Appendix A:
Monitoring Event Summaries for Toxicity, OC Pesticides, Nutrients, Metals, and Salts

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 62: Quarterly Water Sampling and Sediment

Sampling Crews: Kinnetic Laboratories, Inc. (KLI), Fugro
Crew #1: Greg Cotten (KLI), Amy Howk (KLI)
Crew #2: Nick Simon (Fugro), David Thornhill (Fugro)

Sampling Dates: Receiving Water and Land Use sites on August 8th and 9th, 2017

Sampling Type: Quarterly Water Chemistry, Toxicity, and Salts

SITES SAMPLED

Site ID		Constituents					
	Sample Date	General Parameters	Toxicity	Metals	Nutrients	PCBs, OP, OC, and Pyrethroid Pesticides	Salts
01_RR_BR	8/9/17	X		X	X	X	
02_PCH	8/9/17	X		X	X		
03_UNIV	8/9/17	X	X	X	X	X	
9B_ADOLF	8/9/17	X	X		X	X	
9BD_ADOLF	8/9/17	X		X		X	X
05D_SANT_VCWPD	8/9/17	X		X	X	X	X
05_CENTR	8/9/17	X			X		
04D_VENTURA	8/9/17	X		X		X	X
04_WOOD	8/9/17	X	X	X	X	X	
01T_ODD2_DCH	8/9/17	X		X	X	X	
07_HITCH	8/9/17	X	X		X	X	
07D_SIM_BUS	8/8/17	X				X	X
13_SB_HILL	8/8/17	X				X	X
10_GATE	8/9/17	X	X			X	
13_BELT	8/9/17	X	X			X	

SITES NOT SAMPLED

Site ID	Reason for Omission
02D_BROOM	Site was dry.
04D_WOOD	Site was dry.
06_UPLAND	Site was dry (sediment sample was taken).
06T_FC_BR	Site was dry.
07D_MPK	Site was dry.
07D_HITCH_LEVEE_2	Site was dry.
9BD_GERRY	Site was dry.

SEDIMENT SITES

Site ID	Sample Notes
02_PCH	Sediment tox and chemistry sampled 8-8-17 at 09:25: rising tide.
04_WOOD	Sediment tox and chemistry sampled 8-8-17 at 12:50
03_UNIV	Sediment tox and chemistry sampled 8-8-17 at 10:45
9B_ADOLF	Sediment chemistry sampled 8-9-17 at 15:30
06_UPLAND	Sediment chemistry sampled 8-9-17 at 08:45
07_HITCH	Sediment chemistry only sampled 8-9-17 at 09:55
9A_HOWAR	Sediment tox and chemistry sampled 8-8-17 at 10:50

DEVIATIONS FROM QAPP

Site ID	Deviation
01_RR_BR	No photo was taken due to rule against photography on base. Flow was not measured due to tidal influence.
02_PCH	Flow was not measured due to tidal influence.
04_WOOD	The conductivity at the site was greater than the accepted range for the designated test species (*Ceriodaphnia dubia*). The QAPP requires the use of *Americamysis bahia*. However, *Hylella azteca* is identified by SWAMP as an appropriate water test species when conductivity is greater than 3,000 us/cm and is currently utilized by the Ventura County Irrigated Lands Group which conducts monitoring in the watershed. To maintain consistency with an existing watershed program, the toxicity testing lab (Pacific EcoRisk) utilized *Hylella azteca* in place of *Americamysis bahia*.
04D_VENTURA	Intermediate container (Ziploc bag) used to fill sample bottles.
05D_SANT_VCWPD	Intermediate container bottle #89 (Sulfate, Chloride) used to fill all sample bottles other than metals which used a ziploc bag.
05_CENTR	Intermediate container bottle #95 (Nitrate) used for used to fill all sample bottles.
9BD_ADOLF	Intermediate container (Ziploc bag) used to fill sample bottles.
10_GATE	Flume installed. Flow measured inside flume.

FOLLOW UP ACTIONS

None.

ADDITIONAL COMMENTS

Both multiparameter field meters passed pre and post event calibrations.

03_UNIV, 04_WOOD, 07_TIERRA, 9B_BARON and 9A_HOWAR salts samples were collected by LWA for this event.

Sediment toxicity samples have been sent to Pacific Ecorisk to be homogenized. A chemistry alliquote was requested to be taken from that sample and sent to Physis for analysis. It was requested that all samples be run together for QC and ease in reporting purposes.

Prepared by:	Amy Howk , KLI	Date:	August 21, 2017
Reviewed by:	Greg Cotten, KLI	Date:	August 24, 2017
Approved by:	Michael Marson, LWA	Date:	September 15, 2017

Event 62 – Mugu Sediment & Tissue

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 62: Mugu Sediment Sampling

Sampling Crews: **MBC Aquatic Sciences**
Crew: J.Nunez, W.Dossett, JNS

Sampling Dates: August 29th and 30th, 2017

Sampling Type: Sediment Toxicity Sampling

SITES SAMPLED

Site ID		Constituents				
	Sample Date	**General Parameters (PSD, %Moisture, TOC)**	**Toxicity**	**Metals**	**Ammonia**	**PCBs, PAHs, OP, OC, and Pyrethroid Pesticides**
01_BPT_14	08/29/17	X	X	X	X	X
01_BPT_15	08/30/17	X	X	X	X	X
01_BPT_3	08/30/17	X	X	X	X	X
01_BPT_6	08/29/17	X	X	X	X	X
01_SG_74	08/29/17	X	X	X	X	X

DEVIATIONS FROM QAPP

Site ID	Deviation

FOLLOW UP ACTIONS

None.

ADDITIONAL COMMENTS

Sediment toxicity samples have been sent to Pacific Ecorisk to be homogenized. A chemistry alliquote was requested to be taken from that sample and sent to Physis for analysis. It was requested that all samples be run together for QC and ease in reporting purposes.

Approved by: Michael Marson, LWA Date: November 7, 2018

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 62: Mugu Tissue Sampling

Sampling Crews: **MBC Aquatic Sciences**
Crew: J.Nunez, W.Dossett, JNS

Sampling Dates: Mugu Lagoon on August 29th and 30th 2017

Sampling Type: Fish Tissue Chemistry

SITES SAMPLED

Site ID		Constituents				
	Sample Date	General Parameters (Lipids, % solids)	Metals (Methyl Mercury, Selenium)	OP Pesticides (Chlorpyrifos)	PCBs and OC Pesticides	Species
01_Central_ Lagoon	08-29-17	X	X	X	X	Opaleye
01_Western_ Arm	08-29-17	X	X	X	X	Opaleye
01_Central_ Lagoon	08-30-17	X	X	X	X	Mussles
01_Western_ Arm	08-29-17	X	X	X	X	Mussles

SITES NOT SAMPLED

Site ID	Reason for Omission

DEVIATIONS FROM QAPP

Site ID	Deviation

FOLLOW UP ACTIONS

None

ADDITIONAL COMMENTS

Mussles were picked to continue with the trend of analyzing those in case no fish are able to be caught.

Prepared by: Michael Marson, LWA Date: November 7, 2018

Event 63

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 63: Quarterly Water Sampling

Sampling Crews: Kinnetic Laboratories, Inc. (KLI), Fugro
Crew #1: Greg Cotten (KLI), Michael Ray (KLI)
Crew #2: David Thornhill (Fugro), Dustin Snider (Fugro – 11/7/2017), Nick Simon (Fugro – 11/8/2017)

Sampling Dates: Receiving water and land use sites on November 7 and 8, 2017

Sampling Type: Quarterly Water Chemistry, Toxicity, and Salts

SITES SAMPLED

Site ID		Constituents					
	Sample Date	General Parameters	Toxicity	Metals	Nutrients	PCBs, OP, OC, and Pyrethroid Pesticides	Salts
01_RR_BR	11-8-17	X		X	X	X	
02_PCH	11-8-17	X		X	X		
03_UNIV	11-7-17	X	X	X	X	X	
9B_ADOLF	11-7-17	X	X		X	X	
9BD_ADOLF	11-7-17	X		X		X	X
05D_SANT_VCWPD	11-7-17	X		X	X	X	X
05_CENTR	11-7-17	X			X		
04D_VENTURA	11-7-17	X		X		X	X
04D_WOOD	11-7-17	X		X	X	X	X
04_WOOD	11-7-17	X	X	X	X	X	
01T_ODD2_DCH	11-7-17	X		X	X	X	
07_HITCH	11-7-17	X	X		X	X	
07D_MPK	11-8-17	X				X	X
07D_SIM_BUS	11-8-17	X				X	X
13_SB_HILL	11-8-17	X				X	X
10_GATE	11-7-17	X	X			X	
13_BELT	11-7-17	X	X			X	

SITES NOT SAMPLED

Site ID	Reason for Omission
02D_BROOM	Site was dry.
06_UPLAND	Site was dry.
06T_FC_BR	Site was dry.
07D_HITCH_LEVEE_2	Site was dry.
9BD_GERRY	Site was dry.

DEVIATIONS FROM QAPP

Site ID	Deviation
01_RR_BR	No photo was taken due to rule against photography on base. Flow was not measured due to tidal influence. Site was sampled near low tide to maximize watershed water.
02_PCH	Flow was not measured due to tidal influence. Site was sampled near low tide to maximize watershed water.
04_WOOD	The conductivity at the site was greater than the accepted range for the designated test species (*Ceriodaphnia dubia*). The QAPP requires the use of *Americamysis bahia*. However, *Hylella azteca* is identified by SWAMP as an appropriate water test species when conductivity is greater than 3,000 us/cm and is currently utilized by the Ventura County Irrigated Lands Group which conducts monitoring in the watershed. To maintain consistency with an existing watershed program, the toxicity testing lab (Pacific EcoRisk) utilized *Hylella azteca* in place of *Americamysis bahia*.
04D_VENTURA	Intermediate container (Ziploc bag) used to fill sample bottles.
05D_SANT_VCWPD	Intermediate container (Ziploc bag) used to fill sample bottles.
07D_MPK	Intermediate container (Ziploc bag) used to fill sample bottles.
9BD_ADOLF	Intermediate container (Ziploc bag) used to fill sample bottles.

FOLLOW UP ACTIONS

None

ADDITIONAL COMMENTS

Both water quality meters passed pre-sampling and post-sampling calibrations.

Prepared by:	Michael Ray, KLI	Date:	November 22, 2017
Reviewed by:	Greg Cotten, KLI	Date:	November 29, 2017
Approved by:	Michael Marson, LWA	Date:	December 4, 2017

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 64: Quarterly Water Sampling

Sampling Crews: Kinnetic Laboratories, Inc. (KLI), Fugro
Crew #1: Greg Cotten (KLI), Tanner Barnes (KLI)
Crew #2: David Thornhill (Fugro), Cory Crocker (Fugro)

Sampling Dates: Receiving water and land use sites on February 7 and 8, 2018

Sampling Type: Quarterly Water Chemistry, Toxicity, and Salts

SITES SAMPLED

Site ID		Constituents					
	Sample Date	General Parameters	Toxicity	Metals	Nutrients	PCBs, OP, OC, and Pyrethroid Pesticides	Salts
01_RR_BR	2-7-2018	X		X	X	X	
02_PCH	2-7-2018	X		X			
03_UNIV	2-7-2018	X	X	X	X	X	
9B_ADOLF	2-7-2018	X	X		X	X	
9BD_ADOLF	2-7-2018	X		X		X	X
05D_SANT_VCWPD	2-7-2018	X		X	X	X	X
05_CENTR	2-7-2018	X			X		
04D_VENTURA	2-7-2018	X		X		X	X
04D_WOOD	2-7-2018	X		X	X	X	X
04_WOOD	2-7-2018	X	X	X	X	X	
01T_ODD2_DCH	2-7-2018	X		X	X	X	
07_HITCH	2-7-2018	X	X		X	X	
07D_MPK	2-8-2018	X				X	X
07D_SIM_BUS	2-8-2018	X				X	X
13_SB_HILL	2-8-2018	X				X	X
10_GATE	2-7-2018	X	X			X	
13_BELT	2-7-2018	X	X			X	

SITES NOT SAMPLED

Site ID	Reason for Omission
02D_BROOM	Site was dry.
06_UPLAND	Site was dry.
06T_FC_BR	Site was dry.
07D_HITCH_LEVEE	Site was dry.
9BD_GERRY	Site was dry.

DEVIATIONS FROM QAPP

Site ID	Deviation
01_RR_BR	No photo was taken due to rule against photography on base. Flow was not measured due to tidal influence. Site was sampled near low tide to maximize watershed water.
02_PCH	Flow was not measured due to tidal influence. Site was sampled near low tide to maximize watershed water.
04_WOOD	The conductivity at the site was greater than the accepted range for the designated test species (*Ceriodaphnia dubia*). The QAPP requires the use of *Americamysis bahia*. However, *Hylella azteca* is identified by SWAMP as an appropriate water test species when conductivity is greater than 3,000 us/cm and is currently utilized by the Ventura County Irrigated Lands Group which conducts monitoring in the watershed. To maintain consistency with an existing watershed program, the toxicity testing lab (Pacific EcoRisk) utilized *Hylella azteca* in place of *Americamysis bahia*.
04D_VENTURA	Intermediate container (Ziploc bag) used to fill sample bottles. Wind level affected flow rates.
05D_SANT_VCWPD	Intermediate container (Ziploc bag) used to fill sample bottles.
07D_MPK	Intermediate container (Ziploc bag) used to fill sample bottles.
9BD_ADOLF	Intermediate container (Ziploc bag) used to fill sample bottles.

FOLLOW UP ACTIONS

None

ADDITIONAL COMMENTS

Team 1 again used the electronic tablet with paper backup as part of our transition to complete electronic field logs for dry weather sampling.

Prepared by:	Tanner Barnes, KLI	Date:	2/19/18
Reviewed by:	Greg Cotten, KLI	Date:	3/27/18
Approved by:	Michael Marson, LWA	Date:	4/5/18

Event 65 – Storm 1

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 65: Wet Weather Sampling

Sampling Crews: Kinnetic Laboratories, Inc. (KLI), Fugro

Crew #1: Greg Cotten (KLI), Kagen Holland (KLI)
Crew #2: Spencer Johnson (KLI), Michael Ray (KLI)
Crew #3: Jeff Pous (Fugro), Seth Gray (Fugro)
Crew #4: David Thornhill (Fugro), Jesse Wooten (Fugro)

Sampling Dates: Receiving water and land use sites on March 10, 2018 and March 11, 2018.

Sampling Type: Wet weather water chemistry, toxicity, metals, PCBs and salts.

SITES SAMPLED

Site ID		Constituents					
	Sample Date	General Parameters	Toxicity	Metals	Nutrients	PCBs, OP, OC, and Pyrethroid Pesticides	Salts
01_RR_BR	3/10/18	X		X	X	X	
02_PCH	3/10/18	X		X	X		
03_UNIV	3/11/18	X	X	X	X	X	X
9A_HOWAR	3/11/18	X					X
9B_ADOLF	3/10/18	X	X		X	X	
9BD_ADOLF	3/10/18	X		X		X	X
05D_SANT_VCWPD	3/10/18	X		X	X	X	X
05_CENTR	3/10/18	X			X		
04D_VENTURA	3/10/18	X		X		X	X
04D_WOOD	3/10/18	X		X	X	X	X
04_WOOD	3/10/18	X	X	X	X	X	X
01T_ODD2_DCH	3/10/18	X		X	X	X	
06T_FC_BR	3/10/18	X			X	X	X
06_UPLAND	3/10/18	X	X		X	X	
07_HITCH	3/10/18	X	X		X	X	
07D_HITCH_LEVEE_2	3/10/18	X			X	X	X

Site ID		Constituents					
	Sample Date	General Parameters	Toxicity	Metals	Nutrients	PCBs, OP, OC, and Pyrethroid Pesticides	Salts
07_TIERRA	3/10/18	X					X
07D_MPK	3/10/18	X				X	X
07D_SIM_BUS	3/10/18	X				X	X
13_SB_HILL	3/10/18	X				X	X
9B_BARON	3/11/18	X					X
9BD_GERRY	3/10/18	X		X	X	X	X
10_GATE	3/10/18	X	X			X	
13_BELT	3/10/18	X	X			X	

SITES NOT SAMPLED

Site ID	Reason for Omission
02D_BROOM	Site was dry.

DEVIATIONS FROM QAPP

Site ID	Deviation
01_RR_BR	No photo was taken due to rule against photography on base. Flow was not measured due to tidal influence.
02_PCH	Flow was not measured due to tidal influence.
9BD_GERRY	To prevent dumping preservative, the Ammonia and TKN bottles were filled with an amber glass bottle is an intermediate container

FOLLOW UP ACTIONS

None

ADDITIONAL COMMENTS

Field meter calibration notes:

Team 1 (13_SB_HILL, 07D_SIM_BUS, 07D_MPK, 07_HITCH, 07D_HITCH_LEVEE_2 and 07_TIERRA) field meter passed both the initial and post calibration except for dissolved oxygen and conductivity during initial calibration.

Team 2 (9B_ADOLF, 9BD_ADOLF, 9BD_GERRY, 10_GATE, 13_BELT and 9B_BARON) field meter passed both initial and post calibration except for dissolved oxygen in post calibration.

Team 3 (06T_FC_BR , 05D_SANT_VCWPD, 05_CENTR, 04D_VENTURA, 06_UPLAND, 9A_HOWAR and 03_UNIV) field meter passed both the initial and post calibration.

Team 4 (04_WOOD, 04D_WOOD, 02D_BROOM, 01T_ODD2_DCH, 02_PCH and 01_RR_BR) field meter passed both the initial and post calibration except for conductivity in post calibration.

Meter exceedences:

Sites where turbidity exceeded 1000 NTU (meter limit), Turbidity was added to the site COC for laboratory analysis. These sites were: 01T_ODD2_DCH, 9BD_GERRY, 05D_SANT_VCWPD, 05_CENTR, 06_UPLAND.

Flow:

Due to dangerous flow conditions, flow was estimated at all sites except 07D_SIM_BUS, 07D_MPK, and 07D_HITCH_LEVEE_2 where flow was measured using preferred methods. 02D_BROOM outfall was ‘dry’. Velocity measurements at night using float method can be very difficult to do accurately at locations with low or no ambient light.

Photos:

Due to sampling occurring at night, several photos were not distinguishable. In order to maximize the information available in the photos, dark images were digitally enhanced which often also produced a grainy quality. Photos were mistakenly not taken at 9B_ADOLF.

Prepared by:	Tanner Barnes, KLI	Date: 4/10/18
Reviewed by:	Michael Ray, KLI	Date: 4/10/18
Apporved by:	Michael Marson, LWA	Date: 5/18/18

Event 66 – Storm 2

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 66: Wet Weather Sampling

Sampling Crews: Kinnetic Laboratories, Inc. (KLI), Fugro

Crew #1: Greg Cotten (KLI), Gary Gillingham
Crew #2: Amy Howk (KLI), Tanner Barnes (KLI)
Crew #3: Jesse Wooten (Fugro), Dustin Snider (Fugro)
Crew #4: David Thornhill (Fugro), Cory Crocker (Fugro)

Sampling Dates: Receiving water and land use sites on March 21, 2018 and March 22, 2018

Sampling Type: Wet weather water chemistry, toxicity, metals, PCBs and salts.

SITES SAMPLED

Site ID		Constituents					
	Sample Date	General Parameters	Toxicity	Metals	Nutrients	PCBs, OP, OC, and Pyrethroid Pesticides	Salts
01_RR_BR	3/21/18	X		X	X	X	
02_PCH	3/21/18	X		X	X		
03_UNIV	3/21/18	X	X	X	X	X	X
9A_HOWAR	3/21/18	X					X
9B_ADOLF	3/21/18	X	X		X	X	
9BD_ADOLF	3/21/18	X		X		X	X
05D_SANT_VCWPD	3/21/18	X		X	X	X	X
05_CENTR	3/21/18	X			X		
04D_VENTURA	3/21/18	X		X		X	X
04D_WOOD	3/21/18	X		X	X	X	X
04_WOOD	3/21/18	X	X	X	X	X	X
01T_ODD2_DCH	3/21/18	X		X	X	X	
06T_FC_BR	3/21/18	X			X	X	X
06_UPLAND	3/21/18	X	X		X	X	
07_HITCH	3/21/18	X	X		X	X	
07D_HITCH_LEVEE_2	3/21/18	X			X	X	X

Site ID		Constituents					
	Sample Date	General Parameters	Toxicity	Metals	Nutrients	PCBs, OP, OC, and Pyrethroid Pesticides	Salts
07_TIERRA	3/21/18	X					X
07D_MPK	3/21/18	X				X	X
07D_SIM_BUS	3/21/18	X				X	X
13_SB_HILL	3/21/18	X				X	X
9B_BARON	3/21/18	X					X
9BD_GERRY	3/22/18	X		X	X	X	X
10_GATE	3/21/18	X	X			X	
13_BELT	3/21/18	X	X			X	

mSITES NOT SAMPLED

Site ID	Reason for Omission
02D_BROOM	Site was dry.

DEVIATIONS FROM QAPP

Site ID	Deviation
01_RR_BR	No photo was taken due to rule against photography on base. Flow was not measured due to tidal influence. Bottle -009 for pesticides was used as a settling bottle for particulates prior to pouring into metals filter.
02_PCH	Flow was not measured due to tidal influence.
9BD_ADOLF	Intermediate container (1L Amber Glass) used for metals.

FOLLOW UP ACTIONS

None

ADDITIONAL COMMENTS

Field meter calibration notes:

Team 1 (13_SB_HILL, 07D_SIM_BUS, 07D_MPK, 07_HITCH, 07D_HITCH_LEVEE_2 and 07_TIERRA) field meter passed both the initial and post calibration.

Team 2 (9B_ADOLF, 9BD_ADOLF, 9BD_GERRY, 10_GATE, 13_BELT and 9B_BARON) field meter passed both initial and post calibration.

Team 3 (06T_FC_BR , 05D_SANT_VCWPD, 05_CENTR, 04D_VENTURA, 06_UPLAND, 9A_HOWAR and 03_UNIV) field meter passed both the initial and post calibration.

Team 4 (04_WOOD, 04D_WOOD, 02D_BROOM, 01T_ODD2_DCH, 02_PCH and 01_RR_BR) field meter passed both the initial and post calibration.

Meter exceedences:

Sites where turbidity exceeded 1000 NTU (field meter maximum) Turbidity was added to the site COC for laboratory analysis. These sites were: 01T_ODD2_DCH, 9BD_GERRY, 05D_SANT_VCWPD, 05_CENTR, 06_UPLAND, 06T_FC_BR, 04_WOOD, 01_RR_BR.

Flow:

Due to dangerous flow conditions, flow was estimated at all sites except 07D_SIM_BUS and 07D_MPK, where flow was measured using preferred methods. 02D_BROOM outfall was ‘dry’.

Photos:

Some locations were collected after sunset. In order to maximize the information from these site photos, digital enhancements were applied and therefore may appear grainy.

Prepared by:	Tanner Barnes, KLI	Date: 04/10/18
Reviewed by:	Michael Ray, KLI	Date: 04/10/18
Approved by:	Michael Marson, LWA	Date: 04/25/18

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 67: Dry Weather Sampling

Sampling Crews: Kinnetic Laboratories, Inc. (KLI), Fugro

Crew #1: Greg Cotten (KLI), Michael Ray (KLI)
Crew #2: David Thornhill (Fugro), Nick Simon (Fugro)
Auditor: Michael Marson (Larry Walker Associates)

Sampling Dates: Receiving water and land use sites on May 15, 2018.

Sampling Type: Quarterly Water Chemistry, Toxicity, Metals, PCBs and Salts.

SITES SAMPLED

Site ID		Constituents					
	Sample Date	General Parameters	Toxicity	Metals	Nutrients	PCBs, OP, OC, and Pyrethroid Pesticides	Salts
01_RR_BR	5/15/18	X		X	X	X	
02_PCH	5/15/18	X		X	X		
03_UNIV	5/15/18	X	X	X	X	X	
9B_ADOLF	5/15/18	X	X		X	X	
9BD_ADOLF	5/15/18	X		X		X	X
05D_SANT_VCWPD	5/15/18	X		X	X	X	X
05_CENTR	5/15/18	X			X		
04D_VENTURA	5/15/18	X		X		X	X
04D_WOOD	5/15/18	X		X	X	X	X
04_WOOD	5/15/18	X	X	X	X	X	
01T_ODD2_DCH	5/15/18	X		X	X	X	
07_HITCH	5/15/18	X	X		X	X	
07D_SIM_BUS	5/15/18	X				X	X
13_SB_HILL	5/15/18	X				X	X
10_GATE	5/15/18	X	X			X	
13_BELT	5/15/18	X	X			X	

SITES NOT SAMPLED

Site ID	Reason for Omission
02D_BROOM	Site was dry.
06T_FC_BR	Site was dry.
07D_HITCH_LEVEE2	Site was dry.
07D_MPK	Site was dry.
06_UPLAND	Site was dry.

DEVIATIONS FROM QAPP

Site ID	Deviation
01_RR_BR	No photo was taken due to rule against photography on base. Flow was not measured due to tidal influence.
02_PCH	Flow was not measured due to tidal influence.
04_WOOD	The conductivity at the site was greater than the accepted range for the designated test species (*Ceriodaphnia dubia*). The QAPP requires the use of *Americamysis bahia*. However, *Hylella azteca* is identified by SWAMP as an appropriate water test species when conductivity is greater than 3,000 us/cm and is currently utilized by the Ventura County Irrigated Lands Group which conducts monitoring in the watershed. To maintain consistency with an existing watershed program, the toxicity testing lab (Pacific EcoRisk) utilized *Hylella azteca* in place of *Americamysis bahia*.
04D_VENTURA	Intermediate container (Ziploc bag) used to fill sample bottles. Flow was not measured due to very thin sheet flow and the wind was blowing upstream. Flow was estimated by Michael Marson.
05_CENTR	Intermediate container (Ziploc bag) used to fill sample bottles.
05D_SANT_VCWPD	Intermediate container (Ziploc bag) used to fill sample bottles.
9BD_ADOLF	Intermediate container (Ziploc bag) used to fill sample bottles.

FOLLOW UP ACTIONS

None

ADDITIONAL COMMENTS

- 13_BELT toxicity container had “clean” tape, but also had “in house only” on it
- 02D_BROOM outfall is buried with wood debris from storm flooding.
- Both teams used digital field logs with paper logs as backup.
- 01_RR_BR was sampled near 3.17 ft. tidal stage at Point Mugu.
- 02_PCH was sampled near 3.74 ft. tidal stage at Point Mugu.
- Michael Marson met and followed Crew #1 (KLI) at 13_BELT and 10_GATE
- Michael Marson met and followed Crew #2 (Fugro) at 04D_VENTURA, 04D_WOOD, and 04_WOOD

Field meter calibration notes:

Team 1 (13_BELT, 10_GATE, 07_HITCH, 9B_ADOLF, 9BD_ADOLF and 07D_SIM_BUS) field meter passed all parameters for both initial and post calibration.

Team 2 (01_RR_BR, 02_PCH, 03_UNIV, 05D_SANT_VCWPD, 05_CENTR, 04D_VENTURA, 04D_WOOD, 04_WOOD, 01T_ODD2_DCH, 13_SB_HILL) field meter passed all parameters both initial and post calibration.

Prepared by:	Michael Ray, KLI	Date:	5/23/18
Reviewed by:	Tanner Barnes, KLI	Date:	5/31/18
Approved by:	Michael Marson, LWA	Date:	6/25/18

Calleguas Creek Watershed TMDL Monitoring Program
Post Event Summary
Event 67: Tissue Sampling

Sampling Crews: ICF International (ICF)
Crew: Joel Mulder (ICF), S Horvath (ICF)

Sampling Dates: Receiving water sites on May 8th, 2018

Sampling Type: Yearly Fish Tissue Chemistry

SITES SAMPLED

Site ID		Constituents			
	Sample Date	General Parameters (Lipids, % solids)	Metals (Methyl Mercury, Selenium)	OP Pesticides (Chlorpyrifos)	PCBs and OC Pesticides
03_UNIV	05-08-18	X			X
9B_ADOLF	05-08-18	X			X
04_WOOD	05-08-18	X	X	X	X
07_HITCH	05-08-18	X			X
07_TIERRA					
9B_BARON					

SITES NOT SAMPLED

Site ID	Reason for Omission
07_TIERRA	Enough fish were caught at other sites.
9B_BARON	Enough fish were caught at other sites.

DEVIATIONS FROM QAPP

Site ID	Deviation

FOLLOW UP ACTIONS

None

ADDITIONAL COMMENTS

Enough fish were caught for all the analysis to be performed. No other day is needed to collect fish.

Prepared by: Michael Marson, LWA Date: August 30, 2018

Appendix B. Rating Curves and EC/Salt Relationships for Salts TMDL Compliance Sites for the July 2017-June 2018 Monitoring Year

RATING CURVES

Continuous water level time series data (5-min intervals) were converted to time series of flow estimates (cfs) using the USGS shift-adjusted rating curve method. The method establishes a base rating for a given date range. Over the date range that shares a base rating, this rating is then shifted, as necessary, for subsets of the data to account for small changes in the geometry of natural channels often caused by deposition, scouring, and vegetation. Rating curves for all sites took the form $Q = c^* (Lvl + a + S)^b$ where,

Q = discharge (cfs)

Lvl = water level or "stage", referenced to depth sensor elevation (cm)

c = scaling coefficient

a = coefficient accounting for the vertical difference between depth sensor elevation (stage = 0) and stage at zero discharge (cm)

b = coefficient accounting for channel shape, natural channels fall between endpoints b=1.5 (square channel), and b=2.5 (triangular channel).

S = stage shift, typically varies over time for natural channels (cm).

Monthly manual measurements of discharge are performed at all sites and are used to establish base ratings and to determine the required "shifts" ("S" in the equation above) over time for a monitoring year. Base rating curve equations used for the July 2017-June 2018 monitoring year are provided in Table 1.

Table 1. Rating Curves for Salts TMDL Compliance Sites for Monitoring Year July 2017-June 2018

Site	Rating Curve
03_UNIV	$Q = 0.45^*(Lvl – 29.42 + S)^{1.92}$
04_WOOD	$Q = 0.0080^*(Lvl - 16.0 + S)^{2.0}$
07_TIERRA [a]	$Q = 0.0158^*(Lvl - 21 + S)^{2.0} + 0.012^*(Lvl - 40 + S)^{2.3}$
9A_HOWAR	$Q = 0.0090^*(Lvl – 5.0 + S)^{2.2}$
9B_BARON	$Q = 0.0102^*(Lvl -4 + S)^{2.10}$

[a] Starting in the 2016/2017 monitoring year, a compound rating has been used for 07_TIERRA that includes a second term that applies to stage heights above Lvl=40 cm to account for details in the shape of the channel control (a metal drop structure) that affect the wetted width of the cross section where the gage is located.

EC/SALT RELATIONSHIPS

Site-specific, linear relationships between specific conductivity (EC) and salt constituents were used to convert continuous EC sensor data to estimate salt concentrations. Surrogate relationships were derived from field data for EC and salts (grab samples for TDS, sulfate, chloride, or boron from quarterly-dry and up to two wet events per year) using linear regression, in the following form:

[Ion] = A*EC + B, where

[Ion] = concentration of TDS, sulfate, chloride, or boron (mg/L)

A = slope

EC = specific conductivity (µS/cm)

B = y intercept

At the conclusion of the 2017/2018 monitoring year, surrogate relationships were updated using linear regression. As is done each year, ANCOVA analysis was performed to detect evidence of statistically significant temporal shifts in surrogate relationships that might signal a change in watershed conditions and justify adjustments in the date ranges of the field data used to construct the relationships.[1] As expected, addition of another year of monitoring data to the data sets led to minor adjustments in regression equations. The analysis for 2017/2018 supported changes in the structure or the underlying time frames of relationship in the following cases:

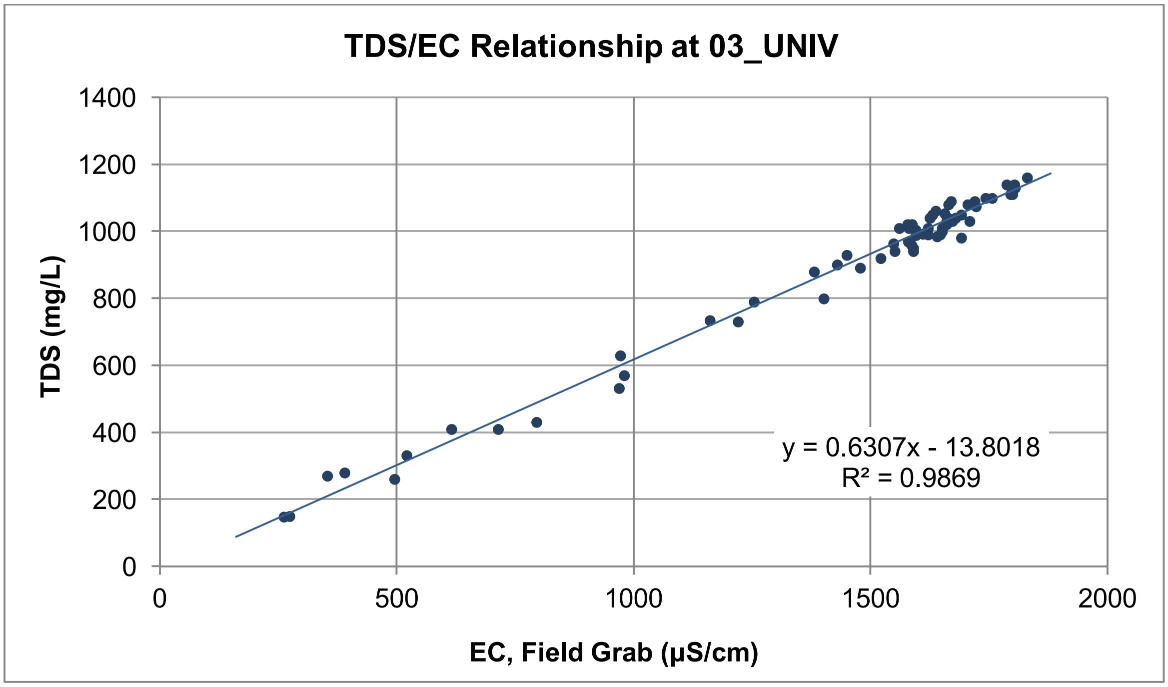
- The time frames for the data underlying the EC/Cl relationships at 03_UNIV, 9A_HOWAR and 9B_BARON, and the EC/SO4 relationships at 03_UNIV and 9A_HOWAR were adjusted to ones starting in August 2017.
- Different EC/Cl relationships for wet and dry weather were established for 04_WOOD for the first time in 2017/2018, using a threshold of 2,500 µS/cm to split the data set, and excluding field data prior to 5/23/2013.

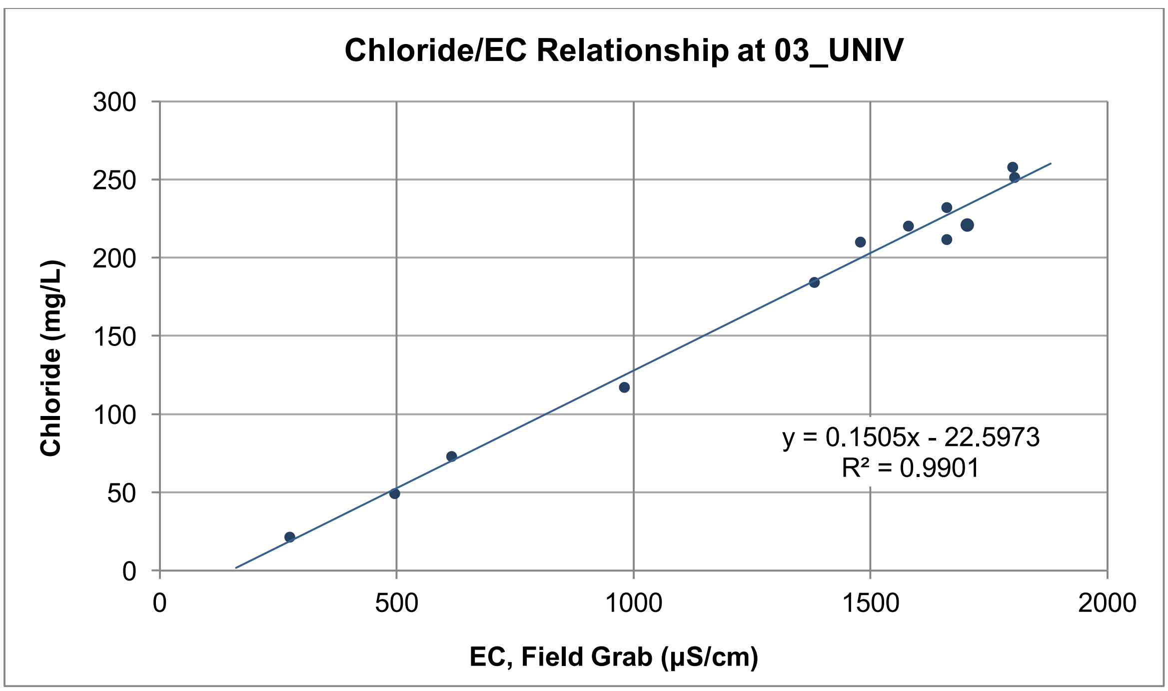
Surrogate relationships used to process the 2017/2018 EC sensor data are reported in **Table 2** and illustrated in figures following the table.

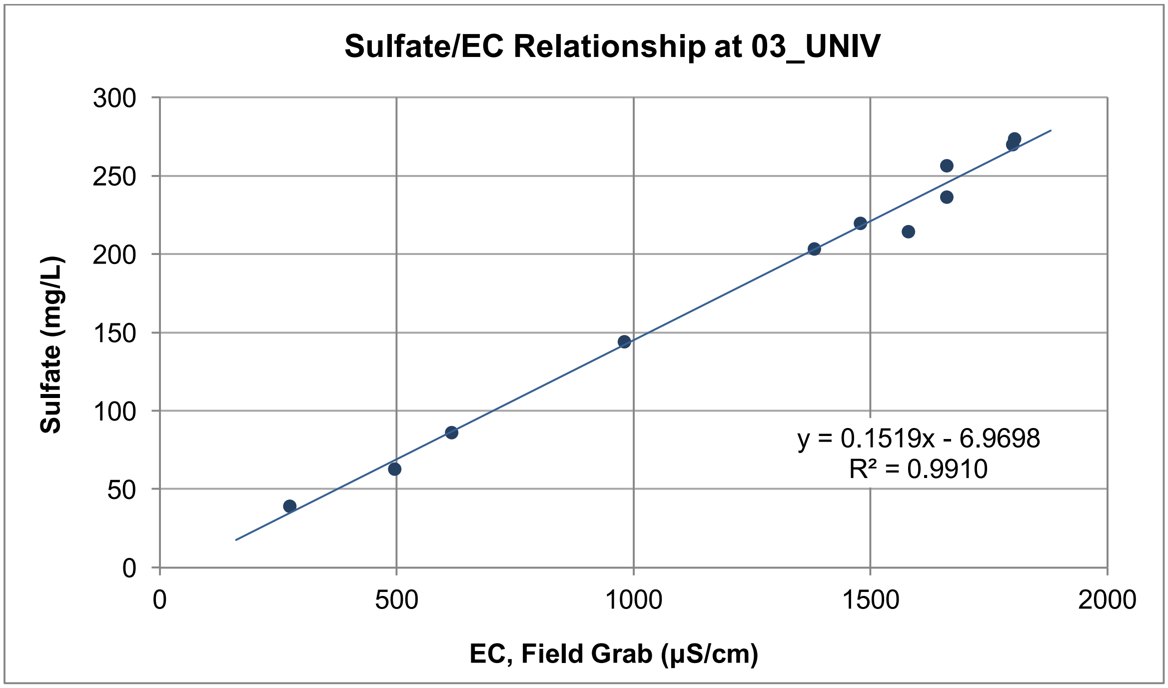
[1] For example, analysis conducted after the 2014/2015 monitoring year showed that changes in date ranges were appropriate for some surrogate relationships related to a shift in the blend of imported water entering the watershed (i.e., a shift to a combination of San Joaquin/Sacramento Delta and Colorado River water imported by Calleguas Municipal Water District starting in Spring 2014).

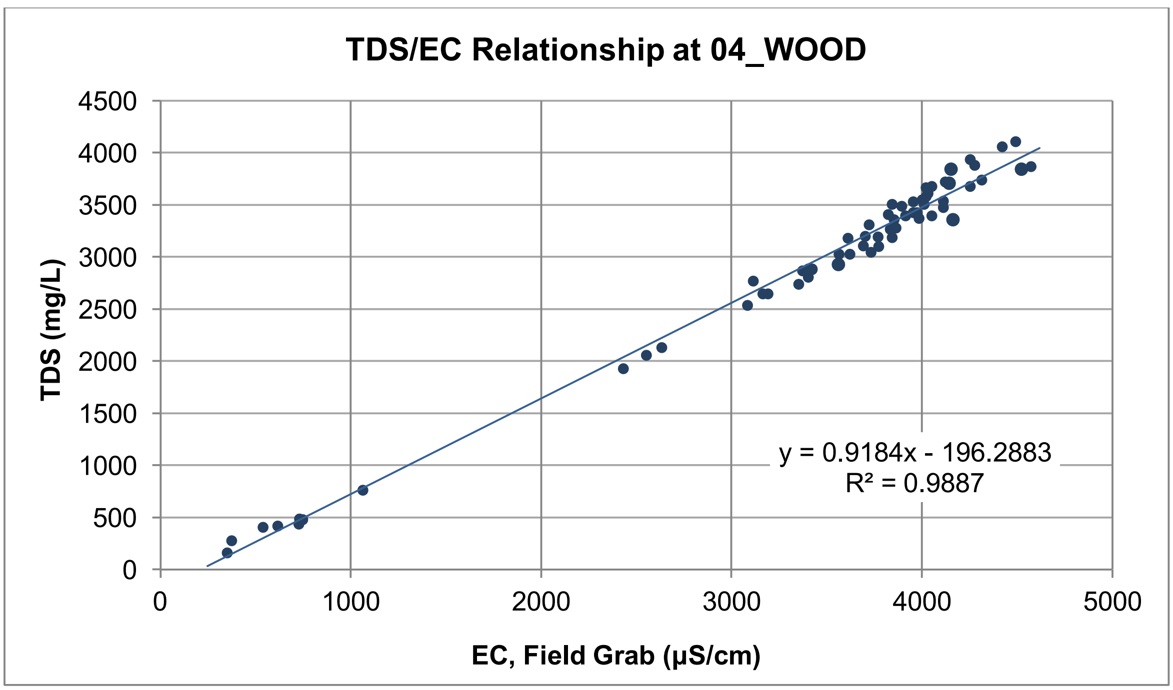
Table 2. Surrogate Relationships Used to Convert EC to Salt Concentrations for the 2017/2018 Monitoring Year

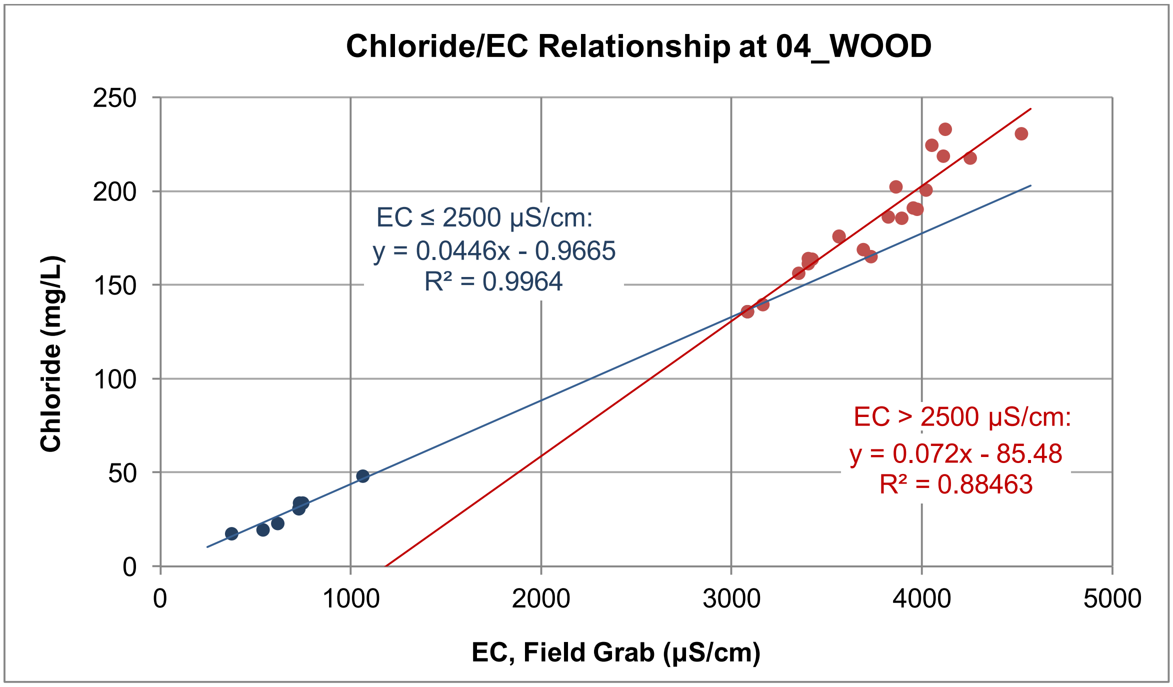
Site	Proxy Relationship	r^2	Underlying Field Data	
			Sample Size	Date Range
03_UNIV	TDS = (0.6307 * EC) – 13.8018	0.9869	66	1/31/2011 – 5/7/2018
	Cl = (0.1505 * EC) – 22.5973	0.9901	12	8/25/2016 - 5/7/2018
	SO4 = (0.1519 * EC) – 6.9698	0.9910	11	8/25/2016 - 5/7/2018
04_WOOD	TDS = (0.9184 * EC) – 196.2883	0.9887	64	1/31/2011 – 5/7/2018
	High Conductivity (>2500 µS/cm): Cl = (0.07203 * EC) – 85.4803	0.8846	21	5/23/2013 - 5/7/2018
	Low Conductivity (≤2500 µS/cm): Cl = (0.04461 * EC) – 0.9665	0.9964	8	5/23/2013 - 5/7/2018
	SO4 = (0.4770 * EC) – 105.1167	0.9918	23	2/28/2014 - 5/7/2018
	B = (0.000478 * EC) - 0.1207	0.9060	64	1/31/2011 – 5/7/2018
07_TIERRA	TDS = (0.7122 * EC) – 67.4325	0.9868	52	1/31/2011 – 5/7/2018
	Cl = (0.1097 * EC) – 13.6194	0.9892	24	2/28/2014 - 5/7/2018
	High Conductivity (>1400 µS/cm): SO4 = (0.4340 * EC) – 297.4593	0.7973	40	1/31/2011 – 5/7/2018
	Low Conductivity (≤1400 µS/cm): SO4 = (0.2530 * EC) – 21.0947	0.9583	11	1/31/2011 – 5/7/2018
	B = (0.000428 * EC) - 0.0608	0.9631	32	8/28/12 - 5/7/2018
9A_HOWAR	TDS = (0.6199 * EC) – 13.5355	0.9876	55	1/31/2011 – 5/7/2018
	Cl = (0.1543 * EC) – 21.4218	0.9705	12	8/25/2016 - 5/7/2018
	SO4 = (0.1637 * EC) – 23.6693	0.9723	11	8/25/2016 - 5/7/2018
9B_BARON	TDS = (0.6083 * EC) – 14.6960	0.9802	55	1/31/2011 – 5/7/2018
	Cl = (0.1634 * EC) – 25.8230	0.9846	12	8/25/2016 - 5/7/2018
	High Conductivity (>1000 µS/cm): SO4 = (0.2812 * EC) -168.0055	0.8039	40	3/20/2011 - 5/7/2018
	Low Conductivity (≤1000 µS/cm): SO4 = (0.1367 * EC) – 2.5933	0.9793	10	3/20/2011 - 5/7/2018

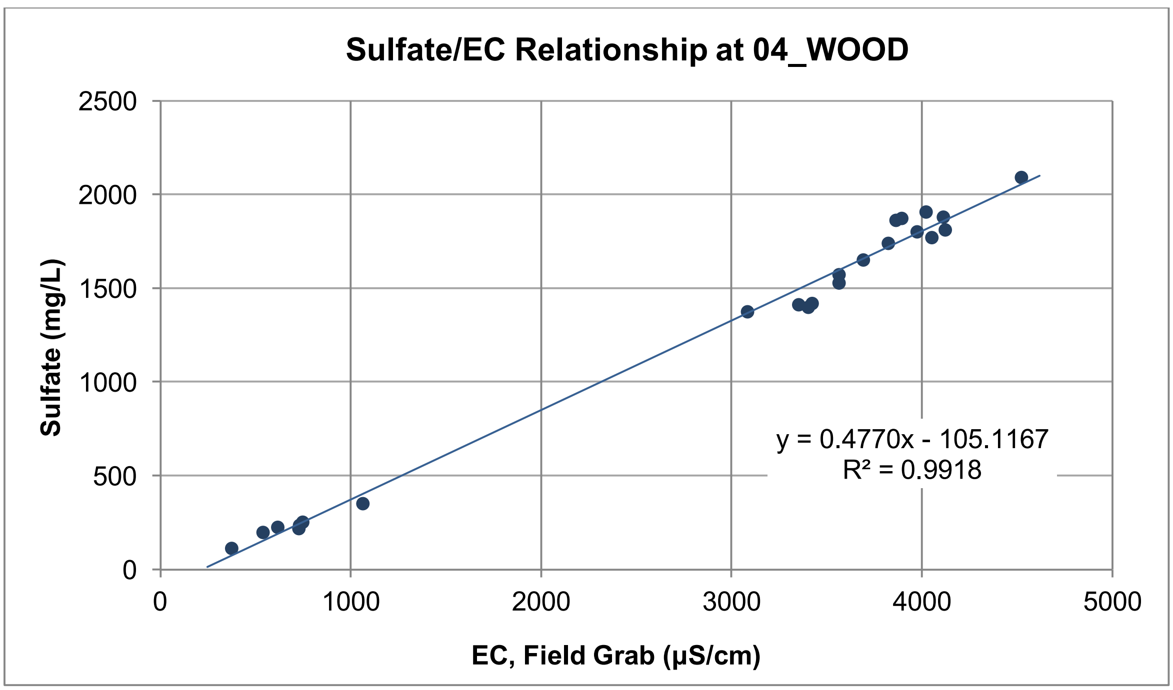

TDS/EC Relationship at 03_UNIV
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
TDS (mg/L)
EC, Field Grab (µS/cm)
y = 0.6307x - 13.8018
R² = 0.9869

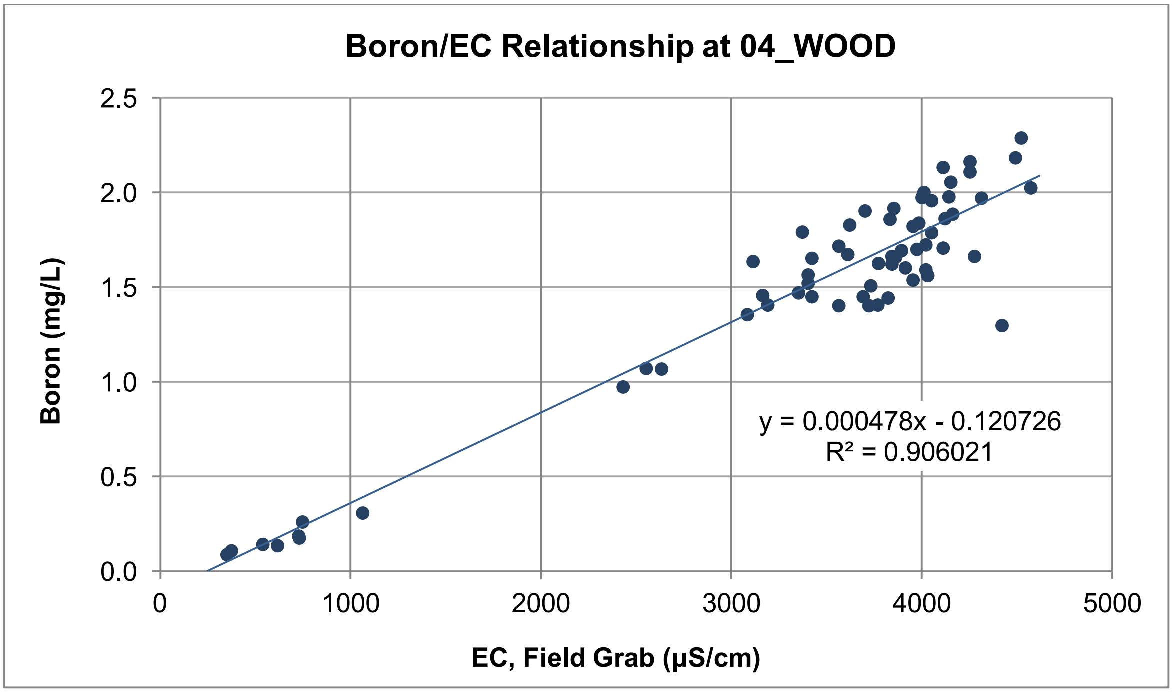

Chloride/EC Relationship at 03_UNIV
300
250
200
150
100
50
0
0
500
1000
1500
2000
Chloride (mg/L)
EC, Field Grab (µS/cm)
y = 0.1505x - 22.5973
R² = 0.9901


Sulfate/EC Relationship at 03_UNIV
Sulfate (mg/L)
300
250
200
150
100
50
0
0
500
1000
1500
2000
EC, Field Grab (µS/cm)
y = 0.1519x - 6.9698
R² = 0.9910

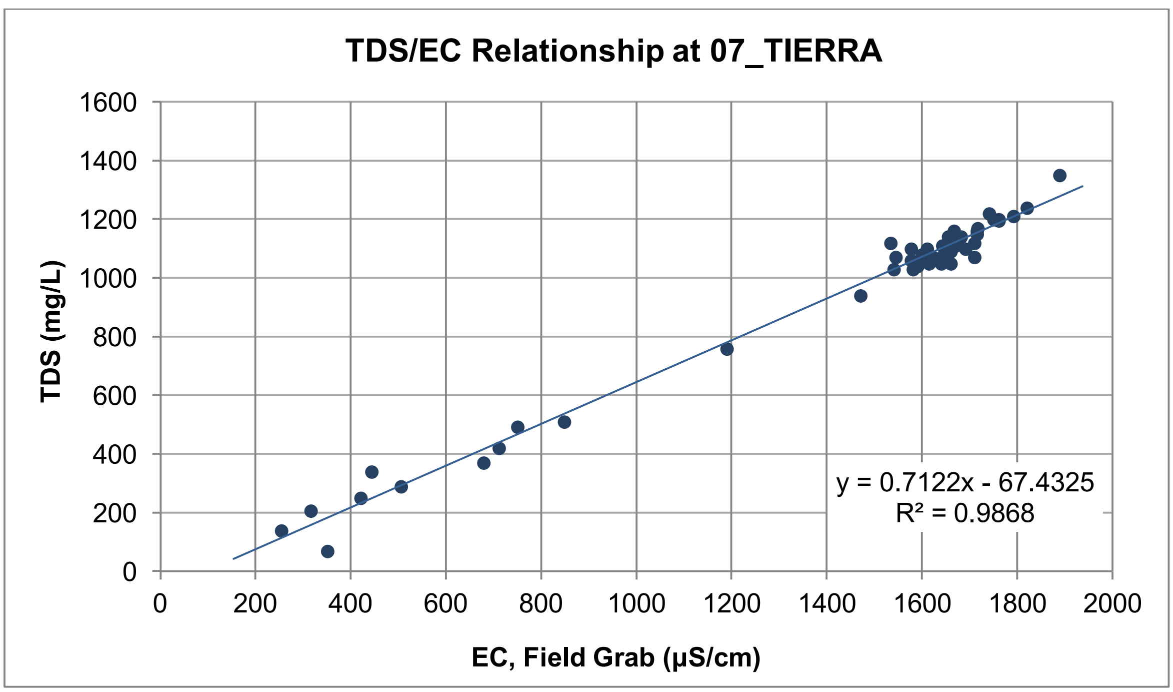

TDS/EC Relationship at 04_WOOD
TDS (mg/L)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
EC, Field Grab (µS/cm)
y = 0.9184x - 196.2883
R² = 0.9887


Chloride/EC Relationship at 04_WOOD
250
200
150
100
50
0
0
1000
2000
3000
4000
5000
Chloride (mg/L)
EC, Field Grab (µS/cm)
EC ≤ 2500 µS/cm:
y = 0.0446x - 0.9665
R² = 0.9964
EC > 2500 µS/cm:
y = 0.072x - 85.48
R² = 0.88463

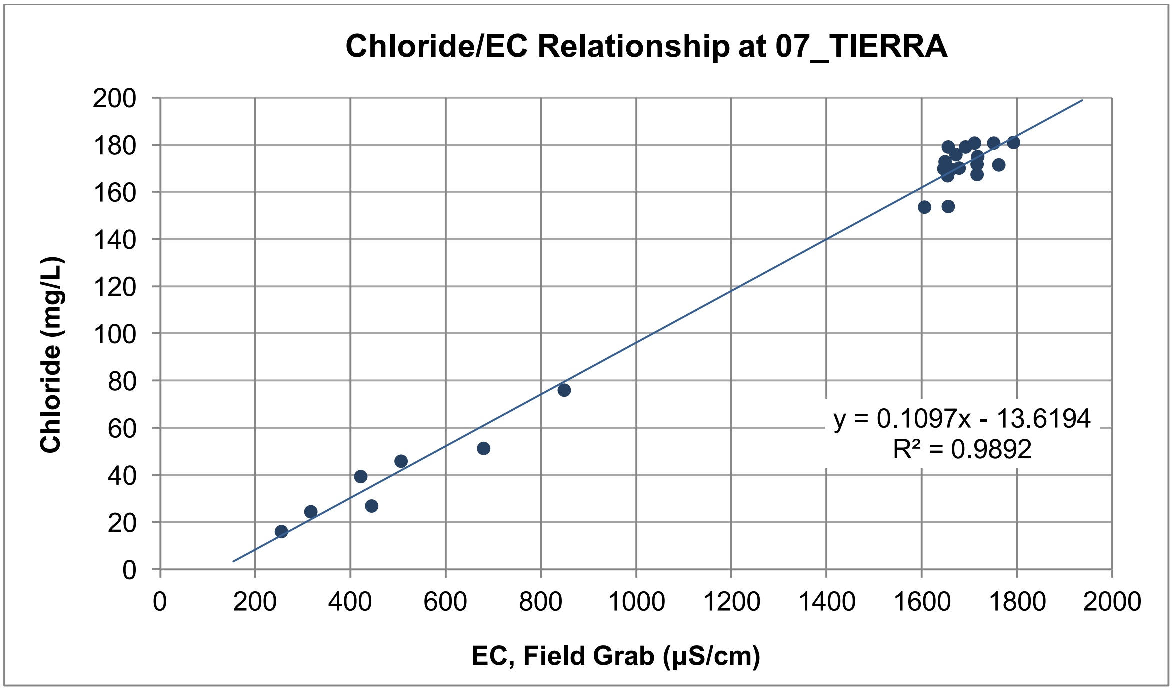

Sulfate/EC Relationship at 04_WOOD
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
Sulfate (mg/L)
EC, Field Grab (µS/cm)
y = 0.4770x - 105.1167
R² = 0.9918



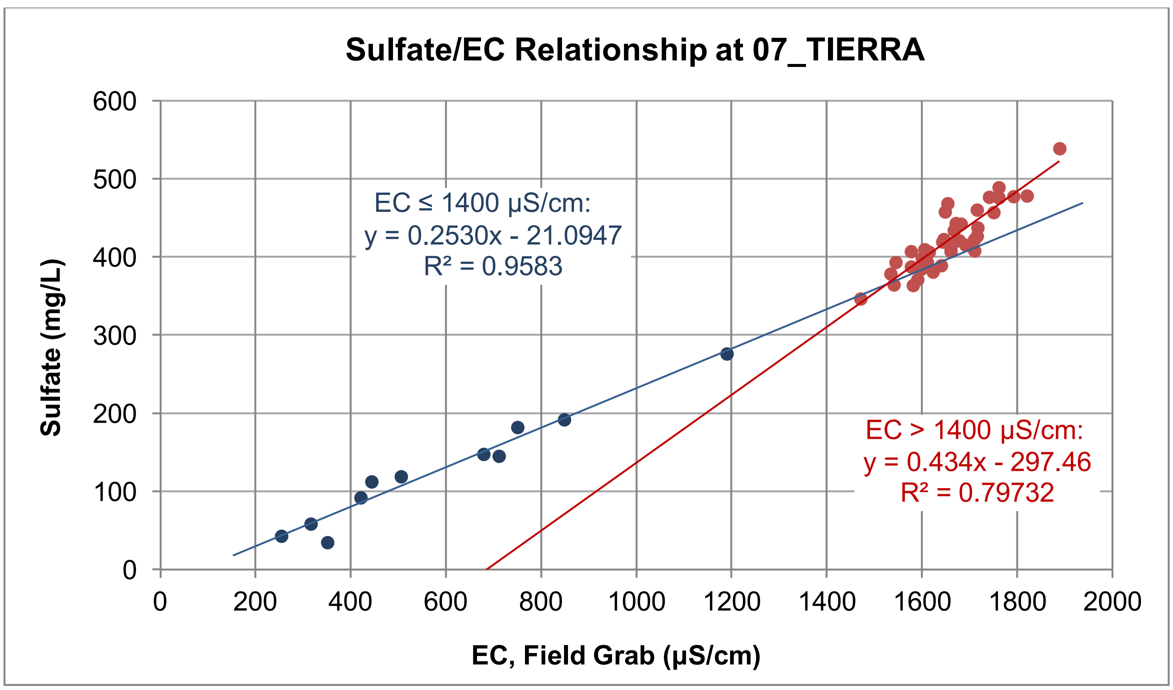
Boron/EC Relationship at 04_WOOD
Boron (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
0
1000
2000
3000
4000
5000
EC, Field Grab (µS/cm)
y = 0.000478x - 0.120726
R^2 = 0.906021



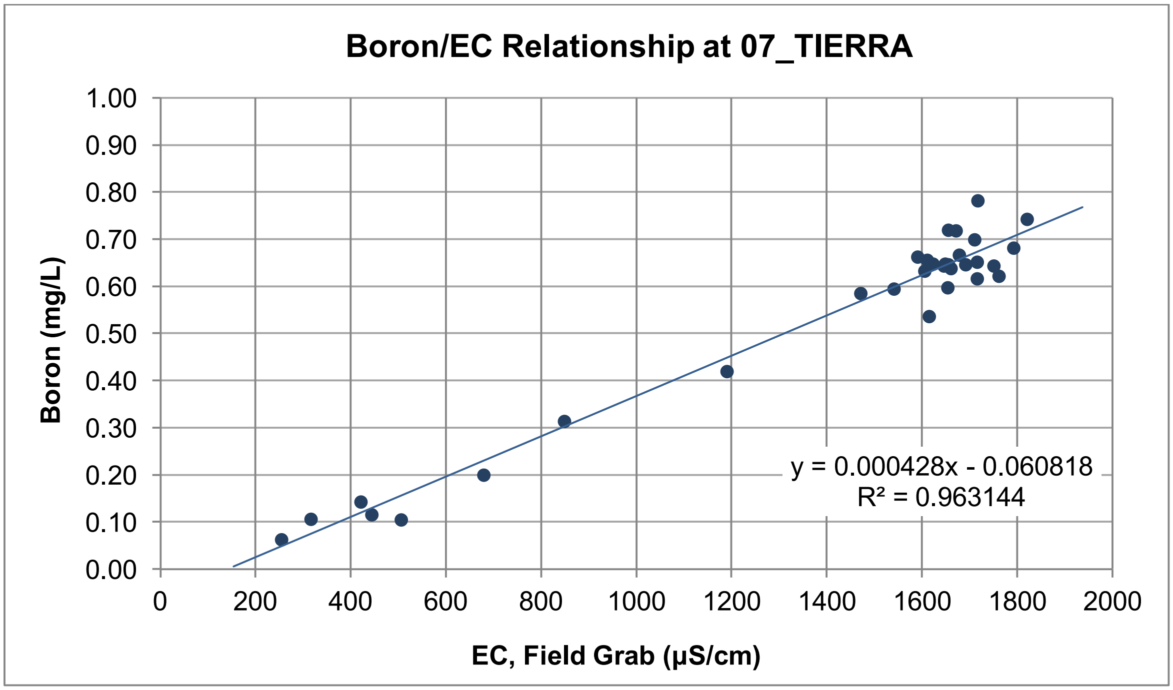
TDS/EC Relationship at 07_TIERRA
TDS (mg/L)
1600
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
EC, Field Grab (µS/cm)
y = 0.7122x - 67.4325
R^2 = 0.9868

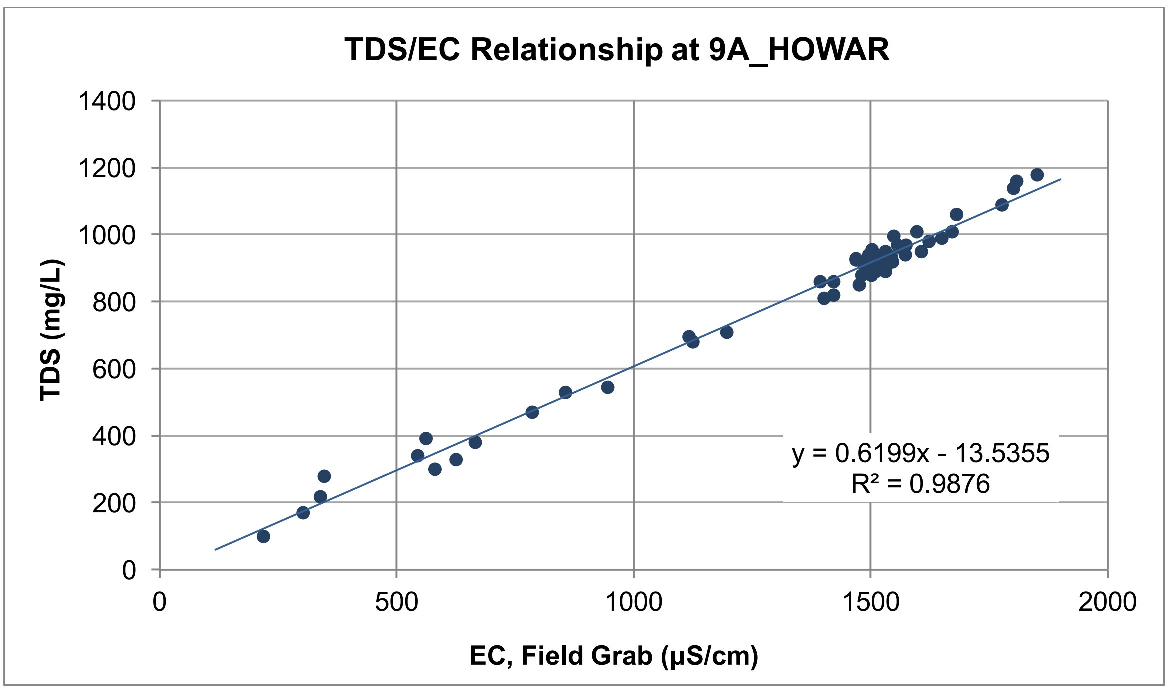


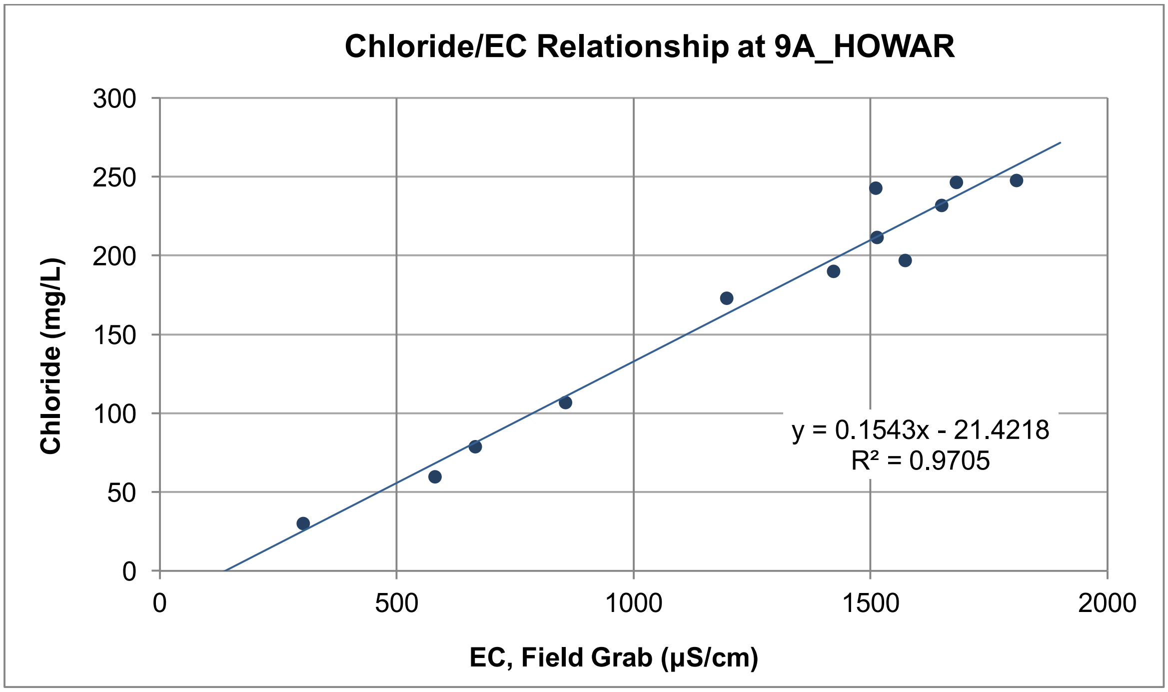
Chloride/EC Relationship at 07_TIERRA
Chloride (mg/L)
200
180
160
140
120
100
80
60
40
20
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
EC, Field Grab (µS/cm)
y = 0.1097x - 13.6194
R² = 0.9892

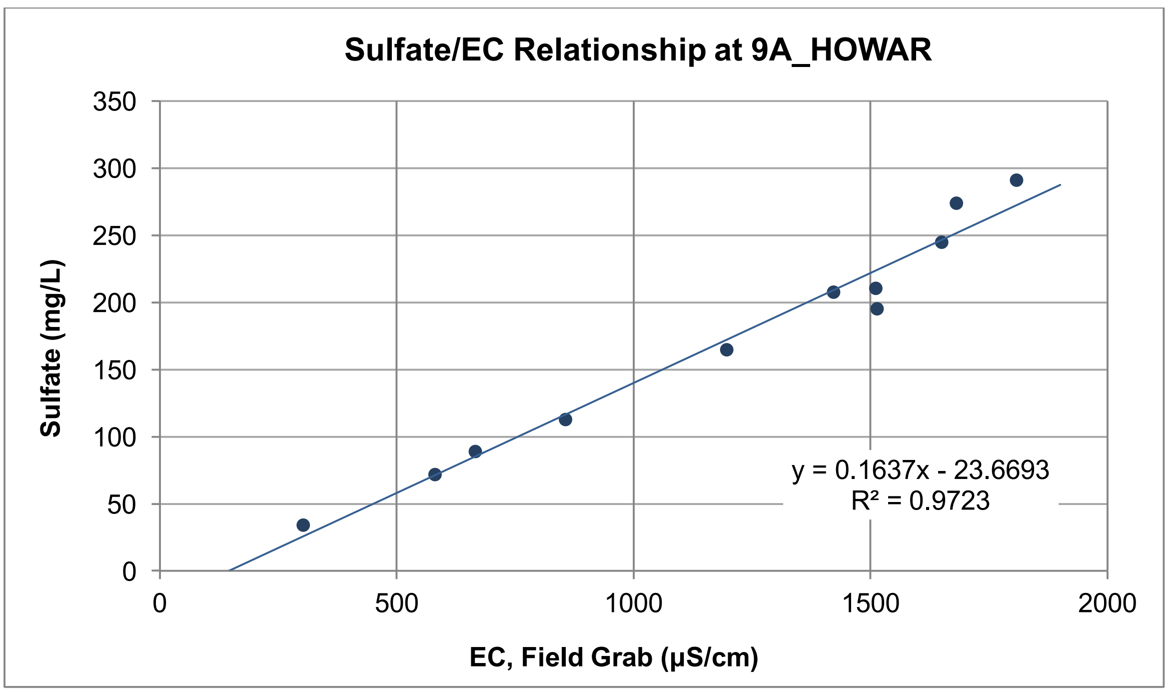


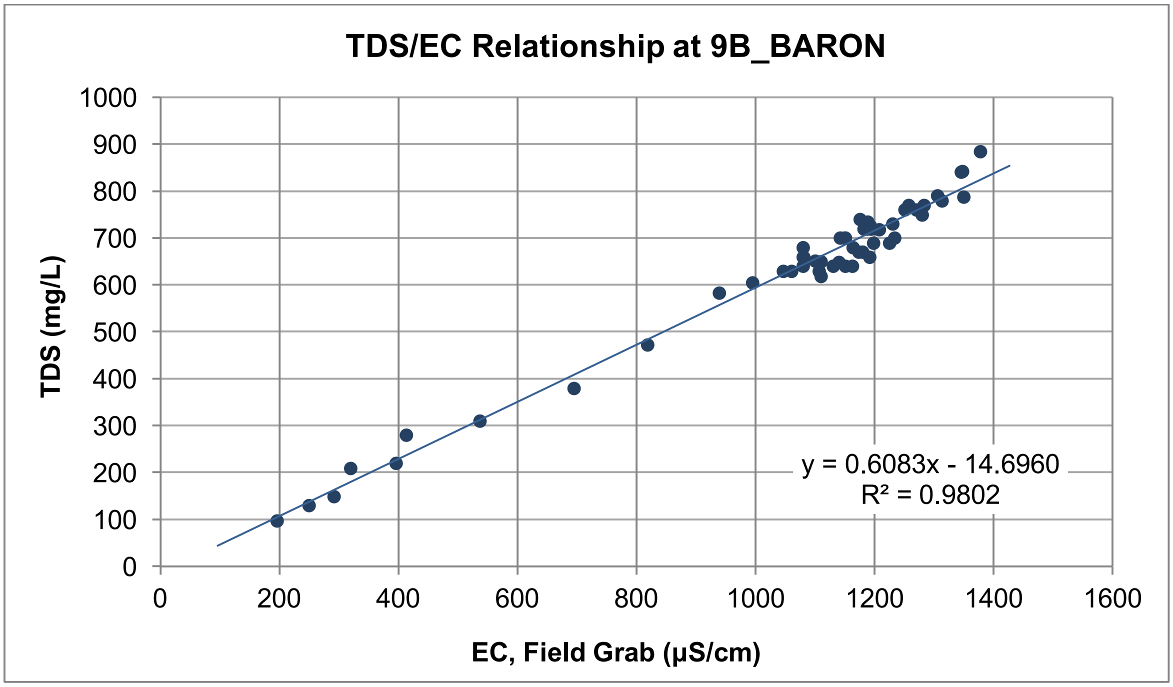
Sulfate/EC Relationship at 07_TIERRA
Sulfate (mg/L)
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
EC, Field Grab (µS/cm)
EC ≤ 1400 µS/cm:
y = 0.2530x - 21.0947
R² = 0.9583
EC > 1400 µS/cm:
y = 0.434x - 297.46
R² = 0.79732

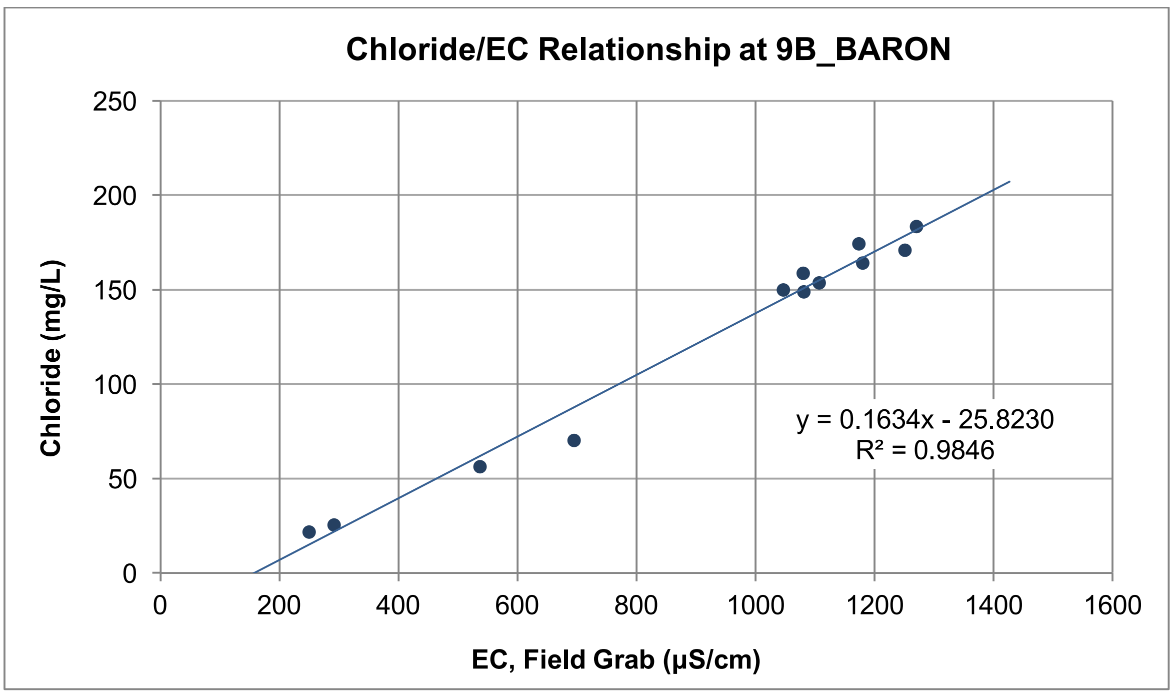

Boron/EC Relationship at 07_TIERRA
Boron (mg/L)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
200
400
600
800
1000
1200
1400
1600
1800
2000
EC, Field Grab (µS/cm)
y = 0.000428x - 0.060818
R² = 0.963144

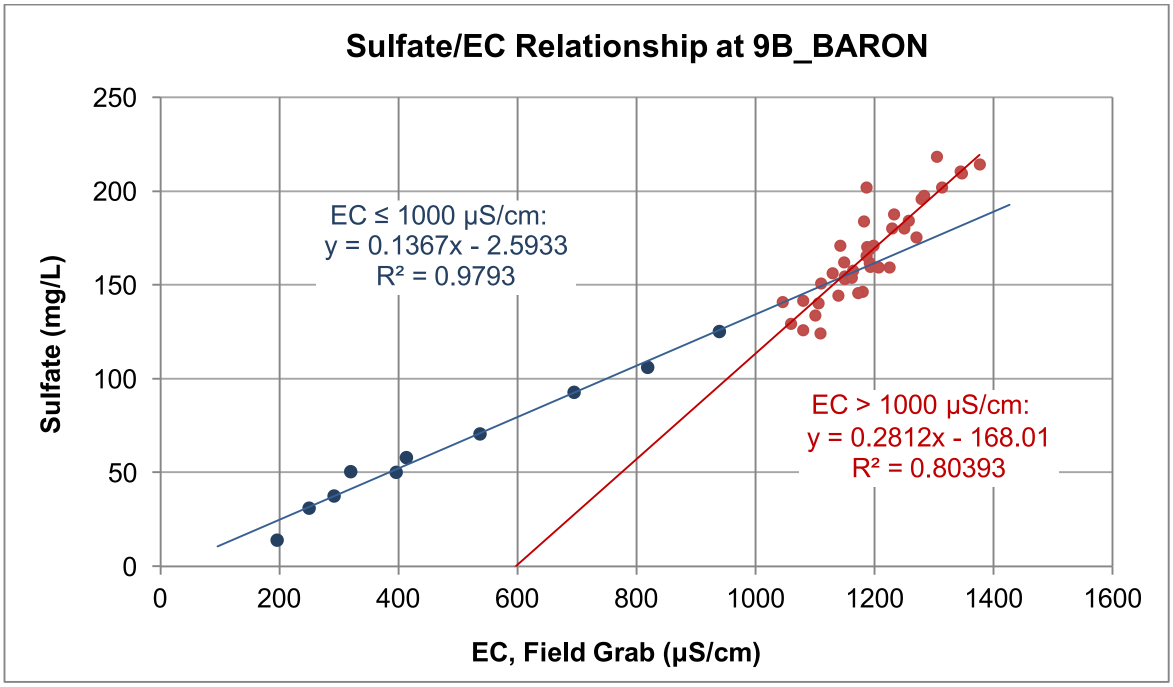

TDS/EC Relationship at 9A_HOWAR
TDS (mg/L)
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
EC, Field Grab (µS/cm)
y = 0.6199x - 13.5355
R² = 0.9876


Chloride/EC Relationship at 9A_HOWAR
Chloride (mg/L)
300
250
200
150
100
50
0
0
500
1000
1500
2000
EC, Field Grab (µS/cm)
y = 0.1543x - 21.4218
R² = 0.9705


Sulfate/EC Relationship at 9A_HOWAR
Sulfate (mg/L)
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
EC, Field Grab (µS/cm)
y = 0.1637x - 23.6693
R² = 0.9723


TDS/EC Relationship at 9B_BARON
TDS (mg/L)
1000
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
1600
EC, Field Grab (µS/cm)
y = 0.6083x - 14.6960
R² = 0.9802


Chloride/EC Relationship at 9B_BARON
Chloride (mg/L)
250
200
150
100
50
0
0
200
400
600
800
1000
1200
1400
1600
EC, Field Grab (µS/cm)
y = 0.1634x - 25.8230
R² = 0.9846


Sulfate/EC Relationship at 9B_BARON
Sulfate (mg/L)
EC, Field Grab (µS/cm)
EC ≤ 1000 µS/cm:
y = 0.1367x - 2.5933
R² = 0.9793
EC > 1000 µS/cm:
y = 0.2812x - 168.01
R² = 0.80393
0
50
100
150
200
250
0
200
400
600
800
1000
1200
1400
1600

Appendix C: Toxicity Testing and Toxicity Identification Evaluations (TIE) Summary

TOXICITY TESTING PROCEDURES

For the Calleguas Creek Watershed Total Maximum Daily Load (TMDL) Compliance Monitoring Program (CCWTMP), toxicity testing at various locations is conducted to meet TMDL requirements. The following is a brief summary of the procedures for the analytical methods used by the CCWTMP. Specific details concerning the standard operating procedures (SOPs) followed by field crews collecting applicable samples and laboratory analyses can be found in the Quality Assurance Project Plan (QAPP).

For the CCWTMP toxicity measures, standard test species were utilized for toxicity testing. *Ceriodaphnia dubia* was used for fresh water aquatic toxicity testing and *Hyalella azteca* for the saline water aquatic toxicity testing and bulk sediment and porewater toxicity testing. *Hyalella azteca* was used to conduct aquatic toxicity testing if sample salinity exceeded 1.5 part per thousand (PPT) but was less than 15 PPT. Lagoon sediment samples were tested using *Eohaustorius estuaries* as well as the additional optional species *Mytilus galloprovincialis.* Required results are summarized in this appendix and additional optional testing information can be founr in Attachment 1. All test species are standard United States Environmental Protection Agency (USEPA) test species and considered the most applicable for the various types of pollutants impacting the watershed, and all analytical testing procedures were conducted using standard USEPA methods.

The results of each toxicity test are used to trigger further investigations to determine the cause of observed laboratory toxicity if necessary per the QAPP. If testing indicates the presence of significant toxicity in the sample, toxicity identification evaluations (TIEs) procedures are initiated to investigate the cause of toxicity. For the purpose of triggering TIE procedures, significant toxicity is defined as at least 50 percent mortality. The 50 percent mortality threshold is consistent with the approach recommended in guidance published by USEPA for conducting TIEs (USEPA, 1996), which recommends a minimum threshold of 50 percent mortality because the probability of completing a successful TIE decreases rapidly for samples with less than this level of toxicity.[1] A component of the compliance requirement when significant toxicity is found is to initiate a targeted Phase 1 TIE and test to determine the general class of constituent (*i.e.*, non-polar organics) causing toxicity. The targeted TIE focuses on classes of constituents anticipated to be observed in drainages dominated by urban and agricultural discharges and those previously observed to cause toxicity. Phase 2 TIEs may also be utilized to identify specific constituents causing toxicity if warranted. TIE methods will generally adhere to USEPA procedures documented in conducting TIEs.[2,3,4,5] For samples exhibiting toxic effects consistent

[1] United States Environmental Protection Agency (USEPA). 1996. Marine Toxicity Identification Evaluation. Phase I Guidance Document EPA/600/R-96/054. USEPA, Office of Research and Development, Washington, D.C.

[2] United States Environmental Protection Agency (USEPA). 1991. Methods for Aquatic Toxicity Identification Evaluations: Phase 1 Toxicity Characterization Procedures (Second Edition). EPA-600/6-91/003. USEPA, Environmental Research Laboratory, Duluth, MN.

with carbofuran, diazinon, or chlorpyrifos, TIE procedures follow those documented in Bailey *et al.*[6]

The decision to initiate TIE procedures on any sample, including samples exceeding the mortality threshold, as well as the focus and scope of TIE procedures, is determined by the Project Manager and toxicity laboratory staff. When deciding whether to initiate TIE procedures for a specific site and monitoring event, a number of factors are considered, including the level of toxicity, the magnitude of sample mortality and/or reburial levels as compared to lab control results, history of toxicity at the site, the species and endpoints exhibiting toxic effects, as well as the primary technical basis for triggering TIEs described above. A summary of the toxicity results and subsequent TIE actions, including the rationale for initiating TIE procedures for a specific sample are described below.

TOXICITY RESULTS SUMMARY

Freshwater sediment toxicity samples are collected annually during the first event of each monitoring year. Water column toxicity samples are collected at freshwater sites during each of the quarterly and wet weather events. Sediment toxicity samples are collected every three years in Mugu Lagoon. As such, freshwater and lagoon sediment toxicity samples were collected during the first event of this monitoring year. Monitored sites include the following:

- **Freshwater Sediment Toxicity Sites**
  - 02_PCH (Toxicity Investigation site)
  - 03_UNIV
  - 04_WOOD
  - 9A_HOWAR (Toxicity Investigation site)
- **Lagoon Sediment Toxicity**
  - 01_BPT_3
  - 01_BPT_6
  - 01_BPT_14
  - 01_BPT_15

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[3] United States Environmental Protection Agency (USEPA). 1992. Toxicity Identification Evaluation: Characterization of Chronically Toxic Effluents Phase 1. EPA/600/6-91/005. USEPA, Office of Research and Development, Washington, D.C.

[4] United States Environmental Protection Agency (USEPA). 1993a. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fourth Edition. EPA/600/4-90/027F. USEPA, Office of Research and Development, Washington, D.C.

[5] United States Environmental Protection Agency (USEPA). 1993b. Methods for Aquatic Toxicity Identification Evaluations: Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity. EPA/600/R-02/080. USEPA, Office of Research and Development, Washington, D.C.

[6] Bailey, H.C., DiGiorgio, C., Kroll, K., Miller, J.L., Hinton, D.E., Starrett, G. 1996. Development of Procedures for Identifying Pesticide Toxicity in Ambient Waters: Carbofuran, Diazinon, Chlorpyrifos. Environ. Tox. and Chem. V15, No. 6, 837-845.

- o 01_SG_74

- **Freshwater Water Column Toxicity Sites**
  - o 04_WOOD
  - o 03_UNIV
  - o 9B_ADOLF
  - o 06_UPLAND
  - o 07_HITCH
  - o 10_GATE (Toxicity Investigation site)
  - o 13_BELT (Toxicity Investigation site)

Sediment toxicity samples were collected during dry weather event 62. Water column toxicity testing was conducted during all four dry weather events (Events 62, 63, 64, and 67), and the wet weather events (Events 65 and 66). The following section describes the toxicity samples collected at each site for each event, the results of the tests, and a summary of applicable TIEs initiated per the requirements in the QAPP.

Event 62 Sediment Toxicity

Table 1. Lagoon and Freshwater Sediment Toxicity Event 62 - *Hyalella azteca* and *Eohaustorius estuaries*

Site ID	*Hyalella azteca*			*Eohaustorius estuarius*		
	Survival	Growth	TIE?	Survival	Reburial	TIE?
02_PCH	Yes	Yes	No[1]			
03_UNIV	No	No	No			
04_WOOD	Yes	No	No[2]			
9A_HOWAR	No	No	No			
01_BPT_3				No	No	No
01_BPT_6				No	No	No
01_BPT_14				Yes	Yes	No[1]
01_BPT_15				No	No	No
01_BPT_74				Yes	Yes	No[1]

1. TIE not initiated due to mortality < 50 percent.
2. A TIE was not initiated at this site. TIEs conducted during previous monitoring years identified organic compounds such as pesticides as the likely cause of the toxicity. TIEs have been suspended while efforts are taken to reduce the source of the toxicity.

Event 62 Water Column Toxicity

Table 2. Freshwater Water Column Toxicity Event 62 - *Ceriodaphnia dubia and Hyalella azteca*

Site ID	*Ceriodaphnia dubia*			*Hyalella azteca*	
	Survival	Reproduction	TIE?	Survival	TIE?
03_UNIV	No	No	No		
04_WOOD				No	No
07_HITCH	No	Yes	No		
9B_ADOLF	No	No	No		
10_GATE	No	Yes	No		
13_BELT	No	No	No		

Event 62 Toxicity and TIE Summary

- Freshwater sediment sites exhibited reduced survival at the 02_PCH and 04_WOOD sites. Though statistically significant in comparison to the control, survival at 02_PCH was still quite high at 92.5% mean survival. Mean survival at 04_WOOD was 15%.
- Lagoon sediment sites exhibited reduced survival at the 01_BPT_14 and 01_BPT_74 sites. Though statistically significant in comparison to the control, survival at these two sites were still quite high, 95% mean survival at 01_BPT_14 and 94% at 01_BPT_74.
- There were no significant reductions in survival of *Ceriodaphnia dubia* in any of the Calleguas Creek ambient waters.
- Significant reductions in reproduction were observed for *Ceriodaphnia dubia* at 03_UNIV and 10_GATE.
- There were no significant reductions in survival or reproduction of *Hyalella Azteca* in any of the Calleguas Creek ambient waters.
- A TIE was not initiated at the 04_WOOD site. TIEs conducted during previous monitoring years identified organic compounds such as pesticides as the likely cause of the toxicity. TIEs have been suspended while efforts are taken to reduce the source of the toxicity.
- No TIEs were performed on samples collected at any other site for this sampling event.

Event 63 Water Quality Toxicity

Table 3. Water Quality Toxicity Event 63 - *Ceriodaphnia dubia* and *Hyalella azteca*

Site ID	*Ceriodaphnia dubia*			*Hyalella azteca*	
	Survival	Reproduction	TIE?	Survival	TIE?
03_UNIV	No	Yes	No		
04_WOOD				No	No
07_HITCH	No	Yes	No		
9B_ADOLF	No	No	No		
13_BELT	No	No	No		
10_GATE	No	No	No		

Event 63 Toxicity and TIE Summary

- No significant reductions in survival were observed for *Ceriodaphnia dubia* at the five freshwater sample sites during the sampling event.
- Significant reductions in reproduction were observed for *Ceriodaphnia dubia* at 03_UNIV and 07_HITCH.
- No significant reduction in survival was observed for *Hyalella azteca* at the 04_WOOD site.
- No TIEs were performed on samples collected for this sampling event.

Event 64 Water Quality Toxicity

Table 4. Water Quality Toxicity Event 64 - *Ceriodaphnia dubia* and *Hyalella azteca*

Site ID	*Ceriodaphnia dubia*			*Hyalella azteca*	
	Survival	Reproduction	TIE?	Survival	TIE?
03_UNIV	No	Yes	No		
04_WOOD				No	No
07_HITCH	No	No	No		
9B_ADOLF	No	No	No		
10_GATE	No	No	No		
13_BELT	No	No	No		

Event 64 Toxicity and TIE Summary

- No significant reductions in survival were observed for *Ceriodaphnia dubia* at the five freshwater sample sites during the sampling event.
- No significant reductions in survival were observed for *Hyalella azteca* at the 04_WOOD site.
- There was a significant reduction in reproduction observed for *Ceriodaphnia dubia* at 03_UNIV.
- No TIEs were performed on samples collected for this sampling event.

Event 65 Water Quality Toxicity

Table 5. Water Quality Toxicity Event 65 - *Ceriodaphnia dubia*

Site ID	*Ceriodaphnia dubia*		
	Survival	**Reproduction**	**TIE?**
03_UNIV	No	No	No
04_WOOD	Yes	Yes	No
07_HITCH	No	No	No
9B_ADOLF	No	No	No
06_UPLAND	No	No	No
10_GATE	No	No	No
13_BELT	No	No	No

Event 65 Toxicity and TIE Summary

- There was a significant reduction in survival and a significant reduction in reproduction observed for *Ceriodaphnia dubia* at the 04_WOOD site.
- A TIE was not initiated at the 04_WOOD site. TIEs conducted during previous monitoring years identified organic compounds such as pesticides as the likely cause of the toxicity. TIEs have been suspended while efforts are taken to reduce the source of the toxicity.
- No TIEs were performed on samples collected at the remaining sites for this sampling event.

Event 66 Water Quality Toxicity

Table 6. Water Quality Toxicity Event 66 - *Ceriodaphnia dubia*

Site ID	*Ceriodaphnia dubia*		
	Survival	**Reproduction**	**TIE?**
03_UNIV	No	No	No
04_WOOD	No	No	No
07_HITCH	No	No	No
9B_ADOLF	No	No	No
10_GATE	No	No	No
13_BELT	No	No	No

Event 66 Toxicity and TIE Summary

- No significant reductions in survival or significant reductions in reproduction were observed for *Ceriodaphnia dubia* at all sites.
- No TIEs were performed on samples collected for this sampling event.

Event 67 Water Quality Toxicity

Table 7. Water Quality Toxicity Event 67 - *Ceriodaphnia dubia* and *Hyalella azteca*

Site ID	*Ceriodaphnia dubia*			*Hyalella azteca*	
	Survival	Reproduction	TIE?	Survival	TIE?
03_UNIV	No	No	No		
04_WOOD				No	No
07_HITCH	No	No	No		
9B_ADOLF	No	No	No		
10_GATE	No	Yes	No		
13_BELT	No	Yes	No		

Event 67 Toxicity and TIE Summary

- No significant reductions in survival were observed for *Ceriodaphnia dubia* or *Hyalella azteca*.
- Significant reproduction toxicity for *Ceriodaphnia dubia* was observed at the 10_GATE and 13_BELT sites.
- No TIEs were performed on samples collected for this sampling event.

Appendix D:
Laboratory QA/QC Results and Discussion

QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance and quality control (QA/QC) measures are built into the Calleguas Creek Watershed Total Maximum Daily Load (TMDL) Compliance Monitoring Program (CCWTMP) to assure that collected data are credible. Two types of quality controls were conducted. Field quality controls (to test for field contamination and precision) were conducted by the field crews and include: equipment blanks, field blanks, and field duplicates. Laboratory quality controls (to test for laboratory contamination and precision) were conducted by the laboratories and include: method blanks, blank spikes, blank spike duplicates, lab duplicates, matrix spikes, matrix spike duplicates, laboratory control samples, and surrogates (for organics only). Equipment blanks only apply to the shovels used in sediment sample collection. All field protocols for the collection of clean samples were followed according to the Quality Assurance Project Plan (QAPP). The following section lists the quality control failures that occurred during the 2017-2018 monitoring year and any associated qualifiers and comments.

Blank Contamination

Blank samples are used to identify the presents of and potential sources of sample contamination. During the tenth year of monitoring, there were three types of blank samples conducted.

- **Field blanks** are conducted by field crews and are looking for possible contamination in the collection process and transportation of samples.
- **Equipment blanks** are done by the field crews and look for contamination with the sampling equipment (e.g. shovels for sediment).
- **Laboratory blanks** are conducted by the analyzing laboratory and look for contamination in the lab.

Blank sample constituent detections were less than half a percent considering all blank samples for the monitoring year. Most detections in blank samples were laboratory blanks. All field blank detections occurred in Boron, Ammonia, or Total Kjeldahl Nitrogen (TKN) samples. There were two equipment blank (EB) failures with Ammonia and Total Organic Carbon (TOC). All Ammonia sediment samples were greater than 10 times the EB detection, so were not flagged. The TOC sediment samples were all flagged, because all samples were within 10 times the EB concentration. Of the 14 laboratory blank failures, approximately half were for general water quality parameters and the remainder occurred in metals and pyrethroids samples. Even though the detections were above the MDL value, most were low compared to the environmental sample or the environmental sample was not detected, so very few qualifications of the field sample data were needed. Details of all the blank sample detections are reported in **Table 1** below. The following lists a basic summary of the blank contamination results:

- Field Blanks – 1856 analyzed – 9 detections above the MDL (0.48%) (does not include lab duplicates or surrogates)
- Equipment Blanks – 277 analyzed – 2 detections above the MDL (0.72%) (does not include lab duplicates or surrogates)
- Laboratory Blanks – 3957 analyzed – 14 detections above the MDL (0.35%) (does not include surrogates)

Precision

Precision (reproducibility) of sample collection, preparation, and analytical methods is demonstrated by analyzing duplicate samples and calculating the relative percent difference (RPD) between the original sample and its duplicate. The RPD is reported for field duplicates, lab duplicates, blank spike duplicates, laboratory control spike (LCS) duplicates, and matrix spike duplicates. An RPD is computed as:

$$RPD = 2 * |O_i - D_i| / (O_i + D_i) * 100$$

Where:

RPD = Relative Percent Difference
O_i = value of compound *i* in original sample
D_i = value of compound *i* in duplicate sample

QA failures for precision are noted when the RPD between a sample and its duplicate are greater than the acceptance value. Details of all the RPD failures are reported in **Table 2** below. The following list summarizes the precision analysis results:

- Field Duplicates – 2015 analyzed – 52 failed RPD (2.58%) (does not include surrogates)
- Laboratory Duplicates – 856 analyzed – 21 failed RPD (2.45%) (includes surrogates)
- Blank Spike/LCS Duplicates – 3498 analyzed – 13 failed RPD (0.37%) (includes surrogates)
- Matrix Spike Duplicates – 753 analyzed – 25 failed RPD (3.32%) (includes surrogates)

Accuracy

Accuracy is defined as the degree of agreement of a measurement to an accepted reference or true value. Accuracy is measured as the percent recovery (%R) of a spiked compound and calculated as:

$$\%R = 100 * [(C_s - C) / S]$$

Where:

%R = Percent Recovery
C_s = analyzed spiked concentration
C = analyzed concentration of sample matrix
S = known spiked concentration

Percent recoveries of blank spike samples, LCS samples, and matrix spike samples check the accuracy of the laboratory reported sample concentrations. All of the blank spike samples and LCS samples that fell outside the acceptable range were from pesticides, except for one Dissolved Organic Carbon sample. Of the matrix spike samples that fell outside the acceptable range, they were from all three matrixes; 49 from water, 7 from sediment, and 9 from tissue.

Table 3 summarizes the QA/QC sample results for accuracy that did not meet percent recovery objectives. The following lists the results of the accuracy analysis results:

- Blank Spike/LCS Samples – 6897 Analyzed – 14 fell outside the range (0.20%) (does not include surrogates)
- Matrix Spike Samples – 1456 Analyzed – 65 fell outside the range (4.46%) (does not include surrogates)

Table 1. Blank Contamination Observed

Constituent	Matrix	Event Number	Lab Batch	Equip Blank	Field Blank	Lab Blank	Program Qualifier
General Water Quality							
Electrical Conductivity (umhos/cm)	Water	62	2P1709567-B			0.4	DNQ
Electrical Conductivity (umhos/cm)	Water	65	2P1802847-A			0.27	DNQ
Electrical Conductivity (umhos/cm)	Water	66	2P1803297-A			0.5	DNQ
Total Dissolved Solids (mg/L)	Water	62	2P1709590-A			7.4444	DNQ
Total Dissolved Solids (mg/L)	Water	63	2P1713625-A			14.706	=
Total Dissolved Solids (mg/L)	Water	64	2P1801621-A			7.0588	DNQ
Total Dissolved Solids (mg/L)	Water	64	2P1801621-B			8.6275	DNQ
Total Dissolved Solids (mg/L)	Water	67	2P1805350-A			9.6667	DNQ
Total Organic Carbon, Total (mg/L)	Water	62	Physis_O-16004_W_TOC	0.31			DNQ
Nutrients							
Ammonia as N (mg/L)	Water	66	Physis C-30144 W		0.0262		DNQ
Ammonia as N (mg/L)	Water	66	Physis C-30144 W		0.0437		
Ammonia as N (mg/L)	Water	67	Physis C-30149 W		0.013		DNQ
Ammonia as N, Total (mg/L)	Water	62	Physis_C-30074_W_NH3	0.06			
Total Kjeldahl Nitrogen (mg/L)	Water	64	Associated_QC1187739 _W_CON		0.393		DNQ
Total Kjeldahl Nitrogen (mg/L)	Water	64	Associated_QC1187739 _W_CON		0.579		=
Metals & Selenium							
Boron, Total (µg/L)	Water	62	Physis E-13031 W		1.094		DNQ
Boron, Total (µg/L)	Water	66	Physis E-16013 W		61.6		=
Boron, Total (µg/L)	Water	66	Physis E-16013 W		61.6		=
Boron, Total (µg/L)	Water	67	Physis E-16015 W		6.62		=
Nickel, Dissolved (µg/L)	Water	62	W7H0870			0.0557	DNQ
Nickel, Dissolved (µg/L)	Water	64	W8B0649			0.0748	DNQ

Constituent	Matrix	Event Number	Lab Batch	Equip Blank	Field Blank	Lab Blank	Program Qualifier
Zinc, Dissolved (µg/L)	Water	62	W7H0870			0.97	DNQ
Zinc, Dissolved (µg/L)	Water	64	W8B0649			1.13	DNQ
OC Pesticides							
None							
OP Pesticides							
Dimethoate (µg/L)	Water	63	W7K0686			0.00821	DNQ
PCBs							
None							
Pyrethroid Pesticides							
Bifenthrin (µg/L)	Water	62	W7H0866			0.000923	DNQ

Table 2. Precision QA/QC Issues

Constituent	Matrix	Event	Lab Batch	Site	BS/ BSD RPD	Field Dup RPD	Lab Dup RPD	MS/ MSD RPD	Program Qualifier	Comments
General Water Quality										
Total Dissolved Solids (mg/L)	Water	62	2P1709590-A	QAQC			***5.2***		LD RPD	LabDuplicate RPD Failed
Total Suspended Solids (mg/L)	Water	62	Physis C-33030 W	03_UNIV		***31***	15		FD RPD	FieldDup RPD Failed
Nutrients										
Ammonia as N (mg/L)	Water	67	Physis C-30149 W	01T_ODD2_DCH	7	***74***	7	6	FD RPD	FieldDup RPD Failed
Nitrite as N (mg/L)	Water	65	Physis C-34148 W	01T_ODD2_DCH	1	***160***	2	2	FD RPD	FieldDup RPD Failed
Nitrite as N (mg/L)	Water	65	Physis C-34148 W	07_HITCH	1	***140***	2	2	FD RPD	FieldDup RPD Failed
Orthophosphate as P (mg/L)	Water	65	Physis C-34148 W	01T_ODD2_DCH	4	***56***	1	2	MS <LL, FD RPD	MS failed lower limit, FieldDup RPD Failed
Total Kjeldahl Nitrogen (mg/L)	Water	66	Associated_QC1189741_W_CON	9B_ADOLF		***31***				
Salts										
Chloride (mg/L)	Water	67	Physis C-37036 W	04D_WOOD	3		12	***72***	MS <LL, MS >UL, EST MS/MSD	MS failed lower limit, MS failed upper limit, Estimate due to RPD failure between MS/MSD
OC Pesticides										
Chlordane, alpha-, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_OCH	04_WOOD	2	***82***	0	1		
Chlordane, gamma-, Total (µg/L)	Water	65	Physis O-17062 W	01T_ODD2_DCH	19	***53***			FD RPD	FieldDup RPD Failed

Constituent	Matrix	Event	Lab Batch	Site	BS/ BSD RPD	Field Dup RPD	Lab Dup RPD	MS/ MSD RPD	Program Qualifier	Comments
Chlordane, gamma-, Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	6	***35***				
Chlordane, gamma-, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_OCH	04_WOOD	3	***100***	0	4		
DDD(o,p'), Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	3	***38***			FD RPD	FieldDup RPD Failed
DDD(p,p'), Total (µg/L)	Water	65	Physis O-17064 W	07_HITCH	1	***53***			FD RPD	FieldDup RPD Failed
DDD(p,p'), Total (µg/L)	Water	67	Physis O-17128 W	01T_ODD2_DCH	2	***63***				
DDD(p,p') (µg/wet g)	Tissue	67	Physis O-18058 W	9B_ADOLF	4		***46***	4		
DDD(p,p'), Total (ng/g dw)	Sediment	62	Physis_O-14040_S_OCH	04_WOOD	2	***55***	0	1		
DDE(o,p') (ng/wet g)	Tissue	62	Physis O-14050 W	01_Central_Lagoon	12		***37***	7		
DDE(o,p'), Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	6	***31***				
DDE(p,p'), Total (µg/L)	Water	65	Physis O-17064 W	07_HITCH	3	***95***			FD RPD	FieldDup RPD Failed
DDE(p,p'), Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	6	***36***			FD RPD	FieldDup RPD Failed
DDE(p,p') (µg/wet g)	Tissue	67	Physis O-18058 W	9B_ADOLF	6		***35***	20	LD RPD	LabDuplicate RPD Failed
DDE(p,p'), Total (ng/g dw)	Sediment	62	Physis_O-14040_S_OCH	01_SG_74	2	16	***52***	3		
DDT(o,p'), Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	6	***40***			FD RPD	FieldDup RPD Failed

Constituent	Matrix	Event	Lab Batch	Site	BS/ BSD RPD	Field Dup RPD	Lab Dup RPD	MS/ MSD RPD	Program Qualifier	Comments
DDT(o,p'), Total (ng/g dw)	Sediment	62	Physis_O-14040_S_OCH	04_WOOD	4	***43***	0	3		
DDT(p,p'), Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	2	***50***			FD RPD	FieldDup RPD Failed
Dieldrin (µg/wet g)	Tissue	67	Physis O-18058 W	9B_ADOLF	11		***179***	0	LD RPD	LabDuplicate RPD Failed
Endrin aldehyde (µg/wet g)	Water	67	Physis O-18058 W	LABQA	***93***		0	14		
Ethyl parathion (µg/L)	Water	63	W7K0686	10D_HILL				***38***		
Naled (µg/L)	Water	63	W7K0686	10D_HILL				***41***		
Nonachlor, cis, Total (µg/L)	Water	65	Physis O-17062 W	01T_ODD2_DCH	9	***37***				
Nonachlor, cis, Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	3	***69***				
Nonachlor, trans, Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	5	***54***				
Nonachlor, trans, Total (µg/L)	Water	66	Physis O-17066 W	9B_ADOLF	5	***33***				
Nonachlor, trans (µg/wet g)	Tissue	67	Physis O-18058 W	9B_ADOLF	8		***39***	6		
Nonachlor, trans, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_OCH	04_WOOD	3	***46***	0	1		
Tetrachloro-m-xylene (Surrogate), Total (%)	Water	65	Physis O-17062 W	01T_ODD2_DCH	5	***42***				
Tetrachloro-m-xylene (Surrogate) (%)	Tissue	67	Physis O-18058 W	9B_ADOLF	9		***34***	4		

Constituent	Matrix	Event	Lab Batch	Site	BS/ BSD RPD	Field Dup RPD	Lab Dup RPD	MS/ MSD RPD	Program Qualifier	Comments
Tetrachloro-m-xylene-2,4,5,6 (Surrogate), Total (%)	Water	63	Physis O-13122 W	10_GATE	6	***51***				
PCBs										
PCB 030 (Surrogate), Total (%)	Water	65	Physis O-17062 W	01T_ODD2_DCH	3	***42***				
PCB 030 (Surrogate) (%)	Tissue	67	Physis O-18058 W	9B_ADOLF	12		***33***	2		
PCB 112 (Surrogate), Total (%)	Water	65	Physis O-17064 W	07_HITCH	3	***75***				
PCB 112 (Surrogate) (%)	Tissue	67	Physis O-18058 W	9B_ADOLF	8		***35***	5		
PCB 194 (ng/wet g)	Tissue	62	Physis O-14050 W	01_Central_Lagoon	***31***		0	9		
PCB 198 (Surrogate), Total (%)	Water	65	Physis O-17064 W	07_HITCH	10	***77***				
PCB 198 (Surrogate) (%)	Tissue	67	Physis O-18058 W	9B_ADOLF	5		***36***	2		
OP Pesticides										
Chlorpyrifos, Total (µg/L)	Water	65	Physis O-17064 W	07_HITCH	14	***160***				
Demeton-o (µg/L)	Water	62	W7H0791	10D_HILL				***51***		
Demeton-o (µg/L)	Water	63	W7K0686	10D_HILL				***31***		
Demeton-o (µg/L)	Water	67	W8E0802	10D_HILL				***39***		
Demeton-s (µg/L)	Water	63	W7K0686	10D_HILL				***47***		

Constituent	Matrix	Event	Lab Batch	Site	BS/ BSD RPD	Field Dup RPD	Lab Dup RPD	MS/ MSD RPD	Program Qualifier	Comments
Demeton-s (µg/L)	Water	64	W8B0511	10D_HILL				***31***		
Diazinon (µg/L)	Water	64	W8B0511	10D_HILL				***39***		
Dimethoate (µg/L)	Water	63	W7K0686	10D_HILL				***113***		
Dimethoate (µg/L)	Water	64	W8B0511	10D_HILL				***37***		
Ethoprop (µg/L)	Water	63	W7K0686	10D_HILL				***32***		
Ethoprop (µg/L)	Water	64	W8B0511	10D_HILL				***37***		
Fensulfothion (µg/L)	Water	63	W7K0686	10D_HILL				***42***		
Fensulfothion (µg/L)	Water	64	W8B0511	10D_HILL				***33***		
Fenthion (µg/L)	Water	63	W7K0686	10D_HILL				***37***		
Malathion (µg/L)	Water	63	W7K0686	10D_HILL				***42***		
Merphos (µg/L)	Water	64	W8B0511	10D_HILL				***41***		
Methyl parathion (µg/L)	Water	63	W7K0686	10D_HILL				***44***		
Mevinphos (µg/L)	Water	63	W7K0686	10D_HILL				***58***		
Mevinphos (µg/L)	Water	64	W8B0511	10D_HILL				***42***		
Stirophos (µg/L)	Water	63	W7K0686	10D_HILL				***51***		
Stirophos (µg/L)	Water	64	W8B0511	10D_HILL				***32***		
PAHs										
Biphenyl, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_PAH	01_SG_74	2		***90***	8		
Naphthalene, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_PAH	01_SG_74	6		***70***	12		

Constituent	Matrix	Event	Lab Batch	Site	BS/ BSD RPD	Field Dup RPD	Lab Dup RPD	MS/ MSD RPD	Program Qualifier	Comments
Phenanthrene, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_PAH	01_SG_74	1		***44***	1		
Pyrethroid Pesticides										
Bifenthrin, Total (µg/L)	Water	65	Physis O-17064 W	07_HITCH	3	***48***			FD RPD	FieldDup RPD Failed
Bifenthrin, Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	1	***51***			FD RPD	FieldDup RPD Failed
Cyfluthrin (µg/L)	Water	62	W7H0866	10D_HILL	***35***					
Cyfluthrin, total, Total (µg/L)	Water	65	Physis O-17064 W	07_HITCH	4	***41***			FD RPD	FieldDup RPD Failed
Cyfluthrin, total, Total (µg/L)	Water	66	Physis O-17066 W	9B_ADOLF	7	***34***			FD RPD	FieldDup RPD Failed
Cypermethrin, total, Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	5	***57***			FD RPD	FieldDup RPD Failed
Cypermethrin, total, Total (µg/L)	Water	66	Physis O-17066 W	9B_ADOLF	5	***35***			FD RPD	FieldDup RPD Failed
Danitol, Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	2	***52***				
Danitol, Total (µg/L)	Water	67	Physis O-17128 W	01T_ODD2_DCH	2	***39***				
Danitol, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_PYR	04_WOOD	0	***51***	0	16	FD RPD	FieldDup RPD Failed
Deltamethrin/Tralomethrin (µg/L)	Water	62	W7H0866	10D_HILL	***35***					
Dichloran (µg/L)	Water	62	W7H0866	10D_HILL	***39***					
Esfenvalerate, Total (µg/L)	Water	65	Physis O-17064 W	07_HITCH	3	***53***				
Esfenvalerate, Total (µg/L)	Water	66	Physis O-17066 W	04_WOOD	9	***52***				

Constituent	Matrix	Event	Lab Batch	Site	BS/ BSD RPD	Field Dup RPD	Lab Dup RPD	MS/ MSD RPD	Program Qualifier	Comments
Fenvalerate, Total (µg/L)	Water	65	Physis O-17064 W	07_HITCH	4	***56***				
L-Cyhalothrin, Total (µg/L)	Water	65	Physis O-17064 W	07_HITCH	2	***154***			FD RPD	FieldDup RPD Failed
L-Cyhalothrin (µg/L)	Water	62	W7H0866	10D_HILL	***35***					
Pendimethalin (µg/L)	Water	62	W7H0866	10D_HILL	***35***					
Permethrin, trans-, Total (µg/L)	Water	64	Physis O-17024 W	LABQA	***48***	0				
Permethrin, trans-, Total (ng/g dw)	Water	62	Physis_O-14040_S_PYR	LABQA	***48***	0	0	4		
Prallethrin, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_PYR	01_SG_74	19	0	0	***32***		
Tefluthrin (µg/L)	Water	62	W7H0866	10D_HILL	***35***					
Metals and Selenium										
Aluminum, Dissolved (µg/L)	Water	66	Physis E-16025 W	04_WOOD	1	***63***	1	2		
Antimony, Dissolved (µg/L)	Water	67	Physis E-16034 W	01T_ODD2_DCH	1	***75***	2	1	FD RPD	FieldDup RPD Failed
Cadmium, Total (µg/L)	Water	62	Physis E-13021 W	07D_SIMI		25	***53***		LD RPD	LabDuplicate RPD Failed
Cadmium, Total (µg/L)	Water	63	Physis E-13084 W	04_WOOD	2	***31***	28	0	FD RPD	FieldDup RPD Failed
Cadmium, Dissolved (µg/L)	Water	64	Physis E-13135 W	07D_SIMI		1	***34***	1	LD RPD	LabDuplicate RPD Failed
Chromium, Dissolved (µg/L)	Water	66	Physis E-16025 W	04_WOOD		***45***	16	1	FD RPD	FieldDup RPD Failed

Constituent	Matrix	Event	Lab Batch	Site	BS/ BSD RPD	Field Dup RPD	Lab Dup RPD	MS/ MSD RPD	Program Qualifier	Comments
Iron, Dissolved (µg/L)	Water	67	Physis E-16034 W	04_WOOD		7	2	***339***	MS <LL, EST MS/MSD	MS failed lower limit, Estimate due to RPD failure between MS/MSD
Mercury, Dissolved (µg/L)	Water	63	Physis E-12113 W	04_WOOD		***67***	0		FD RPD	FieldDup RPD Failed
Mercury, Total (µg/L)	Water	63	Physis E-12113 W	04_WOOD	4	***36***	6	7	FD RPD	FieldDup RPD Failed
Molybdenum, Dissolved (µg/L)	Water	65	Physis E-16009 W	01T_ODD2_ DCH		***38***	1	0	FD RPD	FieldDup RPD Failed
Selenium, Dissolved (µg/L)	Water	62	Physis E-13021 W	03_UNIV	2	***40***	1	2	FD RPD	FieldDup RPD Failed
Selenium, Total (µg/L)	Water	65	Physis E-16018 W	01_RR_BR	0		***46***		LD RPD	LabDuplicate RPD Failed
Silver, Total (µg/L)	Water	62	Physis E-13035 W	01_RR_BR	2		***67***			
Silver, Total (µg/L)	Water	65	Physis E-16009 W	01T_ODD2_ DCH	2	***91***			FD RPD	FieldDup RPD Failed
Thallium, Dissolved (µg/L)	Water	64	Physis E-13135 W	03_UNIV	1	***31***	***45***	0	LD RPD	LabDuplicate RPD Failed
Thallium, Dissolved (µg/L)	Water	64	Physis E-13135 W	07D_SIMI	1		***118***	2	LD RPD	LabDuplicate RPD Failed
Tin, Dissolved (µg/L)	Water	64	Physis E-13129 W	01_RR_BR	4		***38***			
Tin, Dissolved (µg/L)	Water	65	Physis E-16009 W	01T_ODD2_ DCH		***186***	15	1	FD RPD	FieldDup RPD Failed
Tin, Dissolved (µg/L)	Water	66	Physis E-16025 W	04_WOOD		***186***	30	4	FD RPD	FieldDup RPD Failed
Tin, Dissolved (µg/L)	Water	67	Physis E-16034 W	01T_ODD2_ DCH		***95***	3	2		

EST BS/BSD = Estimated due to Blank Spike/Blank Spike Duplicate RPD failure.
EST MS/MSD = Estimated due to Matrix Spike/Matrix Spike Duplicate RPD failure

FD RPD = Field Duplicate Relative Percent Difference failure
LD RPD = Lab Duplicate Relative Percent Difference failure
MS <LL = Matrix spike recovery was below the Lower Limit of the acceptance range
MS >UL = Matrix spike recovery was above the Upper Limit of the acceptance range

Table 3. Accuracy QA/QC Issues

Constituent	Matrix Name	Event Number	LabBatch	LCL	UCL	LCS	LCSD	MS	MSD	LWACode
General Water Quality										
None										
Nutrients										
Nitrite as N (mg/L)	samplewater	66	Physis E-15027 W	73	140	111	117	***30***	***40***	MS failed lower limit
Phosphorus, Total as P (mg/L)	samplewater	65	Physis C-36110 W	67	119	104	106	***740***	***805***	MS failed upper limit
Total Kjeldahl Nitrogen (mg/L)	samplewater	66	Associated_QC1189743_W_CON	80	120	92		***77***	80	MS failed lower limit
OC Pesticides										
Chlordane, Total (µg/L)	Samplewater	62	W7H0791	76	128	***51***		89	84	BS failed lower limit
Chlordane, Total (µg/L)	Samplewater	67	W8E0802	76	128	96		85	***75***	MS failed lower limit
DDT(p,p'), Total (ng/g dw)	samplewater	65	Physis C-37028 W	82	114			***115***	***115***	MS failed upper limit
DDT(p,p'), Total (ng/g dw)	samplewater	66	Physis C-37034 W	82	114			***118***	***116***	MS failed upper limit
DDT(p,p'), Total (ng/g dw)	Samplewater	67	Physis C-37036 W	82	114			***136***	***64***	MS failed upper limit, MS failed lower limit
Dieldrin, Total (µg/L)	Blankwater	67	W8E0961	50	150	149	***153***			BS failed upper limit
Endosulfan I (ng/wet g)	Tissue	62	Physis O-14050 W	46	154	106	118	***166***	***172***	MS failed upper limit
Endrin (ng/wet g)	Tissue	62	Physis O-14050 W	44	157	106	121	***161***	***164***	MS failed upper limit
Endrin ketone, Total (µg/L)	Blankwater	67	W8E0961	50	150	***156***	141			BS failed upper limit
Hexachlorobenzene, Total (µg/L)	Samplewater	63	W7K0686	5	229	150		206	***302***	MS failed upper limit

Constituent	Matrix Name	Event Number	LabBatch	LCL	UCL	LCS	LCSD	MS	MSD	LWACode
Methoxychlor, Total (µg/L)	Tissue	62	Physis O-14050 W	52	152	90	110	148	***165***	MS failed upper limit
Mirex, Total (µg/L)	Samplewater	62	Physis E-13021 W	65	134	105	101	***145***	130	MS failed upper limit
Mirex, Total (µg/L)	Samplewater	67	Physis E-16034 W	65	134			***-24***	93	MS failed lower limit
Nonachlor, cis, Total (µg/L)	Tissue	62	Physis O-14050 W	54	166	131	145	***230***	***209***	MS failed upper limit
Nonachlor, trans, Total (µg/L)	Samplewater	63	W7K0686	0.1	249	162		208	***325***	MS failed upper limit
PCBs										
PCB 018, Total (ng/g dw)	Samplewater	63	Physis C-34082 W	63	126	92	92	64	***62***	MS failed lower limit
PCB 031, Total (µg/L)	samplewater	65	Physis C-34148 W	63	145	98	102	***54***	***55***	MS failed lower limit
PCB 033, Total (µg/L)	blankwater	65	Physis O-17062 W	55	132	107	***133***			BS failed upper limit
OP Pesticides										
1,3-Dimethyl-2-nitrobenzene (µg/L)	Blankwater	62	Physis_O-14040_S_PAH	33	112	***31***	33			BS failed lower limit
Chlorpyrifos, Total (µg/L)	Sediment	62	Physis_C-30084_S_NH3	78	121	102	102	***123***	118	MS failed upper limit
Dimethoate (µg/L)	Blankwater	67	W8E0961	50	150	148	***155***			BS failed upper limit
Fenthion, Total (µg/L)	Samplewater	62	W7H0791	4	222	161		***227***	221	MS failed upper limit
Fenthion, Total (µg/L)	Samplewater	63	W7K0686	4	222	144		155	***558***	MS failed upper limit
Phorate, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_OPP	50	150	71	91	***35***	***34***	MS failed lower limit

Constituent	Matrix Name	Event Number	LabBatch	LCL	UCL	LCS	LCSD	MS	MSD	LWACode
Ronnel (µg/L)	Samplewater	62	W7H0791	29	153	135		142	***163***	MS failed upper limit
Ronnel (µg/L)	Samplewater	63	W7K0686	29	153	114		***154***	***180***	MS failed upper limit
Stirophos (µg/L)	Samplewater	62	W7H0791	0.1	167	155		***182***	***198***	MS failed upper limit
Stirophos (µg/L)	Samplewater	63	W7K0686	0.1	167	154		***222***	***374***	MS failed upper limit
Trichloronate (µg/L)	Samplewater	63	W7K0686	40	150	113		***151***	***170***	MS failed upper limit
PAHs										
None										
Pyrethroid Pesticides										
Deltamethrin, Total (µg/L)	Samplewater	63	W7K0686	37	168	114		155	***185***	MS failed upper limit
Esfenvalerate, Total (µg/L)	Samplewater	63	W7K0686	0.1	207	108		164	***266***	MS failed upper limit
Fenvalerate, Total (µg/L)	blankwater	63	Physis O-16014 W	67	114	***115***	113	90	90	BS failed upper limit
Fluvalinate, Total (µg/L)	Tissue	67	Physis O-18058 W	0	162	49	43	***2914***	***2189***	MS failed upper limit
L-Cyhalothrin, Total (µg/L)	Samplewater	63	W7K0686	23	169	77		144	***208***	MS failed upper limit
Permethrin, cis-, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_PYR	50	150	66	63	***21***	***20***	MS failed lower limit
Permethrin, trans-, Total (µg/L)	blankwater	64	Physis O-17024 W	41	147	***35***	57			BS failed lower limit
Permethrin, trans-, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_PYR	50	150	***49***	80	55	53	BS failed lower limit
Prallethrin, Total (ng/g dw)	Sediment	62	Physis_O-14040_S_PYR	50	150	62	51	***44***	***32***	MS failed lower limit

Constituent	Matrix Name	Event Number	LabBatch	LCL	UCL	LCS	LCSD	MS	MSD	LWACode
Tefluthrin (µg/L)	Blankwater	63	W7K0783	48	161	55	***47***			BS failed lower limit
Metals and Selenium										
Copper, Dissolved (µg/L)	Samplewater	63	W7K0686	0.1	154			151	***180***	MS failed upper limit
Copper, Dissolved (µg/L)	Samplewater	67	W8E0802	0.1	154	152		***199***	***194***	MS failed upper limit
Nickel, Dissolved (µg/L)	Samplewater	63	W7K0686	6	184	115		159	***244***	MS failed upper limit
Silver, Dissolved (µg/L)	Samplewater	62	Physis E-13021 W	52	115	94	101	55	***51***	MS failed lower limit
Silver, Dissolved (µg/L)	samplewater	66	Physis E-16029 W	52	115			***43***	***50***	MS failed lower limit
Strontium, Dissolved (µg/L)	Samplewater	62	Physis E-13021 W	75	125	107	105	***149***	***150***	MS failed upper limit
Strontium, Dissolved (µg/L)	Samplewater	64	Physis E-13135 W	75	125			***131***	***133***	MS failed upper limit
Strontium, Dissolved (µg/L)	Samplewater	64	Physis E-13135 W	75	125			***140***	***147***	MS failed upper limit
Strontium, Dissolved (µg/L)	Samplewater	67	Physis E-16034 W	75	125			121	***127***	MS failed upper limit
Strontium, Dissolved (µg/L)	Samplewater	67	Physis E-16034 W	75	125			***260***	***300***	MS failed upper limit
Titanium, Dissolved (µg/L)	Samplewater	67	Physis E-16034 W	75	131			120	***140***	MS failed upper limit

LCL = Lower Control Limit
UCL = Upper Control Limit
MS = Matrix Spike
MSD = Matrix Spike Duplicate
LCS = Laboratory Control Spike
LCSD = Laboratory Control Spike Duplicate

Appendix C:
Mugu Benthic Infauna Report

CALLEGUAS CREEK
WATERSHED MONITORING PROGRAM

2017 MUGU LAGOON
BENTHIC INFAUNA REPORT

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March 2018

CALLEGUAS CREEK WATERSHED MONITORING PROGRAM

2017 MUGU LAGOON BENTHIC INFAUNA REPORT

INTRODUCTION

The benthic infauna, invertebrates that live in the bottom sediments, are an important part of the marine ecosystem. These animals are a major food source for fish and other larger invertebrates, and contribute to nutrient recycling. Some species are highly sensitive to effects of human activities, while others thrive under altered conditions. The assessment of the benthic community is, therefore, a major component of many marine monitoring programs.

As part of the Calleguas Creek watershed Total Maximum Daily Load (TMDL) monitoring program, the benthic infaunal community of Mugu Lagoon, an estuarine embayment at the mouth of the creek, was sampled (Figure 1). Benthic sampling was included in the monitoring program to assess infaunal community condition, a potential indicator of exposure to contaminants in the sediments. Infaunal community composition, in conjunction with toxicity testing and chemical analysis, form a triad of standardized tools to determine sediment quality in potentially impacted habitats and provide managers and regulators a means to assess and evaluate local conditions in comparison to regional Sediment Quality Objective (SQO) criteria.

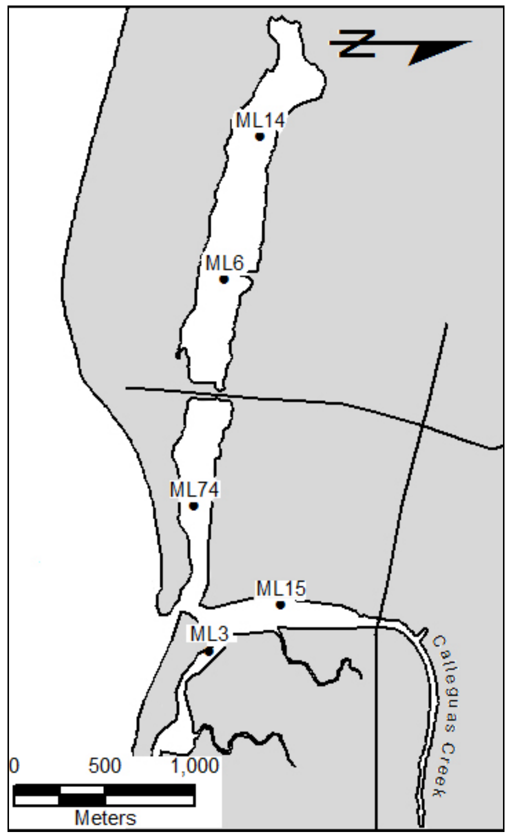

Figure 1. Mugu Lagoon infauna sampling stations.

MATERIALS AND METHODS

Benthic samples for the analysis of the infauna community were collected in conjunction with sediment monitoring on 29 and 30 August 2017 at five stations within Mugu Lagoon (Figure 1, Table 1). A single grab was collected at each station using a chain-rigged, 0.1 square meter (m^2) van Veen grab. Each sample was washed in the field using a 1.0-mm U.S. Standard Sieve, labeled, relaxed in an isotonic solution of magnesium sulfate for a minimum of thirty minutes and fixed in buffered 10% formalin-seawater.

In the laboratory, samples were transferred to 70% isopropyl alcohol, sorted to major taxonomic groups, identified to the lowest practical taxonomic level, and counted. Identifications and nomenclature followed the usage accepted based on Edition 11 of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) list of invertebrate species (SCAMIT 2016). Representative specimens were added to MBC's reference collection. Following identification, the weight of organisms for each major taxonomic group was measured. Specimens were placed on small, pre-weighed mesh screens that had been immersed in 70% isopropyl alcohol, blotted on a paper towel, and air-dried for five minutes. Large organisms, if any, were weighed separately.

Table1. Mugu Lagoon station coordinates, date and time of sampling and water depth.

Infauna Station ID	Station Reference Number	Actual North Latitude	Actual West Longitude	Sample Date	Sample Time (hr)	Depth (m) at Time of Collection
ML3	01 BPT 3	34° 06.139'	119° 05.471'	30 August 2017	0845	0.5
ML6	01 BPT 6	34° 06.158'	119° 06.571'	29 August 2017	0927	1.0
ML14	01 BPT 14	34° 06.272'	119° 07.023'	29 August 2017	1105	1.2
ML15	01 BPT 15	34° 06.325'	119° 05.606'	30 August 2017	1007	0.3
ML74	01 SG 74	34° 06.073'	119° 05.771'	29 August 2017	1341	0..3

Following identification and enumeration of infaunal species, counts tabulated by taxonomists on laboratory bench sheets were entered into MBC's in-house, Microsoft Access-based infauna database. All information was double entered for accuracy and species names were compared with both the in-house database and the current SCAMIT nomenclature list to validate usage. Data were compared among stations using both summary information and mathematical analysis. Analytical methods included: Shannon-Wiener species diversity (H'); comparison of community composition among stations using Euclidean distance; and four indices of benthic community condition (Southern California Benthic Response Index [BRI], Index of Biotic Integrity [IBI], Relative Benthic Index [RBI], and River Invertebrate Prediction and Classification System [RIVPACS]). Since these four indices use different species constituents and methods to evaluate community conditions (BRI and IBI are based on community measures, while RBI and RIVPACS on species composition) relative impact levels may differ among methods. To account for these differences and provide a comprehensive evaluation of condition, the median of the four index category scores for each station was used to determine the Benthic Community Index Integration score, which is used in the SQO evaluation. Descriptions of methods are presented in Appendix A.

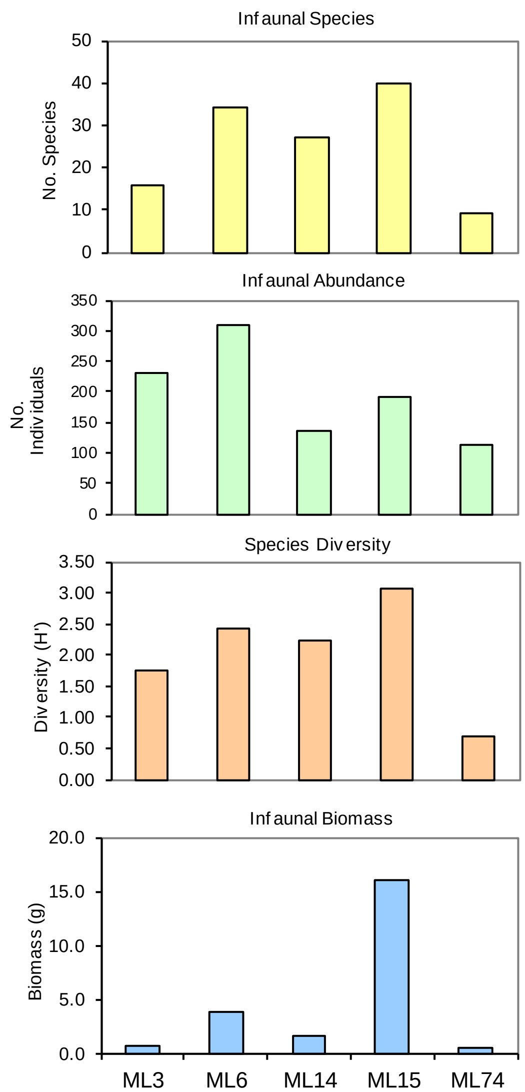

Figure 2. Infauna community characteristics by station.

RESULTS

Species Composition. A total of 982 individuals in 68 species (or taxa) and nine phyla (major groups) were taken in the benthic infauna sampling at Mugu Lagoon (Figure 2, Table 2 and Appendix B). Annelids (segmented worms) were the most diverse phylum, with 32 species (47% of the total), followed by mollusks with 16 species (24%), arthropods with 10 species (15%), nemertean

Table 2. Infaunal community parameters and community indices.

Parameter	ML3	ML6	ML14	ML15	ML74	Total	Mean
	Station						
Number of species							
Total	16	34	27	40	9	68	25
Number of individuals							
Total	232	310	136	190	114	982	196
Density (#/m^2)	2,320	3,100	1,360	1,900	1,140		1,964
Diversity (H')							
Total	1.76	2.44	2.23	3.06	0.68	2.95	2.03
Biomass (g)							
Total	0.56	3.85	1.55	16.08	0.43	22.47	4.49
g/m^2	5.57	38.45	15.52	160.81	4.34		44.94
Index							
Benthic Response Index (BRI)							
Total	52.4	42.8	47.5	39.1	64.8	42.4	49.3
Category Score	3	2	2	1	3	2	2
Index of Biotic Integrity (IBI)							
IBI Score	1	0	1	0	2	1	1
Category Score	2	1	2	1	3	2	2
Relative Benthic Index (RBI)							
RBI Score	0.07	0.59	0.10	0.56	0.02	0.73	0.27
Category Score	4	1	3	1	4	1	3
River Invertebrate Prediction and Classification System (RIVPACS)							
RIVPACS Score (P > 0.5)	0.57	0.86	0.57	1.15	0.57		0.75
Category Score	3	2	3	2	3		3
Benthic Community Index Integration	3	2	3	1	3	2	2

Category Scores: 1 = Reference, 2 = Low Disturbance, 3 = Moderate Disturbance, 4 = High Disturbance

(ribbon) worms with four species (6%), and echinoderms with two species (3%). The remaining four phyla, platyhelminthes (flat worms), nematodes (round worms), phoronids (horseshoe worms), and chordates (here a fish) were each represented by a single taxon. Mollusks were the most abundant phylum with 369 individuals (38% of the individuals in the samples), followed by annelids with 347 individuals (35%), and arthropods with 207 individuals (21%). Nematodes, nemerteans, and phoronids each contributed another 2% to the total abundance, while the three remaining phyla together comprised less than 1% of the total abundance.

Species Richness. Species richness averaged 25 species per station, and ranged from nine species at Station ML74, in the main lagoon, to 40 at Station ML15, the station in the lagoon nearest Calleguas Creek (Figures 1 and 2, Table 2, and Appendix B). Species richness was somewhat variable by station in the lagoon.

Abundance. Abundance averaged 196 individuals per station (a density of 1,964 individuals/m^2) and ranged from 114 individuals at Station ML74 to 310 individuals at Station

ML6, near the middle of the western arm of the lagoon (Figures 1 and 2, Table 2 and Appendix B).

Species Diversity. Shannon-Wiener species diversity (H') averaged 2.03 per station and ranged from 0.68 at Station ML74 to 3.06 at Station ML15 (Figures 1 and 2, Table 2, and Appendix B).

Biomass. Infauna biomass totaled 22.5 g and averaged 4.5 g per station (44.9 g/m^2) (Figure 2, Table 2 and Appendix B). Values ranged from 0.4 g at Stations ML74 to 16.1 g at Station ML15. Mollusks, the most abundant group, contributed nearly 85% to the biomass, with 64% of the survey total contributed by a single Japanese littleneck clam (*Venerupis philippinarum*) collected at Station ML15. Arthropods contributed another 9% to the total, followed by annelids with 5%. The remaining phyla each contributed 1% or less to the total biomass.

Benthic Response Index. The Southern California Benthic Response Index (BRI) is the abundance-weighted average pollution tolerance of species occurring in a sample. For the evaluation, the pollution tolerance scores (p_i) for northern (Point Conception to Newport Bay) bay and harbor habitats were used. BRI values averaged 49.3 for the study area, and ranged from 39.1 (Category 1, Reference Level) at Station ML15 to 64.8 (Category 3, Moderate Disturbance) at Station ML74 (Table 2, Appendices A and B).

Index of Biotic Integrity. The Index of Biotic Integrity (IBI) uses species diversity and abundance of key taxa to distinguish impacted benthic communities from reference benthic conditions. In Mugu Lagoon, IBI scores ranged from 0 (Category 1, Reference) at Stations ML6 and ML15 to an IBI score of 2 (Category 3, Moderate Disturbance) at Station ML74 (Table 2, Appendices A and B).

Relative Benthic Index. Relative Benthic Index (RBI) values are calculated as a weighted sum of four community parameters (number of species, number of crustacean species, number of crustacean individuals and number of mollusk species) and abundances of positive and negative indicators. RBI values in the lagoon ranged from 0.59 (Category 1, Reference) at Stations ML6 to 0.02 (Category 4, High Disturbance) at Station ML74 (Table 2, Appendices A and B).

River Invertebrate Prediction and Classification System. The River Invertebrate Prediction and Classification System (RIVPACS) uses presence or absence of expected species based on habitat variables including station location and depth. RIVPACS scores in the lagoon ranged from 1.15 (Category 2, Low Disturbance) at Station ML15 to 0.57 (Category 3, Moderate Disturbance) at Stations ML3, ML14 and ML74 (Table 2, Appendices A and B).

Benthic Community Index Integration. The Benthic Community Index Integration is the median value (rounded up in value for all fractions) of the Category scores for the four indices at each station. Integration values at Mugu Lagoon ranged from 1 (Reference) at Station ML15, to 3 (Moderate Disturbance) at Stations ML3, ML14 and ML 74 (Table 2, Appendices A and B).

Community Composition. Fifteen species each comprised 1% or more of all individuals collected; together they totaled about 22% of the species but almost 86% of the individuals in the infauna collection (Table 3, Appendix B). They included six annelids, four mollusks, three arthropods, and one taxon each of phoronid and nematode. The clam lesser Tagelus (*Tagelus subteres)* was the most abundant species taken during the survey, accounting of nearly 17% of all individuals collected. Lesser Tagelus was most abundant at Station ML6 in the western arm, and was also abundant at Station ML3, the station farthest east in the main lagoon, an at Station ML14, but was rare or did not occur at the other two stations. Rude barrel-bubble (*Acteocina inculta*) contributed 15% to total abundance, and, while taken at all stations, numbers were overwhelmingly highest at Station ML3. The annelid *Streblospio benedicti* was third overall, contributing 12% to the total. This species was most abundant at the two stations in the western arm of the lagoon, with a moderate number also found at Station ML3, but abundance was low or

Table 3. The 15 most abundant species by station.

Phylum	Species	Station					Total	Percent (%) Total	Cumulative % Total
		ML3	ML6	ML14	ML15	ML74			
MO	*Tagelus subteres*	43	87	29	3	-	162	16.5	16.5
MO	*Acteocina inculta*	109	31	1	1	1	143	14.6	31.1
AN	*Streblospio benedicti*	22	39	54	3	-	118	12.0	43.1
AR	*Excirolana linguifrons*	-	-	-	-	97	97	9.9	53.0
AR	*Oxyurostylis pacifica*	-	60	8	17	-	85	8.7	61.6
AN	*Mediomastus californiensis*	16	7	2	42	-	67	6.8	68.4
AN	Oligochaeta	-	12	4	4	7	27	2.7	71.2
AN	*Notomastus tenuis*	15	3	3	5	-	26	2.6	73.8
MO	*Laevicardium substriatum*	5	6	5	3	-	19	1.9	75.8
PR	*Phoronis* sp	-	1	-	18	-	19	1.9	77.7
AN	*Mediomastus ambiseta*	1	4	2	11	-	18	1.8	79.5
AN	*Spiophanes duplex*	-	8	-	10	-	18	1.8	81.4
NT	Nematoda	2	9	4	-	1	16	1.6	83.0
MO	*Tellina cadieni*	-	1	3	9	-	13	1.3	84.3
AR	*Grandidierella japonica*	-	7	1	4	-	12	1.2	85.5

AN = Annelida; AR = Arthopoda; MO = Mollusca; NT = Nematoda; PR = Phorona

the species was missing at Stations ML15 and ML74. The isopod *Excirolana linguifrons* was fourth in abundance, contributing 10% to the survey total, but was taken only at Station ML74. The remaining taxa each contributed less than 10% to the total abundance. Rude barrel-bubble was the only species found at all five stations during the survey.

Cluster Analyses. The 15 most abundant species were used for the normal (site-group) and inverse (species-group) cluster analyses (Figure 3). Cluster diagrams were drawn based on differences exceeding a level of 50% dissimilarity determined *a priori* as the minimal value indicating a significant separation between faunal and station groups. Within Group I, the communities at Stations ML6 and ML14, both located in the western arm of the lagoon, were very similar, grouping at a very low level of dissimilarity. Within Group I, Station ML3 on the eastern edge of the main lagoon, clustered at a slightly higher level to the western arm stations. Least similar among the stations in Group I was Station ML15, on the north side of the main lagoon, nearest Calleguas Creek. Group II consisted of only Station ML74, in the main lagoon. Group II clustered with Group I at a very high level, indicating effectively no similarity between this station and the remaining stations based on the occurrence of dominant community organisms.

The most abundant species clustered into three groups based on their occurrences (Figure 3). Group A included the lesser Tagelus, rude barrel-bubble, and *Streblospio benedicti*, all of which were most common in at stations in the western arm (Stations ML6 and ML14) and eastern edge of the lagoon (Station ML3). Group B taxa included those that were most common at Station ML15, but were also found at the western arm stations. Group C included *Excirolana linguifrons*, which was taken only at Station ML74.

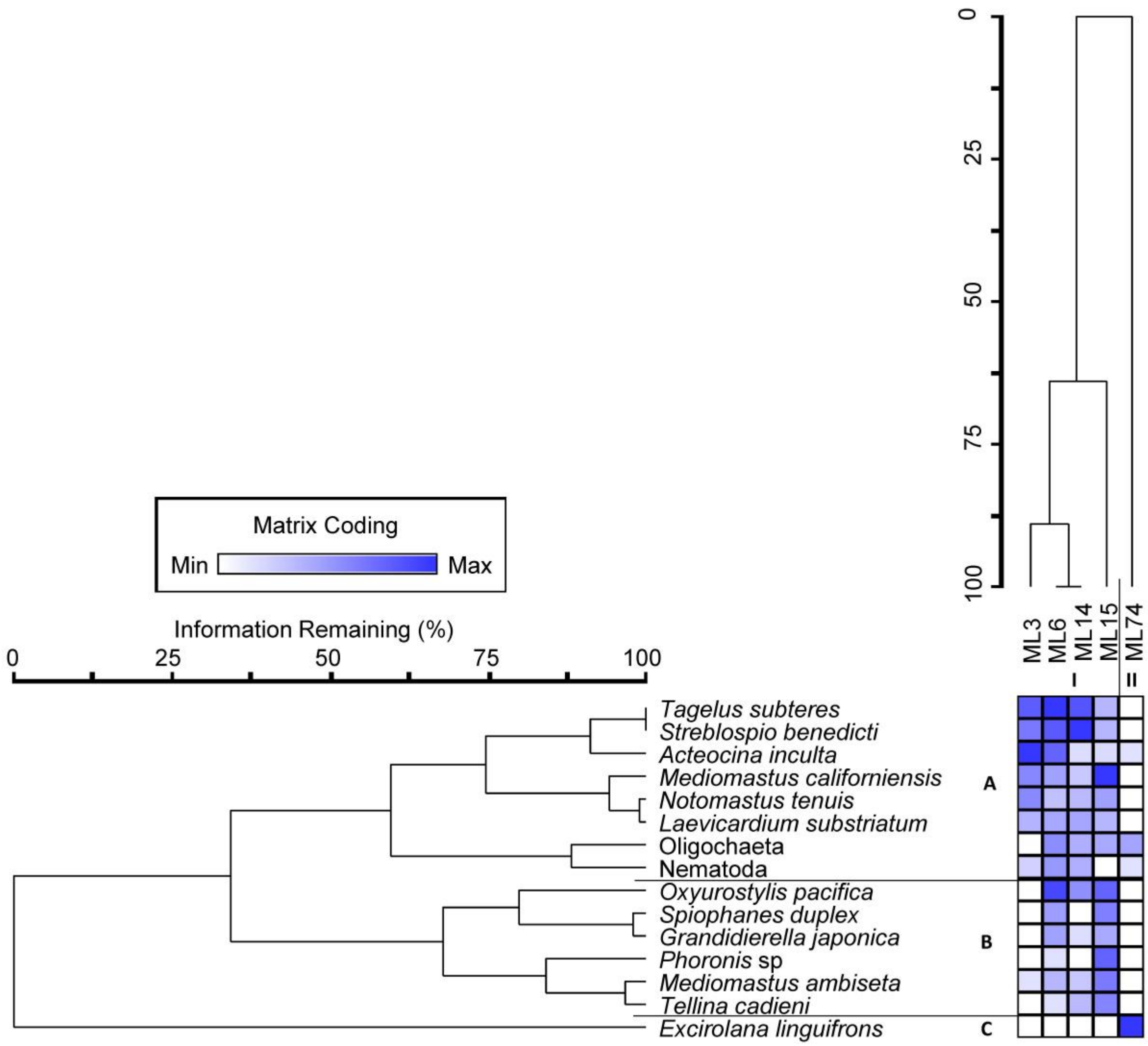

Figure 3. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for the top one percent of infaunal species.

DISCUSSION

The infauna communities in the study area in 2017 were composed predominantly of mollusks (clams and snails), annelid worms, and small arthropods. Community composition was most similar between the two stations in the western arm of the lagoon, and between the western arm stations and the station on the eastern edge of the main lagoon. Greatest number of taxa, highest diversity, and highest biomass were reported at the northernmost station near the mouth of Calleguas Creek (Station ML15), while greatest abundance occurred at Station ML6 in the western arm. Lowest number of species, abundance, diversity, and biomass all occurred at Station ML74, in the middle of the main lagoon.

The 68 taxa reported at the five stations in the lagoon in 2017 was about 40% higher than found in 2011, and similar to the 73 taxa reported in 2008 (Table 2, MBC 2009 and 2011). Mean number of taxa per station in 2017 (25) was nearly identical to that found in 2008 (26), compared to 17 taxa per station, on average, in 2011. Still, there were station-by-station differences among the three surveys (Figure 4). Despite the changes in overall number of species, community dominants have remained consistent among years, and six of the most abundant taxa reported in

2017 were among the community dominants in both 2008 and 2011, while one taxon was reported among the community dominants in both 2008 and 2017, and one more taxon in 2011 and 2017 (Table 2, MBC 2009 and 2011).

While number of species was similar to that reported in 2008, abundance has declined consistently since 2008 (Figure 5). In 2011 total abundance was only slightly more than one-quarter of the 2008 abundance, and abundance in 2017 was less than 40% of that reported in 2011. As a result, total abundance in 2017 was only 9% of that found in 2008 (table 2, MBC 2009 and 2011). The greatest difference among years occurred at Station ML14, where 2017 abundance was only 2% of that first reported in 2008 (Figure 5).

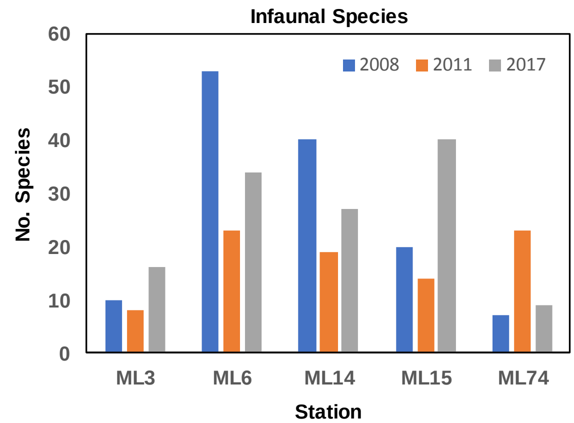

Figure 4. Multi-year comparison of number of species per station. Mugu Lagoon 2008, 2011, and 2017.

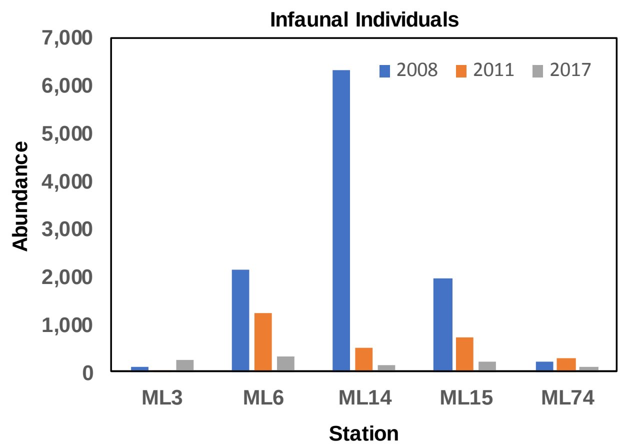

Figure 5. Multi-year comparison of number of individuals per station. Mugu Lagoon 2008, 2011, and 2017.

As a result of the relatively high number of species but low abundance found in 2017 compared to the previous surveys, overall diversity for the survey (2.95) was higher than the 2.37 reported during both of the previous surveys (Table 2, MBC 2009 and 2011). Both the highest station diversity value (3.06 at Station ML15) and lowest station diversity value (0.68 at Station ML74) for all three surveys occurred in 2017.

Biomass has been relatively consistent among the survey years, with the survey totals varying by less than 2% among the three surveys (Table 2, MBC 2009 and 2011). During all surveys, biomass was dominated by mollusks, with a small number of large individuals accounting for most of weight, although the station where the large individuals occurred has varied among the surveys.

Within Mugu Lagoon, the western arm is separated from the rest of the lagoon by a causeway with culverts that mute tidal exchange and likely reduce exposure to contaminants washed downstream from Calleguas Creek. Though the western arm may be subject to inputs from the military base and nearby airfield, in general it is buffered from surface runoff by marsh. In 2008, all community parameters, including species richness, abundance, diversity and biomass were highest at the western arm stations, with highest abundance and biomass values reported at Station ML14 farthest from the causeway (MBC 2009). In both 2011 and 2017, these community parameters were reduced at the stations in the western arm compared to 2008 results (Table 2, MBC 2009). In 2008, the infauna communities of the western arm stations indicated the least disturbance of the stations sampled in the lagoon, with all indices suggesting Reference or Low Disturbance levels at both stations and an overall integrated Benthic Community Index value of Low Disturbance for both western arm stations. In 2011, the stations in the western arm were still among the least disturbed in the lagoon. Levels of all indices indicated Low-to-Moderate

Disturbance, with an overall integrated Benthic Community Index value of Moderate Disturbance at both western arm stations (MBC 2009). In 2017, conditions improved slightly at Station ML6, which resulted in an overall integrated Benthic Community Index value of Low Disturbance, while Moderate disturbance was still indicated at Station ML14 (Table 2).

In the main lagoon in 2017, lowest species richness, abundance, diversity and biomass were reported at Station ML74, in the center on the main lagoon (Table 2). The station is influenced by inputs from both Calleguas Creek and a nearby storm drain. This station was also the least similar among the stations based on community dominants (Figure 3). In 2008, all community indices for Station ML74 indicated Moderate-to-High Disturbance, with an overall integrated Benthic Community Index score in the High Disturbance range (MBC 2009). During the 2011 survey, scores suggested a general improvement in conditions, and a score of Reference for BRI; the resulting overall score for Station ML74 was at the Moderate Disturbance level (MBC 2011). Despite a decline in RBI score, the overall score remained at the Moderate Disturbance level in 2017. During all three surveys, RBI scores have consistently indicated High Disturbance at Station ML74 based on the parameters of the index (Appendix A). Based on community dominants, Station ML3, the easternmost station in the lagoon, was more similar based on community dominants to the western lagoon stations than to the other stations in the main lagoon in 2017. Results at Station ML3 in 2017 suggested a general improvement in community conditions compared to 2011, when most indices and the overall score indicated High Disturbance at the station. Overall in 2017, Moderate Disturbance was found at Station ML3 as it was in 2008, although the individual indices scores varied between the two years (Table 2, MBC 2009). Similar to Station ML74, RBI scores at Station ML3 have indicated High Disturbance during all three surveys. Station ML15 is the closest to Calleguas Creek. Species richness, diversity and biomass were highest at this station in 2017, and abundance was near the station mean for the survey. Based on community dominant species composition, Station ML15 was more similar to the stations in the western arm and Station ML3 than to Station ML74, which is the nearest station. Community indices showed a marked improvement in conditions at Station ML15 in 2017 compared to both 2008 and 2011. This year three of four indices and the overall integrated Benthic Community Index score were at Reference condition levels, compared to three of four indices and overall score of High Disturbance in 2011 and Low-to-Moderate Disturbance rating for the indices and an overall score of Moderate Disturbance in 2008.

Changes in the infaunal communities such as those noted this year are not unusual in lagoon habitats, which are subject to a variety of influences on daily, seasonal, and annual timescales. These influences include changes in water level, salinity, and temperature as a result of tides, seasonal runoff during winter rainstorms, and periodic unusually large storms or very wet years. Large-scale events can have considerable impacts on the infaunal community, including changes in sediment characteristics such as deposition of new sediments or scouring of existing sediments, dramatic short-term changes in salinity, or physical removal of individuals in stormwater flow. All of these can result in the reduction of individuals and alteration or elimination of existing communities. Timing of sampling following a dramatic reduction in the community is important because species that are more likely to be among the first to re-colonize an area are also generally among species known to be tolerant of ongoing disturbance and pollutants. In addition, modifications of the habitat following a large-scale event could promote re-colonization by different species than found in the area prior to the storm impacts

Differences in the infaunal community between years have been observed previously at Mugu Lagoon, with these changes chiefly associated with large-scale storm events and re-colonization and recovery following these events (Onuf 1987). A review of rainfall in the project area indicates that during the year previous to the 2017 sampling, rainfall in the area was the highest in six years, and more than double the amount recorded in any of the previous five years (VCWPD 2018). In 2011, however, unusually high rainfall was associated with worse-than-previous community index results (MBC 2011). These records, along with the previous observations of changes in the infauna community following storms, suggest that the differences noted in the community and the resultant changes in the community indices are likely related to the effects of unusually wet years, but actual influence of these changes on the local resident infaunal community in the lagoon cannot be predicted.

CONCLUSION

In 2017, number of infaunal species increased from levels found in 2011 and were similar to those reported in 2008. Abundance in 2017, however, continued to decline from 2008 levels, and represented less than 10% of the number of individuals reported in 2008. Diversity in 2017 was overall slightly higher than found during both previous surveys, and biomass remained consistent throughout all three sampling events. The Benthic Community Index Integration indicted that the stations in the western arm of Mugu lagoon were Low-to-Moderately Disturbed in 2017 compared to the Low Disturbance found in 2008 and Moderately Disturbed in 2011. In the main lagoon, which is influenced by inputs from both the creek and a nearby storm drain, the benthic community values in 2017 indicated Low-to-Moderate Disturbance (except at Station ML15 surveys which was rated as Reference, the first time this overall score has been reached) compared to Moderate-to-High Disturbance in 2008 and 2011. Results from 2017, from 2011, and from other studies suggest that changes in the infaunal community are likely related to the effects of unusually wet years, but actual influence of these changes on the local resident communities in the lagoon cannot be predicted.

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Appendix A
Analysis Methods

Appendix A. Analysis Methods

Summary statistics developed from the biological data included the number of individuals, number of species, and Shannon-Wiener (Shannon and Weaver 1962) species diversity (H') index. The diversity equation is as follows:

Shannon-Wiener

$$H' = -\sum^{S} \frac{n_j}{N} \ln$$

where: H' = species diversity
n_j = number of individuals in the j^{th} species
S = total number of species
N = number of individuals

Cluster Analysis

Infauna data were subjected to log (x+1) transformations and analyzed using PC-ORD (McCune and Mefford 2011). Transformed data were classified using the Bray-Curtis dissimilarity measure (Clifford and Stephenson 1975). Bray-Curtis dissimilarity results by species and station were plotted in a two-way dendrogram to visualize the community structure. Clusters or groups were identified using best professional judgment after reviewing the resulting two-way dendrogram.

Dendrograms provide a graphic representation of the relative abundance and spatial occurrence of each species, and relationships between species. In theory, if physical conditions were identical at all stations, the biological community would be expected to be identical as well. In practice, this is usually not the case, but it is expected that the characteristics of adjacent stations would be more similar than those distant from one another. The two-way analysis utilized in this study illustrates the relative abundance of species, as well as groupings (clusters) of both species and stations.

Southern California Benthic Response Index (BRI)

The Southern California Benthic Response Index (BRI) is an abundance-weighted average pollution tolerance of species occurring in a sample, and is a measure of the condition of marine and estuarine benthic communities (Smith et al. 2003, SCCWRP 2008). It classifies benthic communities as undisturbed (reference) or one of four levels of response to increased disturbance: Level 1, marginal deviation, or minimal disturbance; Level 2, biodiversity loss, in which more than 25% of species typical of undisturbed sites are not present; Level 3, community function loss, more than 90% of echinoderm and 75% of arthropod species at undisturbed sites are not present; and Level 4, defaunation, more than 90% of species found at undisturbed sites are not present. The formula is:

Benthic Response:

$$BRI_s = \frac{\sum_{i=1}^{n} \sqrt[4]{a_{si}}\, p_i}{\sum_{i=1}^{n} \sqrt[4]{a_{si}}}$$

where: BRI_s = BRI value for sampling unit s_i
n = number of species with pollution tolerance scores in s_i
p_i = pollution tolerance of species i
a_{si} = abundance of species i in s

Species pollution tolerances p_i were determined during BRI development as the position of the abundance distribution of species i on a gradient between the most and least disturbed sites. Species without pollution tolerance values are not included in the calculation. Pollution tolerance values were not assigned to species if the data were insufficient to assign a value. The index was developed for benthic samples that were sieved through a 1-mm mesh screen. Pollution tolerance scores were derived for coastal shelf samples for shallow (10-30 m deep), mid-depth (>30-120 m deep), and deep (>120-324 m deep) habitats, and for bay and harbor habitat samples, northern (Point Conception to Newport Bay) and southern (Dana Point to the U.S.-Mexico border). The species names for which scores are available are based on Edition 5 of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) list of invertebrate species (SCAMIT 2008).

The BRI score is compared to the BRI thresholds.

Table 1. BRI Category Thresholds

BRI Score	Category	Category Score
< 39.96	Reference	1
> 39.96 to < 49.15	Low Disturbance	2
> 49.15 to < 73.27	Moderate Disturbance	3
> 73.27	High Disturbance	4

Index of Biotic Integrity (IBI)

To calculate IBI the total number of taxa, number of mollusk taxa, abundance of *Notomastus* sp., and the number of sensitive species is needed. The sensitive species list should be from the list for the station's habitat. There are three steps needed to determine the IBI category and score (SCCWRP 2008).

Step one: calculate the percentage of sensitive taxa present.

Percent (%) sensitive taxa = (number of sensitive taxa/total number of taxa) X 100

Step two: compare the values from step one to the reference ranges for IBI (Table 2). When the value falls out of these ranges the IBI score is increased by one (with a starting value of zero).

Table 2. Reference Ranges for IBI

Metric	Reference Range
Total Number of Taxa	13 to 99
Number of Mollusk Taxa	2 to 25
Abundance of *Notomastus* sp	0 to 59
Percentage of Sensitive Taxa	19 to 47.1

Step three: compare the IBI score determined in step two with the IBI category thresholds (Table 3).

Table 3. IBI Category Thresholds

IBI Score	Category	Category Score
0	Reference	1
1	Low Disturbance	2
2	Moderate Disturbance	3
3 or 4	High Disturbance	4

Relative Benthic Index (RBI)

The RBI is the weighted sum of: (a) four community metrics related to biodiversity (total number of taxa, number of crustacean taxa, abundance of crustacean individuals, and number of mollusk taxa), (b) abundances of three positive indicator taxa, and (c) the presence of two negative indicator species (SCCWRP 2008). The positive indicator species are: *Monocorophium insidiosum*, *Asthenothaerus diegensis*, and *Goniada littorea*. The negative indicator species are *Capitella capitata* complex and Oligochaeta.

Step one: normalize the values for the benthic community metrics. Use the formulas below for the scaled values.

Total number of taxa / 99
Number of mollusk taxa / 28
Number of crustacean taxa / 29
Abundance of crustaceans / 1693

Step two: use the scaled values to calculate the Taxa Richness Weighted Value (TWV). TWV = Scaled total number of taxa + Scaled number of mollusk taxa + Scaled number of crustacean taxa + (0.25 X Scaled abundance of Crustacea)

Step three: calculate the negative indicator taxa (NIT) value. The NIT starts at a zero value. If *Capitella capitata* complex and / or Oligochaeta are present in any amount the NIT decreases by 0.1. If neither were found the NIT = 0, if both are found the NIT = -0.2.

Step four: calculate the value for the positive indicator taxa (PIT). Use the following formulas to calculate the PIT value for each species:

$$\frac{\sqrt[4]{\text{Monocorophium insidiosum abundance}}}{\sqrt[4]{473}}$$

$$\frac{\sqrt[4]{\text{Asthenothaerus deigensis abundance}}}{\sqrt[4]{27}}$$

$$\frac{\sqrt[4]{\text{Goniada littorea abundance}}}{\sqrt[4]{15}}$$

The individual species PIT values are summed to calculate the PIT sample value. If none of the three species are present, then the sample PIT = 0.

Step five: calculate the raw RBI:

$$\text{Raw RBI} = \text{TWV} + \text{NIT} + (2 \text{ X PIT})$$

Step six: calculate the RBI Score, normalizing the Raw RBI by the minimum and maximum Raw RBI values in the index development data:

$$\text{RBI Score} = (\text{Raw RBI} - 0.03)/4.69$$

The final step is to compare the RBI Score to the RBI thresholds, determining the RBI category.

Table 4. RBI Category Thresholds

RBI Score	Category	Category Score
> 0.27	Reference	1
> 0.16 to ≤ 0.27	Low Disturbance	2
> 0.08 to ≤ 0.16	Moderate Disturbance	3
≤ 0.08	High Disturbance	4

River Invertebrate Prediction and Classification System (RIVPACS)

The RIVPACS index calculates the number of reference taxa present in the test sample (observed or "O") and compares it to the number expected to be present ("E") in a reference sample from the same habitat (SCCWRP 2008).

The Southern California Coastal Water Research project (SCCWRP) currently supports the RIVPACS Benthic Index Calculator Tool, an online benthic index calculator tool based on the River Invertebrate Prediction and Classification System (RIVPACS) to support sediment quality assessment under California's Sediment Quality Objectives (SQO) program.

Step one: determine the probability of the test sample belonging to twelve Southern California Marine Bays reference sample groups. The sampling bottom depth, latitude, and longitude, and habitat code are needed for this step.

Step two: enter station Identification, taxa and abundance per taxa into template.

Step three: upload the data template to the calculator tool to calculate the values. the RIVPACS scores determined are compared to the threshold categories and be given a Category Score.

Table 5. RIVPACS Category Thresholds

RIVPACS Score	Category	Category Score
> 90 to <1.10	Reference	1
> 0.74 to ≤ 0.90 or > 1.10 to < 1.26	Low Disturbance	2
>0.32 to ≤ 0.74 or > 1.26	Moderate Disturbance	3
≤ 0.32	High Disturbance	4

Integrate Benthic Index Category Scores

The four benthic index category scores were combined to create a single benthic index. The integrated scores were calculated by taking the median of the four individual index category scores. If the median falls between two categories the value is rounded up.

Table 6. Index Category Score

Category	Category Score
Reference	1
Low Disturbance	2
Moderate Disturbance	3
High Disturbance	4

Appendix B
Survey Results

Appendix B-1. Infaunal master species list. Mugu Lagoon, 2017.

PHYLUM	Subphylum or Class	Species
PLATYHELMINTHES (PL)		
	Turbellaria	
		Armatoplana reishi
NEMERTEA (NE)		
	Anopla	
		Lineidae
		Tubulanus polymorphus
	Enopla	
		Paranemertes californica
	Unidentified	
		Nemertea
NEMATODA (NT)		
		Nematoda
MOLLUSCA (MO)		
	Gastropoda	
		Acteocina inculta
		Bulla gouldiana
		Haminoea vesicula
		Melanochlamys diomedea
	Bivalvia	
		Bivalvia
		Chione californiensis
		Cooperella subdiaphana
		Donax gouldii
		Laevicardium substriatum
		Macoma nasuta
		Macoma secta
		Mactrotoma californica
		Tagelus subteres
		Tellina cadieni
		Tellina modesta
		Venerupis philippinarum
ANNELIDA (AN)		
	Polychaeta	
		Anotomastus gordiodes
		Armandia brevis
		Aphelochaeta glandaria Cmplx
		Boccardia proboscidea
		Capitella capitata Cmplx
		Capitellidae
		Diopolydroa socialis
		Fabricinuda limnicola
		Glycera americana
		Glycinde polygnatha
		Goniada littorea
		Hemipodia borealis
ANNELIDA (AN) (Cont.).		
	Polychaeta	
		Mediomastus ambiseta
		Mediomastus californiensis
		Metasychis disparidentatus
		Neanthes acuminata Cmplx
		Nephtys caecoides
		Notomastus tenuis
		Owenia collaris
		Pectinaria calforniensis
		Phyllodoce hartmanae
		Polydora cornuta
		Polyophthalmus pictus
		Prionospio lighti
		Prionospio (Prionospio) heterobranchia
		Pseudopolydora paucibranchiata
		Scolelepis (Parascolelepis) tridentata
		Scolelepis (Scolelepis) occidentalis
		Scoloplos acmeceps
		Spiophanes duplex
		Streblospio benedicti
	Oligochaeta	
		Oligochaeta
ARTHROPODA (AR)		
	Malacostraca	
		Brachuyra
		Excirolana linguitrons
		Grandidierella japonica
		Hemigrapsus oregonensis
		Hemigrapsus sp
		Malacoplax californiensis
		Mayerella banksia
		Monocorophium uenoi
		Neotrypaea sp
		Oxyurostylis pacifica
ECHINODERMATA (EC)		
	Echinoidea	
		Dendraster excentricus
		Lovenia cordiformis
PHORONA (PR)		
	Phoronida	
		Phoronis sp
CHORDTA (CO)		
	Vertebrata	
		Gobiidae

Appendix B-2. Infauna results by station. Mugu Lagoon, 2017.

		Station						Percent
Phylum	**Species**	**ML3**	**ML6**	**ML14**	**ML15**	**ML74**	**Total**	**Total**
MO	*Tagelus subteres*	43	87	29	3	-	162	16.50
MO	*Acteocina inculta*	109	31	1	1	1	143	14.56
AN	*Streblospio benedicti*	22	39	54	3	-	118	12.02
AR	*Excirolana linguifrons*	-	-	-	-	97	97	9.88
AR	*Oxyurostylis pacifica*	-	60	8	17	-	85	8.66
AN	*Mediomastus californiensis*	16	7	2	42	-	67	6.82
AN	Oligochaeta	-	12	4	4	7	27	2.75
AN	*Notomastus tenuis*	15	3	3	5	-	26	2.65
MO	*Laevicardium substriatum*	5	6	5	3	-	19	1.93
PR	*Phoronis* sp	-	1	-	18	-	19	1.93
AN	*Mediomastus ambiseta*	1	4	2	11	-	18	1.83
AN	*Spiophanes duplex*	-	8	-	10	-	18	1.83
NT	Nematoda	2	9	4	-	1	16	1.63
MO	*Tellina cadieni*	-	1	3	9	-	13	1.32
AR	*Grandidierella japonica*	-	7	1	4	-	12	1.22
AN	*Pseudopolydora paucibranchiata*	1	1	-	5	1	8	0.81
AN	*Glycinde polygnatha*	-	3	2	1	-	6	0.61
AN	*Hemipodia borealis*	3	-	-	3	-	6	0.61
AN	*Scolelepis (Scolelepis) occidentalis*	-	4	2	-	-	6	0.61
MO	*Haminoea vesicula*	-	-	-	6	-	6	0.61
MO	*Venerupis philippinarum*	5	-	-	1	-	6	0.61
AN	*Neanthes acuminata* Cmplx	5	-	-	-	-	5	0.51
NE	Lineidae	2	1	1	1	-	5	0.51
NE	Nemertea	-	-	-	5	-	5	0.51
AN	*Armandia brevis*	-	-	-	4	-	4	0.41
AN	*Nephtys caecoides*	-	3	-	1	-	4	0.41
AN	*Polyophthalmus pictus*	-	-	-	4	-	4	0.41
MO	*Macoma nasuta*	-	-	-	4	-	4	0.41
NE	*Tubulanus polymorphus*	-	1	-	3	-	4	0.41
AN	*Boccardia proboscidea*	-	-	-	-	3	3	0.31
AN	*Fabricinuda limnicola*	-	3	-	-	-	3	0.31
AN	*Goniada littorea*	-	1	-	2	-	3	0.31
AN	*Scolelepis (Parascolelepis) tridentata*	-	-	-	3	-	3	0.31
MO	*Bulla gouldiana*	1	-	-	2	-	3	0.31
MO	*Cooperella subdiaphana*	-	2	1	-	-	3	0.31
MO	*Mactrotoma californica*	-	2	1	-	-	3	0.31
NE	*Paranemertes californica*	-	3	-	-	-	3	0.31
PL	*Armatoplana reishi*	-	-	-	3	-	3	0.31
AN	*Aphelochaeta glandaria* Cmplx	-	-	2	-	-	2	0.20
AN	*Owenia collaris*	-	1	-	1	-	2	0.20
AN	*Pectinaria californiensis*	-	1	-	1	-	2	0.20
AN	*Prionospio lighti*	-	-	2	-	-	2	0.20
AR	Brachyura	-	-	2	-	-	2	0.20
AR	*Hemigrapsus* sp	-	2	-	-	-	2	0.20
AR	*Malacoplax californiensis*	-	1	1	-	-	2	0.20
AR	*Mayerella banksia*	-	1	1	-	-	2	0.20
AR	*Monocorophium uenoi*	-	-	-	-	2	2	0.20
AR	*Neotrypaea* sp	-	-	-	1	1	2	0.20
EC	*Dendraster excentricus*	-	-	-	2	-	2	0.20
MO	*Macoma secta*	-	2	-	-	-	2	0.20
AN	*Anotomastus gordiodes*	-	-	-	1	-	1	0.10
AN	*Capitella capitata* Cmplx	-	-	1	-	-	1	0.10
AN	Capitellidae	-	-	-	1	-	1	0.10
AN	*Dipolydora socialis*	1	-	-	-	-	1	0.10
AN	*Glycera americana*	-	-	1	-	-	1	0.10
AN	*Metasychis disparidentatus*	-	-	1	-	-	1	0.10
AN	*Phyllodoce hartmanae*	-	-	-	1	-	1	0.10
AN	*Polydora cornuta*	-	-	-	-	1	1	0.10
AN	*Prionospio (Prionospio) heterobranchia*	-	-	-	1	-	1	0.10
AN	*Scoloplos acmeceps*	-	-	1	-	-	1	0.10
AR	*Hemigrapsus oregonensis*	-	-	1	-	-	1	0.10
CO	Gobiidae	1	-	-	-	-	1	0.10
EC	*Lovenia cordiformis*	-	-	-	1	-	1	0.10
MO	Bivalvia	-	1	-	-	-	1	0.10
MO	*Chione californiensis*	-	1	-	-	-	1	0.10
MO	*Donax gouldii*	-	-	-	1	-	1	0.10
MO	*Melanochlamys diomedea*	-	-	-	1	-	1	0.10
MO	*Tellina modesta*	-	1	-	-	-	1	0.10
	Number of individuals	232	310	136	190	114	982	
	Number of species	16	34	27	40	9	68	
	Diversity (H')	1.76	2.44	2.23	3.06	0.68	2.95	

Appendix B-3. Infaunal wet weight biomass data (g). Mugu Lagoon, 2017.

	Station					
Phylum	**ML3**	**ML6**	**ML3**	**ML6**	**ML3**	**Total**
Annelida	0.4362	0.1833	0.1064	0.4443	<0.0001	1.1702
Arthropoda	-	0.7150	0.9122	0.0079	0.4329	2.0680
Mollusca	0.044	2.941	0.525	15.4851*	<0.0001	18.9956
Echinodermata	-	-	-	<0.0001	-	<0.0001
Misc.	0.0763	0.0059	0.0081	0.1432	0.0011	0.2346
Total	0.5565	3.8453	1.5521	16.0805	0.4340	22.4684

Note: - = no animals

* 1 large *Venerupis philippinarum* weighing 14.3379 g