BENTONITE
50	300				1/8 X 1/4

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

✓ Other SITE MAP

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FORSTER PUMP & ENGINEERING, INC.

(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 56 WOODLAND AVE CITY SAN RAFAEL STATE CA ZIP 94901

Signed ___ C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED 2/4/10 C-57 LICENSE NUMBER 426152

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy

Page ____ of ____

Owner's Well No. Site G

Date Work Began 02/10/10, Ended 02/10/10

Local Permit Agency MARIN COUNTY ENVIRONMENTAL HEALTH

Permit No. 09/10-19A (2) Permit Date 02/05/10

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0948217

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE

LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ___ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ____________ FLUID ____________

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	25	BROWN CLAY W/SOME GRAVELS
25	55	WEATHERED SANDSTONE W/ BROWN CLAY & SHALE
55	80	MELANGE
80	100	SANDSTONE & SHALE
100	190	SANDSTONE
190	230	SANDSTONE & SHALE
230	240	SANDSTONE
240	260	SHALE W/SANDSTONE

TOTAL DEPTH OF BORING 260 (Feet)

TOTAL DEPTH OF COMPLETED WELL 260 (Feet)

WELL OWNER

Name SKYWALKER PROPERTIES LTD

Mailing Address P. O. BOX 10877

SAL RAFAEL CA 94903
CITY STATE ZIP

WELL LOCATION

Address 2400 LUCAS VALLEY ROAD

City NICASIO CA 94946

County MARIN COUNTY

APN Book ______ Page ______ Parcel ______

Township ______ Range ______ Section ______

Lat ___ ___ ___ N DEG. MIN. SEC. Long ___ ___ ___ W DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST

See attached

EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. ***PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

___ NEW WELL

MODIFICATION/REPAIR
- ___ Deepen
- ___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY
- ___ Domestic ___ Public
- ___ Irrigation ___ Industrial

MONITORING ✓

TEST WELL ___

CATHODIC PROTECTION ___

HEAT EXCHANGE ___

DIRECT PUSH ___

INJECTION ___

VAPOR EXTRACTION ___

SPARGING ___

REMEDIATION ___

OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ______ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL ______ (Ft.) & DATE MEASURED ______

ESTIMATED YIELD * ______ (GPM) & TEST TYPE ______

TEST LENGTH ______ (Hrs.) TOTAL DRAWDOWN ______ (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	20		X		BENTONITE
20	BOTTOM				1/4 X 1/8

ATTACHMENTS (✓)

- ___ Geologic Log
- ___ Well Construction Diagram
- ___ Geophysical Log(s)
- ✓ Soil/Water Chemical Analyses
- ___ Other Site Map

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FORSTER PUMP & ENGINEERING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

56 WOODLAND AVE SAN RAFAEL CA 94901
ADDRESS CITY STATE ZIP

Signed ____________ 2/16/10 426152
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy

Page ___ of ___ **SITE H**

Owner's Well No. ___

Date Work Began 08/06/10 Ended 08/06/10

Local Permit Agency MARIN COUNTY ENVIRONMENTAL HEALTH

Permit No. 09/10-19A (2) Permit Date 02/05/10

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0945115

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ___ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ___ FLUID ___

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	20	BROWN CLAY W/ GRAVELS
20	30	BROWN CLAY
30	50	SANDSTONE, SHALE & CLAY
50	80	SHALE & CLAY
80	300	SANDSTONE & SHALE

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

WELL OWNER

Name SKYWALKER PROPERTIES LTD

Mailing Address P. O. BOX 10877

CITY SAL RAFAEL STATE CA ZIP 94903

WELL LOCATION

Address 2400 LUCAS VALLEY ROAD

City NICASIO CA 94946

County MARIN COUNTY

APN Book ___ Page ___ Parcel ___

Township ___ Range ___ Section ___

Lat ___ DEG. ___ MIN. ___ SEC. N Long ___ DEG. ___ MIN. ___ SEC. W

LOCATION SKETCH

NORTH

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

☒ NEW WELL

MODIFICATION/REPAIR
- ___ Deepen
- ___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY
- ___ Domestic ___ Public
- ___ Irrigation ___ Industrial

MONITORING ___

TEST WELL ☒

CATHODIC PROTECTION ___

HEAT EXCHANGE ___

DIRECT PUSH ___

INJECTION ___

VAPOR EXTRACTION ___

SPARGING ___

REMEDIATION ___

OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___

ESTIMATED YIELD * ___ (GPM) & TEST TYPE ___

TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)

* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	33		X BENTONITE		
			1/4 X 1/8		
33	BOTTOM				

ATTACHMENTS (✓)

- ☒ Geologic Log
- ___ Well Construction Diagram
- ___ Geophysical Log(s)
- ___ Soil/Water Chemical Analyses
- ___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FORSTER PUMP & ENGINEERING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 56 WOODLAND AVE CITY SAN RAFAEL STATE CA ZIP 94901

Signed ___ C-57 LICENSED WATER WELL CONTRACTOR

DATE SIGNED 8/13/10

C-57 LICENSE NUMBER 426152

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy

Page ___ of ___ **SITE I**

Owner's Well No. ___

Date Work Began 08/10/10, Ended 08/10/10

Local Permit Agency **MARIN COUNTY ENVIRONMENTAL HEALTH**

Permit No. 09/10-19A (2) Permit Date 02/05/10

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0945118

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE ___ LONGITUDE ___

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ___ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ___ FLUID ___

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	10	**BROWN CLAY**
10	50	**SANDSTONE**
50	100	**SANDSTONE & SHALE**
100	120	**SANDSTONE**
120	180	**SANDSTONE & SHALE**
180	200	**SANDSTONE**
200	260	**SANDSTONE & SHALE**
260	300	**SANDSTONE, SHALE & CLAY**

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

WELL OWNER

Name **SKYWALKER PROPERTIES LTD**

Mailing Address **P. O. BOX 10877**

SAL RAFAEL **CA** **94903**

CITY STATE ZIP

WELL LOCATION

Address **2400 LUCAS VALLEY ROAD**

City **NICASIO** **CA 94946**

County **MARIN COUNTY**

APN Book ___ Page ___ Parcel ___

Township ___ Range ___ Section ___

Lat ___ N DEG. MIN. SEC. Long ___ W DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY

___ Domestic ___ Public

___ Irrigation ___ Industrial

MONITORING ✓

TEST WELL ___

CATHODIC PROTECTION ___

HEAT EXCHANGE ___

DIRECT PUSH ___

INJECTION ___

VAPOR EXTRACTION ___

SPARGING ___

REMEDIATION ___

OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___

ESTIMATED YIELD * ___ (GPM) & TEST TYPE ___

TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)

* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	40		X BENTONITE CHIPS		
40	300		X GRAVEL		

ATTACHMENTS (✓)

X Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME **FORSTER PUMP & ENGINEERING, INC.**

(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS **56 WOODLAND AVE** CITY **SAN RAFAEL** STATE **CA** ZIP **94901**

Signed ___ C-57 LICENSED WATER WELL CONTRACTOR

DATE SIGNED 8/13/10

C-57 LICENSE NUMBER **426152**

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Forster PUMP & Engineering inc.
Water Systems - Wells - Tanks - Drainage

Water Well Flow Test

Project FLOW TEST
Location GRADY RANCH WELL #B
2400 LUCAS VALLEY
NICASIO, CA
Owner SKYWALKER PROP

By BOB & SCOTT Date 11/16/09 Well Diameter 5" Casing PVC

Depth 400' Static Level 46' Pump: Type GOULDS SUBMERSIBLE

Model No. 10GS15412L GPM Rating 10 Depth 380' Voltage 230V

PG&E Power ___ Generator X H. P. 1 ½

Date	Time	Static Level	Pumping Rate	Meter Reading
11/16/09	11;00AM	46'	10 GPM	0166610
11/17/09	11:00AM	380'	1.4	0169420
11/18/09	10:30AM	380'	1.2	0170760
11/19/09	9:00AM	380'	1.2	0171840
11/24/09	1:30 PM	60'		

Total Test Period in Minutes 4,200
Total Gallons Pumped 5,230
GPM during Test Period 1.20
Gallons of Chlorine Used 1
Bacteria Sample to Lab YES
Mineral Analysis to Lab YES
Additional comments

THIS REPORT IS FOR INFORMATIONAL PURPOSES ONLY. IT IS IN LIEU OF, AND SUPERSEDES ANY OTHER REPRESENTATIONS OR STATEMENTS OF THE AGENT OF EMPLOYEES OF THE COMPANY, AND ALL OTHER SUCH REPRESENTATIONS OR STATEMENTS SHALL BE RELIED UPON AT THE CUSTOMER'S OWN RISK.

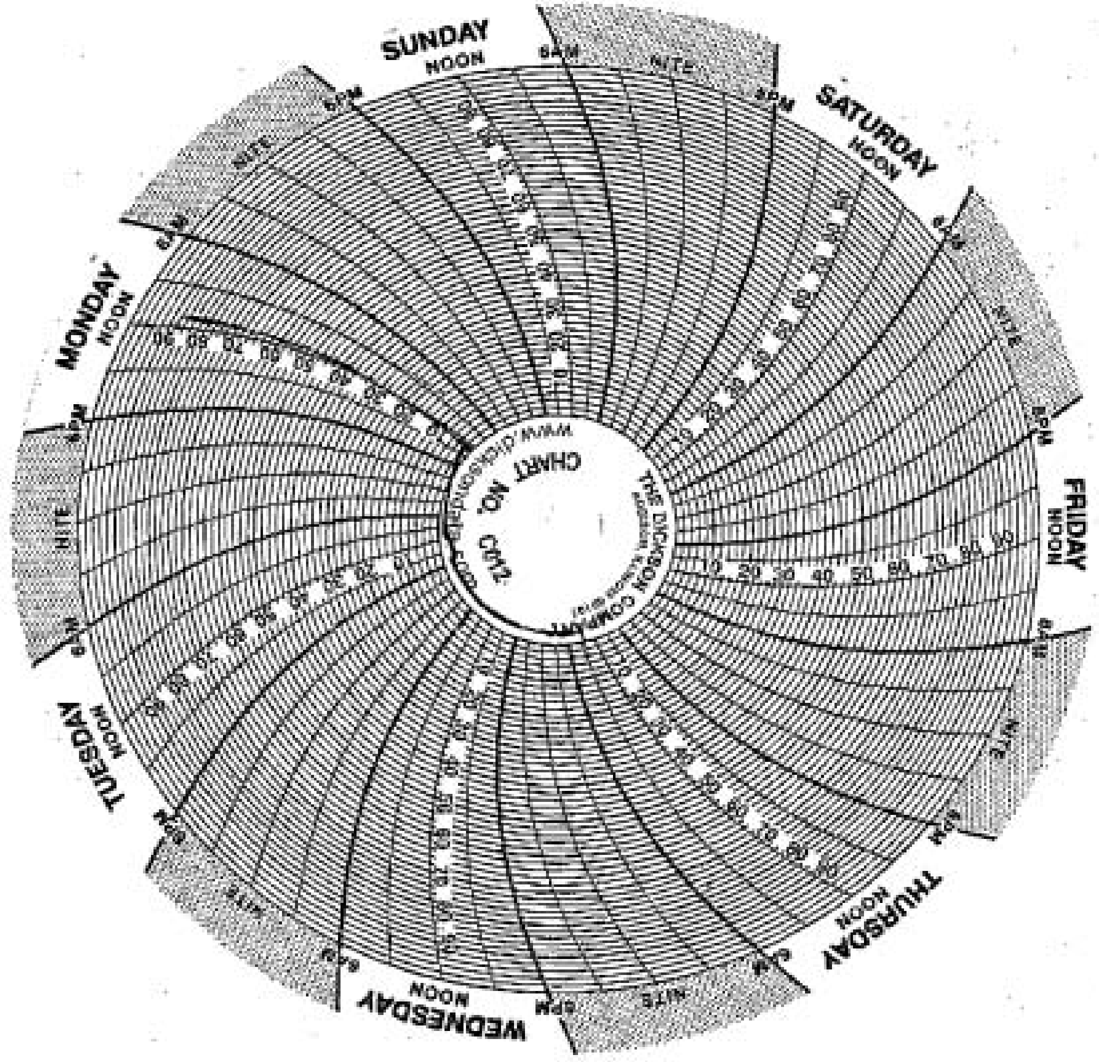
THE DATA AND CONCLUSIONS PROVIDED HEREIN ARE BASED UPON THE TESTS AND OBSERVATIONS OF THE COMPANY USING STANDARD AND ACCEPTED PRACTICES OF THE GROUNDWATER INDUSTRY. HOWEVER, CONDITIONS IN WATER WELLS ARE SUBJECT TO CONSIDERABLE ERROR DUE TO FACTORS WITHIN THE WELL AND GROUNDWATER FORMATION WHICH ARE BEYOND THE COMPANY'S IMMEDIATE CONTROL.

THEREFORE, THE DATA AND CONCLUSIONS ARE VALID ONLY AS OF THE DATE AND WITHIN THE LIMITATIONS OF THE TEST OR THE INSTALLATION INDICATED, AND SHOULD NOT BE RELIED UPON TO PREDICT EITHER THE FUTURE QUANTITY OR QUALITY OF THE WATER THAT THE WELL WILL PRODUCE. THE COMPANY MAKES NO WARRANTIES, EITHER EXPRESSED OR IMPLIED AS TO SUCH FUTURE WATER PRODUCTION. FURTHER, IT EXPRESSLY DISCLAIMS AND EXCLUDES LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES ARISING OUT OF THE BREACH OF AN EXPRESS OR IMPLIED WARRANTY OF THE FUTURE WATER PRODUCTION, OR ARISING OUT OF ANY FURTHER USE OF THIS REPORT BY THE CUSTOMER OR THIRD PARTIES.

IN PRESENTING THE DATE AND CONCLUSIONS CONTAINED HEREIN, THE COMPANY, UNLESS EXPRESSLY STATED TO THE CONTRARY, DOES NOT REPRESENT THE FOLLOWING FACTORS. 1) THAT THE WELL OR PUMP SYSTEM IS IN ANY PARTICULAR STATE OF REPAIR. 2) THAT THE WATER PRODUCED WILL SATISFY ANY GOVERNMENTAL ORDINANCES OR REGULATIONS. 3) THAT THE WATER IS ADEQUATE FOR A PARTICULAR USE CONTEMPLATED BY THE CUSTOMER.

SIGNATURE ROBERT DATE November 20, 2009

Grady Ranch Well Site B
Flow Test Scale
11-19-09



Analytical Sciences

GRADY Ranch
Well # B
LAB Report

December 14, 2009

Bob Lerios
Forster Pump & Engineering, Inc.
56 Woodland Avenue
San Rafael, CA 94901-5344

Dear Bob,

Enclosed you will find Analytical Sciences' final report 9111908 for your Skywalker Properties project. An invoice for this work is enclosed.

Should you or your client have any questions regarding this report please contact me at your convenience. We appreciate you selecting Analytical Sciences for this work and look forward to serving your analytical chemistry needs on projects in the future.

Sincerely,

Analytical Sciences

Mark A. Valentini

Michele Peters
Laboratory Manager

'50336
CA 94975-0336
(707) 769-3128

110 Liberty Street
Petaluma, CA 94952

Analytical Sciences

Report Date: December 14, 2009

Laboratory Report

Bob Lerios
Forster Pump & Engineering, Inc.
56 Woodland Avenue
San Rafael, CA 94901-5344

Project Name:	**Skywalker Properties**	**Grady Ranch - Well Site B**
Lab Project:	**9111908**	

This 5 page report of analytical data has been reviewed and approved for release.

Mark A. Valentini

chele Peters
oratory Manager

Total Coliform & E. Coli

Lab#	Sample ID	Compound Name	Result (MPN/100 mL)		RDL (MPN/100 mL)
9111908-01	**Grady Ranch - Well B**	Total Coliform	110		1
		E. Coli	<1	QT	1

Date Sampled:	11/19/09	Date Analyzed:	11/20/09	QC Batch:	B006674
Date Received:	11/19/09	Method:	SM 9223 B		

Graphite Furnace Metals

Lab#	Sample ID	Compound Name	Result (µg/L)	RDL (µg/L)
9111908-01	**Grady Ranch - Well B**	Antimony (Sb)	ND	5.0
		Arsenic (As)	ND	2.0
		Selenium (Se)	ND	5.0
		Thallium (Tl)	ND	2.0

Date Sampled:	11/19/09	Date Analyzed:	12/03/09	QC Batch:	B006684
Date Received:	11/19/09	Method:	EPA 200.9		

Drinking Water Metals (ug/L)

Lab#	Sample ID	Compound Name	Result (µg/L)	RDL (µg/L)
9111908-01	**Grady Ranch - Well B**	Aluminum (Al)	1700	50
		Barium (Ba)	68	50
		Beryllium (Be)	ND	1.0
		Cadmium (Cd)	ND	1.0
		Chromium (Cr)	5.6	2.5
		Iron (Fe)	2100	100
		Manganese (Mn)	31	20
		Nickel (Ni)	ND	10

Sampled:	11/19/09	Date Analyzed:	11/24/09	QC Batch:	B006637
Received:	11/19/09	Method:	EPA 200.7		

Drinking Water Metals (mg/L)

Lab#	Sample ID	Compound Name	Result (mg/L)	RDL (mg/L)
9111908-01	**Grady Ranch - Well B**	Sodium (Na)	210	5.0

Date Sampled:	11/19/09	Date Analyzed:	11/23/09	QC Batch: B006637
Date Received:	11/19/09	Method:	EPA 200.7	

Hardness

Lab#	Sample ID	Compound Name	Result (mg/L)	RDL (mg/L)
9111908-01	**Grady Ranch - Well B**	Calcium (Ca)	9.0	5.0
		Magnesium (Mg)	1.2	1.0
		Hardness	28	5.0

Date Sampled:	11/19/09	Date Analyzed:	11/23/09	QC Batch: B006637
Date Received:	11/19/09	Method:	SM 2340 B	

Mercury

Lab#	Sample ID	Compound Name	Result (µg/L)	RDL (µg/L)
9111908-01	**Grady Ranch - Well B**	Mercury (Hg)	ND	0.20

ate Sampled:	11/19/09	Date Analyzed:	11/25/09	QC Batch: B006675
ate Received:	11/19/09	Method:	EPA 245.1	

pH

Lab#	Sample ID	Compound Name	Result (pH Units)	RDL (pH Units)
11908-01	**Grady Ranch - Well B**	pH	8.22	1.00

Sampled:	11/19/09	Date Analyzed:	11/19/09	QC Batch: B006650
Received:	11/19/09	Method:	SM 4500-H B	

Alkalinity

Lab#	Sample ID	Compound Name	Result (mg CaC03/L)	RDL (mg CaC03/L)
9111908-01	**Grady Ranch - Well B**	Total Alkalinity	170	5.0
		Bicarbonate Alkalinity	170	5.0
		Carbonate Alkalinity	ND	5.0
		Hydroxide Alkalinity	ND	5.0

Date Sampled:	11/19/09	Date Analyzed:	11/30/09	QC Batch: B006651
Date Received:	11/19/09	Method:	SM 2320 B	

Anions

Lab#	Sample ID	Compound Name	Result (mg/L)	RDL (mg/L)
9111908-01	**Grady Ranch - Well B**	Fluoride	2.2	0.10
		Nitrite as N	ND	0.15
		Nitrate	ND	0.50
		Nitrate as N	ND	0.15

Date Sampled:	11/19/09	Date Analyzed:	11/19/09	QC Batch: B006673
Date Received:	11/19/09	Method:	EPA 300.0	

Free Cyanide

Lab#	Sample ID	Compound Name	Result (µg/L)	RDL (µg/L)
9111908-01	**Grady Ranch - Well B**	Cyanide (free)	160	50

te Sampled:	11/19/09	Date Analyzed:	12/13/09	QC Batch: B006766
e Received:	11/19/09	Method:	SM 4500-CN F	

Notes and Definitions

QT	The bacterial test utilized is a quantitative test. A result of less than 1 (<1) is indicating bacteria are "absent" in 100 milliliters of sample water.
RDL	Reporting Detection Limit
ND	Analyte NOT DETECTED at or above the reporting detection limit (RDL)
RPD	Relative Percent Difference
NR	Not Reported

Please Note: California Department of Health Services recommended drinking water standards are as follows:

Arsenic (10 ug/L)
Iron (300 ug/L)
Manganese (50 ug/L)
Nitrate (45 mg/L)
Lead (15 ug/L)
Total Coliform (<1 MPN/100 mL)

APPENDIX K

Annual Hydrologic Record and Sediment-Transport Measurements for San Geronimo Creek at Lagunitas Road, Marin County, California:
Data Report for Water Year 2010
(December 2010)

Annual Hydrologic Record and Sediment-Transport Measurements for San Geronimo Creek at Lagunitas Road, Marin County, California:

Data Report for Water Year 2010

Report prepared for:
Marin Municipal Water District

Prepared by:
Jonathan Owens
Barry Hecht

Balance Hydrologics, Inc.

December 2010

A report prepared for:

Marin Municipal Water District
220 Nellen Avenue
Corte Madera, California 94925
Attention: Gregory Andrew
(415) 945-1191

Annual Hydrologic Record and Sediment-Transport Measurements for San Geronimo Creek at Lagunitas Road, Marin County, California:

Data Report for Water Year 2010

Project Assignment: 8801
by

Jonathan Owens
Senior Hydrologist

Barry Hecht, CEG, CHg
Principal/Hydrologist/Geomorphologist

BARRY HECHT
No. 1245

BARRY HECHT
NO. 50

Balance Hydrologics, Inc.®

800 Bancroft Way, Suite 101
Berkeley, California 94710-2251
(510) 704-1000
office@balancehydro.com

December 21, 2010

TABLE OF CONTENTS

ANNUAL SUMMARY FORMS

LIST OF TABLES

LIST OF FIGURES

1. PROJECT PURPOSE AND INTRODUCTION

The Marin Municipal Water District (MMWD) has requested that Balance Hydrologics, Inc. (Balance) monitor streamflow and sediment transport in San Geronimo Creek at the Lagunitas Road bridge. This report summarizes stream flows in San Geronimo Creek during water year 2010[1] and is a continuation of hydrologic record keeping at this station that has been ongoing since November 1979. Results of stream gaging at this site are used by MMWD and its cooperators for diverse applications:

- Streamflow is the basic influence affecting aquatic habitat and sensitive-species protection for coho and steelhead, which are MMWD priorities, and those of the County, and have been so for many San Geronimo Valley residents since at least the 1977 general plan for the valley.
- Streamflow measurements and records for San Geronimo Creek can be used to estimate flows on other Lagunitas Creek tributaries, as well as on other ungaged streams in western Marin County and the region. This station has the longest period of record of any gage on unregulated streams in relatively non-urbanized portions of Marin County.
- On-line stream flow and rainfall information are frequently consulted by MMWD and others to track conditions on the stream, and by many residents 'simply to stay in touch with what's going on in the creek'.
- Bedload-sediment transport rates, especially at the moderate to high flows which move gravels and other bed material, are an important factor influencing the amount and quality of salmonid rearing habitat, as wells as the availability, quality and mobility of spawning gravels for anadromous species – both in San Geronimo Creek and in Lagunitas Creek. Information collected at this gage is essential in understanding the variability of the accumulation and depletion of sand and gravel in Lagunitas Creek, to which San Geronimo Creek flows.
- Bed sediment stored, temporarily or long-term, in Lagunitas Creek below Kent Lake can affect the amount and quality of habitat available for the California freshwater shrimp *(Syncaris pacifica)* and other aquatic biota, in addition to salmonid habitat.

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[1] Most hydrologic and geomorphic monitoring occurs for a period defined as a water year, which begins on October 1 and ends on September 30 of the named year. For example, water year 2010 (WY2010) began on October 1, 2009, and concluded on September 30, 2010.

- Bedload-sediment transport rates, especially at low to moderate flows (which can only move smaller material like sand and fine gravel), are a good measure of sediment availability in the channel. These rates may also prove to be one measure of the effectiveness of erosion-control programs for the San Geronimo Creek watershed sponsored by Marin County, MMWD, the Marin County Resource Conservation District (MCRCD), and the Marin Open Space Conservation District (MCOSD), among others.

This data report summarizes our work at the gage on San Geronimo Creek during water year 2010. The report:

- Briefly describes where and what measurements and observations were made;
- Summarizes the results of these measurements;
- Reports daily streamflow in San Geronimo Creek during the study period;
- Compares daily and annual streamflow to those gaged during the prior 30 years;
- Records storm peaks affecting salmonid passage and bed-surface material in the Lagunitas Creek/San Geromino Creek system;
- Develops a preliminary estimate of bedload-sediment discharge for San Geronimo Creek during the water year; and
- Develops a preliminary estimate of suspended-sediment discharge for San Geronimo Creek during the water year.

Data collection by MMWD has been suspended at the close of water year 2010. On a very limited basis, Balance Hydrologics (‘Balance’) may continue to make measurements sustaining the stream gage and to conduct sediment-transport measurements.

2. STATION DESCRIPTION

2.1 San Geronimo Creek at Lagunitas Road

The gage is located in San Geronimo Creek at the Lagunitas Road bridge; this station has been designated as 'K4' since its inception in 1979. The watershed of 8.7 square miles receives long-term average precipitation of approximately 45 to 46 inches per year based on the USGS's isohyetal maps (Rantz, 1971). Balance staff have maintained an automatic creek-level recorder here and have been measuring water levels, streamflow, specific conductance, and bedload sediment since November 1979. The station was converted to continuous-electronic recording at the onset of water year 1998. A new electronic recorder and rain gage[2] were installed during March 2006; this new equipment includes real-time telemetry of the data to Balance's website[3] and is now accessible both to MMWD staff and the general public.

During water year 2007, we switched to referencing a new staff plate at the same location installed on the northern side of the creek, affixed to the north bridge abutment. This staff is at a different datum, offset approximately 4.0 feet lower, such that a stage of 1.0 on the original staff plate corresponds to a stage of 5.0 on the new staff plate. The original 1979 datum is still intact and is cross referenced at high flows. The change addresses a gradual shift northward of the typical low-flow channel at this site.

Bedload transport was monitored intensively from late 1979 through 1982 (Hecht, 1983), and at reduced 'reconnaissance' frequencies during many subsequent years. Beginning in water year 2006, bedload measurements were made with increased frequency.

Suspended-sediment transport rates were measured from late 1979 through June 1982 and then resumed again beginning with water year 2005.

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[2] As often occurs in forested areas, the rain gage is located near taller trees, and may slightly under-report rainfall for some storms. No claim of meeting USWB standards is made.

[3] Real-time rainfall, stage, and streamflow data are available in near real time at http://www.balancehydrologics.com/geronimo/creek/index.php. Note the conditions posted on this site.

2.2 Comparisons to Other Watersheds

Additional comparisons for validation were made to Wildcat Creek in Contra Costa County, another gaging station operated by Balance about 20 miles to the east, and to Walker Creek near Marshall (USGS station #11460750), about 10 miles to the northwest.

We chose Wildcat Creek for comparison because its watershed size and relief are more similar to the San Geronimo Creek drainage than most other gaging stations that are closer to the San Geronimo Valley. This station is located at Vale Road on the Richmond/ San Pablo border, and has a drainage area of 7.8 square miles, compared to 8.7 square miles at the San Geronimo gage. Soils are, however, considerable more clay rich, the lower watershed is highly urbanized, and rainfall rates are lower within the Wildcat Creek watershed. Wildcat Creek streamflow is also slightly affected by Jewel Lake and Lake Anza, two small impoundments in the upper watershed. Real-time data for Wildcat Creek can presently be obtained on the same Balance website.

Walker Creek near Marshall, with a watershed area of 31.1 square miles, is the nearest operating gage with a long-term record to the Lagunitas watershed. It is substantially regulated by an upstream reservoir (Soulajule Reservoir on Arroyo Sausal) with flow-bypass requirements. Rainfall and geologic substrate in the Walker Creek watershed are more similar to those in the San Geronimo Creek watershed. Real-time data for the Walker Creek gage may be obtained on the USGS website through NWIS (waterdata.usgs.gov/nwis).

3. HYDROLOGIC SUMMARY

We collected a continuous record of water level for water year 2010, and converted this record to streamflow through a stage-discharge rating curve developed with periodic manual streamflow measurements at a range of stages. Daily flows are presented in Form 1 and Figure 1. A comparison to flow in the other creeks discussed above is shown in Figure 2. Measurements and observations from site visits are listed in Table 1.

3.1 Water Year 2010

The water year began with baseflow below normal in October, likely a result of the 3 previous dry years. An unusually large amount of rain fell on October 13 (approximately 4.9 inches), which substantially increased baseflow. Several small and moderate rains occurred in December 2009, then more substantial rain fell in a succession of days in mid January 2010. The peak flow for the year was approximately 640 cfs at 9:30 AM January 20, 2010. Occasional moderate rain continued through mid April and small rain happened periodically through the end of May. Flows during the spring flow recession were slightly higher than usual (Figure 3). Summer baseflow declined in a typical pattern, with September baseflow being close to average.

3.2 Comparison to Other Watersheds

Figure 2 shows the flow hydrograph of San Geronimo Creek plotted with Wildcat Creek and Walker Creek. We used Figure 2 to validate the San Geronimo Creek record in its response to storms and other perturbations; we concluded that the record was reasonable based on the timing and magnitude of the flow peaks, and the pattern of flow recession *after* flow peaks. In addition, we used Figure 2 in conjunction with Figure 5 to evaluate if there were any flow peaks that are not associated with rainfall, and are therefore most likely due to human influence; we did not identify any such peaks for San Geronimo Creek during this water year.

3.3 Year-to-Year Comparisons

Table 3 and Figure 3 show that streamflow on San Geronimo Creek during water year 2010 totaled at the long-term median. Although the instantaneous peak flow was quite small, the total yearly flow was close to average. An unusually high percentage of rainfall occurred in October, April and May, when much of the rainfall does not contribute to runoff; hence, it is not surprising that rainfall was slightly above the long-term average yet runoff is slightly below average for this year.

3.4 Rainfall

Balance installed a tipping bucket rain gauge during March 2006. The gauge collects 15-minute and hourly data and posts the data to Balance's website. The recorded rainfall total for water year 2010 was 50.0 inches, after adjustments[4]. This is about 110 percent of the estimated long-term average precipitation for this location[5] of approximately 45 to 46 inches per year (Rantz, 1971). Daily and cumulative rainfall data for water year 2010 are shown in Figure 5.

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[4] The rain gauge became clogged on October 13, 2009. We made adjustments to the data based on the amount of rainfall found in the funnel when it was cleaned, and from nearby rain gauges.

[5] The estimated long-term average annual rainfall is taken from an isohyetal (rainfall contours) map for the location of our gaging station. S.E. Rantz (1971) of USGS produced a map of average annual rainfall for the entire San Francisco Bay Area that was based on a network of long-term rain gages for the years 1931 to 1970. For zones between rain gages, Rantz's isohyets were constructed based on expected patterns due to terrain elevations.

4. DEVELOPING A STREAMFLOW RECORD

The flow record starts with detailed field measurements; to calculate flow we measure depth and velocity at many verticals across a cross section of the creek (Rantz and others, 1982). Based on our periodic site visits, staff plate readings, and flow measurements (Table 1), we created an empirical stage-to-discharge relationship, also referred to as a stage-discharge "rating curve". We then applied this rating curve to the datalogger and pressure-transducer record of water levels. The stage record is presented in Figure 4. During the monitoring period, as is typically done, we calibrate the stage record to observations of gage height; we then apply stage shifts to account for local scour and fill, and the effects of leaf dams during low flows. The last step is to apply the stage-discharge rating curve applicable to that date. We have directly measured flow up to 1,610 cfs; above that range we extend the rating curve to our estimate of peak flows (Shaw and others, 2007).

The upper end of the stage-discharge rating curve was established based on the peak flow of water year 2006. That peak flow of December 31, 2005 was estimated using standard 'indirect methods' protocols. We surveyed high-water marks left by the peak flow, as well as channel cross-sections, a longitudinal profile, and other measurements and observations[6] required for indirect peak-discharge estimates. From this surveyed data we applied the slope-area method (Benson and Dalrymple, 1967) using our observations during this storm of flow, slope, and obstruction locations to calculate an estimate of the peak flow (3,940 cfs). We consider our estimate to be within about 10 percent of the peak flow (+/- 400 cfs). We then extended the rating curve to meet this point.

As with all other open-channel gaging of natural streams, some uncertainty remains (especially at high flows) in spite of efforts to be as precise as possible.

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[6] Our staff were at the site a few hours after the peak flow and made observations that no log jams or other transient obstructions to flow had occurred; these observations confirm the assumptions in the slope-area method used to calculate the peak flow.

Most of our results are presented as daily flow, which are averaged from data recorded and calculated every 15 minutes. Upon request, the more detailed 15-minute record can be made available for specific periods of interest.

5. SEDIMENT TRANSPORT

5.1 Importance of Measuring Sediment in San Geronimo Creek

Sediment transport and bed sedimentation are measured at San Geronimo Creek because they are potentially-significant factors in a broader effort to understand the sources and transport of sediment within the San Geronimo Creek and Lagunitas Creek watersheds. The data help in evaluating MMWD's steps to make water supply as compatible as possible with other watershed values and functions, and to interpret conditions in San Geronimo and Lagunitas Creeks. Beginning in water year 2005, we resumed measuring suspended-sediment concentrations and calculating suspended-sediment loads, in addition to the ongoing measurements and calculations of bedload sediment authorized in 2001.

We distinguish two types of sediment in transport: bedload sediment and suspended sediment. *Bedload sediment* is supported by the bed; it rolls and saltates along the bed, commonly within the lowermost 3 inches. Movement can be either continuous or intermittent, but is generally much slower than the mean velocity of the stream. In San Geronimo Creek, bedload consists primarily of coarse sands and gravels. *Suspended sediment* is supported by the turbulence of the water, and is transported at a rate approaching the mean velocity of flow.

For the purposes of this study, we measured and calculated values for bedload sediment, because excess bedload can be an especially impairing portion of the sediment load[7] to salmonid habitat, bedload transport is closely related to the degree of bed sedimentation, and bedload has been the basis for managing sedimentation and bed conditions in the Lagunitas Creek watershed.

In San Geronimo Creek, as typically occurs elsewhere in unregulated streams, suspended sediment consists of fine sands, silts, and clays, and tends to be entrained at

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[7] Bedload in excess can fill pools used for rearing, can make spawning riffles more prone to scour, or can impede passage. Bedload also fills the undercut banks used by *Syncaris pacifica* (a federally-listed freshwater shrimp). Insufficient bedload can also create habitat-management issues.

lower flows than bedload. As a result, fine sediment may be deposited on top of the coarse sands and gravels used for fish spawning during the flow recession periods, or deposited in pools that are used for summer rearing.

5.2 Field Methods for Sampling Sediment

Sediment measurements are listed in Table 2 and plotted in Figures 6, 7, and 8. Standard methods and equipment reviewed by the Federal Interagency Sedimentation Project (FISP) were used to make measurements of sediment transport. Field measurements of sediment discharge are made either by hand samplers applied in transects across the channel at wadeable flows or with cable-suspended samplers from the bridge railing at high flows. We use Helley-Smith 3-inch bedload samplers, and DH-48, DH-81 and D-74 suspended-sediment samplers. Bedload- and suspended-sediment samples are taken at multiple verticals across the creek to collect a representative sample (Emmett, 1980; Edwards and Glysson, 1999, and older references cited therein). For bedload-sediment sampling we first establish the active-bed width by observation and/or preliminary sampling, then sample within that portion of the creek. For suspended-sediment sampling, we use two sampling methods depending on conditions; both methods are used and endorsed by the USGS to collected suspended-sediment samples that are representative of the mean sediment concentration of a stream. The two methods are the equal-discharge-increment method (EDI) and the equal-width-increment method (EWI) (Edwards and Glysson, 1999). With both methods we collect depth-integrated samples at multiple verticals across the creek.

Bedload samples are dried and weighed at Balance's office. Suspended-sediment samples are analyzed by Soil Control Lab in Watsonville, California, a state-certified laboratory.

5.3 Developing and using Sediment-rating Curves

The principal purpose of the sediment sampling is to develop an annual empirical relationship of the amount of sediment transported at a given flow. These "sediment-rating curves" (see Figures 6, 7 and 8) are the basis for calculating the volume of sediment transported by the creek past the gaging station for each 15-minute period and hence for each day (see Section 5.4).

The rating curves are also diagnostic of the processes of sediment movement through the stream system. As the position of the curve changes, a different relationship between streamflow and sediment transport is expressed, indicating limitations or increases in sediment supply (c.f., Hecht and Owens, 2006). Sediment transport at a given flow may change over short periods, such as during rising and receding hydrograph limbs, and will also generally change whenever watershed or channel conditions upstream make sediment more or less available for mobilization. Distinguishing when changes affect the nature or position of the sediment-rating curve is a key decision to be made by experienced professionals who regularly observe the channel and maintain familiarity with the watershed; distinguishing when to shift or develop a new sediment-curve is an essential basis for valid calculation of sediment yield (c.f., Benson and Dalrymple, 1967; Hecht, 1983; Hecht and Owens, 2006).

We do not have measurements of sediment transport at very high flows (above 1,620 cfs), yet this is when much of the sediment may be transported in high-flow years. Unless data clearly indicate otherwise, to estimate sediment transport at high flows, we extend the sediment-rating curves using the same slopes as calculated from lower-flow data, a relationship empirically verified during prior years of sampling. Extension to higher flows at rating-curve slopes observed in prior years is a customary and widely used practice. Sediment-transport rates at high flows are therefore considered to be at the reconnaissance level, and are preliminary and subject to revision.

5.3.1 Discussion of bedload sediment

In Figures 6 and 7, the location of the plotted rating curves is an indicator of the mobility of bedload for the period that a curve represents. The lower on the graph that the rating curve plots, the lower bedload sediment transport (or more precisely, 'delivery') has been, at a given flow.

Bedload-transport measurements from water years 1995 through 2010 are plotted in Figure 7. The bedload-sediment rating curve shown for water year 2010 seems to represent a similar rate of transport at a given flow when compared with those previous data. Slight adjustments were made to the curve for water year 2010. This comparison is a major purpose of the bedload measurement program; we are finding that the position of the rating curve may be a useful indication of bed conditions in San Geronimo and portions of Lagunitas Creeks.

At lower flows (less than 100 cfs), sediment-transport rates seem similar to those observed last year and within the mid-range of previous data, but remain well above the levels observed between 1996 and 2002 (Hecht and others, 2009).

5.3.2 Discussion of suspended sediment

Suspended-sediment measurements were carried out during water year 2010. The measurements are detailed in Table 2 and plotted in Figures 6 and 8. Suspended-sediment data collected during 2010 were at similar concentrations at a given flow when compared to previous years. Figure 6 shows that suspended-sediment discharge is generally greater than bedload discharge, a typical condition for San Geronimo Creek. Figure 6 also shows the expected relationships at low flows (less than 40 cfs); we have observed sediment in suspension (visual turbidity) when bedload is not moving.

5.4 Creating a Continuous Record of Sediment-discharge Rates

Because we have represented our sediment measurements as a function of flow (Figures 6, 7, and 8), we then can use the continuous flow record (15-minute intervals) in conjunction with the sediment-rating curves to create continuous records of sediment discharge. The sediment-rating curves shown in Figure 6 are the "sediment-discharge" functions that we apply to the continuous flow record. This continuous record of sediment discharge is vastly simplified from the many individual events, processes, and occurrences that influence the actual discharge of sediment, but experience has shown it to be a useful and reasonably accurate approximation of this complex reality (c.f., Edwards and Glysson, 1999; Emmett, 1980). This record can serve as a useful tool for year-to-year comparisons. The interpolation from our manual measurements to a continuous record allows us to calculate daily and annual estimates of sediment yield (Form 2 and Table 3).

5.5 Reconnaissance-level Sediment-Yield Estimates

One of our purposes in sampling sediment at this site is to compare sediment-discharge rates as a function of flow in the stream and to detect long-term trends, as in Figures 6 through 8. Nonetheless, we have developed preliminary estimates of sediment discharge from San Geronimo Creek to have been approximately 270 tons of bedload and 920 tons of suspended sediment in water year 2010 (Form 2 and Table 3). Because the number of samples can limit the precision of the results, we developed this pair of reconnaissance-level estimates solely to compare sediment yields under present watershed conditions with the annual average sediment yield computed for conditions prevailing during previous years at this station, using either similar reconnaissance-, or more precise, full-scale methods.

The annual sediment totals that we calculate depend on three main factors: 1) the magnitude of the peak flow of the water year, 2) the amount of total streamflow during the water year, and 3) the relative position of the sediment-rating curves (high vs. low for a given flow). During water year 2010, the peak flow was low, the total flow was average, and the rating curves were in the middle range of previous data.

We emphasize that the sediment data and totals are approximate, due to the irregular and supply-driven nature of sediment discharge in small coastal streams. It is not intended that the yearly estimates of bedload discharge presented above substitute for a full-scale bedload discharge-rate investigation (such as we conducted during the early 1980’s) when nearly every storm is to be sampled. Preparation of long-term reconnaissance sediment yield estimates is of necessity done with caution and with the detailed knowledge associated with individual samplings and storm periods. Our recent work has shown that the sediment-rating curves can be a useful, sensitive, and early indicator of bed conditions during the subsequent summer in Lagunitas Creek, immediately downstream (Hecht and others, 2008; 2009).

6. FUTURE MONITORING

MMWD has decided to suspend stream gaging and sediment-transport monitoring on San Geronimo Creek for water year 2011. Balance may perform just enough field visits to maintain the equipment at the site, and collect basic data from which skeletal records might be able to be developed at a later date should monitoring resume in the near future.

Please contact us if you can contribute any observations or measurements, have data that can guide revisions, or have questions concerning this work.

7. REFERENCES

Benson, M.A. and Dalrymple, T., 1967. General field and office procedures for indirect discharge measurements. U. S. Geological Survey techniques of water-resources investigations, Book 3, Chapter A8

Edwards, T.K., and Glysson, G.D., 1999, Field methods for measurement of fluvial sediment: Techniques of water-resource investigations of the U.S. Geological Survey. Chapter C2, Book 3, Applications of Hydraulics, U.S. Department of the Interior, Reston, Virginia. (See also techniques and criteria described in older USGS TWRI manuals cited and subsumed in this report.)

Emmett, W. W., III, 1980, A field calibration of the sediment-trapping characteristics of the Helley-Smith bedload sampler : U.S. Geological Survey Open-File Report 79-411, 48 p.

Hecht, B., 1983, Substrate enhancement / sediment management study. Lagunitas Creek, Marin County, Phase IIIb -- sediment transport and bed conditions, 1979-1982: HEA consulting report prepared for the Marin Municipal Water District, 172 p + appendices.

Hecht, B., and Owens, J., 2006, Evaluating sediment discharge in unregulated streams tributary to San Francisco and Suisun Bays. Presented at CALFED Bay-Delta Science Conference, Sacramento, Ca., October 23-25. Abs., Proceedings of the Bay-Delta Science Conference, 2006.

Hecht, B., Shaw, D., Owens, J., Woyshner, M.R., and Austensen, E., 2008, Sediment-rating curves as rigorous quantitative baselines for evaluating changes in habitat-impairing sediment: Am. Fish Soc. CalNeva Chapter Annual Meeting, Tahoe City, CA, Abstracts with programs.

Hecht, B., Strudley, M., and Brown, S., 2009, Streambed monitoring report, 1995-2007, Lagunitas Creek sediment and riparian management plan, Marin County, California: Balance Hydrologics, Inc., consulting report prepared for the Marin Municipal Water District, 64 p. + 6 appendices

Owens, J., and Hecht, B., 2010. Annual Hydrologic Record and Sediment-Transport Measurements for San Geronimo Creek at Lagunitas Road, Marin County, California: Data Report for Water Year 2009. Consulting report prepared for Marin Municipal Water District. 16p.

Rantz, S.E., 1971, Precipitation depth-duration frequency relations: San Francisco Bay region, California. Basic data contribution No. 25. U.S. Department of the Interior Geological Survey, U.S. Department of Housing and Urban Development Research and Technology.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow: Volume 1. Measurement of stage and discharge. Geological Survey Water-Supply Paper 2175. U.S. Government Printing Office, Washington, D.C.

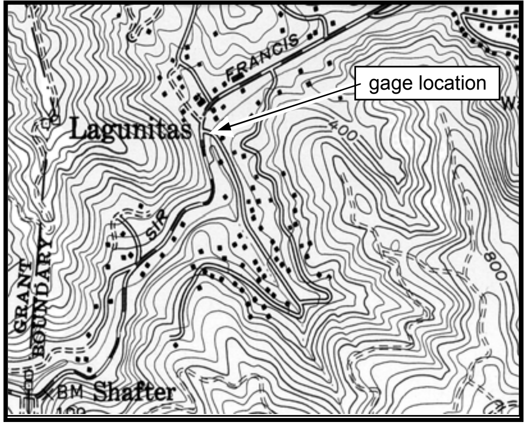
Shaw, D., Owens, J., and Hecht, B., 2007, Annual hydrologic record and bedload-sediment transport measurements for San Geronimo Creek at Lagunitas Road bridge, Marin County, California: Data report for water years 2002-2005. Balance Hydrologics consulting report prepared for the Marin Municipal Water District, 13 p + forms, tables and figures.

FORMS

Water Year:	**2010**
Stream:	**San Geronimo Creek**
Station:	**at Lagunitas Road bridge (K4)**
County, State:	**Marin County, California**

Form 1. Annual Hydrologic Record

Map



Station Location / Watershed Descriptors

Latitude: 36 00' 40", Longitude: 122 42' 02" in Rancho San Geronimo at Lagunitas. The gage is at Lagunitas Road bridge. Land use includes open space, golf course, pasture, and low- to medium-density residential uses in valleys. Drainage area upstream of gage is 8.7 sq. miles.

Mean Daily Flow

Mean daily flow (MDQ) for WY 2009 is 6.7 cfs; MDQ WY'08 = 10.8 cfs; MDQ WY'07 = 6.4 cfs.
Mean annual flow (MAQ) is 15.4 cfs (based on 28 years of record; WYs 1980 to 2009).

Peak Flows

Date	Time	Peak Stage (feet)	Discharge (cfs)	Date	Time	Peak Stage (feet)	Discharge (cfs)
10/13/09	16:15	6.80	225	2/6/10	5:45	6.08	166
1/18/10	12:15	8.39	481	2/24/10	0:30	7.48	349
1/19/10	7:15	7.85	389	2/26/10	15:30	6.41	201
1/20/10	**9:30**	**9.01**	**640**	3/3/10	5:30	6.41	202
1/21/10	17:00	7.0	287	4/4/10	18:00	7.28	317
1/25/10	19:15	6.52	220	4/11/10	15:15	7.54	356

Peak flow at this station for the period of gaging record was 3,940 +/- 400 cfs, 12/31/2005.
Another high flow at this station for the period of gaging record was 3,800 +/- 300 cfs, 1/4/1982.

Period of Record

Staff plate and crest gage installed 11/17/79. Electronic water-level recorders were installed 10/22/97 (left bank), then 3/20/06 (right bank). Monitoring sponsored by Marin Municipal Water District.

WY 2010 Mean Daily Flow in cubic feet per second (cfs)

	DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
	1	0.04	0.60	0.82	3.31	18.21	26.55	15.40	9.38	2.98	1.01	1.05	0.24
	2	0.03	0.58	0.81	3.17	15.94	65.45	29.09	8.53	2.77	0.98	1.02	0.22
	3	0.03	0.60	0.81	2.82	14.41	108.09	25.38	7.70	2.67	0.92	1.02	0.19
	4	0.04	0.65	0.81	2.50	53.41	57.10	85.09	7.32	2.64	0.86	0.99	0.16
	5	0.04	0.82	0.82	2.24	74.89	35.64	63.62	6.36	2.51	0.83	0.89	0.17
	6	0.03	0.98	0.90	2.04	71.94	26.50	30.36	6.20	2.41	0.88	0.82	0.17
	7	0.03	0.94	1.43	1.88	39.56	20.84	22.07	5.80	2.39	0.89	0.73	0.15
	8	0.03	0.95	0.94	1.78	28.50	17.14	17.61	5.48	2.33	0.89	0.68	0.17
	9	0.03	0.91	0.82	1.72	34.76	14.78	14.75	5.37	2.25	0.89	0.66	0.20
	10	0.03	0.88	0.85	1.63	25.74	16.05	12.96	5.78	2.15	0.86	0.59	0.19
	11	0.03	0.89	1.70	1.55	21.69	12.77	141.45	5.31	2.07	0.84	0.58	0.18
	12	0.03	0.86	8.59	19.96	23.21	32.73	126.80	4.90	1.96	0.85	0.58	0.18
	13	52.93	0.82	39.00	24.28	21.08	27.45	47.97	4.55	1.84	0.87	0.56	0.19
	14	6.38	0.78	11.34	11.86	18.48	20.32	29.94	4.28	1.75	0.82	0.54	0.18
	15	1.66	0.72	5.94	8.11	16.43	17.06	22.66	4.07	1.72	0.77	0.52	0.18
	16	0.96	0.69	9.36	7.18	14.59	14.75	18.16	3.97	1.67	0.76	0.51	0.18
	17	0.73	0.71	6.99	17.00	13.18	13.22	15.21	4.76	1.59	0.76	0.49	0.20
	18	0.68	0.73	5.03	169.52	12.07	12.01	13.33	4.78	1.54	0.78	0.47	0.21
	19	16.36	0.69	3.92	198.74	11.18	10.67	11.93	4.08	1.53	0.77	0.46	0.22
	20	7.74	2.00	3.21	245.39	10.33	9.68	18.32	3.77	1.50	0.85	0.47	0.21
	21	3.02	1.19	3.50	201.48	10.13	8.96	13.00	3.61	1.42	0.89	0.45	0.20
	22	1.80	0.87	3.25	122.11	9.62	8.46	11.41	3.44	1.32	0.93	0.42	0.19
	23	1.31	0.80	2.66	63.64	52.34	7.94	9.98	3.29	1.27	0.95	0.38	0.20
	24	1.06	0.79	2.34	38.18	152.36	7.59	9.06	3.14	1.26	0.94	0.35	0.19
	25	0.91	0.82	2.09	117.14	42.01	7.82	8.39	3.75	1.29	0.95	0.31	0.17
	26	0.81	0.80	2.88	116.42	65.93	7.01	7.82	4.12	1.18	0.99	0.30	0.17
	27	0.83	0.71	4.36	54.27	60.06	6.51	19.08	7.33	1.07	1.09	0.30	0.18
	28	0.77	0.77	3.34	33.85	36.34	6.23	14.59	5.02	1.02	1.04	0.28	0.15
	29	0.71	0.80	3.10	28.35		6.88	11.85	3.95	0.98	1.00	0.28	0.14
	30	0.66	0.82	4.92	26.45		8.84	10.36	3.47	0.98	1.01	0.25	0.13
	31	0.63		3.74	21.17		14.53		3.16		1.04	0.27	
Monthly	MEAN	3.24	0.84	4.53	49.99	34.58	20.96	29.25	5.05	1.80	0.90	0.55	0.18
	MAX	52.93	2.00	39.00	245.39	152.36	108.09	141.45	9.38	2.98	1.09	1.05	0.24
	MIN	0.03	0.58	0.81	1.55	9.62	6.23	7.82	3.14	0.98	0.76	0.25	0.13
	cfs days	100.3	25.2	140.3	1549.8	968.4	649.6	877.6	156.7	54.1	27.9	17.2	5.5
	ac-ft	199	50	278	3074	1921	1288	1741	311	107	55	34	11

Monitor's Comments

1. Data collection was continuous for the entire water year.
2. Starting in water year 2007 the stage datum references the staff plate on the north side of the creek. The new, north-bank staff plate reads about 4.0 feet higher than the old staff plate.
3. Multiple stage shifts were applied to account for scour and fill, as well as leaf dams.
4. Peak flows are based on the 15-minute electronic record.
5. Values with more than 2 or 3 significant figures are the result of calculations; no additional precision is implied.

Water Year 2010		
Mean Daily Flow	**12.5**	(cfs)
Max. Daily Flow	**245**	(cfs)
Min. Daily Flow	**0.03**	(cfs)
Total Flow	**4,573**	(cfs-days)
Total Flow	**9,070**	(ac-ft)

Balance Hydrologics, Inc., 800 Bancroft Way, Suite 101, Berkeley, CA 94710 phone:(510) 704-1000 fax:(510) 704-1001
www.balancehydro.com

Water Year: 2010
Stream: San Geronimo Creek
Station: Lagunitas Road bridge (K4)
County: Marin County, CA

Form 2. Annual Sediment-Discharge Record

Daily Suspended-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	0.0	0.2	0.5	0.1	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.1	6.8	1.4	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.1	19.7	0.5	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0	14.9	3.4	32.1	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	8.2	1.0	5.2	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	7.4	0.5	0.7	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	1.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.6	0.2	0.2	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	1.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	0.0	0.3	0.1	83.2	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.3	0.3	1.4	28.9	0.0	0.0	0.0	0.0	0.0	
13	11.2	0.0	2.0	0.4	0.3	0.5	2.2	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.1	0.1	0.2	0.2	0.7	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	93.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
19	0.7	0.0	0.0	105.4	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	207.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	80.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	23.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	4.5	23.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	1.2	64.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.0	28	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	21.1	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	3.0	3.8	0.0	0.3	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.9	1.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.6		0.0	0.1	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	0.0	0.5		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
31	0.0		0	0.3		0.2		0.0		0.0	0.0		**Annual**
TOTAL	12	0	2	570	141	36	157	0	0	0	0	0	**918**
Max.day	11	0	2	207	65	20	83	0	0	0	0	0	**207**

Daily Bedload-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.0	2.1	0.2	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	4.6	0.5	9.7	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	2.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	0.0	0.0	0.0	24.6	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.0	0.0	0.2	9.5	0.0	0.0	0.0	0.0	0.0	
13	3.4	0.0	0.4	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	27.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.1	0.0	0.0	31.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	58.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	24.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.8	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.1	19.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.0	9.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	7.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
31	0.0		0.0	0.0		0.0		0.0		0.0	0.0		**Annual**
TOTAL	3	0	0	168	40	10	46	0	0	0	0	0	**267**
Max.day	3	0	0	59	19	7	25	0	0	0	0	0	**59**

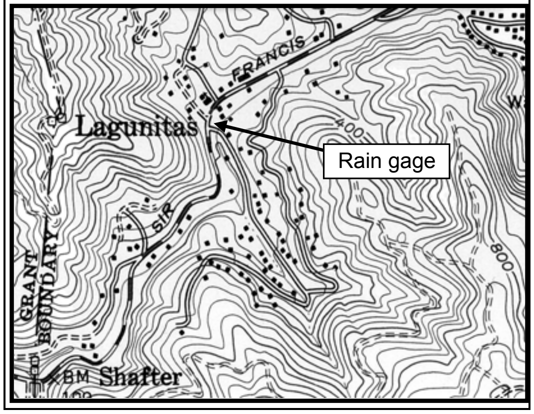
Daily values are based on calculations of sediment discharge at 15-minute intervals.
Multiple sediment-discharge rating curves were used for different periods of the year and ranges of flow.
Daily values with more than 2 to 3 significant figures result from electronic calculations. No additional precision is implied.

Total annual sediment discharge
(suspended plus bedload sediment)
WY 2010: 1,185 ***tons***

Balance Hydrologics, Inc., 800 Bancroft Way, Suite 101, Berkeley, CA 94710 phone:(510) 704-1000 fax:(510) 704-1001

Form 3. Annual Rainfall Record: San Geronimo Creek at Lagunitas

Water Year: **2010**
Watershed: San Geronimo Creek
Station: Lagunitas Road bridge
County, State: Marin County, CA
Station Location Map:



Station Location / Watershed Descriptors

Located on a telephone pole at the north side of the Lagunitas Road bridge
Latitude: 36 00' 40", Longitude: 122 42' 07"
Elevation: 239 feet

Period of Record

6-inch, tipping-bucket rain gauge installed March 2006
Sponsored by Marin Municipal Water District

Peak Daily Rainfall and **Peak Rainfall Intensity**

Date	Daily total (in)
10/13/09	**4.92**
1/18/10	1.74
1/19/10	1.65
1/20/10	1.95
2/23/10	2.34
4/11/10	2.77

Date	Max. Hourly Intesity (in/hr)
10/13/09	**0.85**
1/12/10	0.42
1/19/10	0.58
2/23/10	0.40
2/26/10	0.62
4/11/10	0.40

Water Year 2010 Daily Total Rainfall (inches)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.00	0.01	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.04	0.00	1.14	1.24	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.08	1.03	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	1.46	0.01	1.28	0.00	0.00	0.00	0.00	0.00
5	0.00	0.05	0.00	0.00	0.22	0.00	0.11	0.00	0.00	0.00	0.00	0.00
6	0.00	0.12	0.23	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.01	0.12	0.07	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.54	0.16	0.00	0.05	0.00	0.00	0.00	0.00
10	0.00	0.00	0.07	0.00	0.00	0.20	0.04	0.27	0.00	0.00	0.00	0.00
11	0.00	0.00	0.84	0.00	0.32	0.00	2.77	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	1.11	1.63	0.33	1.22	0.20	0.00	0.00	0.00	0.00	0.00
13	4.92	0.00	0.97	0.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.01	0.00	0.61	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.01	0.04	0.01	0.89	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00
18	0.01	0.01	0.00	1.74	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00
19	0.65	0.00	0.00	1.65	0.00	0.00	0.04	0.01	0.00	0.00	0.00	0.00
20	0.00	0.66	0.14	1.95	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.01
21	0.00	0.00	0.35	1.27	0.21	0.00	0.01	0.00	0.00	0.00	0.00	0.00
22	0.01	0.04	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.32	2.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.01	0.00	0.01	0.16	0.64	0.21	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	1.63	0.00	0.05	0.00	0.71	0.00	0.00	0.00	0.00
26	0.00	0.00	0.46	0.30	1.16	0.00	0.00	0.01	0.00	0.00	0.00	0.00
27	0.00	0.03	0.03	0.00	0.33	0.00	1.31	0.80	0.00	0.00	0.00	0.00
28	0.00	0.00	0.01	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.42	0.49		0.65	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.01	0.01		0.26	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00		0.01	0.00		0.80		0.00		0.00	0.00	
Total	5.83	0.96	5.45	13.18	8.18	5.81	7.86	2.75	0.00	0.00	0.00	0.01
Max	4.92	0.66	1.11	1.95	2.34	1.22	2.77	0.80	0.00	0.00	0.00	0.01

Notes and comments:
The rain gauge became clogged on 10/13/2009. The amount of rainfall was corrected by the volume of water found in the funnel of the rain gauge on 11/5/09. The pattern of rainfall was correlated a nearby rain gauge that Balance operates.

Water Year 2010

Total Annual	50.03	(inches)
Maximum Daily Total	4.92	(inches)

TABLES

Table 1. Stream gaging observer log:
San Geronimo Creek at Lagunitas Road bridge, water year 2010

Site Conditions					*Streamflow*				*Water Quality Observations*				*High-Water Marks*		*Remarks*
Date/Time (observation time)	Observer	Stage (left bank)	Stage (right bank)	Hydrograph	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Additional sampling?	Estimated stage at left-bank staff plate	Inferred dates?	
(mm/dd/yr)		*(feet)*	*(feet)*	*(R/F/S/B)*	*(cfs)*		*(AA/PY)*	*(e/g/f/p)*	*(oC)*	*(µmhos/cm)*	*(at 25 oC)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
9/22/09 17:00	jo	…	3.915	B	…	0.05	visual	p	17.6	362	422	DO	…	…	low flow very difficult to measure, measurements deemed invalid, so estimated flow is reported; DO = 49%; water clear, many leaf dams
11/5/09 15:47	tb, sr	0.09	4.06	B, R	0.96	1.0	PY	f	13.0	327	425	…	2.3, 0.11	Oct. 13, today	rain today, increasing; cleaned rain gauge
12/9/09 17:00	mw	0.18	…	F, B	0.83	…	PY	f	…	…	…	…	too dark		leaf dam across creek below bridge
1/18/10 13:05	mw, gp	4.00	…	F	…		…	…	…	…	…	3 Qss, 3 Qbed	…	…	bridgeboard; left-bank stage fell from 4.4 ft. at 11:00 to 3.1 ft. at 14:40
1/20/10 11:35	mw, gp	3.70	…	F	…		…	…	12.0	95	129	2 Qss, 2 Qbed	…	…	bridgeboard; left-bank stage fell from 4.1 ft. at 11:10 to 3.45 ft. at 12:05
1/26/10 11:30	mw	1.81		F					11	125	175	Qss, Qbed			not too turbid, not much bedload
2/18/10 13:30	gp	0.38	4.34	B	13.03	…	AA	e	11.7	222	297	…	4.1, 2.6	…	water is clear; HWM are on left-bank staff plate
2/24/10 11:00	mw	1.90	…	F	…	…	…	…	12	122	166	Qss, Qbed	2.4	today	recessional HWM at~2.4 feet; seemed to be a higher HWM but not clear
3/19/10 16:00	jo	0.33	4.31	F, B	10.40	…	PY	g	11.8	225	300	…	1.1, 2.3, 4.5	recent, season	many 1-inch fish in creek; water clear
4/5/10 8:45	mw	1.37	…	F	…	70.0	visual	p	…	…	…	Qss, 2 Qbed	…	…	no clear high-water marks
4/6/10 8:05	mw	0.88	…	F	…	35.0	visual	p	9.5	160	233	Qss, Qbed	3.0	4/4/2010	baseflow staying high from two days ago
4/30/10 11:00	jo, sr	0.33	4.32	F, B	10.69	9.0	PY	g	10	212	297	…	4.3, 0.8	season, recent	water mostly clear; some coarse sand on bed between gravels and in lee of rocks
6/2/10 16:30	jo	0.08	4.06	B	2.57	2.5	PY	f, g	11.1	…	…	…	6.1, 1.1, 0.6	season, recent	water clear, no fish seen; pebble casings of bug larva on some rocks
6/29/10 15:55	jo	0.020	3.995	B	0.96	1.2	PY	f,g	17.3	328	382	…	1.0, 2.0	spring	water clear; many 2- to 3-inch fish; leaf and twig dams in staff pool
8/3/10 12:17	gp	0.020	4.00	B	1.07	1.0	PY	f,g	15.6	327	398	…	…	…	water is clear, did not see any fish, leaf dams dowstream of staff plates were not cleared
9/2/10 17:50	mw	0.04	4.02	B	0.19	…	PY	f	18.0	360	419	…	…	…	Leaf dam at riffle crest below gage affecting water level; dam left in place; all riffles have leaf dams.
9/30/10 12:00	mw	0.01	3.99	B	0.14	…	PY	g	15.0	340	427	…	…	…	Leaf dams everywhere. I was careful not to break dam. Cleaned staff plates.

Observer Key: (mw) is Mark Woyshner; (gp) is Gustavo Porras; (jo) is Jonathan Owens, (tb) is Travis Baggett, (sr) is Sarah Richmond
Stage: Water level observed at outside staff plate
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (B
Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual (V
Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) estimated percent accuracy give
High-water mark (HWM): Measured or estimated at location of the staff plate
Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductanc
Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, Nutr = nutrients; other symbols as appropriate

Table 2. Sediment transport measurements:
San Geronimo Creek at Lagunitas Road bridge (K4), water year 2010

	Site Conditions					*Bedload Sampling Details*						*Sediment Transport*			
Sample Date:Time	**Observer(s)**	**Gage Height (left bank)**	**Gage Height (right bank)**	**Stream Discharge**	**Stream Condition**	**Active Bed Width**	**Sampler Width**	**No. of Verts.**	**Time/Vert.**	**Total Time**	**Sample Dry Weight**	**Bedload Discharge Rate**	**Bedload Discharge Rate**	**Suspended Sediment Concentration**	**Suspended Sediment discharge**
		(ft)	*(ft)*	*(cfs)*	*R,F,B, P*	*(ft)*	*(ft)*		*(sec)*	*(sec)*	*(grams)*	*(lb/sec)*	*(tons/day)*	*(mg/L)*	*(tons/day)*
1/18/2010 12:50	mw, gp	4.4	8.4	440	F	…	…	…	…	…	…	…	…	531	630.3
1/18/2010 13:35	mw, gp	3.7	7.7	350	F	22	0.25	5	20	100	616.7	1.197	50.23	…	…
1/18/2010 13:48	mw, gp	3.4	7.4	325	F	22	0.25	5	20	100	342.4	0.664	27.89	…	…
1/18/2010 13:55	mw, gp	3.3	7.3	315	F	…	…	…	…	…	…	…	…	350	297.4
1/18/2010 14:25	mw, gp	3.2	7.2	275	F	…	…	…	…	…	…	…	…	330	244.8
1/18/2010 14:40	mw, gp	3.1	7.1	260	F	20	0.25	5	30	150	1,588.7	1.868	78.42	…	…
1/20/2010 11:15	mw, gp	3.95	7.9	403	F	…	…	…	…	…	…	…	…	408	443.6
1/20/2010 11:35	mw, gp	3.8	7.8	375	F	22	0.25	5	25	125	2,673.0	4.149	174.18	…	…
1/20/2010 11:50	mw, gp	3.6	7.6	355	F	22	0.25	5	25	125	834.3	1.295	54.36	…	…
1/20/2010 12:05	mw, gp	3.45	7.4	338	F	…	…	…	…	…	…	…	…	248	226
1/26/2010 11:30	mw	1.81	5.8	116	F	"not much bedload"					…	…	1	29.4	9
2/24/2010 11:00	mw	1.9	5.9	125	F	19	0.25	5	60	300	989.0	0.55	23.2	30.4	11
4/5/2010 8:50	mw	1.37	5.4	66	F	14	0.25	5	120	600	194.3	0.04	1.7	37.3	7
4/5/2010 9:05	mw	1.36	5.3	64	F	14	0.25	5	120	600	85.0	0.02	0.7	…	…
4/6/2010 8:00	mw	0.88	4.9	32	F	12	0.25	5	240	1200	12.2	0.00	0.04	13.8	1.3

Notes:

Observer Key: (jo) is Jonathan Owens; (mw) is Mark Woyshner; (gp) is Gustavo Porras

Streamflow discharge is the measured or estimated instantaneous flow when sediment was sampled, and usually differs from the mean flow for the day.

Stream Condition: R = rising, F = falling, B = baseflow, P = near peak of storm.

Values for sediment discharge having more than two to three digits displayed are the result of calculations; increased precision is not implied.

Active Bed Width: The width thought by the field observer to be transporting significant amounts of bedload, based on field observations and sampling.

Sampler Width and Type: 0.25 = 3-inch Helley Smith; 0.50 = 6-inch Helley Smith

Bedload Discharge (lbs/sec) = [active bed width (ft) * sample dry weight (gm) * 0.002205 (lbs)]/ [sampler width (ft) * sampling time (sec)]

Bedload Discharge (tons/day) = [active bed width (ft) * sample dry weight (gm) * 86,400 (sec)]/ [sampler width (ft) * sampling time (sec) * 907,200 (gm)]

Value of *0.01* tons/day assigned to observations of "no bedload", so that threshold values of bedload sediment transport can be plotted on a logarithmic axis and estimated.

Table 3. Hydrologic summary for recent water years,
San Geronimo Creek at Lagunitas Road, Marin County, California

	Annual Flow				Precipitation		Sediment Discharge				Peak Flow		
Water Year	Mean Annual Flow	Maximum Daily Flow	Minimum Daily Flow	Total Flow Volume	Annual Rainfall	percent of long-term average	Suspended Sediment	percent suspended	Bedload Sediment	percent bedload	Peak Flow	Peak Stage	Date Time
	(cfs)	(cfs)	(cfs)	(ac-ft)	(inches)		(tons)		(tons)		(cfs)	(ft)	(24-hr)
	period of record commenced November 1979												
1997	14.2	540	0.05	10,315	…		…		…		1,352	7.50	1/1/1997
1998	29.7	570	0.13	21,525	…		…		…		2,049	9.30	2/3/1998 1:30
1999	16.6	575	0.11	12,040	…		…		…		1,103	6.75	2/6/1999 17:00
2000	13.4	558	0.06	9,733	…		…		423		1,150	6.89	2/13/2000 7:15
2001	6.4	158	0.03	4,611	…		…		71		341	2.97	2/21/2001 6:15
2002	11.9	396	0.05	8,590	…		…		3,348		1,595	8.15	12/1/2001 13:00
2003	12.0	391	0.04	8,710	…		…		1,174		1,789	8.68	12/16/2002 3:45
2004	13.6	649	0.04	9,864	…		…		1,612 e		1,648	8.29	12/29/2003 11:00
2005	15.9	510	0.05	11,516	…		2,452	74%	851	26%	1,264	7.03	12/27/2004 5:00
2006	27.3	1094	0.37	19,756	…		26,395	79%	6,874	21%	3,940	12.30	12/31/2005 5:45
2007	6.4	300	0.05	4,638	34.3	75%	433	65%	229	35%	478	8.20*	12/26/2006 18:45
2008	10.7	578	0.01	7,804	38.4	84%	3,072	83%	623	17%	1,664	11.85*	1/4/2008 12:30
2009	6.7	361	0.01	4,873	37.3	82%	664	64%	374	36%	641	9.17*	2/22/2009 14:00
2010	12.5	245	0.03	9,070	50.0	110%	918	77%	267	23%	640	9.01*	1/20/2010 9:30
mean 1980 to 2010	15.3	583	0.10	11,079			5,656	80%	1,423	20%	1,466		
median 1980 to 2010	12.5	540	0.10	9,070			1,685	76%	523	24%	1,350		

Notes:

The period of record for this station is Nov. 1979 to Sept. 2010. Monitoring was not continued for water year 2011.

A "water year" ends on Sept. 30 of the named year. For example, water year 2010 starts Oct.1, 2009, and ends Sept.30, 2010.

For water years 1997, 2004, and 2005 the record was incomplete; annual statistics were calculated using some correlated records.

Daily flow values computed from instantaneous flow calculated at 15-minute intervals. Sediment discharge values totalled from calculations at 15-minute intervals.

* Stage is the staff plate reading; the staff plate is set at an arbitrary datum and does not represent the absolute depth of water in the creek. Starting in water year 2007 we switched datums to a new staff plate on the right (north) side of the creek (looking downstream). The new, right-bank staff plate reads approximately 4.0 feet higher than the old staff plate.

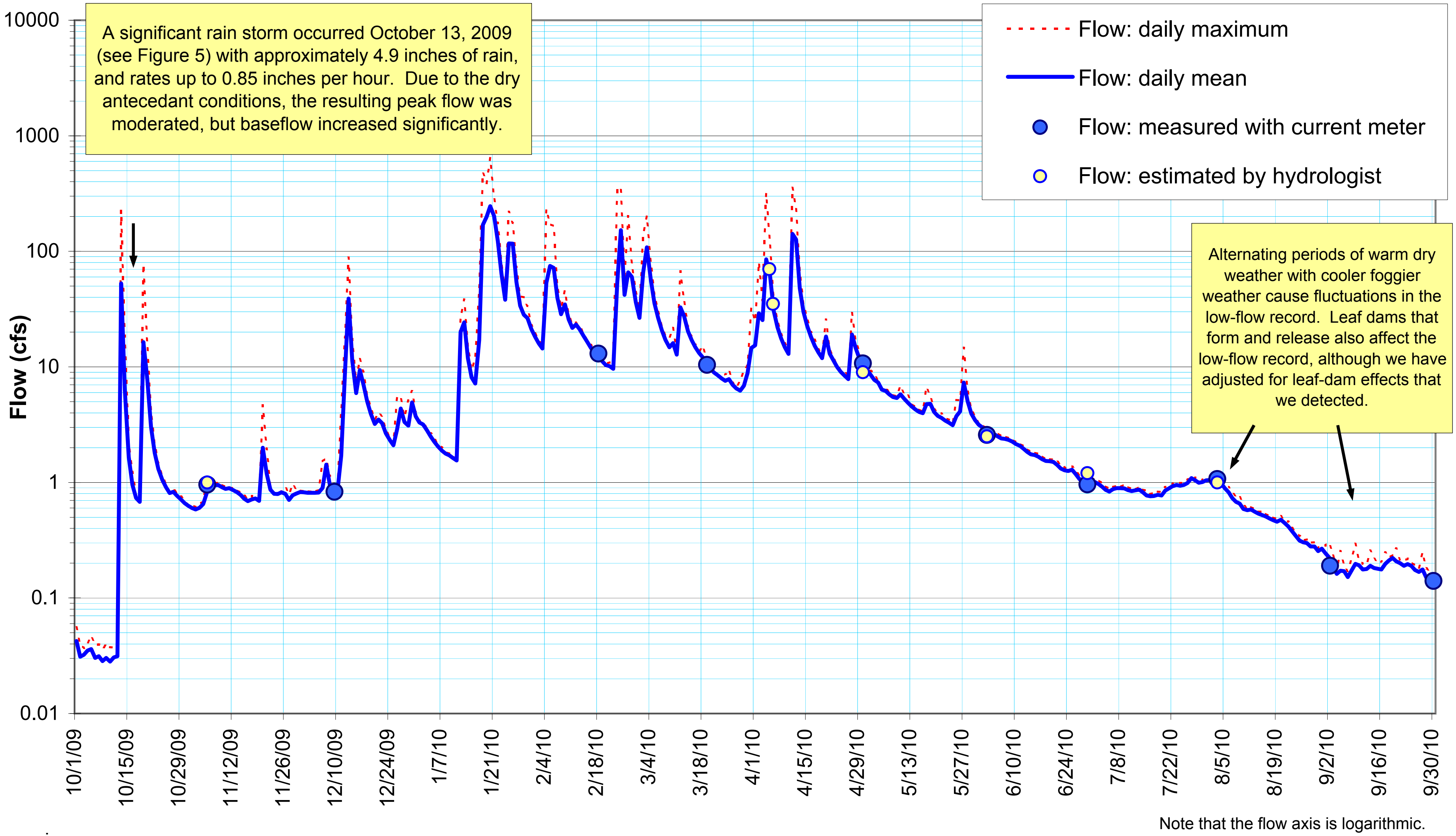
Values displaying more than 2 or 3 significant figures are the result of calculations; no additional precision is implied.

Bedload discharge is based on sampling 4 to 10 times per season, and is for the limited purpose seeking general trends in sediment loads and bed sedimentation over time.

Daily data were not collected during summer 2004. Total flow volumes reported for water years 2004 and 2005 are calculated based on correlated data.

e = Estimated value following partial reactivation of this gage. Data are preliminary, subject to review, and not for publication without consultation.

FIGURES



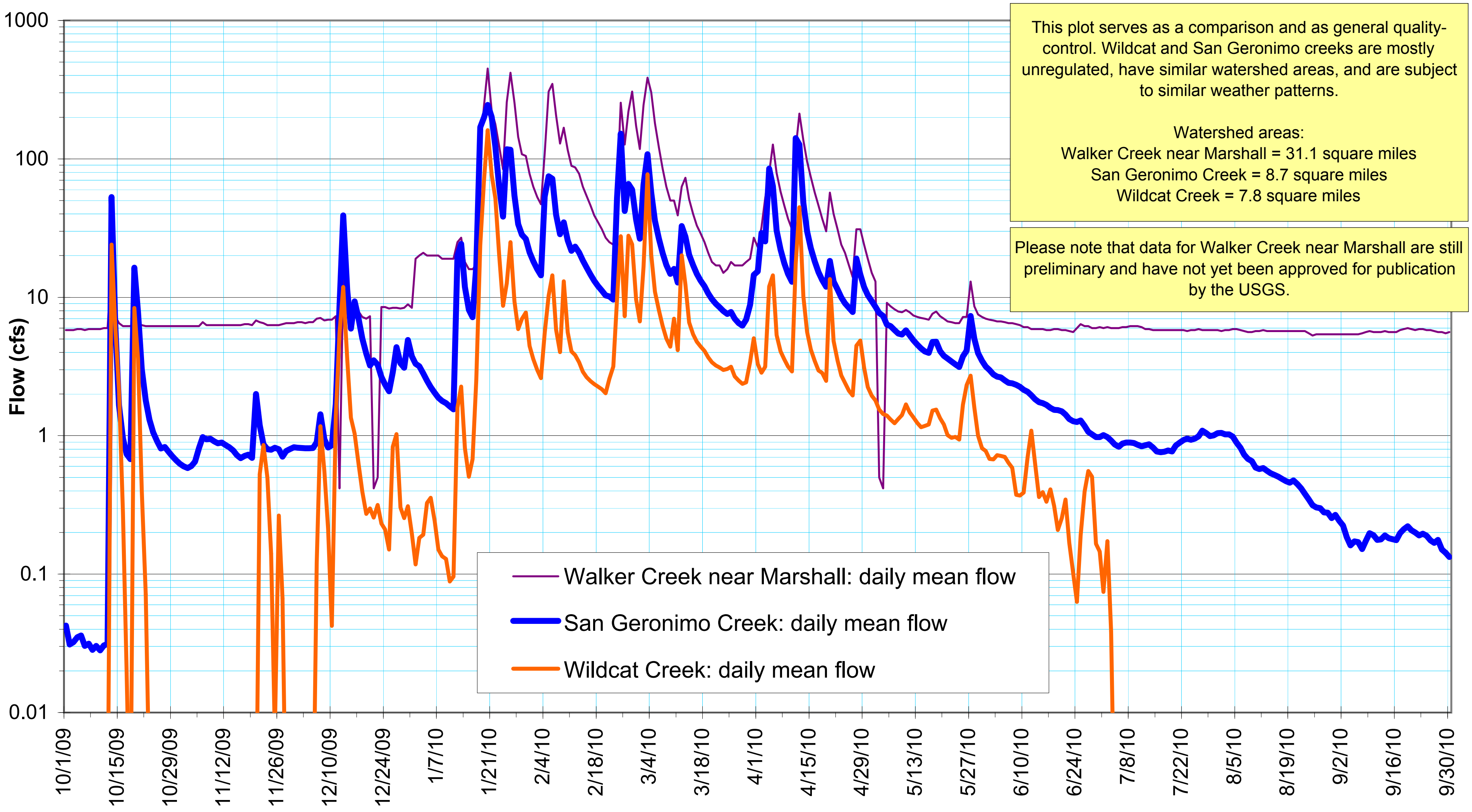
A significant rain storm occurred October 13, 2009 (see Figure 5) with approximately 4.9 inches of rain, and rates up to 0.85 inches per hour. Due to the dry antecedant conditions, the resulting peak flow was moderated, but baseflow increased significantly.

Alternating periods of warm dry weather with cooler foggier weather cause fluctuations in the low-flow record. Leaf dams that form and release also affect the low-flow record, although we have adjusted for leaf-dam effects that we detected.

Note that the flow axis is logarithmic.

Balance Hydrologics, Inc.

Figure 1. Daily flow hydrograph: San Geronimo Creek at Lagunitas Road, water year 2010. The peak flow of approximately 640 cfs occurred January 20, 2010 at 9:30 AM. The flow peak this year was in the low range compared to previous years (see Table 3). Multiple stage shifts have been applied to this record to account for localized scour and fill, and the effects of leaf dams during low flows.



This plot serves as a comparison and as general quality-control. Wildcat and San Geronimo creeks are mostly unregulated, have similar watershed areas, and are subject to similar weather patterns.

Watershed areas:
Walker Creek near Marshall = 31.1 square miles
San Geronimo Creek = 8.7 square miles
Wildcat Creek = 7.8 square miles

Please note that data for Walker Creek near Marshall are still preliminary and have not yet been approved for publication by the USGS.

Note that the flow axis is logarithmic.

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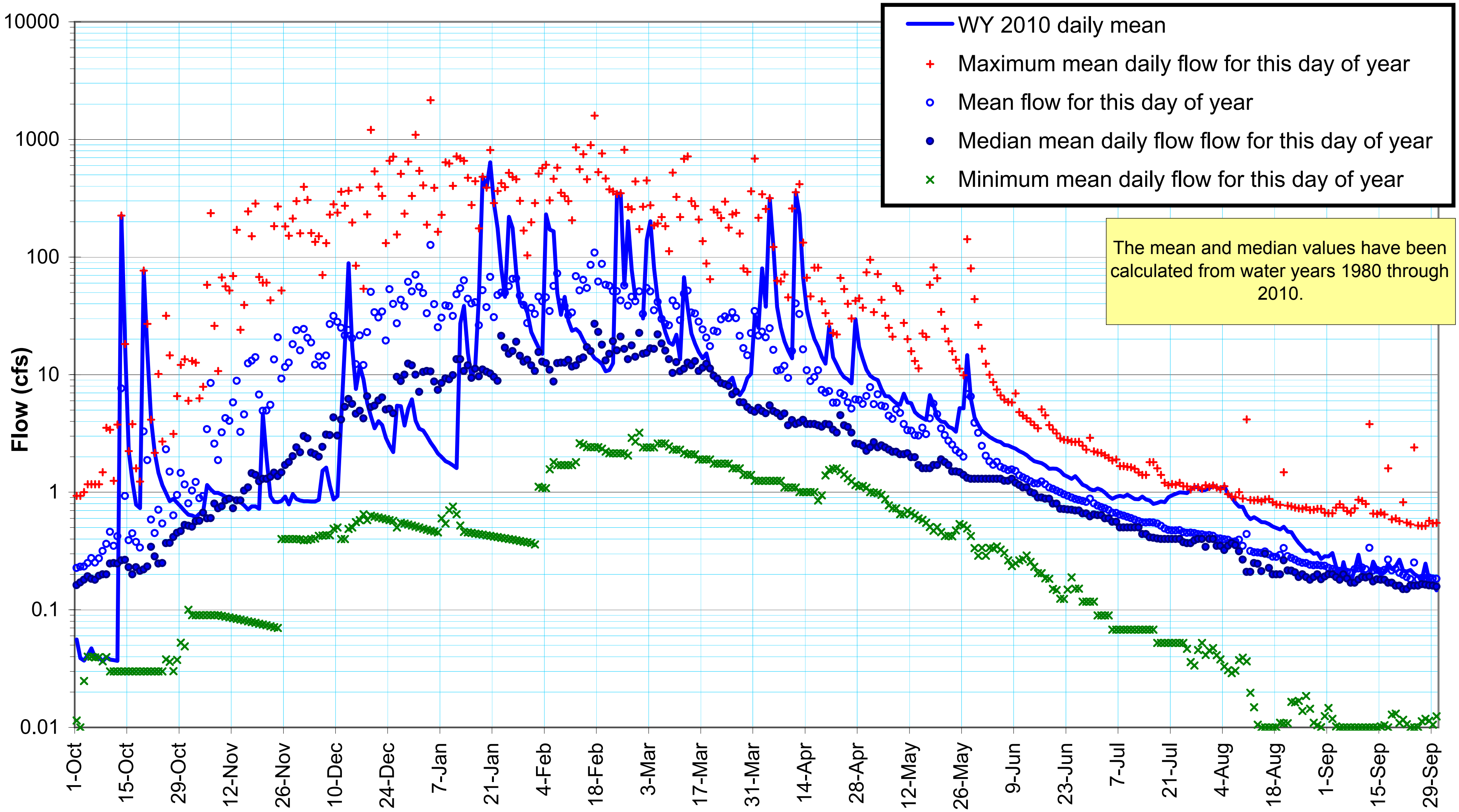
Figure 2. Daily flow comparison: San Geronimo Creek, Walker Creek near Marshall, and Wildcat Creek in Richmond (Contra Costa County), water year 2010. All three creeks behave similarly during winter peaks. Walker Creek receives slightly less rainfall and is affected by Soulajule Resevoir (evident during low-flow dips and the lack of summer recession). Wildcat Creek receives significantly less rainfall and generally has lower baseflows.



The mean and median values have been calculated from water years 1980 through 2010.

Note that the flow axis is logarithmic.

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Figure 3. Flow comparison of water year 2010 to period of record: San Geronimo Creek at Lagunitas Road. Due to several moderate storms and sporadic spring rain, total flow for water year 2010 was slightly above the long-term average and long-term median. San Geronimo Creek has been gaged by Balance staff at this location since November 1979.

8801 K4_WY2010_daily summary, Flow (median) (2)

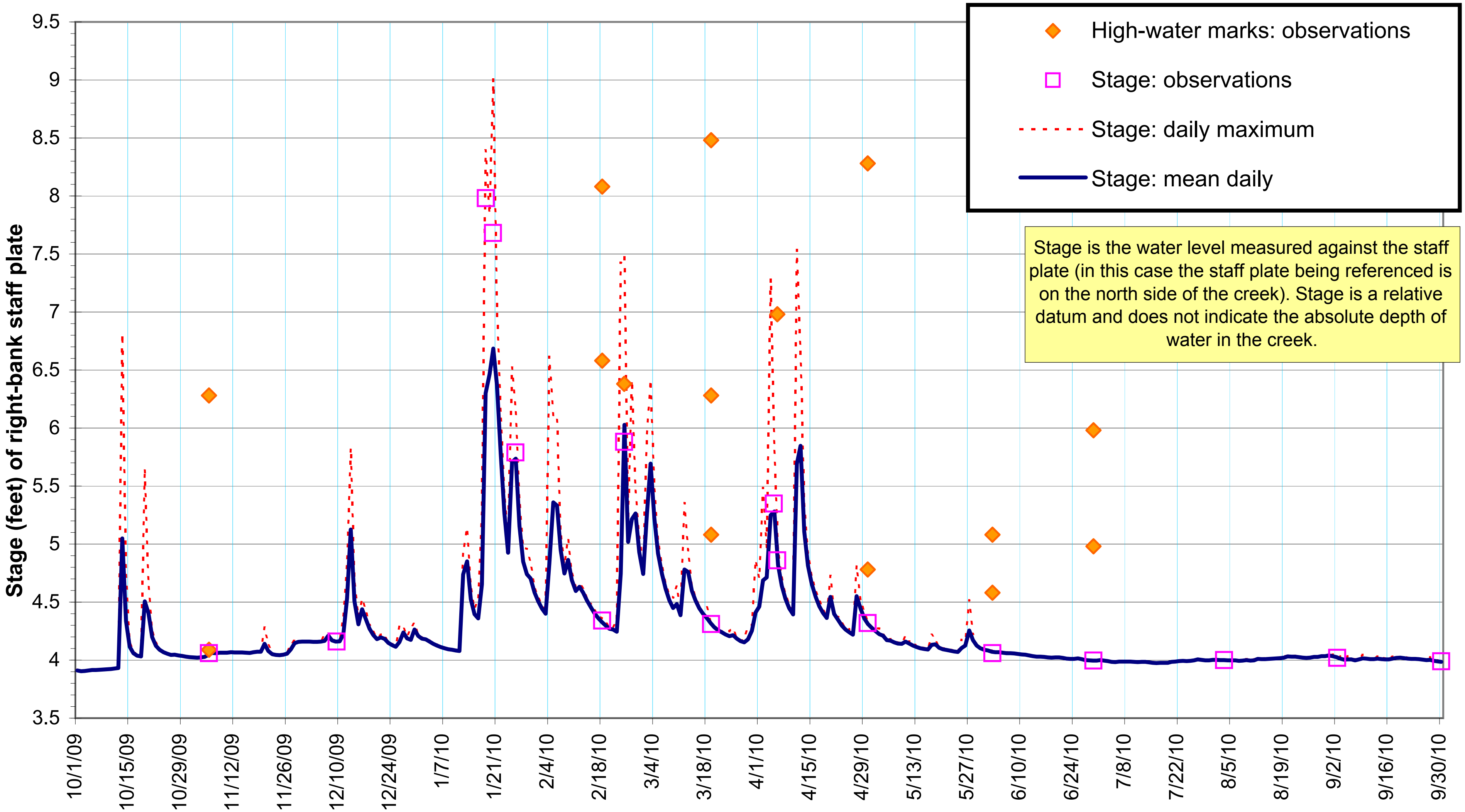

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Figure 4. Daily stage record: San Geronimo Creek at Lagunitas Road, water year 2010. The peak stage of 9.01 feet occurred on January 20, 2010 at 9:30 AM. During low flows, naturally-formed leaf dams can temporarily raise water levels, and regularly occur during the fall and late summer.

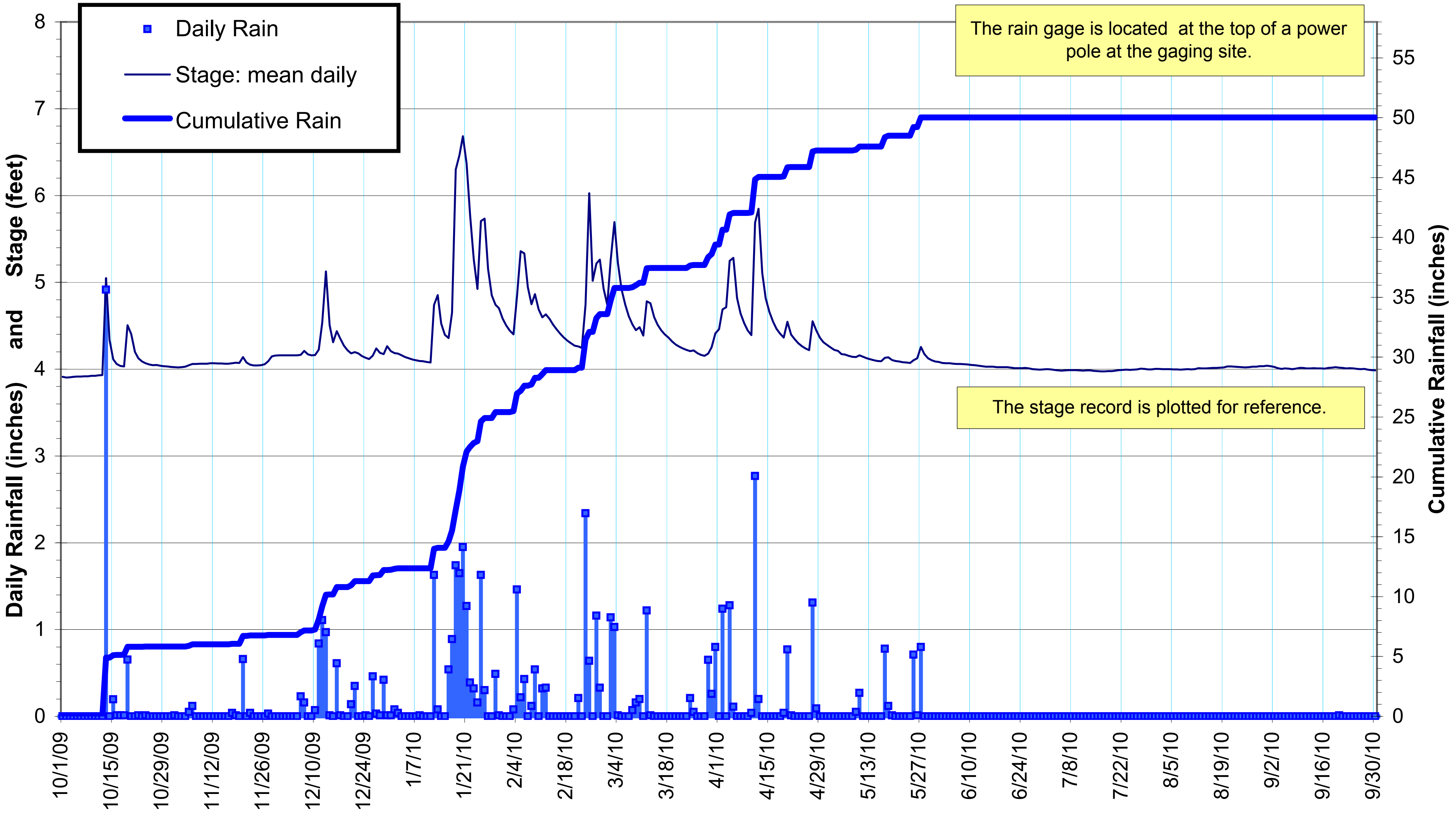

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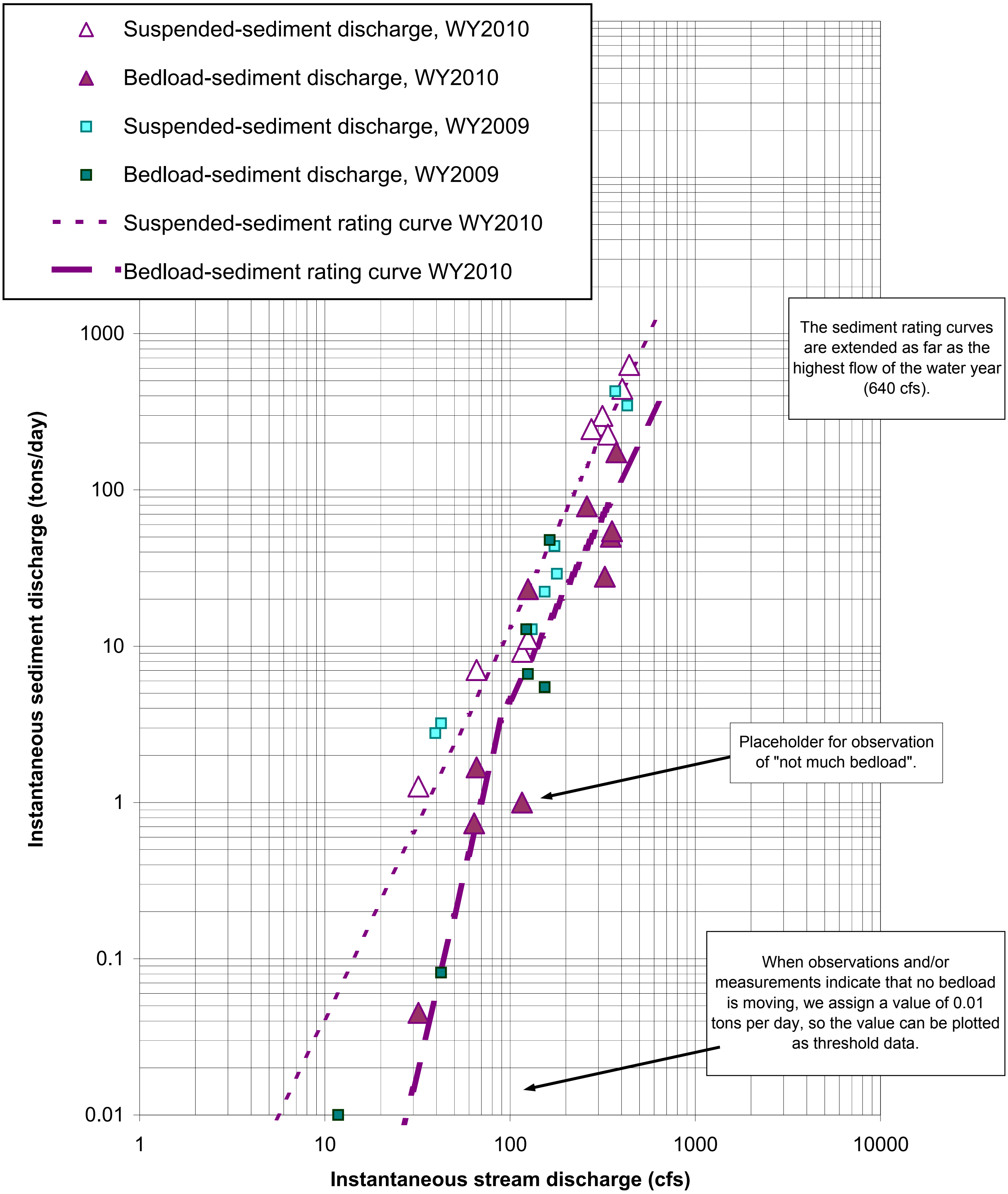
Figure 5. Rainfall record: San Geronimo Creek at Lagunitas Road, water year 2010. The rainfall total for water year 2010 was 50.0 inches, or approximately 110 percent of long-term average precipitation (45 to 46 inches). Water year 2010 is the first above average water year after 3 years in a row with below average rainfall.



The sediment rating curves are extended as far as the highest flow of the water year (640 cfs).

Placeholder for observation of "not much bedload".

When observations and/or measurements indicate that no bedload is moving, we assign a value of 0.01 tons per day, so the value can be plotted as threshold data.

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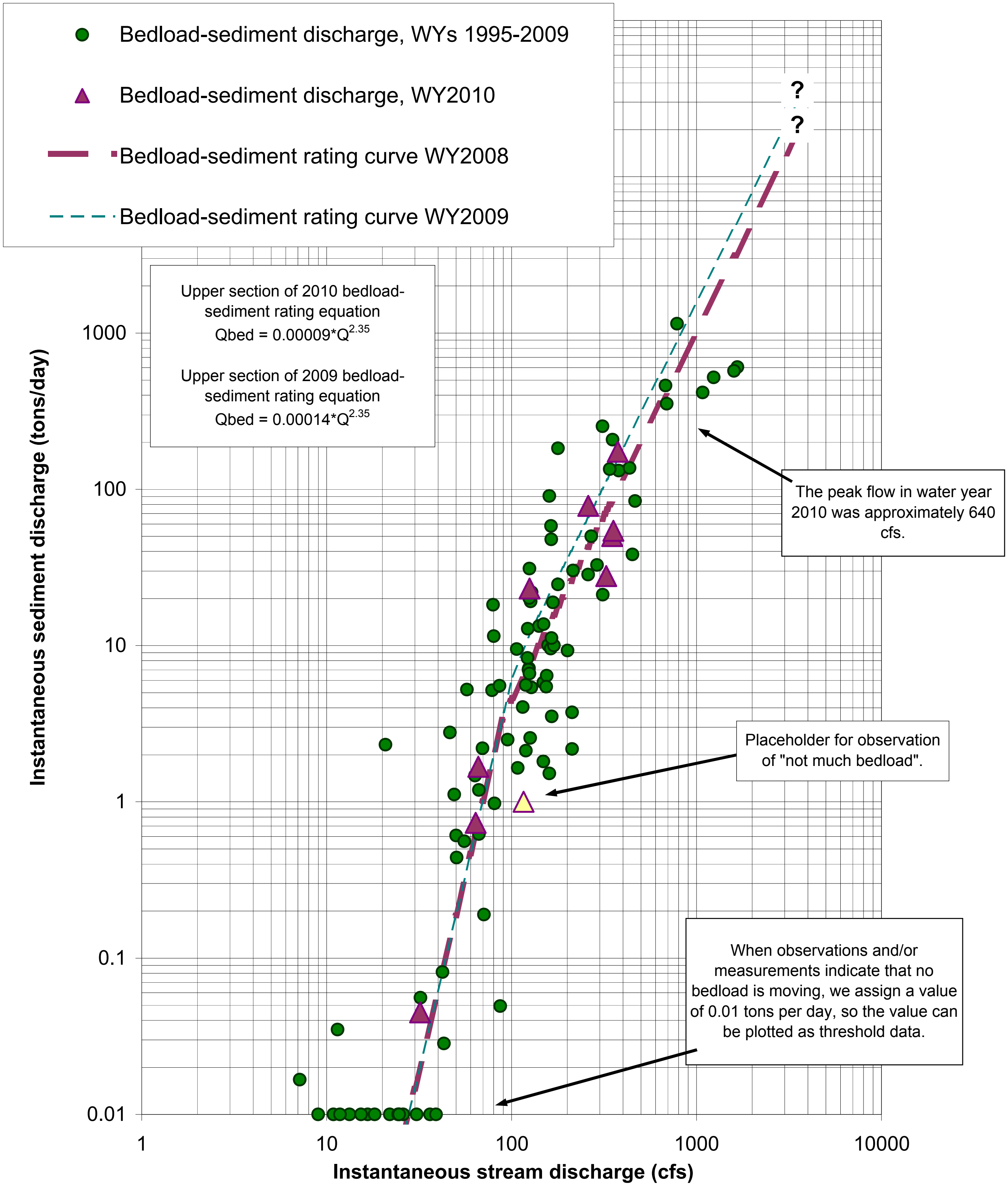
Figure 6. Sediment discharge and rating curves: San Geronimo Creek at Lagunitas Road, water year 2010. These data suggest that more suspended-sediment is moved by the creek than bedload sediment at all flow levels.



Upper section of 2010 bedload-sediment rating equation
Qbed = 0.00009*$Q^{2.35}$

Upper section of 2009 bedload-sediment rating equation
Qbed = 0.00014*$Q^{2.35}$

The peak flow in water year 2010 was approximately 640 cfs.

Placeholder for observation of "not much bedload".

When observations and/or measurements indicate that no bedload is moving, we assign a value of 0.01 tons per day, so the value can be plotted as threshold data.

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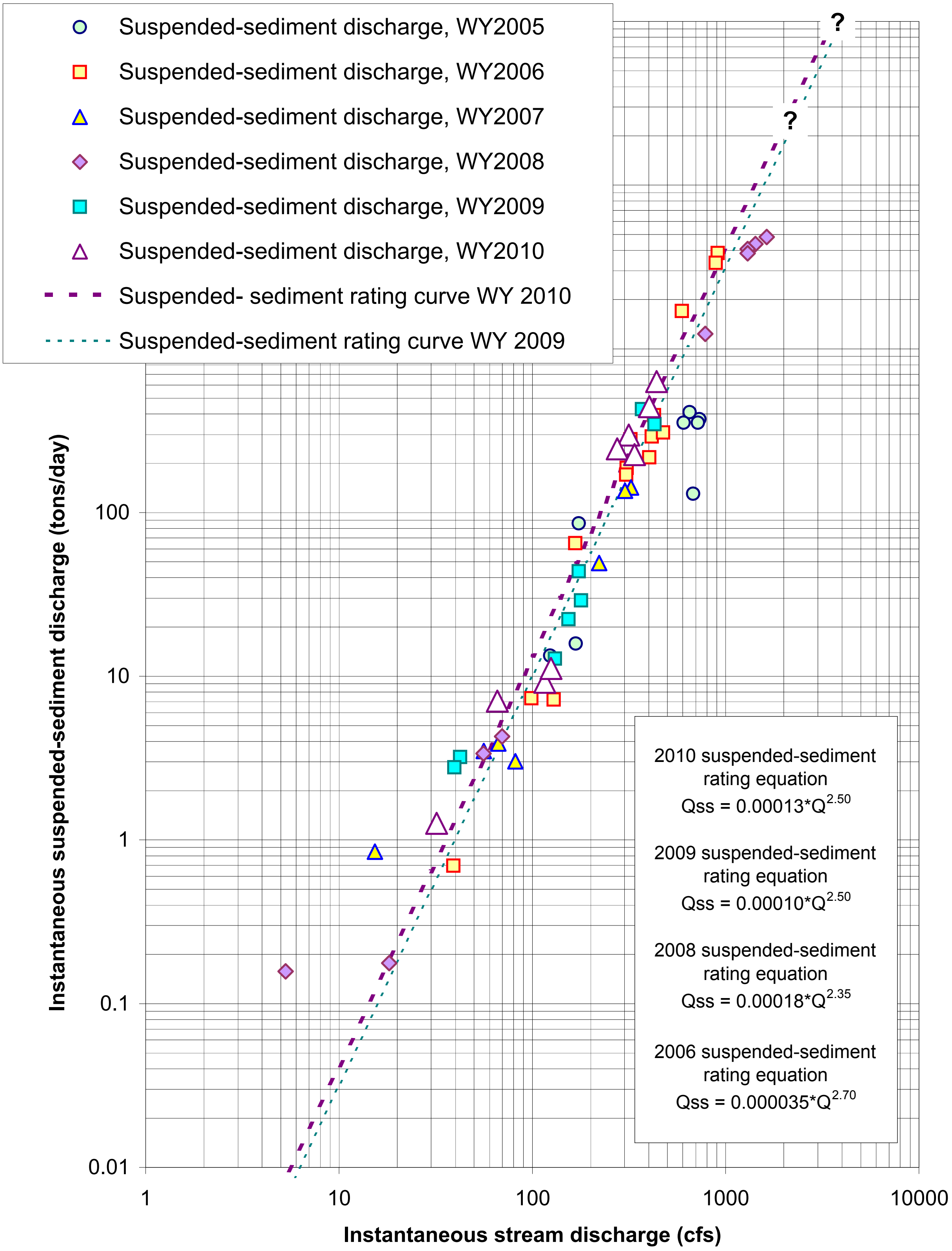
Figure 7. Comparison of bedload-sediment discharge to previous years: San Geronimo Creek at Lagunitas Road. Bedload-sediment discharge rates during water year 2010 seem generally similar to previous data, but slightly lower than water year 2009.



2010 suspended-sediment rating equation
$Qss = 0.00013*Q^{2.50}$

2009 suspended-sediment rating equation
$Qss = 0.00010*Q^{2.50}$

2008 suspended-sediment rating equation
$Qss = 0.00018*Q^{2.35}$

2006 suspended-sediment rating equation
$Qss = 0.000035*Q^{2.70}$

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Figure 8. Comparison of suspended-sediment discharge to previous years: San Geronimo Creek at Lagunitas Road. Suspended-sediment discharge rates seem similar to previous data.