THE RANCH PLAN PLANNED COMMUNITY

PLANNING AREAS 3 AND 4 RUNOFF MANAGEMENT PLAN

Michael Baker INTERNATIONAL

TECHNICAL APPENDIX L

Amendment to Stream Monitoring Program

The Ranch Plan Planned Community
Planning Areas 3 and 4 Runoff Management Plan

Stream Monitoring Program

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Planning Areas 3 and 4 Runoff Management Plan

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Introduction

This supplement report is intended to amend the "San Juan Creek Watershed Stream Monitoring Program, PA-1 Development Area, PA-2 Development Area and the Ranch Development Plan" (Stream Monitoring Program) report prepared by PACE, dated December 2011 (PACE, 2011) to include the additional monitoring requirements for the PA-3&4 Development Area. It is anticipated that subsequent stream monitoring reports for the San Juan Creek Watershed will be completed to include both the PA-1, PA-2, PA-3, and PA-4 development areas in one document.

The objective of this program is to ensure the adjustments within active floodplain of San Juan Creek and the major tributaries are monitored to evaluate changes in stability of the streambed and streambanks consistent with CEQA commitments and conditions of approval. The stream monitoring data provides the foundation for a broad range of assessments, including:

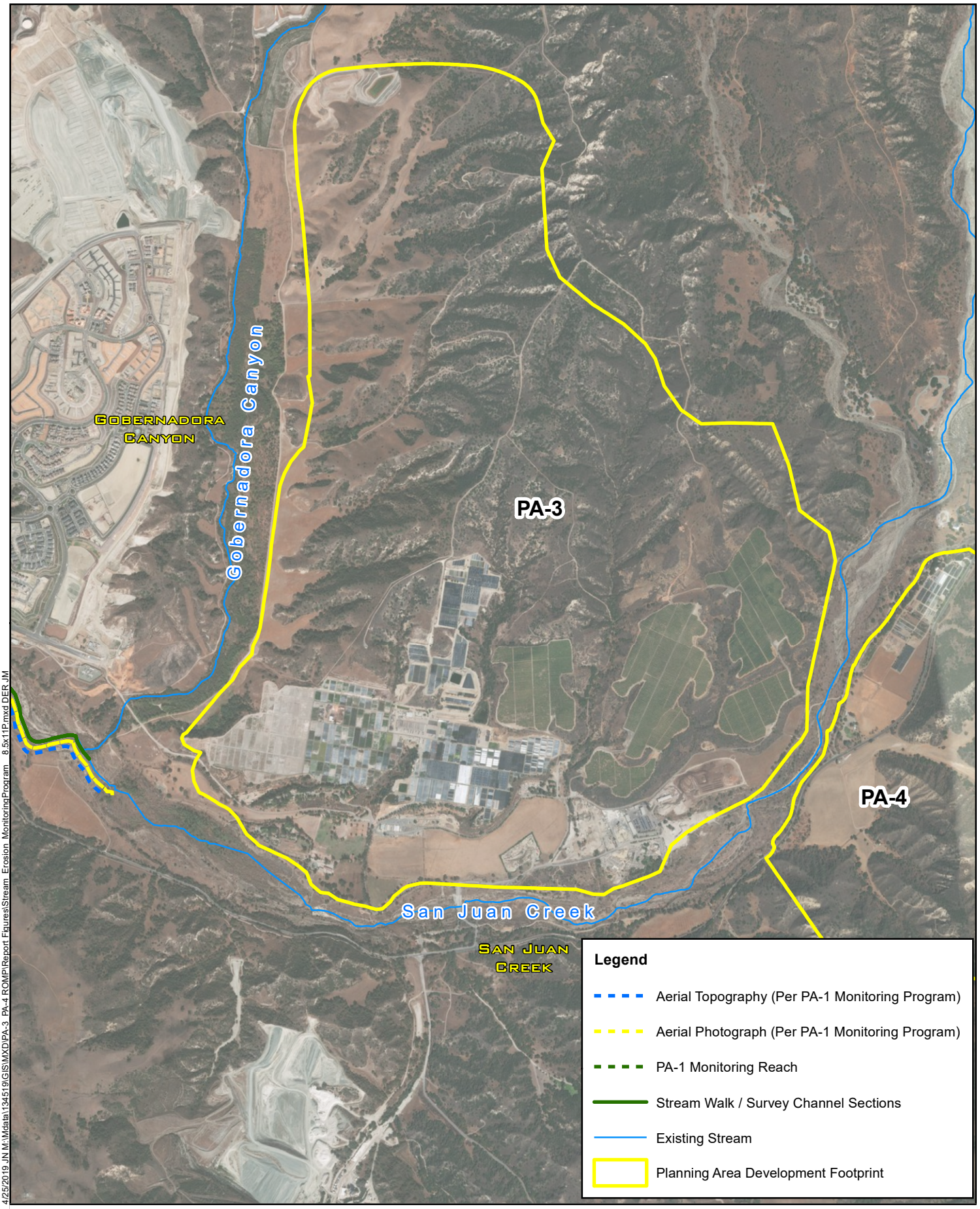
- Monitoring trends in fluvial and geomorphic conditions.
- Quantifying impacts.
- Assessing stream and watershed response to different management activities.
- Change in the inventory of stream resources.
- Allowing valid comparisons of the stream system over time.

The specific requirements for the monitoring are outlined in detailed in the Stream Monitoring Program for PA-1. The program is consistent with the mitigation measure requirements of the Ranch Plan FEIR and includes:

1. Stream walks
2. Major stream cross section monitoring
3. Periodic aerial photography
4. Evaluation of changes downstream of ponds and basins
5. Supplemental assessments

The requirements and frequency for each of the stream monitoring categories is defined in the PA-1 Stream Monitoring Program and PA-2 ROMP Stream Monitoring Program Amendment are not repeated here. A summary of the Ranch Plan FEIR stream monitoring requirements from the PA-1 Stream Monitoring Report and PA-2 ROMP Amendment are provided in Table 1 and Table 2 for reference.

The San Juan Creek and major tributary monitoring limits expanded for the PA-3&4 development area is shown in Figure 1. The expanded monitoring generally includes extending the field walks along San Juan Creek and Gobernadora Creek to upstream of the PA-3&4 development, and additional cross section monitoring along both creeks. The periodic aerial and topographic mapping requirements for San Juan Creek are outlined in the PA-1 report and include the entire reach within the Ranch Plan development; therefore, no additional areas are necessary for the PA-3&4 amendment.



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Michael Baker INTERNATIONAL

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Rancho Mission Viejo - PA-3&4 Stream Erosion Monitoring Program

PA-3&4 Stream Monitoring Reaches

Figure 1

Table 1 - Summary of EIR Stream Monitoring Requirements [1]				
Category	**Performed By**	**Requirements and Metrics**	**Frequency**	**Deliverable**
Stream Walk (Item 1 MM 4.5 – 8)	Registered Geologist/ Engineer	1. Note bed condition 2. Measure high-water marks 3. Note new sources of sediment 4. Note new source of bank distress 5. Estimate Manning's n at key locations 6. Assess bed and bank vegetation suitability to meet conveyance and habitat objectives 7. Assess lower 2 miles of Bell Canyon and Upper Chiquita watershed north of Oso Parkway to serve as control segments 8. Take photographs showing key sites or problems 9. Perform walk in late April in years 1, 2, 3, 4, 5, and 10 following substantial grading in named stream basin, and in any year within the first 10 seasons when 6-hour rainfall intensities exceed the 5-year recurrence at a nearby pre-selected rain gauge 10. Prepare annual report by June 20 of relevant years	Years 1, 2, 3, 4, and 10 following substantial grading in stream/basin	Annual report due June 20
Major Stream Cross-Sections (Item 2 MM 4.5 – 8)	Stream Walker	1. Establish and survey County approved, monumented cross-sections at: • Additional sections on San Juan Creek 2. Cross-section spacing shall be 0.6 to 1.2 miles and approved by the County 3. Sections shall be surveyed to the nearest 0.05 feet in vertical direction 4. Surveys shall include: a. Notations of bed material b. Qualitative descriptions of vegetation c. Other observations conforming to conventions such as the International Hydrologic Vigil Network standards. 5. Initial survey shall be conducted prior to grading 6. Resurveys shall be conducted during years 1, 3, 5, and 10 following initial grading and as determined by the County 7. Resurveys shall be conducted when 6-hour rainfall intensities exceed 5-year recurrence or occurrences at gauges selected by the County 8. Results shall be analyzed by stream-walker and report submitted by May 20 of each year to allow for design and implementation (where needed) prior to next winter	Years 1, 2, 3, 4, and 10 following substantial grading in stream/basin	Annual report due May 20

Table 1 - Summary of EIR Stream Monitoring Requirements [(1)]

Category	Performed By	Requirements and Metrics	Frequency	Deliverable
Periodic Aerial Photography (Item 3 MM 4.5 - 8)	Geomorphologist and Others	1. Aerial photographs of entire project area to be taken in May or June following project approval. 2. Subsequent aerial photographs to be taken in years ending in '5' or '0' until project is considered complete by the County. 3. Aerial photograph resolution shall be sufficient to prepare 200-foot scale maps with 2-foot contours maps. 4. Contour maps shall be prepared for San Juan Creek channel corridor from Verdugo Canyon confluence to 0.5 mile downstream of Antonio Parkway. 5. Contour maps shall show topography of streambed and banks up to elevations of 15 feet above adjoining bed. 6. LIDAR or other technologies may be substituted for photogrammetric methods. 7. A Qualified geomorphologist shall review the aerial photos of the entire project area and: a. Identify new sources of sediment. b. Identify event-related or land-use disturbance, or evidence of channel change and instability. c. Assess discontinuities in sand transport. 8. Prepare annual report by July 15 of relevant year with assessment of changes, if any, and recommendations for maintenance, repair, or other actions	Years 1, 2, 3, 4, and 10 following substantial grading in stream/basin	Annual report due July 15
Evaluation of changes downstream of ponds and basins (Item 4 MM 4.5 – 8)	Stream walker/ Geomorphologist	1. Longitudinal profiles and channel drainage-way cross-sections shall be established downstream of basins and ponds with capacities exceeding 1-foot or which create a 4-foot elevation change in the energy gradeline. 2. Resurveys shall be conducted whenever incipient incision or erosion is identified during aerial photograph review. 3. Resurveys shall be completed before July 1 for needs identified in May 20 report.	Years 1, 2, 3, 4, and 10 following substantial grading in stream/basin	July 1
Supplemental assessments (Item 5 MM 4.5 – 8)		Additional assessments may be conducted by the applicants as deemed necessary to achieve desired bank and bed conditions. This may include County/USGS monitoring data, as appropriate.	Years 1, 2, 3, 4, and 10 following substantial grading in stream/basin	As necessary

Table 1 - Summary of EIR Stream Monitoring Requirements [1]				
Category	**Performed By**	**Requirements and Metrics**	**Frequency**	**Deliverable**
ROMP Monitoring and Mitigation Program (MM 4.5 – 1)	In a manner approved by the Manager FCD	1. For San Juan Creek and major tributaries, within the Ranch to the La Novia Bridge. 2. Monitoring to occur during project development phases and extend for a period of 10 years following completion of final grading of the last PA within the Ranch. 3. Include at least 2 storm events that generate discharges of at least 20% of computed 100-year high confidence discharges.	Years 1, 2, 3, 4, and 10 following substantial grading in stream/basin	Contained within the ROMP
Flood Control Detention Facilities Monitoring (MM 4.5 – 5)	In a manner approved by the Manager FCD	1. Monitoring program will track performance of detention facilities and stability of stream channels within and downstream of Ranch to La Novia Bridge. 2. Will identify regular maintenance needs of detention facilities and track any emerging problems with erosion or sedimentation in stream channels.	Years 1, 2, 3, 4, and 10 following substantial grading in stream/basin	Approved monitoring program prior to construction of facilities

1. Reference: *San Juan Creek Watershed Stream Monitoring Program, PA-1 Development Area and the Ranch Development Plan* (PACE, 2011).

Table 2 - Summary of PA-2 ROMP Stream Monitoring Amendment Requirements [1]	
Category	**Amendment**
Stream Walk	Extends field walk requirements to upstream of Gobernadora confluence and designates monitoring points in Canada Chiquita.
Major Stream Cross-Sections	San Juan Creek Sections: SJC7, SJC8, and SJC9 Chiquita Creek Sections: CC1, CC2, CC3, and CC4

1. Reference: *PA-2 ROMP Stream Monitoring Program Amendment (RBF, 2014)*.

1.1 Documentation and Reporting

The annual documentation and reporting requirements are identified in the PA-3&4 Stream Monitoring Report. An annual data review and evaluation shall be prepared which includes a summary of annual monitoring activities, findings of the review process and corrective actions taken, if any. All records relating to the Program shall be retained by RMV or designated contractor at a pre-determined location. These records include stream field inspection sheets, topographic and aerial photograph, ground photographs, and annual summary and evaluation reports. Records shall be retained for a period of at least 5 years.

It is anticipated that the PA-3&4 monitoring documentation will be included in a combined report with the PA-1 and 2 development areas. An annual report template is included the PA-1 Stream Monitoring Report *Appendix B*. Annual reports will be submitted to the County of Orange by July 15 of each year monitoring occurs. Subsequent versions for the report should be expanded to include the PA-3&4 development area requirements outlined herein.

2 PA-3&4 Development Area Monitoring Amendment

This section identifies the additional stream monitoring requirements associated with the PA-3&4 development area. It includes the field walk and major stream cross section monitoring locations.

Stream Walks

The additional field walk requirements include extending the reach along San Juan Creek to upstream the PA-4 development at regional node 119. The field walk reach is extended upstream of PA-4 to capture the effects of the proposed planning area outlets. The field walk limits are also extended along Gobernadora Canyon from the San Juan Creek confluence to upstream of the Gobernadora Multipurpose Basins. This reach is included to comply with the requirements of mitigation measure (MM) 4.5-1 m., which indicates that monitoring for project impacts shall be conducted for San Juan Creek and its major tributaries within and downstream of the Ranch to La Novia Bridge. The limits of the field walks are shown on Figure 1.

Major Stream Cross Section Monitoring

The objective of the monumented stream cross sections is to provide a reference for long term comparative record of the stream geometry to monitor changes which may be influenced by urbanization within the watershed. The minimum requirements for the establishment and monitoring of the stream cross sections has been defined in the Mitigation Monitoring requirements of the Ranch Plan FEIR under MM 4.5-8 Stream Monitoring Program. For the PA-3&4 development area the requirements include:

1. Gobernadora Canyon – 4 locations
2. San Juan Creek – 3 locations

An extended stream monitoring plan will be prepared by PACE to identify the future survey stream cross section locations for the remaining areas of the Ranch Plan. The document titled, "*Expanded Stream Monitoring Plan, Selection of Extended Survey Stream Cross Section Locations, San Juan Creek and Major Tributaries Stream Monitoring Program (Amendment to Stream Monitoring Plan),"* (PACE, 2014b) is dated March 24, 2014. It includes the recommended locations for the all the future cross sections along San Juan Creek, Chiquita Creek and Canada Gobernadora associated with Planning Areas 2, 3, 4, and 5. The extend plan includes all the future stream monitoring locations. The following sections shall be incorporated into the amended monitoring for the PA-3&4 development areas:

San Juan Creek Sections: **SJC10, SJC11, and SJC12**

Gobernadora Sections: **CG1, CG2, CG3, and CG4**

The location of the cross sections is shown on Figures 1-7 from the extended plan (PACE, 2014b) in Appendix A.

The recommended locations of the stream cross sections will be chosen to be representative of the study stream reaches and associated with critical locations adjacent to the development areas. The locations are not precise, but rather indicate the general intended location based on the regional data. The exact location of each section should be determined through the initial field walk with the river/hydraulic engineer and field surveyor to establish the control monuments. The final location of the section will be based on the interpretation of the field conditions in order to provide the optimum monitoring position. The final locations of the cross sections shall be approved by the County.

2.1 Cross Section Locations

2.1.1 San Juan Creek

Section SJC10: This cross section is located 4,300 ft upstream of the previous cross section and aligns with to San Juan Creek HEC-RAS Model Sta. 46348 (Bell to Gobernadora Reach). This reach is expected to aggrade for the 100-yr event under existing conditions as well as over the long term.

Section SJC11: This cross section is located 5,500 ft upstream of the previous cross section and is aligned with San Juan Creek HEC-RAS Model Sta. 51824 (Bell to Gobernadora Reach). This reach is expected to aggrade for the 100-yr event as well as over the long term.

Section SJC12: This is the most upstream of the proposed control sections. It is located at San Juan Creek HEC-RAS Model Sta. 56024 (Bell to Gobernadora Reach). The reach is expected to aggrade for both the 100-year event and over the long term.

2.1.2 Canada Gobernadora

Section CG1: This proposed cross section is located 3,200 feet upstream of the confluence of Canada Gobernadora with San Juan Creek, 2,200 feet upstream of the existing cow camp crossing, and approximately 1,000 feet upstream of the proposed future Cow Camp Bridge across Canada Gobernadora. The reach has a tendency to degrade for the existing condition 100-yr event as well as over the long-term.

Section CG2: The cross section is located immediately downstream of the southern boundary of the Gobernadora Ecological Restoration Area (GERA). The reach has a degradational tendency for the 100-yr event, as well as a slightly aggradational response over the long term.

Section CG3: The proposed cross section is situated inside GERA. The reach has an aggradational response for the 100-yr event as well as over the long term. Additionally, the proposed cross section is situated inside GERA.

Section CG4: This cross section is located approximately is situated immediately downstream of proposed Multipurpose Gobernadora Basin. This portion of Gobernadora Creek is aggradational in nature and has a tendency to silt up for the 100-yr event as well as over the long term.

2.2 Streambank Erosion Corrective Measures

If excessive scour or deposition is identified as a result of the monitoring, guidelines for the identification and use of potential stream erosion corrective measures have been identified by PACE as part of the PA-1 Stream Monitoring Program (PACE, 2011), and the Ranch Plan ROMP (PACE, 2013). A

variety of potential hydraulic and structural measures were identified in order to provide a suitable range of alternatives for San Juan Creek and the major tributaries.

"Appendix E - Adaptive Streambank Erosion Corrective Measures Guidelines" in the PA-1 Stream Monitoring Program provides guidance for the selection of appropriate stream erosion corrective measures and the identification of the measures based on general categories of measure type. Table 2 is taken from that Appendix and provides a general list of potential corrective measures. The full document is included in Appendix B.

Table 2 - Stream Erosion Potential Corrective Measures [(1)]

In-stream Flow Redirection Techniques	Bank Armoring Protection Techniques	Biotechnical Bank Protection Measures	Avulsion Prevention Techniques	Structure Protection
• Groins • Buried groins • Barbs • Bendway weir • Porous weir • Palisades	• Anchor points • Roughness • Riprap • Rock toe • Cribwalls • Concrete slopes • Grouted rock • Flexible mattress	• Woody plantings • Herbaceous cover • Soil reinforcement • Riparian buffer • Bank reshaping • Buffer management	• Floodplain roughness • Headcut prevention • Erosion cut-off fill and armoring	• Outfall rock protection • Launching stone • Bridge/abutment pier rock armor

1. Reference: *San Juan Creek Watershed Stream Monitoring Program, PA-1 Development Area and the Ranch Development Plan* (PACE, 2011).

3 References

County of Orange (2004). *The Ranch Plan Final Environmental Impact Report (FEIR) No. 589.*

PACE (2011). *San Juan Creek Watershed Stream Monitoring Program, PA-1 Development Area and the Ranch Development Plan*. December 2011 (Amended).

PACE et al. (2013). *Ranch Plan Planned Community, Runoff Management Plan.*

PACE (2014a). *San Juan Creek Watershed Stream Monitoring Assessment, 2013 Annual Report, PA-1 Development Area and the Ranch Development.* January 2014.

PACE (2014b). *Expanded Stream Monitoring Plan, Selection of Extended Survey Stream Cross Section Locations, San Juan Creek and Major Tributaries Stream Monitoring Program (Amendment to Stream Monitoring Plan).* March 24, 2014.

RBF (2014). *The Ranch Plan Planned Community, PA-2 Runoff Management Plan Update.* February 2014.

Appendix A

Expanded Stream Monitoring Plan, Selection of Extended Survey Stream Cross Section Locations, San Juan Creek and Major Tributaries Stream Monitoring Program (Amendment to Stream Monitoring Plan)

(PACE, 2014b)

EXPANDED STREAM MONITORING PLAN

SELECTION OF EXTENDED SURVEY STREAM CROSS SECTION LOCATIONS

San Juan Creek and Major Tributaries Stream Monitoring Program

(Amendment to Stream Monitoring Plan)

March 24, 2014

General

The following memorandum contains a list of the proposed new monumented channel cross sections to be established and surveyed on along a) San Juan Creek, b) Canada Chiquita, and c) Canada Gobernadora, per item MM 4.5-8 of the EIR Stream Monitoring Program. This current list of additional cross section should be regarded as an amendment to the list previously defined in the *San Juan Creek Watershed Monitoring Program, PA-1 Development Area and the Ranch Development Plan* (PACE, 2011). The objective of the monumented cross sections is to provide a reference for the long-term comparative record of the stream geometry in order to monitor changes which may be influenced by urbanization within the watershed. The location of the control cross sections was based on several factors, including (1) the existence of specific geologic formations, (2) historic erosion patterns based on aerial photographs, (3) creek geometry trends from aerial topography, and (4) average hydraulics based on floodplain modeling. Since the monitoring of stream cross sections provides the basis for the evaluation of changes in channel form, hydraulic characteristics, and stream stability, the following considerations were also taken into account when selecting the cross section locations: (1) not locating a cross section where the character of the channel changes (i.e. break in the channel slope), (2) locating it outside of the hydraulic influence from hydraulic structures, (3) channel section and form should be typical of the stream reach, and (4) no existing local scour influences. The selection of the monumented cross sections was also based on the results from the stream stability analysis for San Juan Creek, Canada Chiquita, and Canada Gobernadora included in Chapters 12 and 17 of the *Ranch Plan ROMP*. Under this analysis, the three major watercourses were evaluated for sediment transport capacity and their tendency to aggrade or degrade based on existing, proposed and mitigated flow conditions. The results from this analysis were incorporated into the cross section selection process by proposing locations that were situated within each reference channel segment and that could be considered representative of the overall channel reach hydraulics. Finally, the proposed survey locations of the stream cross section also comply with the maximum interval spacing requirements established in the original mitigation monitoring program.

Geologic Data

Geologic and soils data was available from the NRCS regional soil maps and from the field geologic mapping for PA-1 area generated by GMU Geotechnical, Inc. These maps were used to understand the general characteristics of the streambanks and their potential for erosion or stability. In general, the location of monumented cross sections intersecting stable geologic and soil formations (hard points)

was discouraged as these locations are rarely affected by changes in flow hydraulics resulting from the development of the watershed.

Hydraulic Data

Key hydraulic parameters for the 100-yr event at each proposed cross section were obtained from approved HEC-RAS models for main stem San Juan Creek, Canada Chiquita and Canada Gobernadora (see ROMP, 2013). The average hydraulic parameters were determined for each survey control section as well as for several other neighboring cross sections for comparison purposes.

Historic Erosion

Historic erosion patterns for main stem San Juan Creek, Canada Gobernadora, and Canada Chiquita, where available, were used to better inform the cross section selection process. In particular, the study of historical flow patterns helped in the determination of (1) limits of the active streambed, and (2) changes of the thalweg location. These two features allowed for the identification of key locations that have been historically stable or have shown the potential for erosive trends that may need to be anticipated. As discussed above, geologic stable areas resistant to erosion may not necessarily be appropriate locations for establishing monumented cross sections as they may not indicate the effects from urbanization.

Current Aerial Photographs

Up-to-date aerial photographs were used to further assist in defining the cross section locations utilizing information on current erosion patterns and vegetation within the streambed or along the streambank.

Description of Cross Section Locations and Selection Discussion

The proposed cross section locations for San Juan Creek, Canada Chiquita and Canada Gobernadora are shown in Exhibits 1 through 12. It is important to stress that the proposed locations are not precise, but rather indicate the general intended locations based on the regional data. There is flexibility in the final locations as long as they are placed within certain limits. The exact location of each control section will be determined through a field walk with the river/hydraulic engineer and field surveyor in order to establish the control monuments. The final location of the section will be based on the interpretation of the field conditions in order to provide the optimum monitoring position.

The minimum requirements for the establishment and monitoring of control field survey cross sections for the mainstem San Juan Creek and its major tributaries has been defined in the Mitigation Monitoring requirements of the EIR under item MM 4.5-8 Stream Monitoring:

"Monumented cross sections will be established and surveyed on San Juan Creek and all monitoring locations will first be approved by the County of Orange before implementation. The cross sections will be spaced approximately 0.6 to 1.2 miles apart and approved by the County. They will be surveyed to the nearest 0.05 feet vertical, and include notations of bed material encountered and qualitative descriptions

of vegetation, and other observations conforming to geomorphic conventions, such as the International Hydrologic Vigil network standards.

The initial surveys will be conducted prior to grading, with resurveys during years 1, 3, 5 and 10 following initial grading or at frequencies determined by the County of Orange. Re-surveys will also be conducted during years when 6-hour rainfall intensities exceed the 5-year recurrence at a nearby pre-selected recording rainfall gauge or selected occurrences by the County of Orange. Results will be analyzed by the steam-walker, and included in the related report, recommending maintenance and restorative measures. The report will be submitted by May 20 of each year, to allow design and implementation (where needed) prior to next winter."

A total of six (6) new cross-sections are recommended along San Juan Creek for the implementation of the monitoring program upstream of the PA-1 monitoring limits which will encompass PA-2 through PA-5. The proposed cross-sections are illustrated in Exhibits 1 through 6. Note that these additional 6 cross sections are all located upstream of cross section No. 6 from the PA-1 Monitoring Program (also included in Exhibits 1 thought 6 for completeness). In all cases, the cross-sections lie perpendicular to the direction of flow and can be considered to be representative of a particular reach of the channel based on the hydraulic and geologic properties. Similarly, a total of four (4) cross sections are recommended for implementation in Canada Chiquita along that portion of the channel extending from its confluence with San Juan Creek and PA-2 northwestern boundary. Finally, a total of four (4) cross sections are proposed for implementation along Gobernadora Creek, between its confluence with San Juan Creek and the proposed location of the Multipurpose Gobernadora Basin.

Main Stem San Juan Creek (Exhibits 1 through 6)

Section SJC7: this cross section is located approximately 1,370 feet upstream of the Canada Chiquita confluence with San Juan Creek and aligns with San Juan Creek HEC-RAS model Sta. 36174 (Gobernadora to Chiquita Reach). The cross section is also located within Reach 4 of the San Juan Creek stream stability analysis (Chapters 12 and 17 of the Ranch Plan ROMP). According to this analysis, the reach behaves as aggradational for the existing condition 100-yr event, yet it is expected to remain in equilibrium under the long-term. The cross section lies immediately downstream of the PA-2 Outfall No. 5, one of the major outfalls for this planning area, and therefore serves as a key benchmark location for tracking potential changes to stream stability resulting from the PA-2 development, as well as other upstream developments. The cross section will also provide important information regarding the meandering nature of San Juan Creek in the vicinity of this location, which is characterized by the existence of a long-radius meander curve impinging on the creek's right bank (thus indicating the potential for lateral erosion). The average hydraulics for the selected cross section, as well as the hydraulic parameters for other neighboring cross sections along the same reach is shown in the following table.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	36579	10.9	0.0087	6.5	3251	515
	36478	11.6	0.0122	6.2	3422	646
	36375	10.1	0.0097	7.1	2969	662
	36277	11.2	0.0065	7.1	2975	589
SJC7	36174	10.6	0.0066	6.4	3332	833
	36073	10.1	0.0068	5.5	3836	932
	35973	10.2	0.0070	5.8	3653	711
	35865	10.5	0.0093	6.4	3333	583
	35758	9.8	0.0114	7.3	2916	574
Average		**10.6**	**0.0087**	**6.5**	**3299**	**672**

Section SJC8: This cross section is located at the apex of a medium size meander curve which is presently leaning against the San Juan Creek's left bank (looking downstream). The cross section is located approximately 2,200 feet above the previous cross section and 900 ft downstream of the Canada Gobernadora confluence. The cross section aligns with San Juan Creek HEC-RAS Model Sta. 38398 (Gobernadora to Chiquita Reach) and is located within the extents of Reach 4 of the San Juan Creek stream stability analysis. According to this study, the reach is expected to aggrade for the existing condition 100-yr event, but remain unchanged in the long-term. The table below contains the section's average hydraulic parameters as well as the hydraulic parameters of several other cross sections nearby. Note that since this cross section is located downstream of the Canada Gobernadora confluence, it will be able to capture the potential impacts from upstream urbanization along San Juan Creek but also those from urbanization along Canada Gobernadora, one of San Juan Creek's major tributaries.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	39147	11.7	0.0101	7.0	3042	512
	38998	10.4	0.0068	5.5	3826	855
	38848	11.5	0.0053	4.4	4798	913
	38665	12.4	0.0040	5.0	4224	755
SJC8	38398	11.4	0.0034	4.8	4459	749
	38173	12.5	0.0040	5.5	3865	667
	38023	11.8	0.0042	5.8	3625	570
	37873	13.1	0.0043	6.1	3485	479
	37722	12.5	0.0039	6.0	3505	512
Average		**11.9**	**0.0051**	**5.6**	**3870**	**668**

Section SJC9: This cross section is located approximately 3,700 feet upstream of the previous cross section. The section features abundant vegetation and is located within a complex braided portion of San Juan Creek. The morphological configuration of the river along this reach has been historically affected by the presence of gravel mining operations in the area and by the construction of an embankment across the creek that had resulted in the formation of an impoundment of considerable size. Consequently, the river presents a significantly wider floodplain than other reaches located either upstream or downstream of this area. Note that the proposed cross section is located a considerable distance upstream of the referred transverse embankment so as to ensure that the hydraulics of the proposed section are not affected by localized influences from this dam. The selected cross section aligns with San Juan Creek HEC-RAS Model Sta. 42073 (Bell to Gobernadora Reach) and is located within Reach 3 of the San Juan Creek stream stability analysis. According to this analysis, Reach 3 shows an aggradational response to the 100-yr event under existing conditions, and a slightly degradational behavior in the long-term. The average hydraulic parameters in the table below reflect the proposed cross section characteristics. Note that the selected section appears to have similar average top-width properties to several other cross sections in the same reach, which is a good indication of the representativeness of the proposed location.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	42673	9.0	0.0036	4.9	4106	636
	42523	8.8	0.0027	4.0	5099	711
	42373	8.7	0.0025	3.9	5213	788
	42223	9.8	0.0021	3.8	5311	785
SJC9	42073	9.5	0.0020	3.6	5583	793
	41923	11.2	0.0017	3.4	5908	766
	41773	11.0	0.0015	3.3	6194	794
	41623	10.8	0.0012	3.1	6467	910
	41473	11.7	0.0013	3.0	6687	858
Average		**10.1**	**0.0021**	**3.7**	**5619**	**782**

Section SJC10: This cross section is located 4,300 ft upstream of the previous cross section and aligns with to San Juan Creek HEC-RAS Model Sta. 46348 (Bell to Gobernadora Reach). The cross section is situated 400 feet downstream of the Cow Camp crossing across San Juan Creek, and will be useful for the documentation and monitoring of potential erosion caused by urbanization upstream of this structure (the Cow Camp crossing has historically shown signs of bank and bed erosion affecting the structure's slope lining on the downstream side of the road embankment, as well as minor failure of the slope lining on the northern embankment). The proposed cross section was located several hundred feet downstream of the crossing, however, to ensure all localized influences from this structure would have dissipated. In addition, the cross section is located within Reach 2 of the San Juan Creek stream stability analysis. This reach is expected to aggrade for the 100-yr event under existing conditions as well

as over the long term. The average hydraulic parameters shown in the table below reflect the proposed cross section characteristics.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
SJC10	46738	12.5	0.0019	5.8	3492	415
	46499	15.6	0.0017	4.3	4745	537
	46348	16.1	0.0031	3.8	5340	658
	46198	19.3	0.0028	5.0	4015	570
	46048	18.8	0.0017	5.5	3678	456
Average		**17.8**	**0.0021**	**4.6**	**4770**	**522**

Section SJC11: This cross section is located 5,500 ft upstream of the previous cross section and is aligned with San Juan Creek HEC-RAS Model Sta. 51824 (Bell to Gobernadora Reach). This control section will be also situated downstream of the future bridge proposed across San Juan Creek connecting RMV PA-3 and PA-4. Note that the cross section is located far enough from the proposed bridge location so as not to be affected by local bridge hydraulics or localized scour). The cross section also lies within Reach 2 of the San Juan Creek stream stability analysis, which shows an aggradational response for the 100-yr event as well as over the long term. The average hydraulics and comparison to the hydraulics parameters for the other sections along the reach is shown in the following table.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
SJ11	52424	8.9	0.0052	4.6	4408	710
	52274	8.0	0.0069	5.0	4049	672
	52124	8.7	0.0086	5.5	3671	669
	51974	7.6	0.0070	5.5	3683	648
	51824	8.5	0.0050	5.1	3997	596
	51674	8.0	0.0036	4.7	4328	610
	51523	9.4	0.0027	4.2	4865	604
	51374	11.0	0.0025	4.1	4916	583
	51224	11.3	0.0028	4.2	4844	569
Average		**9.1**	**0.0049**	**4.8**	**4307**	**629**

Section SJC12: This is the most upstream of the proposed control sections. It is located in agreement with San Juan Creek HEC-RAS Model Sta. 56024 (Bell to Gobernadora Reach) and lies within Reach 1 of the San Juan Creek stream stability analysis. According to this study, the reach is expected to aggrade for both the 100-year event and over the long term. The cross section is located approximately 2,000 ft downstream of the confluence of Verdugo Canyon with San Juan Creek, one of the major tributaries to

San Juan Creek in the study area. Also, note that this proposed cross section is in close proximity to the Ranch boundary and, as a result, will serve as a reference section to gauge the amount of average erosion that would normally occur without the effects from urbanization. The average hydraulic parameters contained in the table below reflect the proposed cross section characteristics.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
SJC12	56624	8.9	0.0057	4.8	4224	736
	56474	10.4	0.0039	4.7	4338	686
	56323	10.5	0.0023	4.1	4968	648
	56175	12.2	0.0017	3.4	5918	703
	56024	12.0	0.0013	3.1	6475	735
	55874	13.8	0.0012	2.9	7005	706
	55724	15.1	0.0014	3.1	6615	618
	55574	15.3	0.0015	3.6	5717	534
	55424	17.1	0.0012	3.6	5718	469
Average		**12.8**	**0.0022**	**3.7**	**5664**	**648**

Canada Chiquita (Exhibits 7 through 9)

Section CC1: This cross section is located approximately 2,200 feet upstream of the confluence of Canada Chiquita with San Juan Creek, and approximately 1,900 feet upstream of the existing Cow Camp road embankment across Canada Chiquita. This ensures that the section hydraulics are not affected by backwater effects resulting from the embankment. The cross section is aligned with Canada Chiquita HEC-RAS Model Sta. 4000 (Chiquita Central Reach), and lies within Reach 12 of the Canada Chiquita stream stability analysis. According to this analysis, the creek at this location is expected to degrade for the 100-yr event as well as over the long-term. The proposed cross section is located on a small, entrenched meandering reach and can be considered to be representative of the hydraulic conditions for Canada Chiquita along this portion of the channel, as suggested by the following table.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
CC1	4300	8.7	0.0209	5.8	399	109
	4200	6.4	0.0189	10.3	225	69
	4100	5.1	0.0122	4.5	447	285
	4000	3.9	0.0145	5.1	460	282
	3900	5.3	0.0185	6.5	414	247
	3800	4.6	0.0161	6.2	400	248
	3700	3.2	0.0160	5.0	466	235
	3600	3.2	0.0181	6.7	350	189

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
Average		**5.6**	**0.0157**	**6.1**	**411**	**204**

Section CC2: This cross section is located approximately 2,400 feet upstream of the previous cross section and will serve to monitor changes in stream morphology resulting from the upstream PA-2 developments, most specifically potential impacts of the development on the SMWD treatment plant. The proposed cross section is located 400 feet downstream of the SMWD treatment plant and aligns with Canada Chiquita HEC-RAS Model Sta. 6402 (Chiquita Central Reach). The cross section is also located within Reach 11 of the Canada Chiquita stream stability analysis, which is expected to slightly degrade for the 100-yr event as well as over the long-term. Note that this cross section is located within a portion of Canada Chiquita in which the floodplain is considerably wider than in most other reaches along the creek. The table below contains the section's average hydraulic parameters, as well as the hydraulic parameters of several other cross sections nearby.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	6800	2.9	0.0219	4.9	469	189
	6700	2.6	0.0171	4.8	486	309
	6600	3.1	0.0205	6.1	383	218
	6500	2.5	0.0261	6.2	387	315
CC2	**6402**	**5.7**	**0.0052**	**8.1**	**321**	**176**
	6294	6.6	0.0042	2.6	843	203
	6202	6.8	0.0274	5.9	483	214
	6100	5.6	0.0099	7.7	301	165
	6000	5.3	0.0075	2.9	808	184
Average		**4.6**	**0.0155**	**5.4**	**498**	**219**

Section CC3: This proposed cross section is located 1,200 feet upstream of the previous cross section and can be assumed to be a representative cross section for Reach 10 of the Canada Chiquita stream stability analysis. The results from this analysis show that the reach has a tendency to degrade for the 100-yr event, yet it is expected to remain in equilibrium over the long term. Note that the proposed cross section aligns with Canada Chiquita HEC-RAS Model Sta. 7599 (Chiquita Central Reach). This location is characterized by a well-defined, 300-foot wide floodplain corridor tucked in between the SMWD property on the left bank and a ranch grove on the right bank. The average hydraulics for the selected cross section, as well as the hydraulic parameters for other neighboring cross sections along the same reach, are shown in the following table.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	7700	3.6	0.0081	2.6	743	282
	7675	3.4	0.0100	2.6	723	278
	7650	3.1	0.0124	2.9	648	277
	7625	2.8	0.0124	3.0	637	277
CC3	**7599**	**2.6**	**0.0114**	**2.9**	**648**	**278**
	7575	2.8	0.0101	2.8	673	279
	7550	3.0	0.0096	2.7	702	282
	7525	2.8	0.0101	2.7	696	285
	7500	3.1	0.0090	2.8	680	284
Average		**3.0**	**0.0103**	**2.8**	**683**	**280**

Section CC4: This cross section is located approximately 1,500 feet upstream of the previous cross section and is in agreement with Canada Chiquita HEC-RAS Sta. 9100 (Chiquita Central Reach). Since this cross section is located west of the north boundary of PA-2 and is not affected by the impacts of urbanization, it serves as a reference cross section for evaluating changes to the creek under undeveloped conditions. In addition, this cross section is taken to be representative of Reach 9 of the Canada Chiquita stream stability analysis. According to this analysis, the reach behaves as aggradational for the existing condition 100-yr event as well as over the long-term. The average hydraulic parameters contained in the table below reflect the proposed cross section characteristics.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	9500	5.0	0.0150	8.8	212	54
	9400	7.1	0.0089	4.6	412	89
	9300	7.1	0.0112	5.0	372	81
	9198	6.4	0.0076	5.7	326	68
4	9100	7.3	0.0062	4.1	454	93
	9004	7.5	0.0108	5.1	365	62
	8900	7.1	0.0164	6.8	275	53
	8800	5.5	0.0138	6.1	309	74
	8700	5.2	0.0099	5.4	347	84
Average		**6.5**	**0.0111**	**5.7**	**341**	**73**

Canada Gobernadora(Exhibits 10 through 12)

Section CG1: This proposed cross section is located 3,200 feet upstream of the confluence of Canada Gobernadora with San Juan Creek, 2,200 feet upstream of the existing cow camp crossing, and approximately 1,000 feet upstream of the proposed future Cow Camp Bridge across Canada Gobernadora. The proposed cross section, which aligns with Canada Gobernadora HEC-RAS Model Sta. 3600, was placed at a sufficient distance upstream of the existing Cow Camp roadway embankment so as to ensure the dissipation of any hydraulic effects resulting from this structure that could, in turn, affect the hydraulics of the proposed section (See Figure 1). As Figure 1 shows, the existing roadway embankment causes a considerable backwater effect, which extends all the way up to HEC-RAS Sta. 3401. Consequently, the control cross section was located away from those portions of the creek subject to lower flow velocities and sedimentation. The proposed cross section lies within Reach 9 of the Canada Gobernadora stream stability analysis. According to this analysis, the reach has a tendency to degrade for the existing condition 100-yr event as well as over the long-term. The average hydraulics for the selected cross section, as well as the hydraulic parameters for other neighboring cross sections along the same reach is shown in the following table.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	4000	13.5	0.0116	6.1	657	127
	3901	11.1	0.0252	13.0	311	87
	3801	9.2	0.0158	10.5	366	214
	3700	10.2	0.0185	8.1	506	266
CG1	3600	6.5	0.0325	12.9	296	58
	3537	6.0	0.0085	10.2	372	89
	3487	10.0	0.0081	7.0	671	126
	3401	7.0	0.0156	13.2	290	74
	3302	7.4	0.0039	9.3	465	233
Average		**9.0**	**0.0155**	**10.0**	**437**	**141**

Section CG2: This cross section is located approximately 3,100 feet upstream of the previous cross section, in agreement with Canada Gobernadora HEC-RAS Model Sta. 6716. The cross section is located immediately downstream of the southern boundary of the Gobernadora Ecological Restoration Area (GERA). The cross section is also representative of Reach 7 in the Gobernadora stream stability analysis, which indicated a degradational tendency for the 100-yr event, as well as a slightly aggradational response over the long term. The location of this control section will not only help monitor the impacts of the future urbanization along Gobernadora Creek but also monitor the hydraulics of the creek immediately downstream of GERA. The average hydraulics and comparison to the hydraulic parameters for the other sections along the reach is shown in the following table.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	6791	6.8	0.0093	12.8	299	60
	6765	7.2	0.0075	8.2	467	81
	6749	7.2	0.0077	10.0	382	74
	6728	7.6	0.0056	9.0	425	76
CG2	6716	8.3	0.0047	7.9	484	79
	6698	9.4	0.0026	8.4	452	68
	6678	10.9	0.0015	5.7	665	83
	6653	10.9	0.0015	5.2	731	85
	6627	10.8	0.0022	5.5	688	89
Average		**8.8**	**0.0047**	**8.1**	**510**	**77**

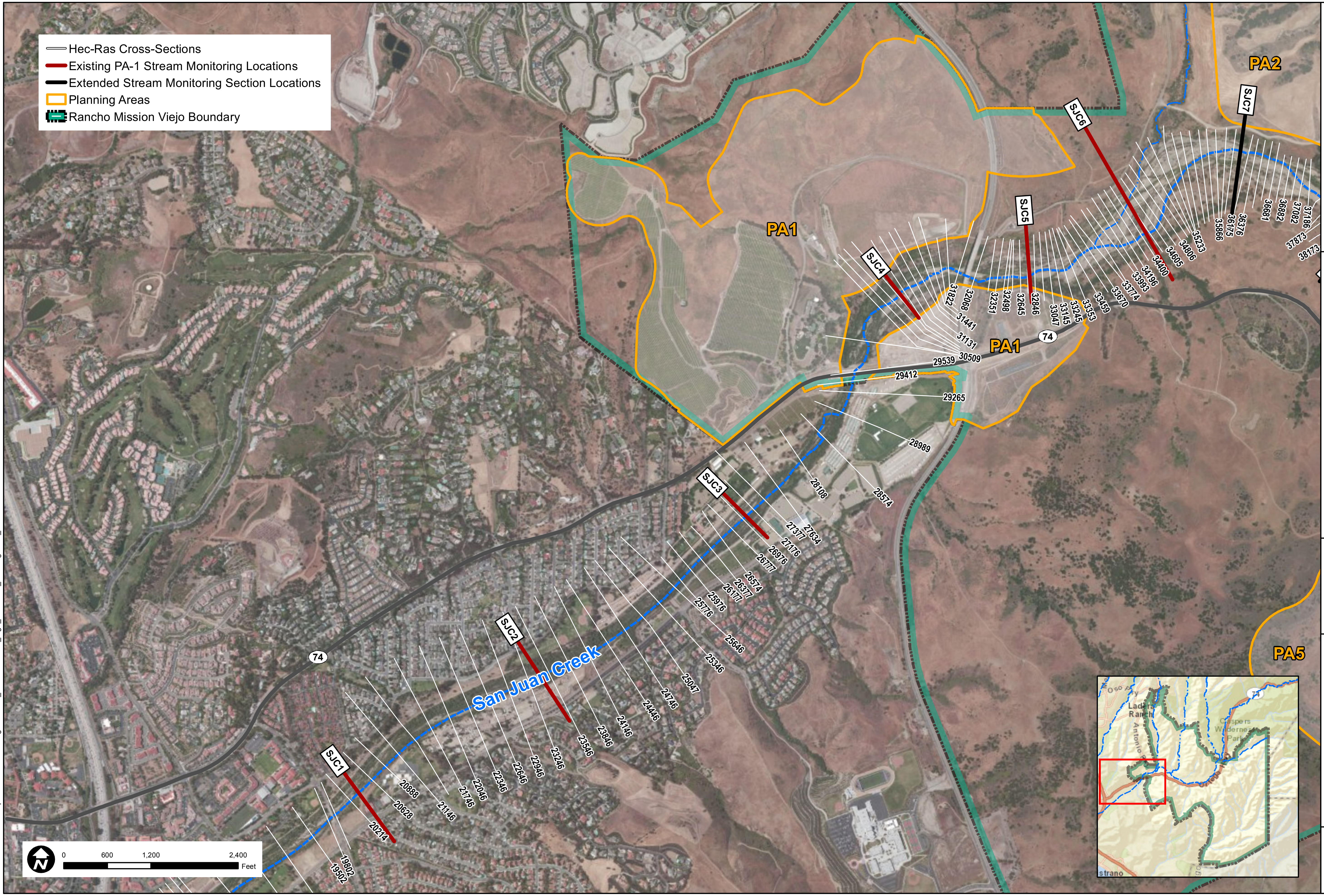
Section CG3: This cross section is located approximately 3,100 feet upstream of the previous cross section in agreement with Canada Gobernadora HEC-RAS Model Sta. 9803. The section is also located within Reach 5 of the Canada Gobernadora stream stability analysis, which shows an aggradational response for the 100-yr event as well as over the long term. Additionally, the proposed cross section is situated inside GERA. This will allow for quantification of urbanization impacts, if any, on this reserve, as well as to monitor the overall performance and sustainability of GERA. The average hydraulic parameters appear to be close or representative of the proposed cross section location based on the following table.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
	10203	3.5	0.0055	2.5	1456	461
	10103	4.0	0.0073	2.5	1463	462
	10002	4.2	0.0067	3.0	1230	444
	9903	4.6	0.0056	2.4	1548	471
CG3	9803	3.9	0.0073	2.9	1265	360
	9702	3.8	0.0093	3.0	1199	379
	9602	3.3	0.0099	3.2	1144	387
	9502	3.4	0.0097	2.9	1246	448
	9402	3.5	0.0134	2.8	1286	506
Average		**3.8**	**0.0083**	**2.8**	**1315**	**435**

Section CG4: This cross section is located approximately 3,700 feet upstream of the previous cross section and is situated immediately downstream of proposed Multipurpose Gobernadora Basin. The cross section also lies towards the south end of Reach 3 of the Canada Gobernadora stream stability analysis, and is in agreement with Canada Gobernadora HEC-RAS Model Sta. 13479. According to the

stream stability analysis, this portion of Gobernadora Creek is aggradational in nature and has a tendency to silt up for the 100-yr event as well as over the long term. Even though the section is not influenced by the urbanization from the PA-2 development, it serves as a benchmark location for assessing the hydraulic performance of the Gobernadora Basin in terms of reduction of flood damage and control of streambed degradation. For this particular section, the December 2010 Storm Damage Assessment report for Crossing at Gobernadora Creek and San Juan Creek prepared by PACE was reviewed to ensure that the proposed section was not placed within already defined potential sediment removal sites (portions of the streambed where excessive sediment deposition has caused the creek to avulse during major flood events). The average hydraulic parameters contained in the table below reflect the proposed cross section characteristics.

Survey Section	River Station	Max Depth (ft)	Friction Slope	Velocity (ft/s)	Flow Area (ft^2)	Top Width (ft)
CG4	13578	1.4	0.0203	5.9	615	574
	13553	1.6	0.0218	5.6	648	655
	13528	2.4	0.0147	5.7	638	640
	13503	3.4	0.0100	4.3	843	684
	13479	4.3	0.0092	4.5	807	586
	13454	4.1	0.0078	4.4	833	571
	13429	3.9	0.0063	4.1	879	566
	13403	3.8	0.0048	3.8	949	579
	13378	3.7	0.0044	3.5	1043	581
Average		**3.2**	**0.0110**	**4.6**	**806**	**604**



TITLE
Cross-Sections & Stream Monitoring Locations San Juan Creek

JOB
SAN JUAN CREEK - LOWER REACH
PA-1 and EXTENDED STREAM EROSION MONITORING PROGRAM
ORANGE COUNTY CA

SCALE	1"= 1,200'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

PACE Advanced Water Engineering

FIGURE
1

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Hec-Ras Cross-Sections
Existing PA-1 Stream Monitoring Locations
Extended Stream Monitoring Section Locations
Rancho Mission Viejo Boundary

Soil Classifications

100: ALO CLAY, 9 TO 15 PERCENT SLOPES
101: ALO CLAY, 15 TO 30 PERCENT SLOPES
102: ALO CLAY, 30 TO 50 PERCENT SLOPES
112: BALCOM CLAY LOAM, 15 TO 30 PERCENT SLOPES
113: BALCOM CLAY LOAM, 30 TO 50 PERCENT SLOPES
126: BOSANKO CLAY, 9 TO 15 PERCENT SLOPES
127: BOSANKO CLAY, 15 TO 30 PERCENT SLOPES
128: BOSANKO CLAY, 30 TO 50 PERCENT SLOPES
129: BOSANKO-BALCOM COMPLEX, 15 TO 30 PERCENT SLOPES
130: BOSANKO-BALCOM COMPLEX, 30 TO 50 PERCENT SLOPES
131: BOTELLA LOAM, 2 TO 9 PERCENT SLOPES
132: BOTELLA CLAY LOAM, 2 TO 9 PERCENT SLOPES
133: BOTELLA CLAY LOAM, 9 TO 15 PERCENT SLOPES
134: CALLEGUAS CLAY LOAM, 50 TO 75 PERCENT SLOPES, ERODED
135: CAPISTRANO SANDY LOAM, 2 TO 9 PERCENT SLOPES
139: CHINO SILTY CLAY LOAM
141: CIENEBA SANDY LOAM, 15 TO 30 PERCENT SLOPES
142: CIENEBA SANDY LOAM, 30 TO 75 PERCENT SLOPES, ERODED
146: CORRALITOS LOAMY SAND
147: CORRALITOS LOAMY SAND, MODERATELY FINE SUBSTRATUM
149: CROPLEY CLAY, 2 TO 9 PERCENT SLOPES
169: MODJESKA GRAVELLY LOAM, 2 TO 9 PERCENT SLOPES
173: MYFORD SANDY LOAM, 2 TO 9 PERCENT SLOPES
174: MYFORD SANDY LOAM, 2 TO 9 PERCENT SLOPES, ERODED
175: MYFORD SANDY LOAM, 9 TO 15 PERCENT SLOPES
176: MYFORD SANDY LOAM, 15 TO 30 PERCENT SLOPES
177: MYFORD SANDY LOAM, 9 TO 30 PERCENT SLOPES, ERODED
178: MYFORD SANDY LOAM, THICK SURFACE, 0 TO 2 PERCENT SLOPES
179: MYFORD SANDY LOAM, THICK SURFACE, 2 TO 9 PERCENT SLOPES
191: RIVERWASH
192: ROCK OUTCROP-CIENEBA COMPLEX, 30 TO 75 PERCENT SLOPES
200: SOPER LOAM, 30 TO 50 PERCENT SLOPES
201: SOPER GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES
204: SOPER-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES
205: SORRENTO SANDY LOAM, 0 TO 2 PERCENT SLOPES
206: SORRENTO LOAM, 0 TO 2 PERCENT SLOPES
207: SORRENTO LOAM, 2 TO 9 PERCENT SLOPES
208: SORRENTO CLAY LOAM, 0 TO 2 PERCENT SLOPES
209: SORRENTO CLAY LOAM, 2 TO 9 PERCENT SLOPES
221: YORBA GRAVELLY SANDY LOAM, 2 TO 9 PERCENT SLOPES
223: YORBA GRAVELLY SANDY LOAM, 15 TO 30 PERCENT SLOPES
224: YORBA COBBLY SANDY LOAM, 9 TO 30 PERCENT SLOPES
225: YORBA COBBLY SANDY LOAM, 9 TO 30 PERCENT SLOPES, ERODED
226: YORBA COBBLY SANDY LOAM, 30 TO 50 PERCENT SLOPES
227: WATER

SJC1 SJC2 SJC3 SJC4 SJC5 SJC6 SJC7
San Juan Creek
74

0 600 1,200 2,400 Feet

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Soil Classifications
San Juan Creek

TITLE

SAN JUAN CREEK - LOWER REACH
PA-1 and EXTENDED STREAM EROSION MONITORING PROGRAM

JOB CA

ORANGE COUNTY

SCALE	1" = 1,200'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

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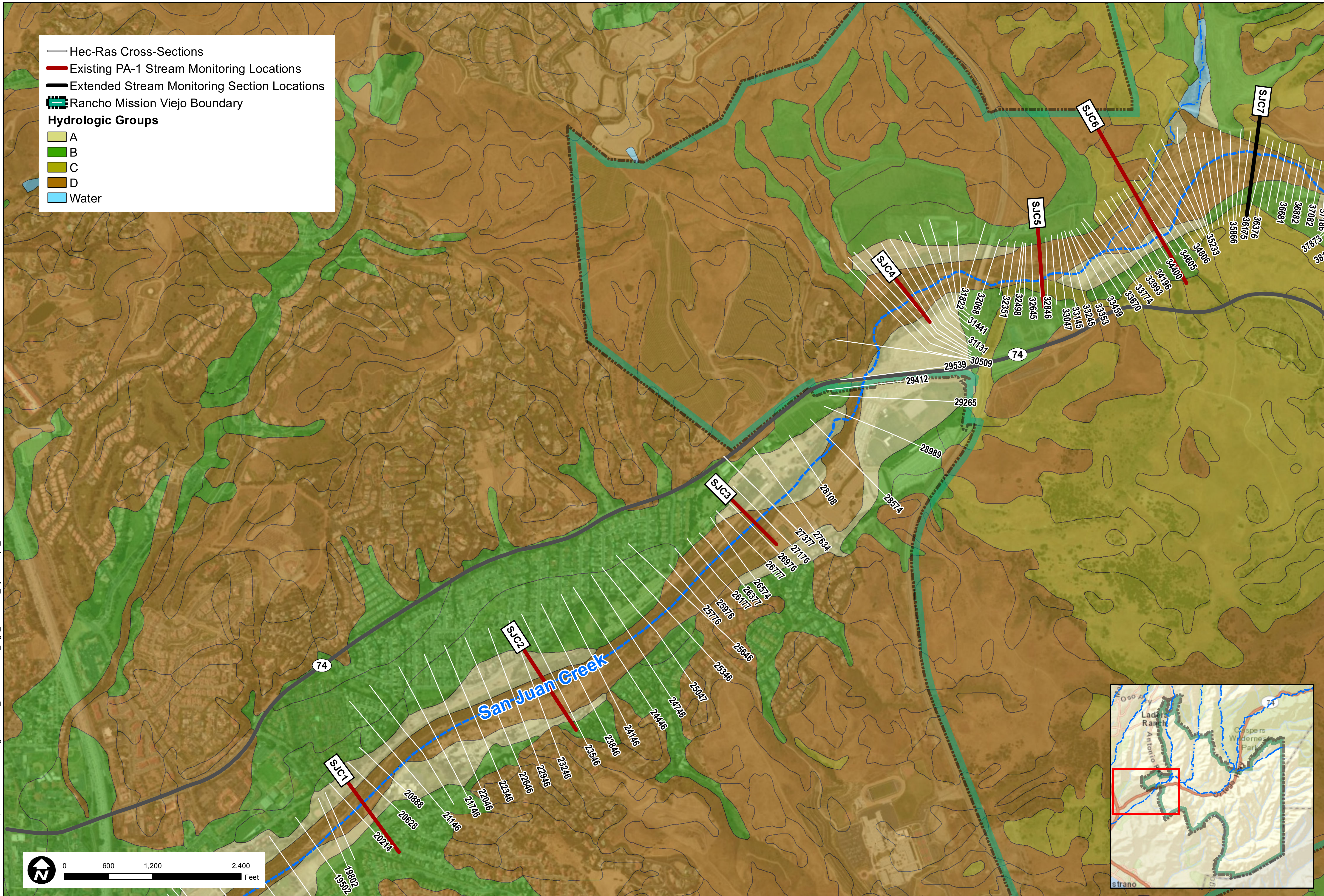
FIGURE
2



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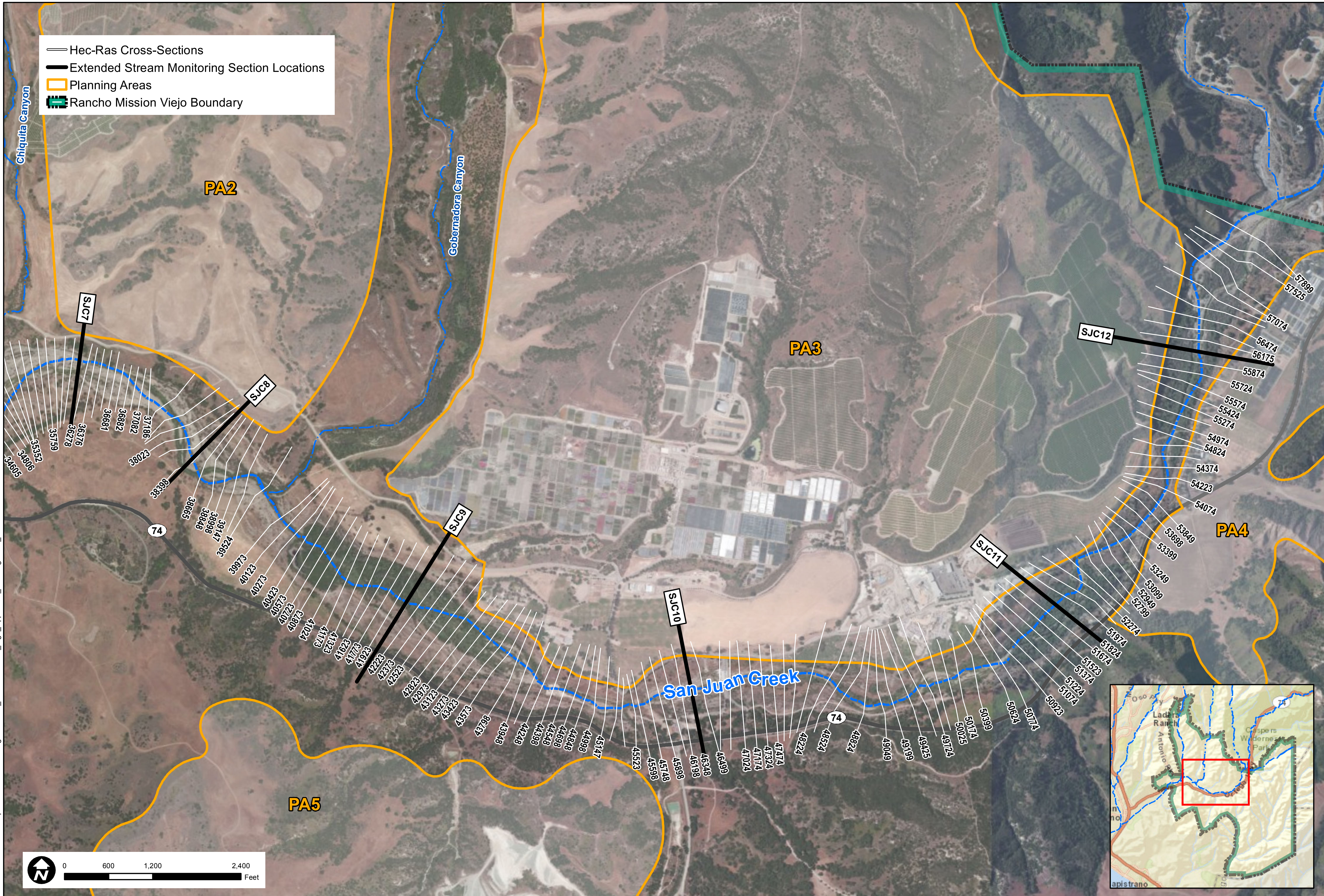
TITLE
Hydrologic Groups
San Juan Creek

JOB
SAN JUAN CREEK - LOWER REACH
PA-1 and EXTENDED STREAM EROSION
MONITORING PROGRAM
ORANGE COUNTY CA

SCALE	1"= 1,200'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

PACE
Advanced Water Engineering

FIGURE
3



TITLE

Cross-Sections & Stream Monitoring Locations San Juan Creek

JOB

SAN JUAN CREEK - UPPER REACH EXTENDED STREAM EROSION MONITORING PROGRAM

ORANGE COUNTY CA

SCALE	1"= 1,200'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

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FIGURE 4

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Hec-Ras Cross-Sections
Extended Stream Monitoring Section Locations
Rancho Mission Viejo Boundary

Soil Classifications

100: ALO CLAY, 9 TO 15 PERCENT SLOPES
101: ALO CLAY, 15 TO 30 PERCENT SLOPES
102: ALO CLAY, 30 TO 50 PERCENT SLOPES
106: ANAHEIM LOAM, 15 TO 30 PERCENT SLOPES
127: BOSANKO CLAY, 15 TO 30 PERCENT SLOPES
128: BOSANKO CLAY, 30 TO 50 PERCENT SLOPES
131: BOTELLA LOAM, 2 TO 9 PERCENT SLOPES
132: BOTELLA CLAY LOAM, 2 TO 9 PERCENT SLOPES
133: BOTELLA CLAY LOAM, 9 TO 15 PERCENT SLOPES
134: CALLEGUAS CLAY LOAM, 50 TO 75 PERCENT SLOPES, ERODED
135: CAPISTRANO SANDY LOAM, 2 TO 9 PERCENT SLOPES
136: CAPISTRANO SANDY LOAM, 9 TO 15 PERCENT SLOPES
139: CHINO SILTY CLAY LOAM
140: CHINO SILTY CLAY LOAM, DRAINED
141: CIENEBA SANDY LOAM, 15 TO 30 PERCENT SLOPES
142: CIENEBA SANDY LOAM, 30 TO 75 PERCENT SLOPES, ERODED
145: CIENEBA-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES
146: CORRALITOS LOAMY SAND
147: CORRALITOS LOAMY SAND, MODERATELY FINE SUBSTRATUM
169: MODJESKA GRAVELLY LOAM, 2 TO 9 PERCENT SLOPES
170: MODJESKA GRAVELLY LOAM, 9 TO 15 PERCENT SLOPES
171: MODJESKA GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES
173: MYFORD SANDY LOAM, 2 TO 9 PERCENT SLOPES
175: MYFORD SANDY LOAM, 9 TO 15 PERCENT SLOPES
176: MYFORD SANDY LOAM, 15 TO 30 PERCENT SLOPES
177: MYFORD SANDY LOAM, 9 TO 30 PERCENT SLOPES, ERODED
179: MYFORD SANDY LOAM, THICK SURFACE, 2 TO 9 PERCENT SLOPES
191: RIVERWASH
192: ROCK OUTCROP-CIENEBA COMPLEX, 30 TO 75 PERCENT SLOPES
193: SAN ANDREAS SANDY LOAM, 15 TO 30 PERCENT SLOPES
197: SOBOBA GRAVELLY LOAMY SAND, 0 TO 5 PERCENT SLOPES
198: SOBOBA COBBLY LOAMY SAND, 0 TO 15 PERCENT SLOPES
200: SOPER LOAM, 30 TO 50 PERCENT SLOPES
201: SOPER GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES
202: SOPER GRAVELLY LOAM, 30 TO 50 PERCENT SLOPES
204: SOPER-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES
207: SORRENTO LOAM, 2 TO 9 PERCENT SLOPES
221: YORBA GRAVELLY SANDY LOAM, 2 TO 9 PERCENT SLOPES
222: YORBA GRAVELLY SANDY LOAM, 9 TO 15 PERCENT SLOPES
225: YORBA COBBLY SANDY LOAM, 9 TO 30 PERCENT SLOPES, ERODED
227: WATER

Chiquita Canyon
San Juan Creek
SJC7
SJC8
SJC9
SJC10
SJC11
SJC12
74

0 600 1,200 2,400 Feet

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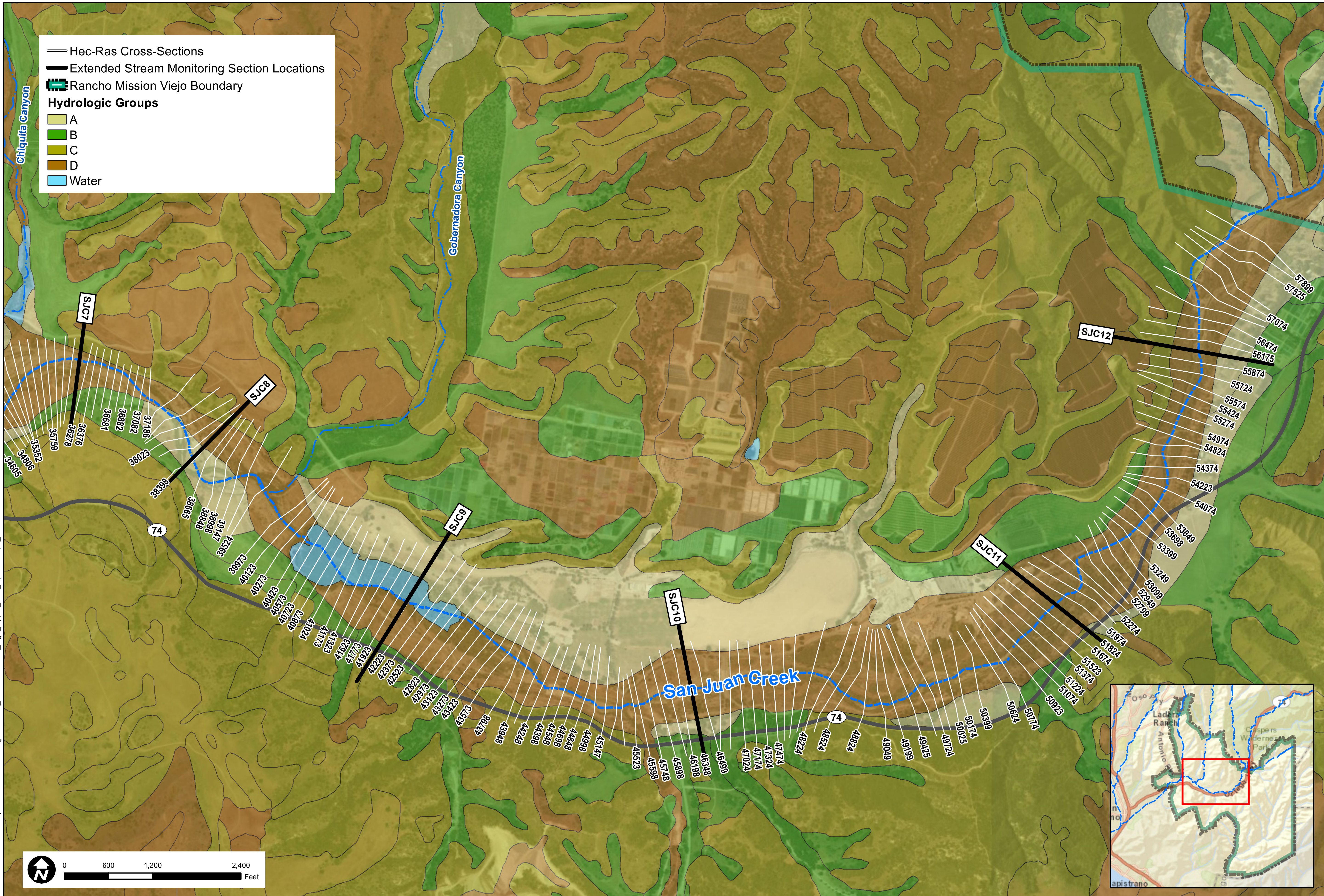
TITLE
Soil Classifications
San Juan Creek

JOB
SAN JUAN CREEK - UPPER REACH
EXTENDED STREAM EROSION
MONITORING PROGRAM
ORANGE COUNTY CA

SCALE	1"= 1,200'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

PACE
Advanced Water Engineering

FIGURE
5



TITLE

Hydrologic Groups San Juan Creek

JOB

SAN JUAN CREEK - UPPER REACH
EXTENDED STREAM EROSION
MONITORING PROGRAM

ORANGE COUNTY CA

SCALE	1"= 1,200'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

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FIGURE

6

P:\A458\6-GIS\Mxds\Workspace\StreamMonitoringXSections_20140318\A458_Fig6_Upper_SJC_HydroGroups_20140319.mxd

Hec-Ras Cross-Sections
Extended Stream Monitoring Section Locations
Planning Areas
Rancho Mission Viejo Boundary

CC1
CC2
CC3
CC4

1905
1732
1601
2128
2400
2501
2700
2900
3000
3200
3300
3500
3600
3700
3800
4000
4200
4300
4400
4600
4800
5000
5201
5300
5402
5600
5701
5900
6100
6202
6402
6500
6600
6700
6850
7150
7350
7430
7550
7622
7725
7825
7900
8000
8100
8313
8600
8800
9004
9100
9300
9400
9674
9975
10051
10174
10300
10375
10500
10600
10800
11000
11200
11401

Chiquita Canyon

San Juan Creek

PA1

PA2

74

0 350 700 1,400 Feet

P:\A458\6-GIS\Mxds\Workspace\StreamMonitoringXSections_20140318\A458_Fig7_Chiquita_PlanningAreas_20140318.mxd

TITLE
Cross-Sections &
Stream Monitoring Locations
Chiquita Canyon

JOB
CANADA CHIQUITA
EXTENDED STREAM EROSION
MONITORING PROGRAM
ORANGE COUNTY
CA

SCALE	1"= 700'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

PACE
Advanced Water Engineering

FIGURE
7

Hec-Ras Cross-Sections
Extended Stream Monitoring Section Locations
Rancho Mission Viejo Boundary

Soil Classifications

100: ALO CLAY, 9 TO 15 PERCENT SLOPES
101: ALO CLAY, 15 TO 30 PERCENT SLOPES
102: ALO CLAY, 30 TO 50 PERCENT SLOPES
126: BOSANKO CLAY, 9 TO 15 PERCENT SLOPES
127: BOSANKO CLAY, 15 TO 30 PERCENT SLOPES
128: BOSANKO CLAY, 30 TO 50 PERCENT SLOPES
131: BOTELLA LOAM, 2 TO 9 PERCENT SLOPES
132: BOTELLA CLAY LOAM, 2 TO 9 PERCENT SLOPES
133: BOTELLA CLAY LOAM, 9 TO 15 PERCENT SLOPES
134: CALLEGUAS CLAY LOAM, 50 TO 75 PERCENT SLOPES, ERODED
135: CAPISTRANO SANDY LOAM, 2 TO 9 PERCENT SLOPES
139: CHINO SILTY CLAY LOAM
141: CIENEBA SANDY LOAM, 15 TO 30 PERCENT SLOPES
142: CIENEBA SANDY LOAM, 30 TO 75 PERCENT SLOPES, ERODED
146: CORRALITOS LOAMY SAND
147: CORRALITOS LOAMY SAND, MODERATELY FINE SUBSTRATUM
149: CROPLEY CLAY, 2 TO 9 PERCENT SLOPES
169: MODJESKA GRAVELLY LOAM, 2 TO 9 PERCENT SLOPES
173: MYFORD SANDY LOAM, 2 TO 9 PERCENT SLOPES
174: MYFORD SANDY LOAM, 2 TO 9 PERCENT SLOPES, ERODED
175: MYFORD SANDY LOAM, 9 TO 15 PERCENT SLOPES
176: MYFORD SANDY LOAM, 15 TO 30 PERCENT SLOPES
177: MYFORD SANDY LOAM, 9 TO 30 PERCENT SLOPES, ERODED
179: MYFORD SANDY LOAM, THICK SURFACE, 2 TO 9 PERCENT SLOPES
191: RIVERWASH
192: ROCK OUTCROP-CIENEBA COMPLEX, 30 TO 75 PERCENT SLOPES
201: SOPER GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES
204: SOPER-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES
207: SORRENTO LOAM, 2 TO 9 PERCENT SLOPES
209: SORRENTO CLAY LOAM, 2 TO 9 PERCENT SLOPES
225: YORBA COBBLY SANDY LOAM, 9 TO 30 PERCENT SLOPES, ERODED
227: WATER

CC1
CC2
CC3
CC4

Chiquita Canyon
San Juan Creek

0 350 700 1,400 Feet

P:\A458\6-GIS\MxdsWorkspace\StreamMonitoringXSections_20140318\A458_Fig8_Chiquita_Soils_20140319.mxd

TITLE: Soil Classifications Chiquita Canyon

JOB: CANADA CHIQUITA EXTENDED STREAM EROSION MONITORING PROGRAM ORANGE COUNTY CA

SCALE	DESIGNED	DRAWING	CHECKED	DATE	JOB NO.
1"= 700'	JH	TH	BP	03/20/14	A458

PACE Advanced Water Engineering

FIGURE 8

P:\A458\6-GIS\Mxds\Workspace\StreamMonitoringXSections_20140318\A458_Fig9_Chiquita_HydroGroups_20140319.mxd

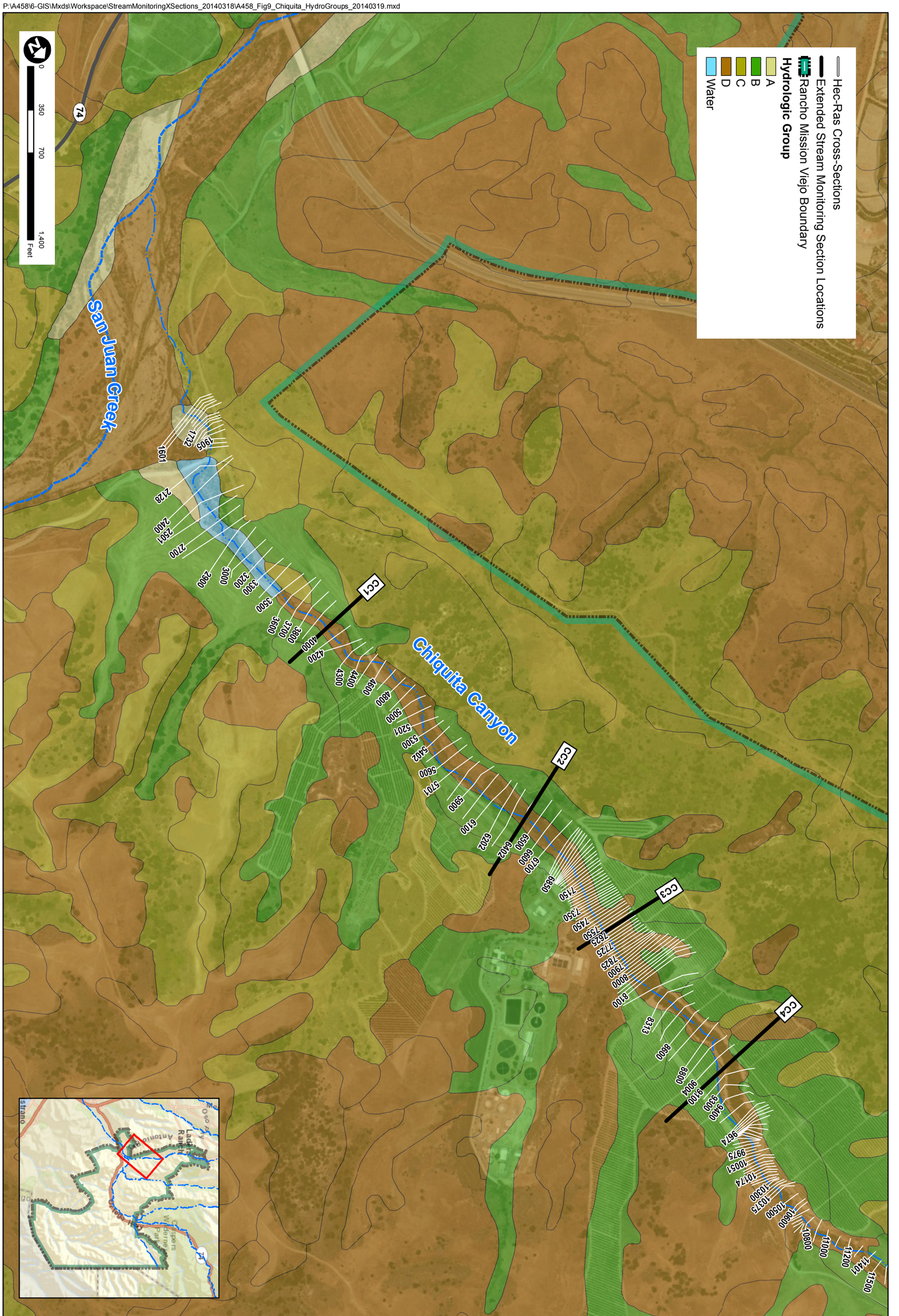
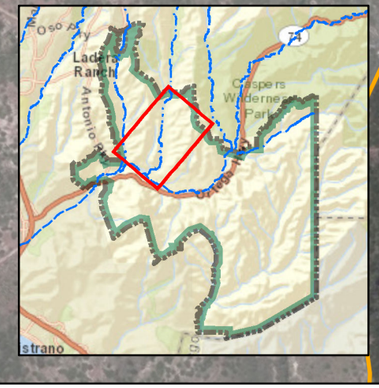


FIGURE					
9	PACE Advanced Water Engineering	SCALE 1"= 700'	JOB	TITLE	
		DESIGNED JH	CANADA CHIQUITA EXTENDED STREAM EROSION MONITORING PROGRAM	Hydrologic Groups Chiquita Canyon	
		DRAWING TH			
		CHECKED BP			
		DATE 03/20/14			
		JOB NO. A458	ORANGE COUNTY CA		

Hec-Ras Cross-Sections
Extended Stream Monitoring Section Locations
Planning Areas
Rancho Mission Viejo Boundary

PA2
PA3
San Juan Creek
Gobernadora Canyon
CG1
CG2
CG3
CG4
400 600 701 827 957 1001 1100 1202 1400 2003 2103 2702 2300 2395 2501 2702 2701 2800 2901 3001 3102 3302 3401 3487 3700 3901 4000 4301 4501 4702 4901 5001 5101 5301 5498 5587 5701 5902 6103 6201 6402 6504 6678 6791 6979 7155 7209 7282 7457 7602 7702 8003 8476 8602 8703 8903 9102 9402 9502 9602 9702 9903 10103 10203 10402 10503 10603 10703 10803 10903 11002 11102 11202 11303 11403 11602 11803 11902 12004 12103 12303 12503 12703 12803 13028 13479 13553 13603 13702 13805 14003 14502 14903

0 400 800 1,600 Feet



TITLE
Cross-Sections & Stream Monitoring Locations
Gobernadora Canyon

JOB
CANADA GOBERNADORA
EXTENDED STREAM EROSION
MONITORING PROGRAM
ORANGE COUNTY CA

SCALE	1" = 800'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

PACE
Advanced Water Engineering

FIGURE
10

P:\A458\6-GIS\Mxds\Workspace\StreamMonitoringXSections_20140318\A458_Fig10_Gobernadora_PlanningAreas_20140318.mxd

Hec-Ras Cross-Sections
Extended Stream Monitoring Section Locations
Rancho Mission Viejo Boundary

Soil Classifications

101: ALO CLAY, 15 TO 30 PERCENT SLOPES
127: BOSANKO CLAY, 15 TO 30 PERCENT SLOPES
128: BOSANKO CLAY, 30 TO 50 PERCENT SLOPES
131: BOTELLA LOAM, 2 TO 9 PERCENT SLOPES
132: BOTELLA CLAY LOAM, 2 TO 9 PERCENT SLOPES
133: BOTELLA CLAY LOAM, 9 TO 15 PERCENT SLOPES
134: CALLEGUAS CLAY LOAM, 50 TO 75 PERCENT SLOPES, ERODED
135: CAPISTRANO SANDY LOAM, 2 TO 9 PERCENT SLOPES
136: CAPISTRANO SANDY LOAM, 9 TO 15 PERCENT SLOPES
139: CHINO SILTY CLAY LOAM
140: CHINO SILTY CLAY LOAM, DRAINED
141: CIENEBA SANDY LOAM, 15 TO 30 PERCENT SLOPES
142: CIENEBA SANDY LOAM, 30 TO 75 PERCENT SLOPES, ERODED
146: CORRALITOS LOAMY SAND
147: CORRALITOS LOAMY SAND, MODERATELY FINE SUBSTRATUM
169: MODJESKA GRAVELLY LOAM, 2 TO 9 PERCENT SLOPES
171: MODJESKA GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES
173: MYFORD SANDY LOAM, 2 TO 9 PERCENT SLOPES
175: MYFORD SANDY LOAM, 9 TO 15 PERCENT SLOPES
176: MYFORD SANDY LOAM, 15 TO 30 PERCENT SLOPES
177: MYFORD SANDY LOAM, 9 TO 30 PERCENT SLOPES, ERODED
179: MYFORD SANDY LOAM, THICK SURFACE, 2 TO 9 PERCENT SLOPES
191: RIVERWASH
192: ROCK OUTCROP-CIENEBA COMPLEX, 30 TO 75 PERCENT SLOPES
193: SAN ANDREAS SANDY LOAM, 15 TO 30 PERCENT SLOPES
201: SOPER GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES
204: SOPER-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES
207: SORRENTO LOAM, 2 TO 9 PERCENT SLOPES
227: WATER

San Juan Creek
Gobernadora Canyon
CG1
CG2
CG3
CG4

0 400 800 1,600 Feet

TITLE: Soil Classifications Gobernadora Canyon

CANADA GOBERNADORA
EXTENDED STREAM EROSION
MONITORING PROGRAM

JOB: ORANGE COUNTY CA

SCALE	1" = 800'
DESIGNED	JH
DRAWING	TH
CHECKED	BP
DATE	03/20/14
JOB NO.	A458

PACE
Advanced Water Engineering

FIGURE
11

P:\A45866-GIS\Mxds\Workspace\StreamMonitoringXSections_20140318\A458_Fig11_Gobernadora_Soils_20140319.mxd

P:\A458\6-GIS\Mxds\Workspace\StreamMonitoringXSections_20140318\A458_Fig12_Gobernadora_HydroGroups_20140318.mxd

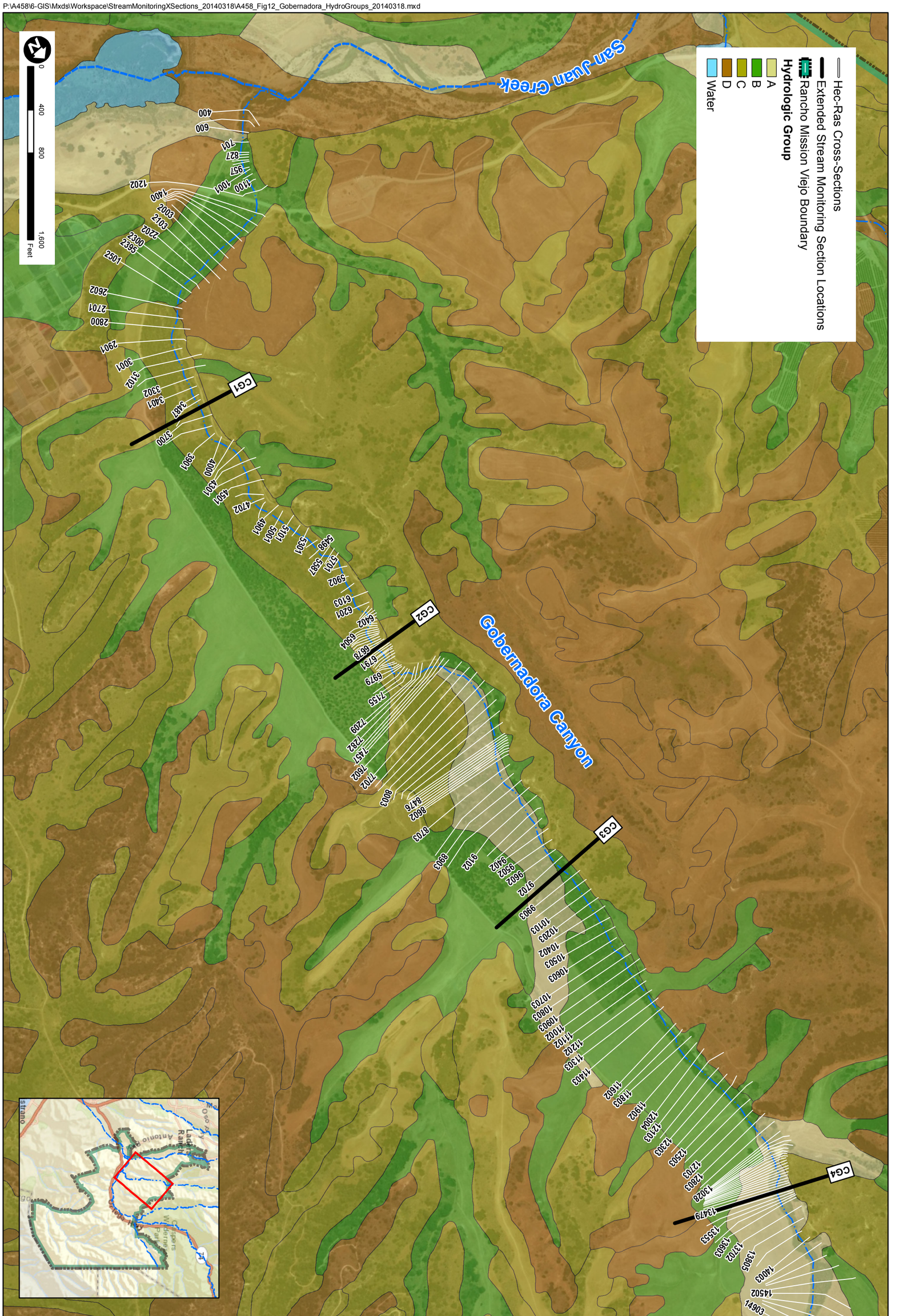


FIGURE 12	PACE Advanced Water Engineering	SCALE 1"= 800'	JOB CANADA GOBERNADORA EXTENDED STREAM EROSION MONITORING PROGRAM	TITLE Hydrologic Groups Gobernadora Canyon	
		DESIGNED JH			
		DRAWING TH			
		CHECKED BP			
		DATE 03/20/14			
		JOB NO. A458	ORANGE COUNTY		CA

Appendix B

Appendix E - Adaptive Streambank Erosion Corrective Measures Guidelines. (PACE, 2011)

APPENDIX E - ADAPTIVE STREAMBANK EROSION CORRECTIVE MEASURES GUIDELINES

Erosion is an expected process of the river fluvial system and continued natural adjustments of the streambank are desirable only through controlled management of the streambank erosion along river corridor. Application / selection of the appropriate or suitable bank protection treatment as a countermeasure for the occurrence of erosion will vary depending on the specific erosion feature location and type of failure mechanism. Correctly identifying the mechanism and cause of failure is critical to selecting the appropriate bank protection solution.

A variety of potential hydraulic and structural alternatives were evaluated in order to provide a suitable bank erosion repair or correction measure for this portion of San Juan Creek which resulted in numerous potential options depending on numerous factors specific to the erosion occurrence. The alternatives investigated as a part of this process encompassed a full range of potential solutions that include conventional flood control solutions and more current geomorphic / bioengineered techniques. The different potential alternative solutions can be grouped into several different categories that include multiple types of facilities or techniques within each category. These can be generally defined as two broad types that either include revetments or flow control structures. Each category has specific advantages and disadvantages particular to this type of application. The most common approaches to dealing with the problem of streambank erosion from the attack of high-velocity flows include: (1) armoring the embankment with erosion resistant material, (2) reduction of the attacking force of water on the streambank through structural means or vegetative techniques, (3) moving the attacking water away from the streambank, and (4) providing an erosion buffer which allows natural erosion to continue. The objectives in formulating the erosion repair or correction action program included to (1) provide an effective erosion protection system that assists in preserving the adjacent floodplain fringe buffer areas from erosion damage, (2) minimize the hydraulic impacts to the natural floodplain, (3) minimize the impact on the fluvial systems, (4) minimize the disturbance to the floodplain and streambed, and (5) minimize future maintenance of any proposed erosion protection solution. An important factor in formulating and evaluating the potential erosion protection alternatives is the compatibility with the existing fluvial system and predicting the anticipated response within the floodplain based on the performance of similar structures within this creek system.

Stream Erosion Characterization

Stream erosion can be characterized through site- and reach-based causes which activate the causes. The following table lists the typical bank failure mechanisms.

Mechanism of Failure	Site Based Causes	Reach-Based Causes
General Bank Erosion	- Reduced vegetative bank structure - Tailout and backwater bars - Smoother Channel - Along a bend (bend scour)	Meander migration Aggradation - reduced hydrology/increased sediment supply - localized downstream constriction - reduced slope - confined channel Degradation - increased hydrology/reduced sediment supply - localized shortened channel - natural channel evolution

		- change in long-term watershed hydrology
Scour - Local Scour	Woody debris Bridge pier or abutments Boulder/outcropping	Not applicable
- Construction Scour	Bridge/road approach Existing bank feature Large wood debris jam	Not applicable
- Drop/Weir Scour	Weir, ledge, or sill	Not applicable
- Jet Scour	Lateral bar Side-channel or tributary Abrupt channel bend (energy sink) Subchannels in a braided channel	Not applicable
Mass Failure	Saturated soils Increased surcharge Loss of root structure Removal of lateral/underlying support	Meander migration Aggradation - reduced hydrology/increased sediment supply - localized downstream constriction - reduced slope - confined channel Degradation - increased hydrology/reduced sediment supply - localized shortened channel - natural channel evolution - change in long-term watershed hydrology
Avulsion/Floodplain Erosion	Floodplain activities Natural conditions	Aggradation Previously relocated channel Braided channel Large storm event

Guidance for Countermeasure Correction Selection Process

The selection process for assessment of the suitable corrective measure based on the field investigation data includes evaluation of specific questions as part of the technical basis as part of the plan formulation process and feasibility selection which include the following:

- What is the cause of the “destabilization” of the streambank? Are there potential stream features that might be modified to prevent the problem rather than constructing control or stabilization measures?
- Will the stabilization works cause bank erosion on the opposite downstream bank? Will it potentially cause erosion upstream or downstream of the bank protection?

- Will the project require removal of the native vegetation and ongoing maintenance to keep the vegetation from returning? What are the typical long-term maintenance costs for similar projects?
- Will the stabilization project reduce aquatic habitat and riparian wildlife habitat, enhance those habitats, or have little effect on such habitats?
- Have the dynamics of the stream been studied so that potential reactions of the stream to the project have been considered? Do potential reactions include the stream forming unwanted cutoffs through meanders or change of gradient?
- Are the project and the project's costs being compared with other potentially less costly stabilization methods?
- Have soil bioengineering techniques (using live or dead plant materials) been evaluated as a project alternative?
- How have similar projects on this stream or in this region performed on a long-term basis?

Erosion Corrective Measures

The following provides the general list summarizing potential corrective measures that can be employed for stream erosion protection/repair. The general categories of alternative bank protection systems could be grouped into the following areas: (1) armor, (2) retards / groins or flow redirection, and (3) vegetative systems.

In-stream Flow Redirection Techniques	Bank Armoring Protection Techniques	Biotechnical Bank Protection Techniques	Avulsion Prevention Techniques	Structure Protection
• Groins • Buried groin • Barbs • Bendway weir • Porous weir • Palisades	• Anchor points • Roughness • Riprap • Rock toe • Cribwalls • Concrete slopes • Grouted rock • Flexible mattress	• Woody plantings • Herbaceous cover • Soil reinforcement • Riparian buffer • Bank reshaping • Buffer management	• Floodplain roughness • Headcut prevention • Erosion cutoff fill and armoring	• Outfall rock protection • Launching stone • Bridge/abutment pier rock armor

A description of these general categories for these different techniques includes the following:

Bank Revetment / Armoring (rigid / flexible) – Armoring is the artificial surfacing of the streambank in order to resist erosion or scour. The armor type systems can be further subdivided into categories of rigid, flexible, and self-adjusting.

Biotechnical Bank Protection – This includes a wide range of methods or procedures that utilize vegetative techniques or integrate live materials into the bank protection system.

Streambank Grading – Corrective grading in the active floodplain in order to redefine a more the active channel that contains the majority of the flow in the center of the floodplain and away from the banks of the conservation area.

Flow Control Structures / Redirectional Bank Stabilization Methods – This includes a broad range of facilities that are indirect methods, and usually discontinuous techniques that redirect the flow and energy of the river or stream away from the area of the eroding bank. This can include bank protection structures such as "retards" which are designed to reduce the near bank velocity and induce siltation or accretion of sediment within this zone. These are generally permeable structures constructed at the toe of the streambank and provide a velocity reduction buffer near

the bank. The resulting deposition reverses the trend of erosion and replaces material that had been lost. This causes a shifting of the stream hydraulic forces away from the bank.