ATTACHMENT 2

2012 BIOASSESSMENT MONITORING REPORT

aquatic bioassay & consulting laboratories, inc

August 10th, 2012

Ms. Bronwyn Kelly
Project Manager
MWH Americas, Inc.
618 Michillinda Avenue, Suite 200
Arcadia, CA 91007

Dear Ms. Kelly:

In accordance with the agreement between MWH Americas Inc. and Aquatic Bioassay and Consulting Laboratories, Inc., we are pleased to present the 2012 Bioassessment Monitoring Report for the Santa Susana Field Laboratory. The enclosed report includes the results for the spring 2012 annual requirements set forth by the California Regional Water Quality Control Board, Los Angeles Region (NPDES Permit No. CA0001309, June 16th, 2010; Order No. R4-2010-0090).

Please contact me with any questions that you may have regarding the content of this report.

Yours very truly,

aquatic bioassay & consulting laboratories, inc
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MWH Americas, Inc.
Santa Susana Field Laboratory
Spring 2012 Bioassessment Monitoring Report
(NPDES CA0001309)

Submitted to:

MWH Americas, Inc.
618 Michillinda Avenue, Suite 200
Arcadia, CA 91007

Submitted by:

Aquatic Bioassay and Consulting Laboratories
29 N Olive Street
Ventura, CA 93001

August 2012

EXECUTIVE SUMMARY

This report includes the results of bioassessment monitoring conducted for MWH Americas on the Santa Susana Field Laboratory (SSFL) property during the spring of 2012. The SSFL is located on property that sits atop a divide that drains northward toward Meier Canyon and the Arroyo Simi, and south toward Bell Canyon. There are no continuous spring fed surface water sources and the drainage from the property is relatively high gradient so that there are no perennial streams on the property.

This situation changed at station SSFL-001 in the winter of 2012 when the 'groundwater extraction treatment system' (GETS) was completed and began to discharge 20 gpm of treated groundwater at the head of Bell Canyon Creek. This freshwater discharge created an ongoing, flow that met SWAMP sampling criteria in May of 2012. However, based on the conditions and operational activities of the GETS, flow from this treatment process may not be continuous in the upcoming year. Importantly, the biological multimetric index used to assess stream health in southern California (SoCal-IBI) was developed using a set of perennial (yearlong flow) stream reference sites located throughout the region. As a result, the index was not intended to be used for streams with intermittent or ephemeral (no flow in dry season) flow. Therefore, the results presented in this document for the 2012 sampling event should be considered as a standalone assessment and should not be linked to future samples unless flow to the stream reach is continuous.

Station SSFL-006, located on Meier Canyon Creek, was dry within a day following the largest rainfall event in 2012 and was not suitable for sampling.

The goal of this program was to evaluate the water quality conditions in Bell Canyon Creek using the benthic macroinvertebrate (BMI) community. BMI's are good monitors of stream health because they are ubiquitous, relatively stationary, and their large species diversity provides a spectrum of responses to environmental stresses. Individual species of BMIs reside in the aquatic environment for a period of months to several years and are sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical contamination.

Sampling in Bell Canyon Creek on May 22, 2012 showed that this site has physical habitat attributes that could be conducive to the establishment of a relatively diverse BMI community. The streambed is composed of bedrock, small boulders, gravel and sand, with good instream cover for BMIs, and relatively good vegetative canopy cover. The water flow regimes in the Creek were predominately glides (slow, shallow water) and riffles (fast, shallow water) and each of the key water quality measures (pH, temperature, dissolved oxygen and conductivity) were within the normal bounds for southern California streams.

For this study, the evaluation of the biotic condition from community data used a multi-metric technique. The Southern California Index of Biological Integrity (SoCal-IBI) score provides a measure of the aquatic health of a stream reach and is calculated using a multi-metric technique that employs seven biological metrics that were each found to respond to a habitat and/or water quality impairment. An overall site score is calculated as the sum of individual metric scores. A score of 39 or less indicates that the BMI communities at the site are 'changed' compared to reference sites in southern California.

The IBI score for Bell Canyon Creek (26) was below the 'changed' threshold (39). While this score is representative of a site where water quality or habitat conditions are below those

found at reference sites in southern California, it was surprisingly high considering that Bell Canyon Creek had only flowed for four continuous months in its history. This allowed very little time for recruitment of the BMI community to occur, especially since there is no upstream source. The fact that EPT taxa (mayflies) and beetle (Coleopteran) taxa were already present in May, gives testament to the rapid colonization that might occur at this site if continuous year round flow were to occur. As a result, sampling in the spring of 2013 should depend on whether flow at SSFL-001 has been ongoing throughout the previous year. If it has not, comparisons between years should not be considered.

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INTRODUCTION

Background

This report includes the results of bioassessment monitoring conducted for MWH Americas at two sampling locations on the Santa Susana Field Laboratory (SSFL) property during the spring of 2012. This monitoring program was initiated, in compliance with the Los Angeles Regional Water Quality Control Board (LARWQCB), SSFL NPDES permit CA0001309 (Order No. R4-2010-0090 Monitoring and Reporting Program Item X). In response to this requirement, Aquatic Bioassay and Consulting Laboratories, Inc. (Aquatic Bioassay) was contracted to conduct sampling at sites in Bell Canyon Creek (SSFL-001) and Meier Canyon Creek (SSFL-006) on the SSFL property. Bioassessment monitoring followed the protocols established by the State of California's, Surface Water Ambient Monitoring Program (SWAMP 2007).

The SSFL is located on property that sits atop a divide that drains northward toward Meier Canyon and the Arroyo Simi, and south toward Bell Canyon. There are no continuous spring fed surface water sources and the drainage from the property is relatively high gradient so that there are no perennial streams on the property. During normal rainfall years, storm flow in the creeks and streams is short in duration, lasting from one to up to a few days. Even during 2005, when record amounts of rain fell on the property, flow in the creeks and streams lasted for only three to four weeks.

The ephemeral hydrologic features of the SSFL property are similar to those found in other areas of southern California and pose a problem for conducting bioassessment monitoring. Valid benthic macroinvertebrate (BMI) samples can only be collected after a creek or stream system has been flowing for at least six weeks following the final rainfall event of the spring or early summer (SWAMP 2007, SMC 2007). This ensures that the BMI community is well established and has recovered from scouring events that might have occurred during the storm season. This requirement is even more important in ephemeral streams where the streambed is dry during most of year and the establishment of a representative BMI community may require more than six weeks.

The reconnaissance of stations SSFL-001 and SSFL-006 that began in 2008 by Aquatic Bioassay biologists showed that even under the best rainfall conditions neither of the two sites met the base criteria of having suitable flow four weeks after the last rainfall event. This situation changed at station SSFL-001 in the winter of 2012 when the 'groundwater extraction treatment system (GETS) was completed and began to discharge 20 gpm of treated groundwater at the head of Bell Canyon Creek (GETS Outfall 019). This freshwater discharge created an ongoing, flow that met SWAMP sampling criteria in May of 2012. Conversely, station SSFL-006 located on Meier Canyon Creek was dry within a day following the largest rainfall event in 2012 and was not suitable for sampling.

Bioassessment Monitoring

Biological communities act to integrate the effects of water quality conditions in a stream by responding with changes in their population abundances and species composition over time. These populations are sensitive to multiple aspects of water and habitat quality and provide the public with more familiar expressions of ecological health than the results of chemical and toxicity tests (Gibson 1996). Benthic macroinvertebrates (BMIs) are ubiquitous, relatively stationary and their large species diversity provides a spectrum of responses to environmental stresses (Rosenberg and Resh 1993). Individual species of BMIs reside in the aquatic environment for a period of months to several years and are sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution (Resh and Jackson 1993). Finally, BMIs represent a significant food source for aquatic and terrestrial animals and provide a wealth of ecological and bio-geographical information (Erman 1996).

For this study, the evaluation of the biotic condition from community data used a multi-metric technique. In multi-metric techniques, a set of biological measurements ("metrics"), each representing a different aspect of the community data, is calculated for each site. An overall site score is calculated as the sum of individual metric scores. Sites are then ranked according to their scores and classified into groups with "good", "fair" and "poor" water quality. This system of scoring and ranking sites is referred to as an Index of Biotic Integrity (IBI) and is the end point of a multi-metric analytical approach recommended by the EPA for development of biocriteria (Davis and Simons 1995). The original IBI was created for assessment of fish communities (Karr 1981) but was subsequently adapted for BMI communities (Kerans and Karr 1994). An IBI specific to the southern California region was developed by State of California's Surface Water Ambient Monitoring Program (SWAMP) between 2000 and 2004, using bioassessment data collected at nearly 300 locations from the Mexican border to the south, Monterey County to the north and to the eastern extent of the Coastal Mountain range. These data were used to create an IBI that is applicable to southern California (SoCal-IBI) and is applied to the data in this report (Ode et al. 2005).

On May 22, 2012 Aquatic Bioassay scientists conducted the first sampling at station SSFL-001 in Bell Canyon Creek. The goal of this program is to evaluate the water quality conditions in Bell Canyon Creek using the BMI community and comparing it to reference site conditions in southern California using the SoCA-IBI (Ode et al. 2005).

All sampling procedures and taxonomic identification of BMIs were conducted in strict adherence to the SWAMP (2007) bioassessment protocol and the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) rules (Rogers and Richards 2011) and standard taxonomic effort levels (Richards and Rogers 2011), respectively. The data results presented here met all of the quality assurance guidelines established in these protocols. This report includes all of the physical, chemical, and biological data collected during the spring 2012 survey and photographic documentation of each site.

MATERIALS AND METHODS

Sampling Site Descriptions

Two sampling locations were visited on the SSFL property on May 22, 2012 (Table 1). Photographs of each site are displayed in Appendix B, Figure 3. Station SSFL-001 is located on Bell Canyon Creek at an elevation of 1,589 feet (Figure 1a). The sampling transect began at the GETS discharge into Bell Canyon Creek at Outfall 019 (40 meters downstream of SSFL-001) and extended downstream 150 meters (blue line). SSFL-006 is located on Meier Canyon Creek at an elevation of 1,754 feet (Figure 1b).

Table 1. Sampling locations at the Santa Susana Field Laboratory.

Station ID	Sample Date	Site Description	Latitude (N)	Longitude (W)	Elevation (ft)
SSFL-001		Bell Canyon Creek	34.21586	-118.69794	1,589
Outfall 019	22-May-12	Bell Canyon Creek	34.21572	-118.69678	1,588
SSFL-006	22-May-12	Meier Canyon Creek	34.23179	-118.71738	1,754

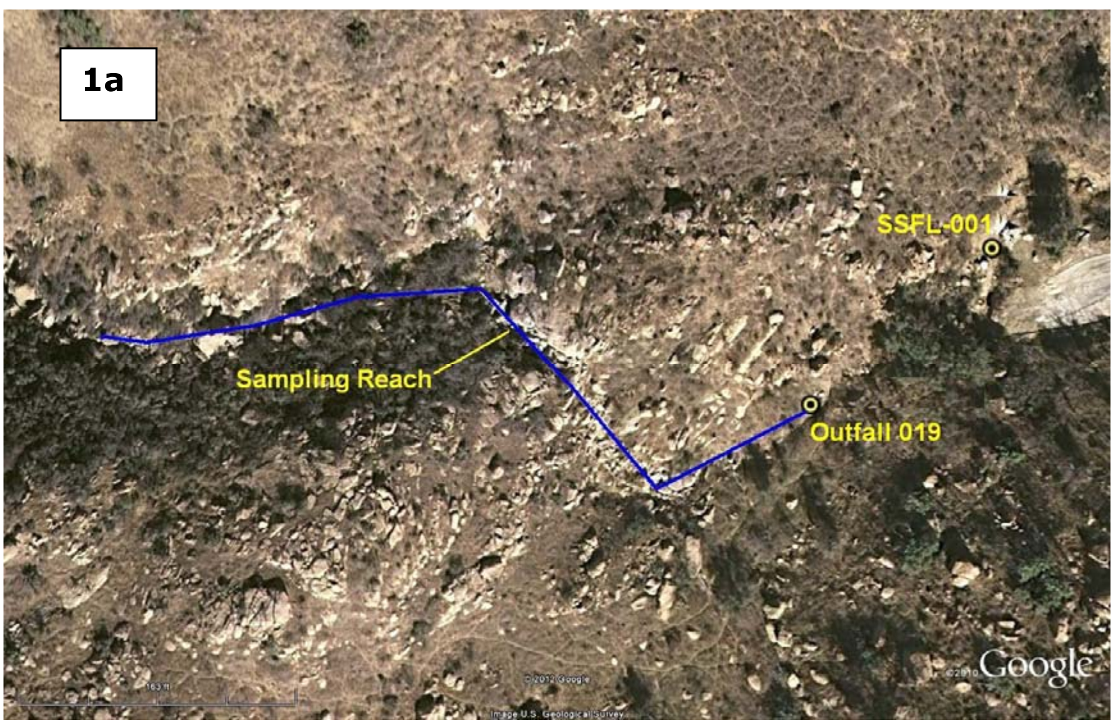

Figure 1a. Bell Canyon Creek 150 meter bioassessment sampling reach (blue line), beginning at Outfall 019 (130 feet downstream of SSFL-001).

Figure 1b. Sampling location SSFL-006 on Meier Canyon Creek.

Rainfall

Figure 2 shows rainfall amounts measured at the SSFL meteorological station for storms between July 2011 and June 2012 on the SSFL property. During this period, rain events began in September, 2011 and ended in May, 2012. The largest storms occurred in March ranging from 1.5 to 2 inches. Total rain for the season was 11.3 inches.

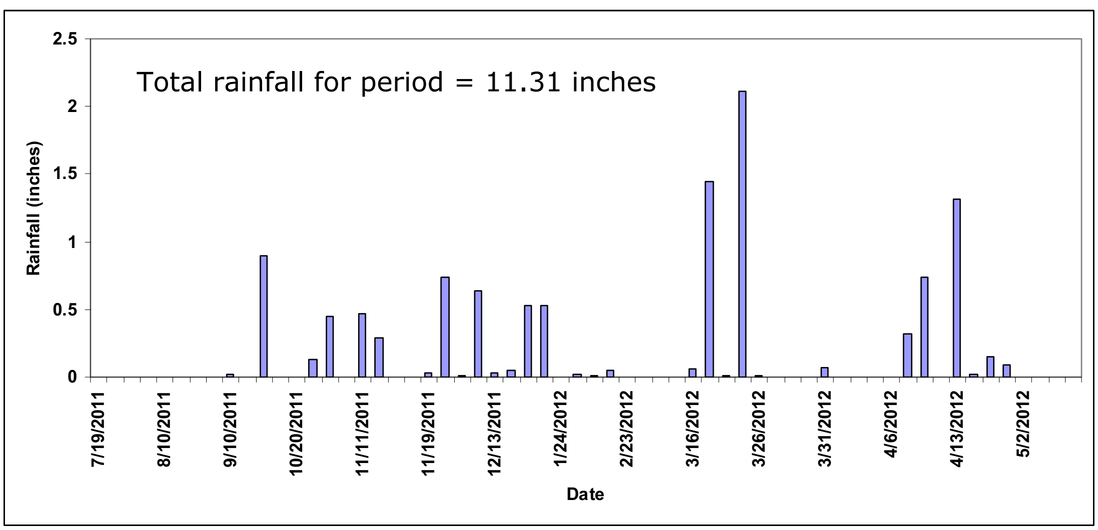

Figure 2. Rainfall (inches) on the SSFL property from July 2011 to June 2012 (from SSFL meteorological station.

Collection of Benthic Macroinvertebrates

Wadeable Streams Protocols:

The field protocols and assessment procedures followed the Surface Water Ambient Monitoring Program (SWAMP 2007) protocols. BMI samples were collected in strict adherence to the SWAMP protocols in terms of both sampling methodology and QC procedures. A 150 meter (m) reach was measured and 11 transects were established equidistant apart from the downstream to upstream end of the reach. The SWAMP Worksheet was used to collect all of the necessary station information and physical habitat data.

The BMI sample was collected, starting with the downstream transect and working upstream, following the Reach Wide Benthos (RWB) sampling protocol:

1. At the most downstream transect, a single location was sampled 25% of the distance from the right wetted width. On the second upstream transect, a sample was collected 50% of the distance from the right wetted width and, on the third transect, 75% of the distance from the right wetted width. This process was repeated until each of the 11 transects had been sampled.
   a) All samples of the benthos were collected within a 0.09 m^2 area upstream of a 0.03 m wide, 0.5 mm mesh D-frame kick-net.
   b) Sampling of the benthos was performed manually by rubbing cobble and boulder substrates in front of the net, followed by disturbing the upper layers of substrate to dislodge any remaining invertebrates.
   c) The duration of sampling ranged from 60-120 seconds, depending on the amount of boulder and cobble-sized substrate that required rubbing by hand; complex substrates require a greater amount of time to process.
2. The 11 samples (per station) were combined into a single composite sample that represented a 0.99 m^2 area of the total reach sampled. The composited samples were transferred into separate two liter wide-mouth plastic jars containing approximately 300 ml of 95% ethanol.
3. Chain of Custody (COC) sheets were completed for samples as each station was completed.

Physical/Habitat Quality Assessment and Water Chemistry

Bioassessment sampling included a measure of the instream physical habitat conditions using a method originally developed by the USEPA and modified by SWAMP (2007) for use in California. This method focuses on the habitat conditions found in the streambed and banks. The team collected the physical habitat measurements at each station, according to the method outlined in the SWAMP manual, and recorded the information on the SWAMP worksheets.

These measurements are summarized as follows:

1. Water temperature, specific conductance, pH, and dissolved oxygen were measured using a hand held YSI 556 MPS water quality meter that was pre-calibrated in the laboratory. A water sample was collected for alkalinity and analyzed using the USEPA's Titrimetric (pH 4.5) 3101 method in the laboratory.

2. Wetted width, and depth were measured in meters using a stadia rod or measuring tape at each transect.
3. Discharge was measured on a single transect, using a hand held flow meter, following the velocity area method specified in the SWAMP bioassessment protocol.
4. A handheld densitometer was used to measure percent canopy cover.
5. Flow habitat regimes were visually estimated.
6. Stream gradient was measured using an inclinometer.

Aquatic Bioassay field teams are audited each year for proficiency using the SWAMP protocols by the Department of Fish and Game's Aquatic Bioassessment Laboratory (Mr. James Harrington) and for the Southern California Stormwater Monitoring Coalition's (SMC) Regional Monitoring Program.

Sample Analysis/Taxonomic Identification of Benthic Macroinvertebrates (BMIs)

Sample sorting and taxonomy were conducted by Aquatic Bioassay in Ventura, California. Identifications were made using standard taxonomic keys (Literature Cited, Taxonomic References) and in most cases, taxa for this study were identified to the species level in adherence with the Standard Taxonomic Effort (STE) level II, specified by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT). Identifications were rolled up to the appropriate taxonomic level for the calculation of biological metrics used in the SoCal-IBI. Samples entering the lab were processed as follows:

600 organisms were sub-sampled from the composite sample using a Katon tray, and then sorted into major taxonomic groups. All remnants were stored for future reference. The 600 organisms were identified to the genus level for most insects, and order or class for non-insects. As new species to the survey area were identified, examples of each were added to the voucher collection. The voucher collection includes at least one individual of each species collected and ensures that naming conventions can be maintained and changed as necessary in the future.

The taxonomic QA/QC procedures followed for this survey included:

1. Sorting efficiencies were checked on all samples and a minimum required sorting efficiency of 95% (i.e. no more than 5% of the total number of organisms sorted from the grids could be left in the sub-sample) was maintained. 10% of all processed material from each sample was inspected by the laboratory supervisor for the aforementioned efficiency. Sorting efficiency results were documented on each station's sample tracking sheet.
2. Once identification work was completed, Aquatic Bioassay taxonomists conduct QC as follows:
    a. 10% of all stations sampled were randomly selected for internal QC by another Aquatic Bioassay taxonomist. Samples were checked for both enumeration and identification accuracy, which must both pass a 95% efficiency criteria. Discrepancies were resolved and the database was updated.
    b. 10% of all samples were sent to the California Department of Fish and Game (CDFG) offices in Chico California for an external QA/QC check. Samples were sorted by species into individual vials that included an internal label. Any

discrepancies in counts or identification found by the CDFG taxonomists were discussed, and then resolved. All data sheets were corrected and, when necessary, bioassessment metrics were updated. The results of this QC process can be found in Appendix C.

3. It is a requisite of our QC program that all staff members involved in taxonomy belong to SAFIT, an organization dedicated to the standardization of freshwater organism naming conventions.

Data Development and Analysis

Multi-metric:

As species were identified and counted they were included in an Excel data sheet, checked for errors, and then imported into the Aquatic Bioassay BMI database system. All biological metrics, figures and tables were then automatically generated. These bioassessment metrics were then used to assess the spatial and temporal distributions of the BMI community or were used to calculate the SoCal-IBI (Ode et al. 2005). The following metrics were calculated and their responses to stressed conditions are listed in Table 2:

1. Richness Measures: Taxonomic Richness, EPT Taxa, Number of Coleoptera Taxa, and Number of Predator Taxa.
2. Composition Measures: EPT Index (%), Sensitive EPT Index (%), Shannon Diversity, Percent Non-Insect Individuals, and Percent Non-Insect Taxa.
3. Tolerance/Intolerance Measures: Percent Hydropsychidae, Percent Baetidae, Mean Tolerance Value, Percent Intolerant Organisms, Percent Tolerant Taxa, Percent Dominant Taxa, and Percent Chironomidae.
4. Functional Feeding Group (FFG): Percent Collector-Gatherers (CG), Percent Collector-Filterers (CF), Percent CG plus CF, Percent Scrapers, and Percent Shredders.

Southern California Index of Biological Integrity (SoCal-IBI):

The seven biological metric values used to compute the SoCal-IBI are presented in Table 3 (Ode et al. 2005). The SoCal-IBI is based on the calculation of biological metrics from a group of 500 organisms from a composite sample collected at each stream reach. Since 600 organisms are identified from each sample, the abundance data were reduced to 500 using Monte Carlo randomization. This technique was validated by Ode et al. (2005).

Table 2. Bioassessment metrics used to describe characteristics of the BMI community and their expected response to stressors.

BMI Metric	Description	Response to Stress
Richness Measures		
Taxa Richness	Total number of individual taxa	Decrease
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	Decrease
Number of Coleoptera Taxa	Number of taxa from the insect order Coleoptera (beetles)	Decrease
Number of Predator Taxa	Number of taxa from the predator functional feeding group	Decrease
Composition Measures		
EPT Index (%)	Percent composition of mayfly, stonefly and caddisfly larvae	Decrease
Sensitive EPT Index (%)	Percent composition of mayfly, stonefly and caddisfly larvae with tolerance values between 0 and 3	Decrease
Shannon Diversity	General measure of sample diversity that incorporates richness and evenness	Decrease
Percent Non-Insect Individuals	Percentage of organisms in sample that are not in the Class Insecta	Increase
Percent Non-Insect Taxa	Percentage of taxa in sample that are not in the Class Insecta	Increase
Tolerance/Intolerance Measures		
Percent Hydropsychidae	Percent composition of caddisfllies in the more tolerant family Hydropsychidae	Increase
Percent Baetidae	Percent composition of mayflies in the more tolerant family Baetidae	Increase
Mean Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values)	Increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	Decrease
Percent Tolerant Taxa	Percent of taxa in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	Increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	Increase
Percent Chironomidae	Percent of organisms in the dipteran family Chironomidae	Increase
Functional Feeding Groups (FFG)		
Percent Collector-Gatherers (CG)	Percent of macrobenthos that collect or gather fine particulate matter	Increase
Percent Collector-Filterers (CF)	Percent of macrobenthos that filter fine particulate matter	Increase
Percent CG + CF	Percent of macrobenthos that belong to either the CG or CF functional feeding groups	Increase
Percent Scrapers	Percent of macrobenthos that graze upon periphyton	Increase
Percent Shredders	Percent of macrobenthos that shreds coarse particulate matter	Decrease

Table 3. Southern California IBI scoring table for the seven metrics included in the index (Ode et al. 2005). After each of the seven biological metrics below are calculated for a given station, the result for each is associated with the 'Metric Score' (left column), and then summed for all seven metrics. This score is multiplied by 1.43 to adjust to a scale of 100.

Metric Scoring Ranges for the Southern California IBI							
Metric Score	Coleoptera Taxa	EPT Taxa	Predator Taxa	% Collector Individuals	% Intolerant Individuals	% Non-Insect Taxa	% Tolerant Taxa
10	>5	>17	>12	0-59	25-100	0-8	0-4
9		16-17	12	60-63	23-24	9-12	5-8
8	5	15	11	64-67	21-22	13-17	9-12
7	4	13-14	10	68-71	19-20	18-21	13-16
6		11-12	9	72-75	16-18	22-25	17-19
5	3	9-10	8	76-80	13-15	26-29	20-22
4	2	7-8	7	81-84	10-12	30-34	23-25
3		5-6	6	85-88	7-9	35-38	26-29
2	1	4	5	89-92	4-6	39-42	30-33
1		2-3	4	93-96	1-3	43-46	34-37
0	0	0-1	0-3	97-100	0	47-100	38-100

RESULTS

Physical Habitat Characteristics and Water Chemistry

General Physical Habitat Characteristics:

The physical characteristics of the reach sampled in Bell Canyon Creek during the spring 2012 survey are presented in Table 4. One hundred percent of flow in the Creek was the result of discharge from the GETS (20 gpm). Without this discharge the creek would have been dry, which is typical of the semi-arid nature of the region. The average wetted width was just under a meter and average depth was 5.6 cm. Average slope on the reach was 13%.

Bank stability is the observed potential of a bank to erode. Approximately 95% of the 150 meter reach was either vulnerable to erosion (55%) or eroded (41%), with 5% of the banks that were stable. Flow habitats were dominated by glides (65%; slow, shallow water) and riffles (34%). The stream substrate was a mixture of mostly sand (32%), fine and course gravel (9% and 12%, respectively) and bedrock (19%). The reach had good vegetative canopy cover (60%). Course particulate material (CPOM) was found at 16% of the measured area. No microalgae were found along the entire reach, while macroalgae was observed on 19% of the reach and macrophytes were moderately abundant (29%).

Water Chemistry:

Water temperature was typical of the spring 21.7 °C and pH was neutral 7.3 (Table 4). Dissolved oxygen concentrations were 6.5 mg/L and specific conductance was 797 μs/cm.

Physical/Habitat (P-Hab) Scores:

Assessment of the P-Hab conditions of a stream reach is necessary to determine the quality of the stream reach as a habitat for BMIs. In many cases, organisms might not be exposed to chemical contaminants, yet their populations indicate that impairment has occurred. These population shifts can be the result of degraded stream bed and/or a degraded riparian habitat. Excess sediment is the leading pollutant in streams and rivers of the United States (Harrington and Born 2000). Sediments fill pools and interstitial areas of the stream substrate, where invertebrates live, and cause invertebrate populations to decline and/or community compositions to be altered. Three important measures of physical habitat quality include epifaunal substrate cover, sediment deposition and channel alteration. A streambed with good epifaunal cover is characterized by a highly irregular and complex habitat composed of cobble, gravel, organic debris, etc. These conditions provide optimum conditions for BMI organisms. Conversely, when a streambed has little epifaunal cover, a large amount of sediment deposition, or its banks have been altered, conditions for BMIs are generally not as good.

Out of a total possible score of 60, the P-Hab score for Bell Canyon Creek was 48 indicating relatively good habitat conditions. Sites with scores greater than 40 are characterized as having good instream cover, little sediment deposition and little channel alteration.

Table 4. Physical habitat scores and characteristics for Bell Canyon Creek.

Metric	Station	
	SSFL-001	SSFL-006[1.]
Physical Habitat Characteristics		
Mean Wetted Width (m)	0.9	-
Mean Depth (cm)	5.6	-
Discharge (gpm)	20	-
Bank Stability:		
% Stable	4.5	-
%Vulnerable	54.5	-
% Eroded	40.9	-
Flow Habitats (%):		
Cascade/Fall	2.0	-
Rapid	0.0	-
Riffle	33.5	-
Run	0.0	-
Glide	64.5	-
Pool	0.0	-
Dry	0.0	-
Substrate:		
Bedrock	19.0	-
Large Boulder	5.7	-
Small Boulder	6.7	-
Cobble	1.9	-
Course Gravel	12.4	-
Fine Gravel	8.6	-
Sand	32.4	-
Fines	1.0	-
Wood	5.7	-
Other	6.7	-
Canopy Cover (%)	59.9	-
CPOM Presence	16.2	-
Presence of Microalgae (%)	0.0	-
Mean Microalgae Thickness (mm)	0.0	-
Macroalgae Presence (%)	19.2	-
Macrophyte Presence (%)	28.8	-
Slope (%)	13.0	-
Habitat Characterization (Scored 0 to 20)		
Channel Alteration	19	
Sediment Deposition	14	
Epifaunal Substrate	15	
Ambient Water Quality Measurements		
Mean Water Temperature (°C)	21.71	-
Mean pH	7.33	-
Alkalinity (mg/L)	262	-
Mean DO (mg/L)	6.5	-
Mean Specific Conductance (μs/cm)	797	-
Salinity (ppt)	0.39	-

1. Site was dry during the spring/summer of 2012, therefore sampling could not be conducted.

BMI Community Structure

A complete taxa list including raw abundances, tolerance values, and functional feeding groups are presented by site for the spring 2012 survey in Appendix A, Table 8. The Monte Carlo randomization abundance and ranked abundances of all taxa at each site are presented in Table 5. The biological metrics calculated for this survey were grouped into the four categories (community richness measures, community composition measures, community tolerance measures, and community feeding group measures) described in Table 6. The SoCA-IBI score at Bell Canyon Creek for 2012 is shown in Table 7.

A total of 563 BMIs were identified and 500 BMIs were randomly selected to calculate metrics and IBI scores. A total of 16 different taxa were identified from the sample collected at Bell Canyon Creek (SSFL-001) during the spring 2012 survey. The majority of organisms collected were midge flies (Chironomidae; 64%), followed by seed shrimp (Ostracoda; 12%), worms (Oligochaeta; 6%) and mayflies (Baetis sp.; 4%) (Table 5).

Biological Metrics

Community Richness Measures:

Taxa richness is a measure of the total number of species found at a site. This relatively simple index can provide much information about the integrity of the community. Few taxa at a site indicate that some species are being excluded, while a large number of species indicate a more healthy community. EPT taxa are the number of all of the mayflies (Ephemeroptera), caddisflies (Trichoptera), and stoneflies (Plecoptera) present at a location. These families are generally sensitive to impairment and when present, are usually indicative of a healthier community than if any or all are absent. Metrics for Coleoptera and Predator taxa are included since they are used to calculate the SoCal-IBI.

Taxonomic richness at Bell Canyon Creek was 16, with EPT and predator taxa contributing 3 taxa each and Coleopteran (beetles) taxa represented by one taxa.

Community Composition Measures:

The percent EPT index, sensitive EPT index, percent non-insect taxa, percent non-insect individuals, and the Shannon Diversity index are all measures of community composition. Species diversity indices are similar to numbers of species; however they contain an evenness component as well. For example, two samples may have the same numbers of species and the same numbers of individuals; however, one station may have most of its numbers concentrated into only a few species while a second station may have its numbers evenly distributed among its species. The diversity index would be higher for the latter station. Percent EPT index is the proportion of the abundance at a site that is comprised of mayflies, stoneflies and caddisflies. Percent sensitive EPT index is similar except it includes only those EPT taxa whose tolerance values range from 0 to 3. These taxa are very sensitive to impairment and when present, can be indicative of better water quality conditions. Percent non-insect taxa is a measure of all non-insect phyla represented at a site and when elevated, generally indicate poorer water quality conditions.

The percent EPT index was 8% with no sensitive EPT taxa present on the reach (Table 6). The percent non-insect individuals was 18% and Shannon diversity index was low (1.3).

Community Tolerance Measures:

The SoCal-IBI uses both the percent intolerant individuals and percent tolerant taxa to evaluate the overall sensitivity of organisms to pollution and habitat impairment. Each species is assigned a tolerance value from 0 (highly intolerant) to 10 (highly tolerant). The percent intolerance individuals is calculated by multiplying the tolerance value of each species with a tolerance value ranging from 0 to 2, by its abundance, and then dividing that value by the total abundance for the site. The percent tolerant taxa are similar except that only species with tolerance values ranging from 8 to 10 are included and total numbers of taxa, instead of individuals, are used to derive the proportion. A site with many tolerant organisms present is considered to be less pristine or more impacted by human disturbance than one that has few tolerant species. The tolerance values for each species were developed in different parts of the United States and can therefore be region specific. Also, different organisms can be tolerant to one type of disturbance, but highly sensitive to another. For example, an organism that is highly sensitive to sediment deposition may be very insensitive to organic pollution. With these drawbacks in mind, the tolerance measures generally depict disturbances in a stream that, when coupled with other metrics, can provide good water quality information regarding a stream reach. Percent dominance reflects the proportion of the total abundance at a site represented by the most abundant species. For example, if 100 organisms are collected at a site and species A is the most abundant with 30 individuals, the percent dominance index score for the site is 30%. The benthic environment tends to be healthier when the dominance index is low, which indicates that more than just a few taxa make up the majority of the community.

Percent dominant taxon was 64% (Table 6). The average tolerance value for all species was moderate (6), and no intolerant species were collected. Sixteen percent of the individuals collected were tolerant species.

Community Feeding Group Measures:

These indices provide information regarding the balance of feeding strategies represented in an aquatic assemblage. The combined feeding strategies of the organisms in a reach provide information regarding the form and transfer of energy in the habitat. When the feeding strategy of a stream system is out of balance it can be inferred that the habitat is stressed. For the purposes of this study, species were grouped by feeding strategy as percent collectors and filterers, percent collectors, percent filterers, percent grazers, percent predators, percent shredders, and percent Chironomidae (Table 6). The SoCal-IBI uses the numbers of predators and percent collectors (gatherers and filterers) at a site to calculate the index.

Collecting was the dominant feeding strategy used by organisms at Bell Canyon Creek (95%; Table 6). Few filterers, grazers, predators or shredders were collected. Chironomidae (midges) were well represented (64%).

SoCal-IBI Scores

The IBI is a multi-metric technique that employs seven biological metrics that were each found to respond to a habitat and/or water quality impairment at reference sites from Monterey, California to the Mexican Border. Each of the seven biological metrics measured at a site are converted to an IBI score then summed and adjusted to a scale of 0 to 100. These cumulative scores can then be ranked accordingly: "very good" (80-100), "good" (60-79), "fair" (40-59), "poor" (20-39) and "very poor" (0-19) habitat conditions. The threshold limit for this scoring index is 39. Despite the fact that rankings can be identified as "fair," sites with scores above 39 are within two standard deviations of the mean reference site conditions in southern California and are not considered to be impaired. Sites with scores below 39 are considered to have impaired conditions. The metric scoring ranges established for the SoCal-IBI, listed above, were used to classify Bell Canyon Creek.

The adjusted SoCal-IBI score calculated for Bell Canyon Creek was 26, ranking it as "poor" (Table 7). Considering that constant flow and recruitment of insect taxa only began in February, 2012 (a little under four months) this score seems reasonably good. The key metrics that elevated the score somewhat were that few non-insect taxa were collected, the percentage of tolerant taxa were relatively low, and one Coleopteran taxon (beetle) was collected. Beetle taxa are generally sensitive to water quality disturbance.

Table 5. Abundance (500 Monte Carlo randomization) and ranked taxonomic abundance of organisms collected at Bell Canyon Creek.

SSFL-001		
Taxa	**Abundance**	**% of Total Abundance**
Chironomidae	320	64.0
Ostracoda	59	11.8
Oligochaeta	30	6.0
Baetis [1]	22	4.4
Caloparyphus/Euparyphus	18	3.6
Dasyhelea	11	2.2
Fallceon	7	1.4
Hydroptila	6	1.2
Bezzia/Palpomyia	5	1.0
Ceratopogonidae	5	1.0
Simulium	4	0.8
Forcipomyia	3	0.6
Hydroptilidae	3	0.6
Dolichopodidae	2	0.4
Ephydridae	1	0.2
Hydroporinae	1	0.2
Nemotelus	1	0.2
Pericoma/Telmatoscopus	1	0.2
Euparyphus	1	0.2
TOTAL	**500**	**100**

1. Genus names italicized

Table 6. BMI metrics for Bell Canyon Creek.

	Bell Canyon Creek
Biological Metric	**SSFL-001**
Community Richness Measures	
Taxonomic Richness (no. species)	16
EPT Taxa (no. species)	3
Predator Taxa (no. species)	3
Coleoptera Taxa (no. species)	1
Community Composition Measures	
EPT Index (%)	7.6
Sensitive EPT Index (%)	0.0
% Non-Insect Taxa	10.5
% Non-Insect Individuals	17.8
Shannon Diversity	1.26
Community Tolerance Measures	
% Dominant Taxa	64
AverageTolerance Value	6.2
% Intolerant Individuals (0-2)	0
% Tolerant Individuals (8-10)	15.8
% Tolerant Taxa (8-10)	21.1
Community Feeding Group Measures	
% Collectors and Filterers	95.6
% Collectors	94.8
% Filterers	0.8
% Grazers	0.0
% Predators	2.6
% Shredders	0.0

Table 7. Southern California IBI scores and rating for Bell Canyon Creek.

	Bell Canyon Creek
Metric	**SSFL-001**
EPT Taxa	1
Predator Taxa	0
Coleoptera Taxa	2
% Non-Insect Taxa	8
% Intolerant Individuals	0
% Tolerant Taxa	6
% Collector Individuals	1
Total	**18**
Adjusted Total (x 1.43)	**26**

SUMMARY AND CONCLUSIONS

The SSFL is located on property that sits atop a divide that drains northward toward Meier Canyon and the Arroyo Simi, and south toward Bell Canyon and Dayton Canyon. There are no continuous spring fed surface water sources and the drainage from the property is relatively high gradient so that there are no perennial streams on the property. During normal rainfall years, storm flow in the creeks and streams on the property is short in duration, lasting from one to up to a few days. Even during 2005, when record amounts of rain fell on the property, flow in the creeks lasted for only three to four weeks in certain locations.

In February 2012 this changed when the groundwater extraction treatment system (GETS) began to continuously discharge 20 gpm of treated groundwater into the head water of Bell Canyon Creek (Station SSFL-001). Since this discharge will be nearly continuous throughout the year, it has created a perennial stream flow habitat. As a result, a bioassessment sample was collected from the Creek on May 22, 2012 approximately four weeks following the final rainfall of the season. While, by definition, the sample from Bell Canyon Creek is valid, it must be noted that this is a streambed that was historically dry with no established BMI community. As a result, one would expect that recruitment and establishment of a stable BMI community could take several seasons.

The habitat conditions in a stream reach play a key role in the development of a healthy aquatic community. In many cases organisms may not be exposed to chemical contaminants, yet their populations indicate that impairment has occurred. These population shifts can be due to degradation of the streambed and bank habitats. For example, excess sediment caused by bank erosion due to human activities can fill pools and interstitial areas of the stream substrate where fish spawn and invertebrates live, causing their populations to decline or to be altered. Also, loss of vegetative canopy cover and reduced width of the riparian zone can have similar effects on the BMI communities.

Sampling in Bell Canyon Creek on May 22, 2012 showed that this site has physical habitat attributes that could be conducive to the establishment of a relatively diverse BMI community. The streambed is composed of bedrock, small boulders, gravel and sand, with good instream cover for BMIs, and relatively good vegetative canopy cover. The water flow regimes in the Creek were predominately glides (slow, shallow water) and riffles (fast, shallow water) and each of the key water quality measures (pH, temperature, dissolved oxygen and conductivity) were within the normal bounds for southern California streams.

The BMI community collected in Bell Canyon Creek was low in diversity (H' = 1.3), composed of moderately pollution tolerant species (average tolerance = 6.2) and dominated by midge flies (% dominate taxon = 64%). Other relatively abundant taxa included seed shrimp (Ostracoda, 12%), worms (Oligochaeta, 6%) and mayflies (4%). No pollution sensitive species were collected and functional feeding groups were represented almost entirely of collector organisms (95%).

The Southern California Index of Biological Integrity (SoCal-IBI) score provides a measure of the aquatic health of a stream reach and is calculated using a multi-metric technique that employs seven biological metrics that were each found to respond to a habitat and/or water quality impairment. The IBI score for Bell Canyon Creek (26) was below the impairment threshold (39) and ranked as "poor". While this score is representative of a site where water quality or habitat conditions are below those found at reference sites in southern California, it was surprisingly high considering that Bell Canyon Creek had only flowed for four continuous months in its history. This allowed very little time for recruitment of the BMI community to occur, especially since there is no upstream source. The fact that EPT taxa (mayflies) and beetle (Coleopteran) taxa were already present is testament to the rapid colonization that might occur at this site. After only four months following the beginning of discharge to Bell Canyon Creek it is clear that BMIs can survive here and there is potential for a relatively balanced population to develop over time.

It is important to note that the SoCal-IBI was developed using reference sites with perennial flow (year round discharge). The flow condition at SSFL-001 was not perennial in 2012 since discharge began in February of the same year. Mazor (et al. 2012) studied several non-perennial streams in southern California and found that the SoCal-IBI responded reliably to reference and stressed water quality conditions. However, more work needs to be done to assess how the index responds to varying lengths of stream flow.

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Appendix A: BMI Taxa Lists and Metrics

Table 8. Spring 2012 BMI raw taxa list for Bell Canyon Creek.

Identified Taxa	Tol Val (TV)	Func Feed Grp	SSFL-001
Insecta Taxa			
Ephemeroptera			
Baetis	5	cg	25
Fallceon	4	cg	7
Trichoptera			
Hydroptila	6	ph	6
Hydroptilidae	4	ph	3
Coleoptera			
Hydroporinae	5	p	1
Diptera			
Bezzia/Palpomyia	6	p	6
Caloparyphus/Euparyphus	8	cg	18
Ceratopogonidae	6	p	8
Chironomidae	6	cg	356
Dasyhelea	6	cg	11
Dolichopodidae	4	p	2
Ephydridae	6		1
Euparyphus	8	cg	1
Forcipomyia	6	cg	3
Nemotelus	8	cg	1
Pericoma/Telmatoscopus	4	cg	1
Simulium	6	cf	5
Non-Insecta Taxa			
Oligochaeta	5	cg	42
Ostracoda	8	cg	66
TOTAL			**563**

APPENDIX B – PHOTOS OF SAMPLING SITES

SSFL-001 facing upstream

SSFL-001 facing downstream

SSFL-006 facing upstream

SSFL-006 facing downstream

Figure 3. Sampling location photos of the two sampling sites on the SSFL property.

APPENDIX C – BMI QC REPORT, COC & FIELD WORKSHEETS