STREAM GAUGE STUDY
FINAL MONITORING PLAN

Submitted to:
City of San Diego
Transportation & Storm Water Department
9370 Chesapeake Drive, Suite 100
San Diego, California 92123

Submitted by:
AMEC Environment & Infrastructure, Inc.
San Diego, California

September 2014

AMEC Project No. 5025141098

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

%	percent
°C	degrees Celsius
µS/cm	microsiemens per centimeter
AMEC	AMEC Environment & Infrastructure, Inc.
Baro	Solinst Barologger Edge
City	City of San Diego
cm	centimeter
LT	Solinst Levelogger Edge
LTC	Solinst LTC Levelogger Junior
ID	identification
QA/QC	quality assurance and quality control
TDS	total dissolved solids
TMDL	total maximum daily load
WMA	watershed management area

This page intentionally left blank

1.0 INTRODUCTION

1.1 BACKGROUND

Many upcoming and current water quality regulations depend on knowledge of the water level of a waterbody. In the six watersheds under the jurisdiction of the City of San Diego (City), the waterbodies include large streams, small streams, and tributaries. Many of these waterbodies have not had regular flow monitoring. The Stream Guage Study aims to fill some of the gaps in the information regarding the level of flow at 20 stream locations. Monitoring locations are spread throughout the City, from the San Dieguito Watershed Management Area (WMA) in the north to the San Diego Bay WMA in the south. The data collected as part of the study will provide information useful to the following programs:

1. Total maximum daily loads (TMDLs)
2. Water quality improvement plans
3. Upcoming bio-objectives
4. Special studies (total dissolved solids [TDS] and bioassessment study)

1.2 PROJECT OBJECTIVES

The goal of this study is to provide water level data on a wide variety of creeks and conveyances within the City's juridistion. This will help the City understand where water is perennial (persisting in the stream year-round) and which streams are ephemeral. The study began during spring 2014 and will continue until spring 2015. At that time, the data collected will be reviewed to determine whether continued monitoring will be needed to characterize stream level at the selected locations.

1.3 PROJECT ORGANIZATION

The City is the municipal government agency that oversees the project, and it has assigned two staff members to provide project oversight:

- Ruth Kolb is responsible for oversight of policy-related and special study projects.
- Andre Sonksen is responsible for oversight of compliance-related projects.

AMEC Environment & Infrastructure, Inc. (AMEC) is coordinating the collection, management, analysis, and reporting of all stream gauge data. AMEC has assigned project responsibilties to several staff members:

- Kristina Schneider is the AMEC project manager, responsible for project coordination and development, scheduling, budget management, and oversight of all project plans and reports.

- Brett Bowen, as the AMEC project coordinator and field sampling manager, is responsible for implementing the monitoring activities and developing the project report.
- Jeremy Burns is the AMEC quality assurance officer, with responsibility for the project quality assurance and quality control (QA/QC), data management, and data analysis.
- Jesse Davis, as the AMEC health and safety officer, is responsible for implementing the project health and safety plan and related practices.

Figure 1-1 shows the project team organization.

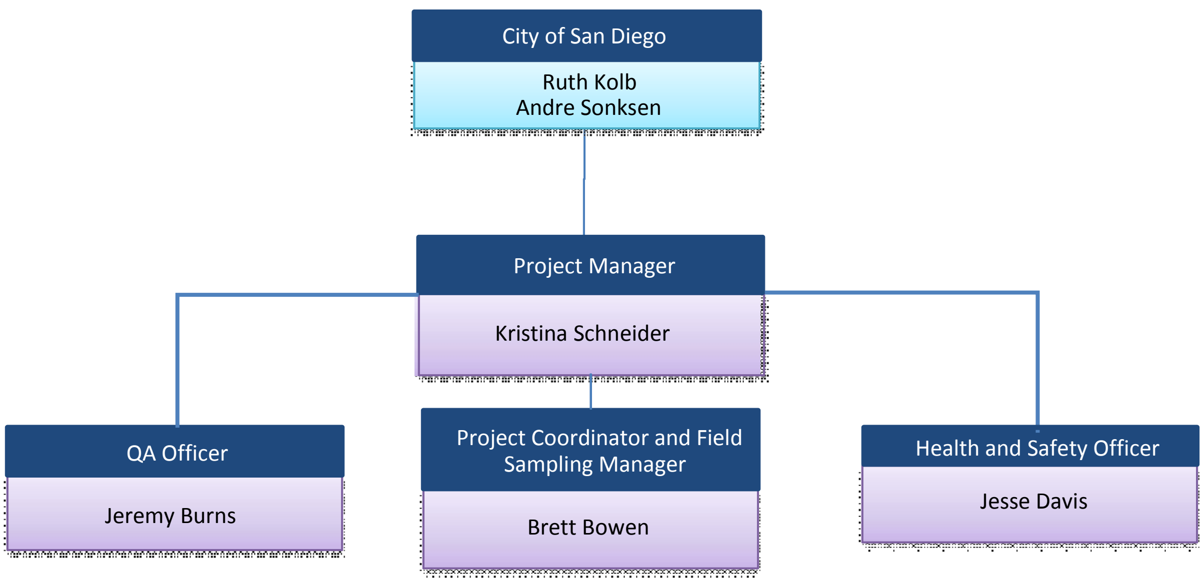

Figure 1-1.
AMEC Project Team Organization

2.0 DESCRIPTION OF STREAM GAUGE LOCATIONS

Stream gauge equipment will be installed in several waterbodies throughout the City's jurisdictional boundary to monitor water level, temperature and in many locations conductivity. The stream gauge locations are shown in Figure 2-1.

2.1 SITE SELECTION CRITERIA

An initial desktop survey of surface waters within the City's jurisdictional boundaries identified streams for implementing the Stream Gauge Study. Site reconnaissance was performed in late April 2014 and in late July 2014 to assess stream conditions and any constraints for equipment installation and data collection. The following factors were considered for selecting the current study sites:

- Safety: Sites must include safe parking, and equipment must be accessible in a wadable section of the stream under base flow conditions.
- Accessibility: Stream locations must not be on private property or in locations where encroachment permits would be required.
- Distance from homeless encampments: Locations adjacent to homeless encampments and human activity were not selected because of their elevated risk of vandalism to or theft of the monitoring equipment.
- Presence of water: Stream sections where flow was evident (riffles and runs) were selected over pools. Deploying monitoring equipment in riffle and run sections will best indicate how water levels fluctuate, as well as when the stream has stopped flowing. Deploying equipment in a pool section is less indicative of a stream no longer flowing because, in many cases, a pool section will retain water long after a stream has stopped flowing.

Site names, identifications (IDs), and the geographic coordinates of each stream gauge monitoring location are listed in Table 2-1.

Figure 2-1.
Stream Gauge Monitoring Locations

Table 2-1.
Stream Gauge Site Locations

Site ID	Site Name	Monitoring Equipment	Latitude Longitude	Site Description	Site Constraints
LP-1	Los Peňasquitos Upstream	LTC	32°56'33.67"N 117° 5'3.15"W	Beneath Spring Brook Drive Bridge, along Sabre Springs Parkway	Earthen bottom stream with poorly defined channel full of vegetation
LP-2	Los Peňasquitos Downstream	LTC	32°54'25.06"N 117° 12'21.69"W	Beneath Sorrento Valley Road, along the Los Peňasquitos Canyon Trail	Well-defined channel beneath bridge, with vegetation filling much of the channel upstream and downstream of bridge
SDG-1	San Dieguito Upstream	LT	33° 6'44.02"N 117° 0'44.89"W	Culvert beneath Rockwood Road, west of San Pasqual Union Elementary School	Poorly defined channel with vegetation growing throughout stream bed and banks
SDG-2	San Dieguito Middle	LT	33° 5'54.54"N 117° 1'4.30"W	Beneath eastern side of bridge on San Pasqual Valley Road, east of Cloverdale Road	Poorly defined channel, similar-height water stains on all pilings; deeper pool along western side; minor rill erosion on eastern side
SDG-3	San Dieguito Downstream	LT	33°3'56.03"N 117° 3'58.28"W	Downstream of footbridge along Mule Hill Historic Trail of the San Dieguito River Park	Small, well-defined channel beneath the bridge with a concrete apron creating a small hydraulic jump; natural stream bottom with some riprap
SDG-3-B	San Dieguito Downstream	BARO	32°3'56.0."N 117° 3'58.28"W	(Same as above)	No constraints; equipment installed in tree adjacent to stream monitoring equipment
MB-RC-1	Rose Creek Upstream	LT	32°51'41.40"N 117°12'35.30"W	Box culvert system running beneath Genesee Avenue, northwest of Centurion Square and University City High School	Braided channel, mostly due to vegetation growth; isolated flow to the box culverts adjacent to the left and right bank

Table 2-1.
Stream Gauge Site Locations (continued)

Site ID	Site Name	Monitoring Equipment	Latitude Longitude	Site Description	Site Constraints
MB-RC-2	Rose Creek Middle	LT	32°50'15.20"N 117°13'58.10"W	Approximately 100 feet downstream of CA-52 East, above the confluence of Rose Creek and San Clemente Canyon	Concrete-lined trapezoidal channel immediately upstream of a sparsely vegetated, well-defined channel containing riprap, sand/gravel substrate
MB-RC-3	Rose Creek Downstream	LT	32°49'22.16"N 117°13'42.18"W	Upstream portion of half-mile-long concrete channel paralleling Morena Blvd, Santa Fe Street, and southwest of Jutland Road	Large pool section above the trapezoidal channel which acts as a dam until flows are high enough to crest the edge of the channel
MB-SC	San Clemente Canyon	LT	32°50'15.50"N 117°13'55.50"W	Streambed parallel to San Clemente/Rose Canyon Hiking Trail, south of CA-52	Braided channel with riffles and runs draining into larger pools; streambed mostly cobble and pebbles
MB-TC-1	Tecolote Creek Upstream	LTC	32°49'38.26"N 117°11'46.27"W	Stream along trail, west of Genesee Avenue at Chateau Avenue	A well-defined stream channel with a natural streambed consisting of bedrock, cobble, and boulders
MB-TC-2	Tecolote Creek Middle	LTC	32°47'52.69"N 117°11'22.25"W	Box culvert running beneath Mt. Acadia Blvd upstream of the Tecolote Canyon Golf Course	Well-defined channel upstream of culvert, which can inhibit flow during low water levels; downstream draining of water into a large pool with eroded banks
MB-TC-2-B	Tecolote Creek Middle	BARO	32°46'52.69"N 117°11'22.25"W	(Same as above)	No constraints; equipment installed in a tree adjacent to stream monitoring equipment
MB-TC-3	Tecolote Creek Downstream	LTC	32°46'28.77"N 117°11'28.34"W	Furthest upstream stretch of concrete trapezoidal channel, which parallels Gardena Avenue to the south	Well-defined, concrete-lined trapezoidal channel upstream of the dry weather diversion; vegetation growing throughout the channel bottom
SDR-1	San Diego River Upstream	LTC	32°50'23.07"N 117° 2'35.74"W	Downstream of Old Mission Dam in Mission Trails Park below the spillway	Well defined riffle/run section which flows along the base of the dam before draining into a large deep pool

Table 2-1.
Stream Gauge Site Locations (continued)

Site ID	Site Name	Monitoring Equipment	Latitude Longitude	Site Description	Site Constraints
SDR-2	San Diego River Middle	LTC	32°46'48.78"N 117° 6'38.78"W	Downstream of Ward Avenue before flowing beneath Interstate 15	Well-defined channel with a natural stream bottom and riprap lining the left (southern) bank of the river
SDR-3	San Diego River Downstream	LTC	32°46'20.64"N 117° 8'40.00"W	East of the Camino Del Este Bridge along riprap to the south of the bridge conveyance	Very low flows and no apparent channeling, except flow traveling beneath bridges; banks predominantly lined with aquatic vegetation and riprap
SDR-SC-1	Shepherd Canyon North	LTC	32°50'17.30"N 117° 5'43.63"W	Downstream of the culvert running beneath Villarrica Way	Water discharging into the culvert from beneath the road and flowing down through the canyon; poorly defined channel due to heavy vegetation
SDR-SC-2	Shepherd Canyon South	LTC	32°49'57.40"N 117° 5'28.61"W	Downstream of the concrete spillway in the canyon running parallel to Avenue Playa Veracruz at Corte Playa Encino	Upstream pond discharging to stream when water overcrests the spillway; well-defined channel, immediately downstream of the spillway
SDR-SC-2-B	Shepherd Canyon South	BARO	32°49'57.40"N 117° 5'28.61"W	(Same as above)	No constraints; equipment installed in tree adjacent to steam monitoring equipment
SDB-DC	Dennery Canyon	LTC	32°35'24.32"N 117° 1'22.48"W	Downstream of the first box culvert running beneath Dennery Road, immediately east of Black Coral Way	Well-defined channel with a natural streambed and heavily eroded banks; stormwater outfall contributing additional discharge to this location
SDB-OR	Otay River	LTC	32°35'26.75"N 117° 3'43.23"W	Beneath eastern side of Beyer Way bridge, immediately downstream of footbridge along the walking trail	Well-defined channel with a short riffle section before flowing beneath Beyer Way into a large pool; upstream channel filled with vegetation
SDB-PC	Poggi Canyon	LTC	32°35'25.32"N 117° 2'29.79"W	Upstream of the footbridge that spans Poggi Canyon south of Rancho Drive	Well-defined channel with riprap lining the banks immediately upstream and downstream of bridge; upstream banks with signs of elevated erosion

Table 2-1.
Stream Gauge Site Locations (continued)

Site ID	Site Name	Monitoring Equipment	Latitude Longitude	Site Description	Site Constraints
SDB-PC-B	Poggi Canyon	BARO	32°35'25.32"N 117° 2'29.79"W	(Same as above)	No constraints; equipment installed in tree adjacent to steam monitoring equipment.

3.0 MONITORING EQUIPMENT

The following equipment is being used to implement the Stream Gauge Study at the sites described in Table 2-1:

- ***The Solinst LTC Levelogger Junior (LTC)*** is a water quality monitoring device (datalogger) that measures water level, temperature, and conductivity. When the datalogger is submerged, it computes water level by combining water pressure and barometric pressure. The manufacturer specifies that these units measure water level accurately to 0.1 percent (%) of 10 meters, which is ±1 centimeter (cm) of the in-situ water level. The conductivity sensor is capable of reading up to 80,000 microsiemens per centimeter (µS/cm). The temperature accuracy is rated for ±0.1 degree Celsius (°C) of the ambient temperature. To collect data, the water level must be approximately 0.5 inches deep so the pressure and conductivity sensors are submerged. These units were installed in specified locations to collect additional data for a TDS study currently being performed under a separate task order for the City.
- ***The Solinst Levelogger Edge (LT)*** measures water level and temperature. Water level is computed using same technology as the LTC, measuring water pressure and barometric pressure. This unit is rated at 0.05% accuracy of 10 meters, which is ±0.5 cm of the ambient water level. The temperature accuracy is rated for ±0.05 °C.
- ***The Solinst Barologger Edge (BARO)*** is designed for deployment out of the water to measure in-situ barometric pressure and air temperature only. The resulting barometric pressure is more precise than the barometric pressure measured by the submerged water level equipment. The manufacturer recommendeds that data collected from the LTC and LT be paired with in-situ data from BARO units to improve water level accuracy. The BARO equipment was installed within the recommended 20-mile radius and 1.000 feet of elevation difference from the LT and LTC units in the streams.

This page intentionally left blank

4.0 FIELD METHODOLOGY

4.1 INSTALLATIONS

AMEC staff programmed LTC, LT, and BARO units to record data at 5-minute intervals prior to site installation. Each LTC and LT unit was attached to the streambed, riprap, or a structure stable enough to withstand periodic flow rates produced by storms. Most of these units were installed within the channel of the stream to collect data during seasonal low flow and dry conditions. In some locations, deeper portions of the channel were either inaccessible because of high water, or there was no structure present for secure installation of the equipment. At these locations, a support structure allowing deployment in the next-deepest portion of the stream was used. BARO units were installed in trees adjacent to stream monitoring locations to record ambient barometric pressure. Equipment installed near areas with higher pedestrian traffic will be reinforced with additional protection to help prevent vandalism, theft, and loss of data.

4.2 CROSS-SECTIONAL CHANNEL SURVEYS

The AMEC field team will conduct cross-sectional channel surveys at each monitoring location to characterize slope, channel geometry, substrate type, and general site conditions prior to the onset of the wet season. Basic surveying equipment (level, surveying rod, tape measure) will be used to collect data along each transect. These data will serve as baseline site conditions, and may be used to develop flow rates where applicable.

The team will use a previously surveyed elevation or a nearby permanent structure as a reference for collecting slopes and elevation changes for each cross-sectional channel survey. Best professional judgment will be used for the spacing and number of data points collected along the transect. More uniform channel geometry can be characterized with fewer points and regular spacing, while a poorly defined channel with variable substrate types may require a greater number of points and more-irregular spacing to obtain the same level of detail.

Data will be collected from left bank to right bank facing downstream, with the transect spanning the stream perpendicular to the direction of flow. Elevation, site condition, and substrate type will be recorded at each point, moving across the channel. Substrate type will be characterized as earthen bottom, vegetation, bedrock, silt, sand, gravel/cobble, boulder/riprap, concrete, or other (with a descriptive note).

4.3 DATA RETRIEVAL AND EQUIPMENT MAINTENANCE

Stream gauge monitoring sites will be visited approximately every two to four weeks to download data and ensure that monitoring equipment is working properly. During each site visit, teams will remove and inspect the data logging equipment for any damage, and download data. If field teams believe equipment has been tampered with, it will be further reinforced or moved to a new location.

4.4 PHOTO DOCUMENTATION

Photo documentation of the stream gauge locations will be performed on a regular basis or each time a site is visited. Photographs will capture upstream, downstream, and stream bank conditions, along with any significant changes to the site area in general. The naming convention will include the site name and the viewing direction of the photograph. For example:

- *SDG-1-up*: San Dieguito Upstream (site), photograph facing upstream (direction)
- *SDG-1-right*: for San Dieguito Upstream, photograph facing right bank.
- *SDG-1-down:* San Dieguito Upstream, photograph facing downstream
- *SDG-1-left*: San Dieguito Upstream, photograph facing left bank
- *SDG-1-right-Erosion:* San Dieguito Upstream, photograph facing right bank, heavily eroded bank due to rain event (descriptor)

5.0 DATA MANAGEMENT

The Stream Gauge Study will generate a large dataset for each monitoring location over the course of the year. Data will be downloaded from each location up to twice every month. All data will be saved and put into a database for developing graphs and figures, and for manipulating data. The monitoring equipment is currently set to record data at five-minute intervals. Water level, temperature, barometric pressure, and conductivity data will be reported at 1-hour intervals, using a moving average, unless otherwise specified by the City.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

This section addresses the quality assurance and quality control (QA/QC) activities associated with data collection and management.

6.1 PRE-INSTALLATION EQUIPMENT CALIBRATION AND TESTING

LTC units were calibrated for conductivity using a three point calibration. Once calibrated, the units were submerged in conductivity calibration solution to verify each unit measured the conductivity accurately. LTC, LT, and BARO units cannot be calibrated for temperature or level; however, each was tested to verify accuracy within the manufacturer's specifications. LT and LTC units were deployed in a bucket full of water which was slowly decanted over a 72 hour period. AMEC staff would periodically manually measure and record the water level and temperature in the bucket over the course of the test and check and verify accuracy of the data recorded by each unit. BARO data was verified with local barometric data over the course of the test.

6.2 FIELD QA/QC PROCEDURES

AMEC staff will collect water level, temperature, and conductivity (where applicable) data during site visits. These manual measurements will be checked against measurements recorded by the LTC and LT units to verify equipment is continuing to function properly within the manufacturer's specifications. BARO data will be checked against locally available barometric data to verify the units are functioning properly.

Equipment that appears to be malfunctioning will be replaced in the field with a back-up unit (if available) or be flagged for replacement as soon as possible. Malfunctioning equipment will be returned to the manufacturer for repair or replacement, and data retrieval if possible.

6.3 DATA MANAGEMENT QA/QC PROCEDURES

The software required to download data in the field will automatically compensate and export data files into excel without the need for manual data entry. Data for each monitoring location will be stored within a dedicated folder within the project folder on AMEC's server, which is backed up every night. Data files for each location include the raw and compensated data files from the equipment software, the exported Excel files, and a master Excel file used to compile the site data.

Excel export files will be saved for each site and will be used to generate hourly data. The hourly data will be incorporated into the site's master file. Within each site's master file, a "metadata" worksheet will be used as a means to document site characteristics, track downloads, document data edits, and document any other pertinent site notes. Periodically, data files will be checked to ensure the data appears appropriate for the site (i.e., reviewed for anomalies), the correct site files are compiled together, and the correct BARO data has been used for barometric compensation. Data reviews and any potential notes will be recorded on the metadata tab.

6.4 MEASURES TO PREVENT DATA LOSS

Data loss due to equipment damage, vandalism, or theft may occur throughout the project. Secure methods of installing the units will be employed to reduce these impacts; however, occasionally damage, vandalism, and/or theft does occur. Relatively frequent site visits (approximately every two to four weeks, as described in Section 4.3) will be made as another measure to reduce the data loss associated with these potential conditions. This will allow for identifying a problem and replacing a unit in a timely manner to reduce data gaps for a given site. Furthermore, if it appears equipment has been tampered with, the unit may be moved to an alternate location within the channel to provide greater security. Relocation of the unit and associated level differences (i.e., level offsets) will be recorded on the metadata tab of the site’s master file.

This page intentionally left blank