

Microbial Source Identification Study for Buccaneer Beach and Loma Alta Creek

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Beach Water Quality Workgroup Meeting
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Introduction

- Project Purpose:
 - Improve upon existing bacteria management (UV system) at Buccaneer Beach
 - Guide watershed management and future investigation strategy
 - Inform actions using Microbial Source Identification results
- Goals:
 - Complete a Microbial Source Identification study per the CA Source ID Manual (SCCWRP 2013)
 - Short-term: understand likely bacteria sources, modes of transport, conditions causing contamination
 - Long-term: reduce bacteria levels at Buccaneer Beach & Loma Alta Creek

Loma Alta Slough

- Section 303(d) List - Buccaneer Beach and Loma Alta Slough (indicator bacteria)
- REC-1 Beneficial Use; Buccaneer Beach and Loma Alta Slough
- Water from the slough may negatively impact water quality at Buccaneer Beach
- Sand Berm forms between the slough and beach during summer months
- UV system built in 2006
 - Treats water from slough and bypasses the sand berm
- Historic and on-going water quality monitoring in the watershed
- AB₄₁₁ monitoring at the beach during summer months

Grant Funding



- State Water Resources Control Board – Clean Beaches
 - Prop 50 – Coastal Nonpoint Source Pollution Control
 - Application submitted by City of Oceanside Water Utilities Department in early 2015
 - Agreement executed December 2015
- Grant Agreement executed December 2015
 - Total Budget: \$393,360
 - SWRCB Funds: \$348,240
 - Local In-kind Match (City of Oceanside): \$45,120

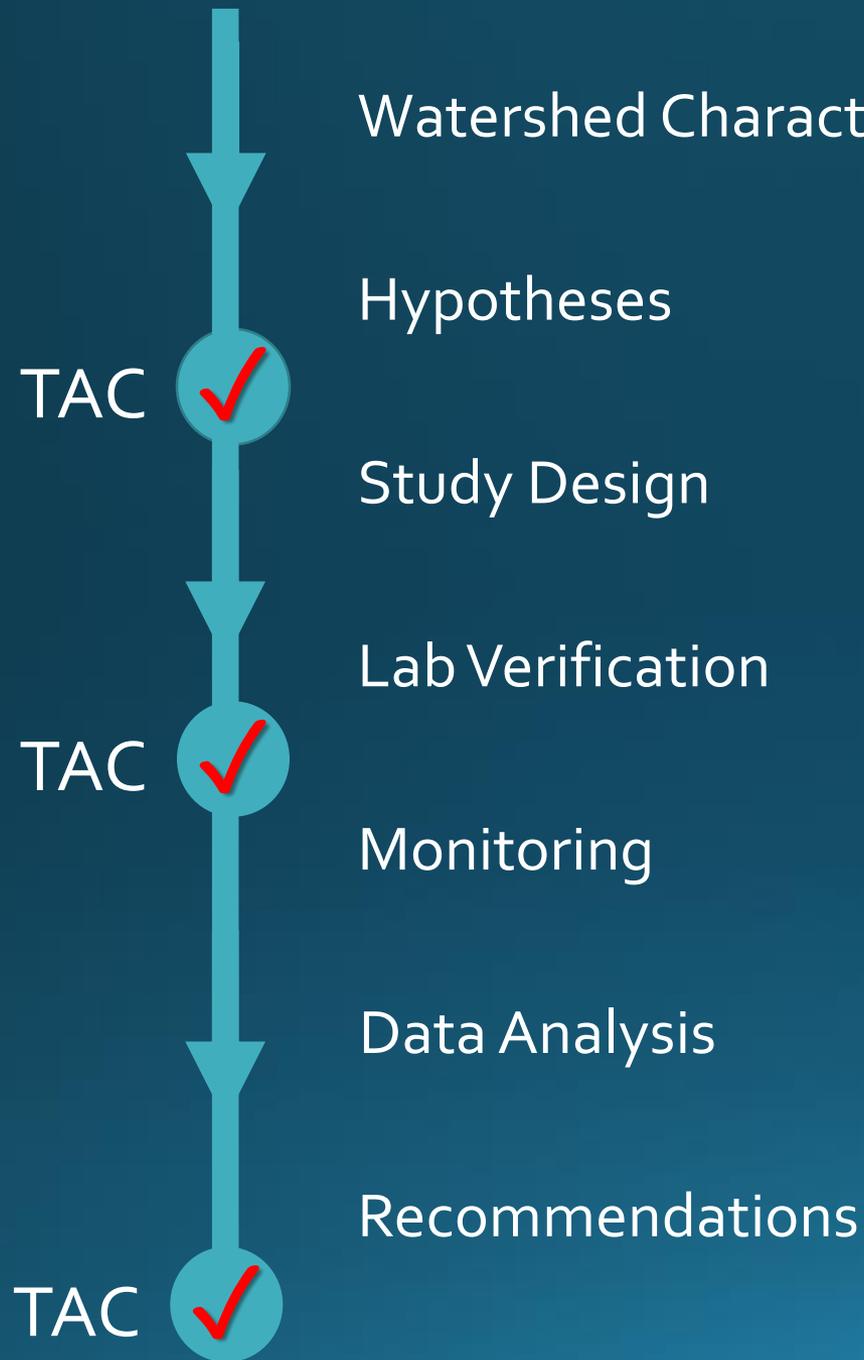
Roles & Responsibilities

- State Water Board
 - Oversight of grant agreement & scope of work
 - Review and approval of invoices and reports
- City of Oceanside (Water Utilities Department)
 - Grantee & project management, progress reporting
 - Coordination of Technical Advisory Committee
 - Source investigations – Sewers & Storm Drains
- Weston Solutions
 - Technical consultant
 - Develop work plans and study design
 - MST fieldwork, lab processing, data analysis, technical reporting

Outline

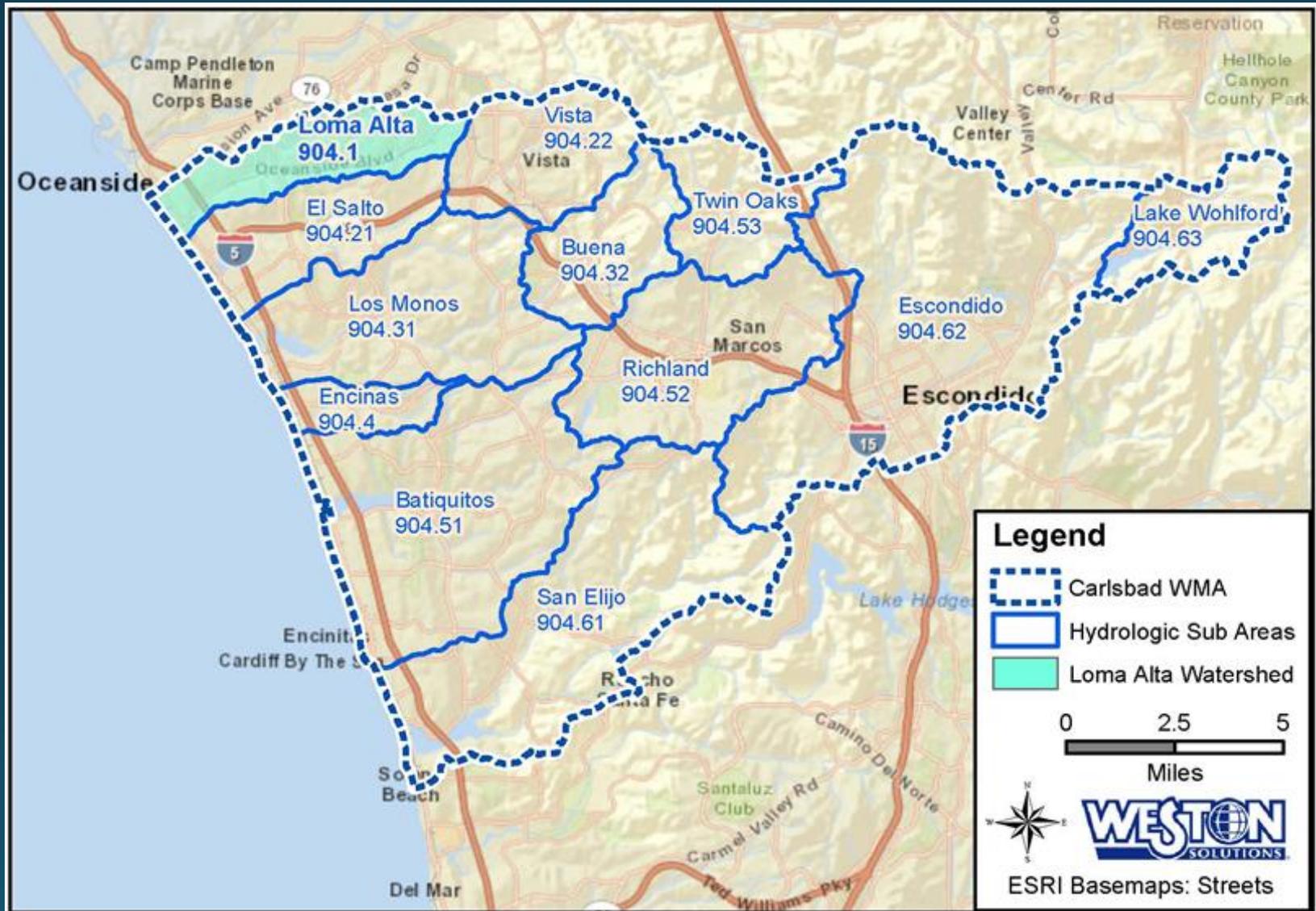
- Background
- Project Components
 - Watershed
 - Study Design
 - Lab Verification Results
 - Monitoring Results
 - Recommendations
- Next Steps



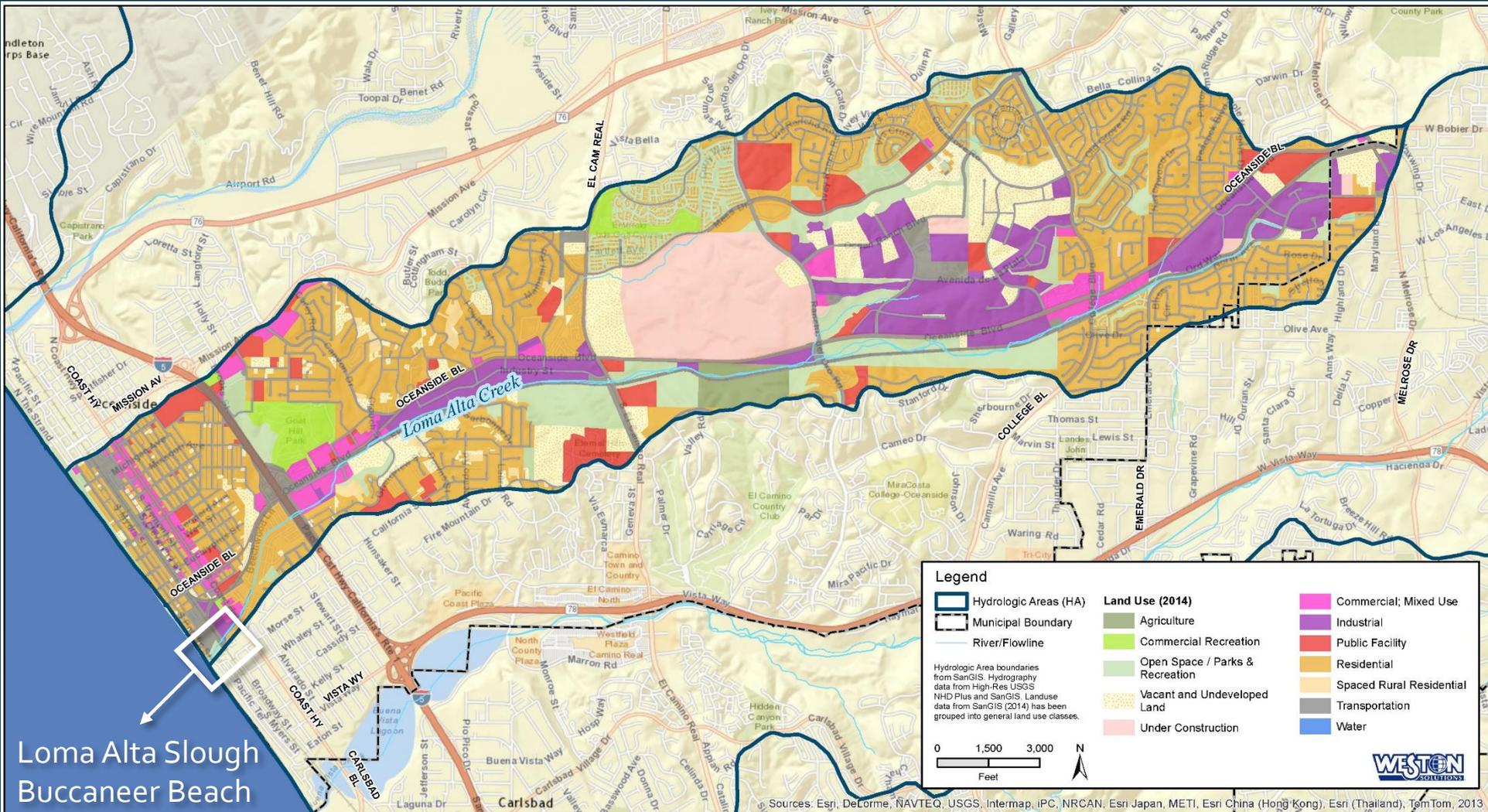


Buccaneer Creek and Loma Alta Watershed

Loma Alta Creek

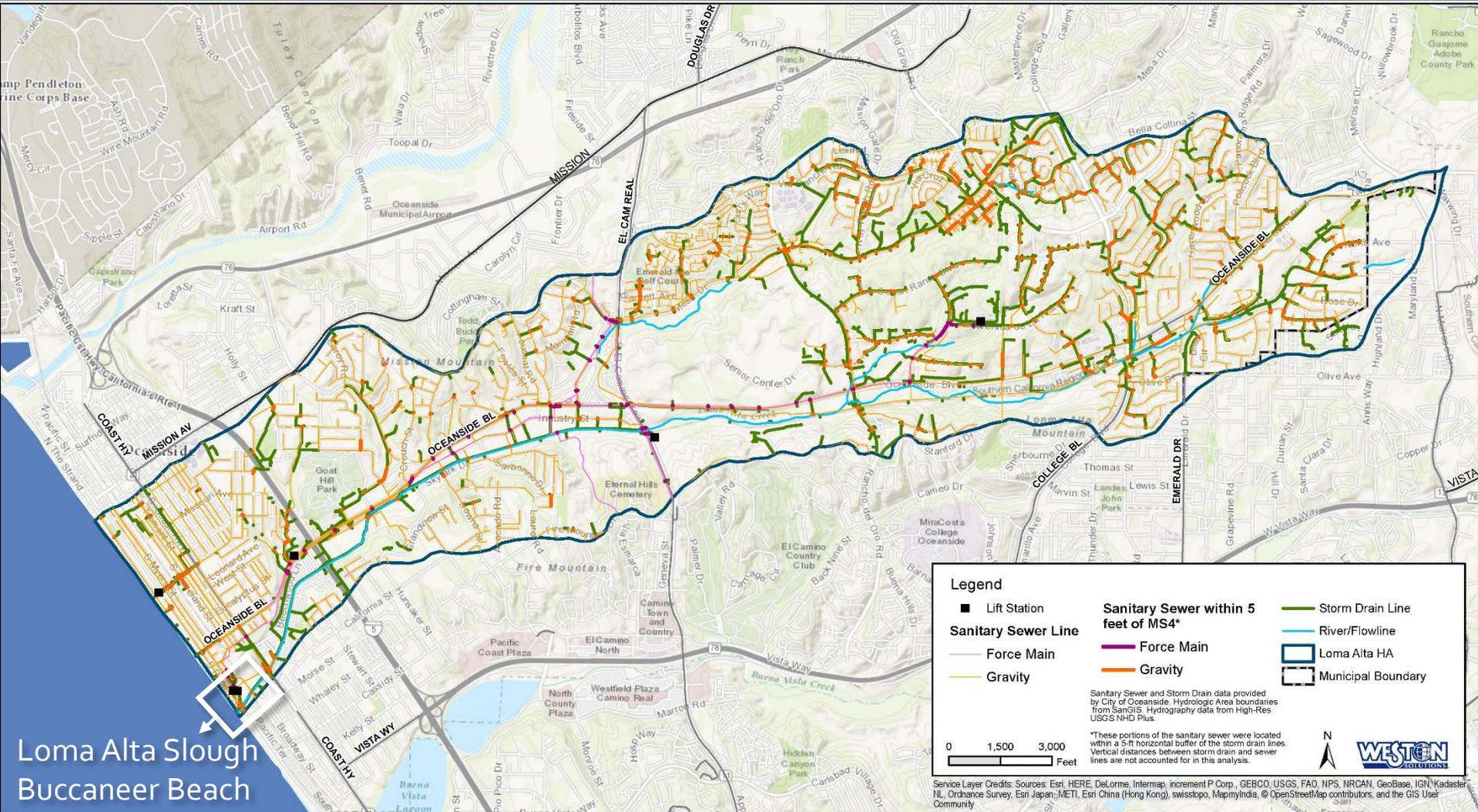


Loma Alta Creek



Loma Alta Slough
Buccaner Beach

Loma Alta Creek



Loma Alta Slough
Buccaneer Beach

Hypotheses

Hypotheses

Primary Hypotheses – Impacts from Potential Human Sources

H1: Human fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during wet season storm flows from Loma Alta Creek.

H2: Human sources contribute to fecal indicator bacteria levels at Buccaneer Beach during dry periods when Loma Alta Creek is flowing to the ocean.

H3: Human fecal contamination is present in the Loma Alta Creek during dry weather and the creek is a contributing source of fecal contamination to the Slough.

Hypotheses

Secondary Hypotheses – Impacts from Potential Non-Human Sources

H_{4a}: Bird fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during wet season storm flows from Loma Alta Creek.

H_{4b}: Dog fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during wet season storm flows from Loma Alta Creek.

H_{5a}: Bird fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during dry periods when Loma Alta Creek is flowing to the ocean.

H_{5b}: Dog fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during dry periods when Loma Alta Creek is flowing to the ocean.

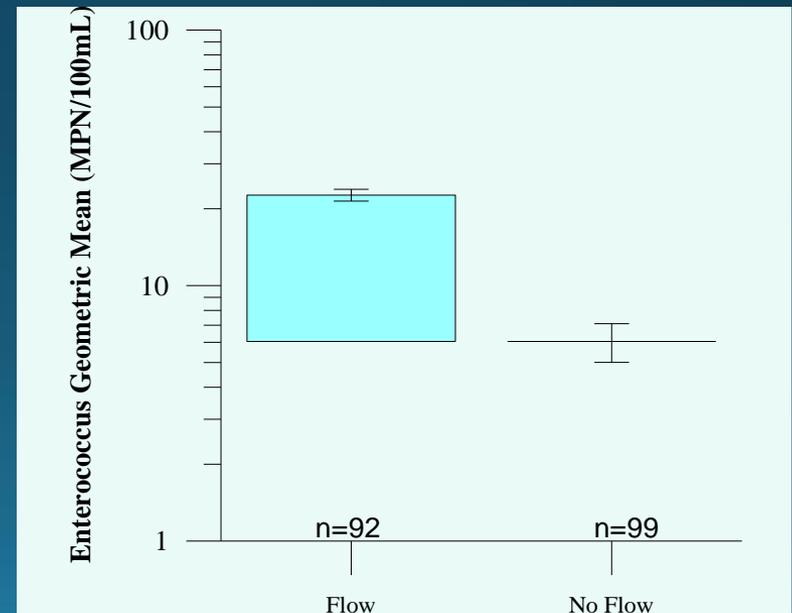
H_{6a}: Bird fecal contamination is present in Loma Alta Creek and Loma Alta Slough during dry weather

H_{6b}: Dog fecal contamination is present in Loma Alta Creek and Loma Alta Slough during dry weather

Study Design

Study Design – Power Analysis

- Utilized existing beach water quality data
 - More variability observed when berm open
 - Minimal variability observed when berm closed
- Modeled 4 scenarios
- Selected a “weighted” study design (3:1)
- Total N of 40
 - 20 events @ two stations
 - 15 berm open; 5 berm closed



Study Design Sampling Events

Collected Sample Size Summary, Presented by Weather and Berm Conditions

Station Location	Number of Stations	Number of Samples
Dry Weather – Berm Closed (5 events)		
Baseline Watershed	2	10
Slough	2	10
Buccaneer Beach	2	10
Comparison Station	1	5
Total	7	35
Dry Weather – Berm Open (15 events)		
Baseline Watershed	2	30
Slough	2	30
Buccaneer Beach	2	30
Comparison Station	1	15
MS ₄ ¹	4	20
Extended Watershed ¹	5	25
Total	16	150
Wet Weather (3 events)		
Baseline Watershed	2	6
Slough	2	6
Buccaneer Beach	2	6 (7) ²
Comparison Station	1	3
MS ₄	4	12
Extended Watershed	5	15
Total	16	48 (49)²

¹ stations sampled during 5 of the 15 "berm open" sampling events ² including additional sample, which was sampled right before berm was opened by wet weather flow on 11/21/2016

23 Events:

- 20 dry
- 3 wet

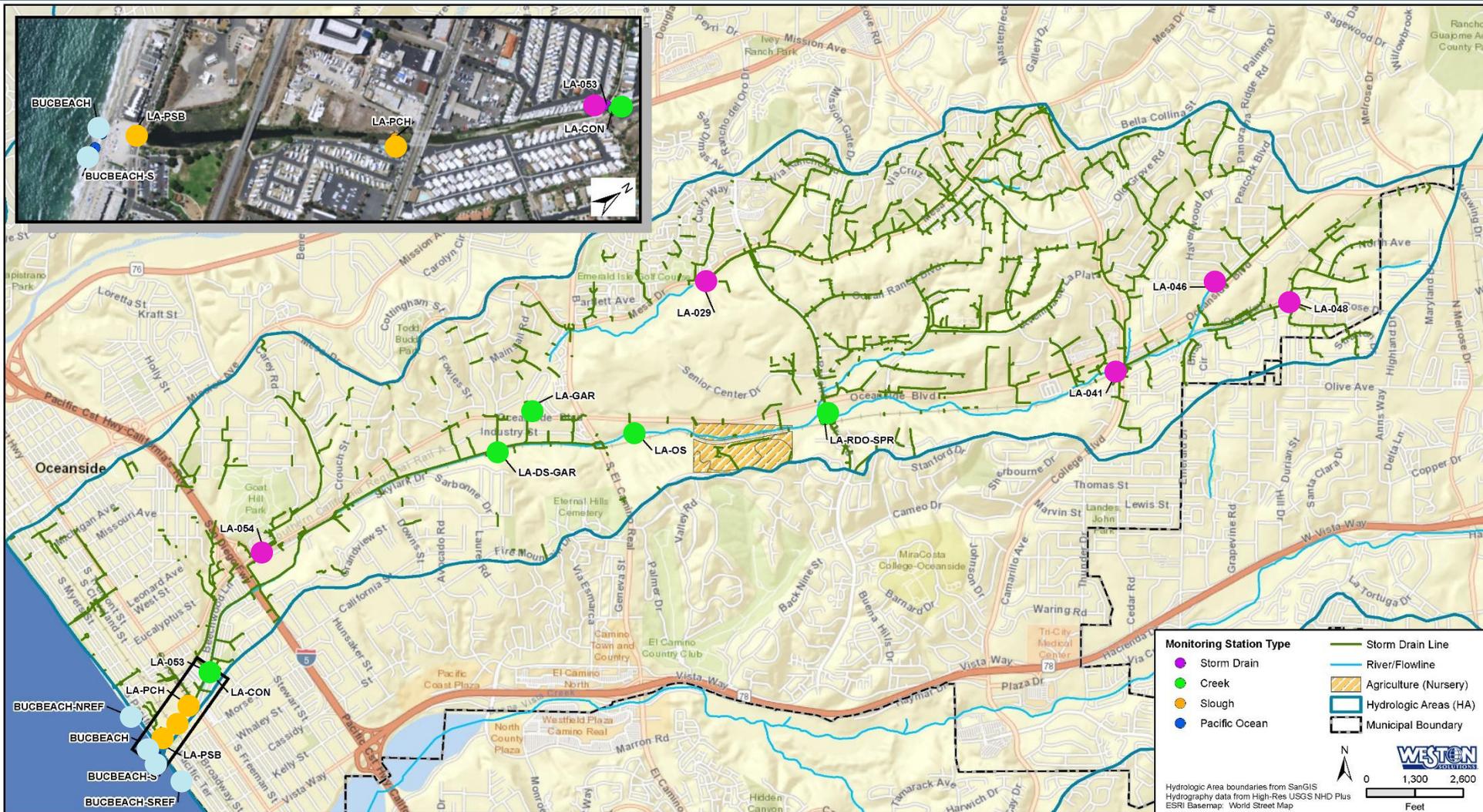
20 Dry Events:

- 5 closed berm
- 15 open berm

16 Sites:

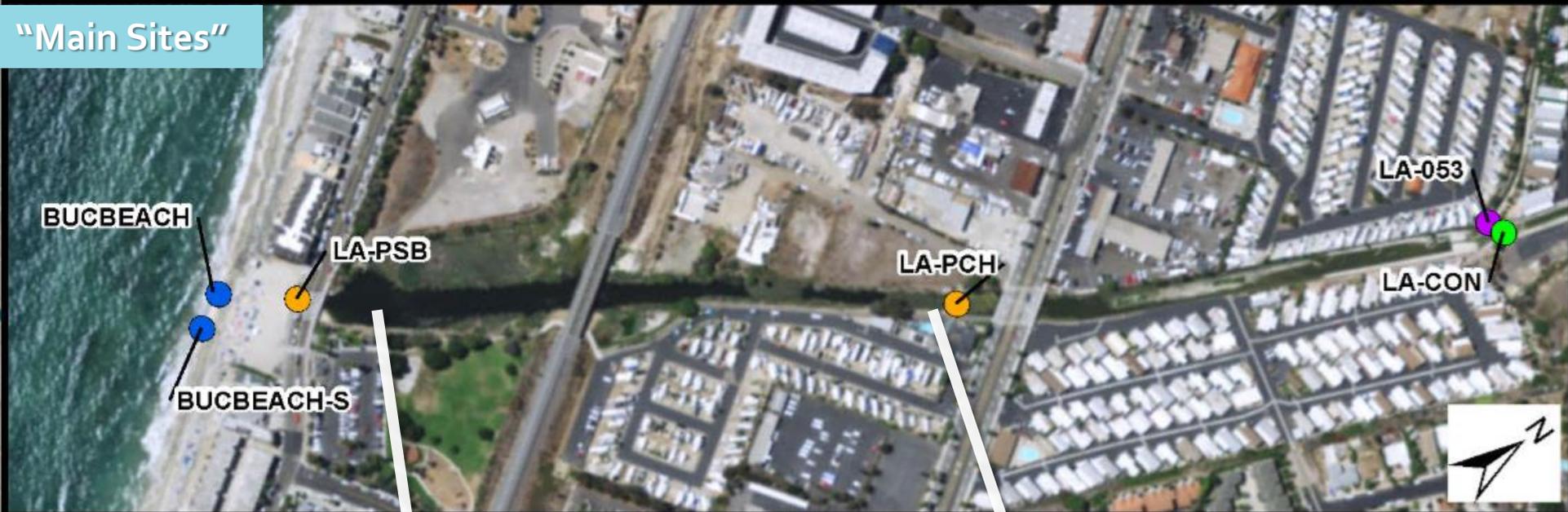
- 7 Main Sites
-> *always sampled*
- 9 Upstream LA Creek Sites
-> *sampled for 3 wet and 5 open berm events*

Study Design – Loma Alta Creek



Study Design - Loma Alta Slough

“Main Sites”











LA-CON

LA-053

Loma Alta Creek Facing Downstream from LA-CON (8/31/2018)

Study Design - Analytes

- Fecal Indicator Bacteria (FIB)

- *Enterococcus* spp.
- *E. coli*
- Total Coliform

- Source identification markers*

- Human-associated: HF183 (HF183F | BacR287 | BacP234MGB)
- Gull/Seabird-associated: Gull2 (Gull2F | Gull2R | Gull2P)
- Canine-associated: DogBact (DF475F | BAc708R | DogBactP)
later replaced by: DG37 (DG37F | DG37R | DG37P)

* As suggested by California MST Manual: SCCWRP - *The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches*. Technical Report 804 – December 2013.

Lab Verification

Lab Verification - Performance

Sensitivity, Specificity, and Frequency of Detection

Sample	Detection per qPCR Marker (N detected/N all samples)				
	HF183	Gull2	DogBact	DG37	Enterococci
Human (Sewage)	5/5	0/5	5/5	5/5	5/5
Bird (feces)	0/6	5/6	2/6	0/5	6/6
Dog (feces)	1/5	2/5	1/5	5/5	5/5
Sensitivity	100%	83%	20%	100%	N/A
Specificity	91%	80%	36%	50%	N/A

Lab Verification - Concentrations

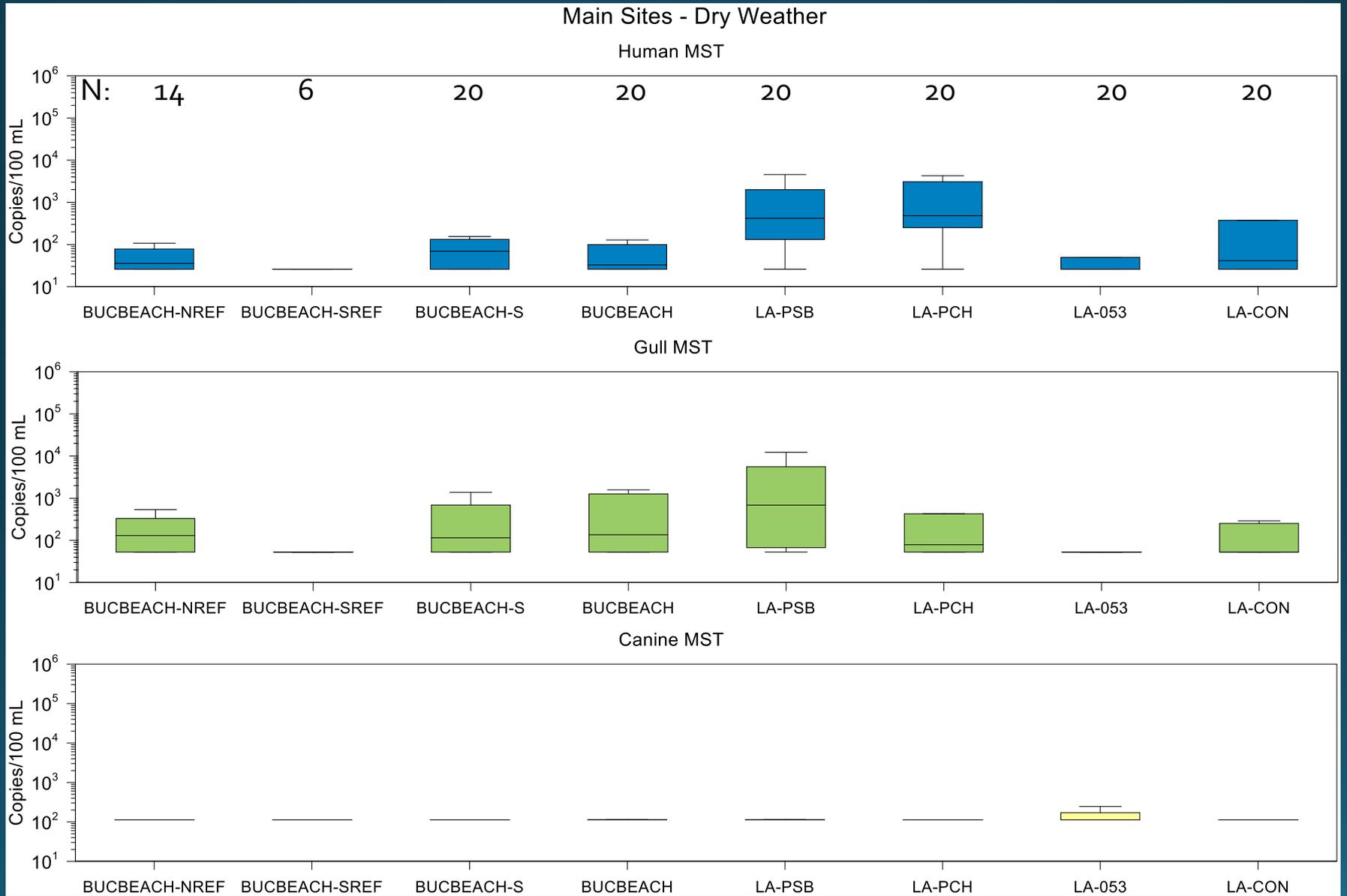
Table. Concentrations of Source Identification Markers in Source Material

Sample ID	Filtered Volume (mL) or Extracted Mass (wet g)	Host-Associated Marker Concentrations			Units
		Human (HF183)	Gull (Gull2)	Dog (DG37)	
Sewage 1 (1:10)	100	63,526,184	(183)	29,438	copies per 100 mL
Sewage 2 (1:10)	100	78,921,079	(194)	58,919	copies per 100 mL
Sewage 3 (1:10)	100	78,331,590	(183)	66,506	copies per 100 mL
Sewage 4 (1:10)	100	84,465,398	(194)	36,883	copies per 100 mL
Sewage 5 (1:10)	100	58,382,124	(194)	28,984	copies per 100 mL
Gull-01	0.50	(68)	3,354,637,197	(231)	copies /wet g
Gull-02	0.50	(68)	3,495,184,179	(231)	copies /wet g
Gull-03	0.50	(70)	1,536,037,197	(238)	copies /wet g
Duck-01	0.50	(68)	3,238	(231)	copies /wet g
Duck-02	0.50	(66)	(366)	(224)	copies /wet g
Cormorant-01	0.32	(103)	41,480	(352)	copies /wet g
Dog-01	0.50	947	28,130	73,995,556	copies /wet g
Dog-02	0.40	119*	657*	29,339,452	copies /wet g
Dog-03	0.50	(77)	(427)	1,251	copies /wet g
Dog-04	0.40	(96)	(534)	6,929	copies /wet g
Dog-05	0.50	(82)	9,460,715	2,226,834	copies /wet g

In parentheses: non-detect replacement concentrations, * amplification below detection limit (BDL)

Monitoring Results

Results - Dry Weather · MST



Results - Dry Weather · MST

Site ID	N	Geomean Source Identification Marker Concentration (copies/100 mL) ^A			N Non-detects (Percent)		
		HF183	Gull2	DG37	HF183	Gull2	DG37
<i>Open Berm</i>							
BUCBEACH-NREF	13	44	167	112	7 (54)	5 (38)	13 (100)
BUCBEACH-SREF	2	26	53	121	2 (100)	2 (100)	1 (50)
BUCBEACH-S	15	81	280	112	6 (40)	5 (33)	15 (100)
BUCBEACH	15	84	643	113	6 (40)	2 (13)	13 (87)
LA-PSB	15	536	1,168	117	2 (13)	2 (13)	13 (87)
LA-PCH	15	863	217	115	0 (0)	5 (33)	13 (87)
LA-053	15	78	62	127	10 (67)	12 (80)	11 (73)
LA-CON	15	142	145	118	6 (40)	7 (47)	13 (87)
<i>Closed Berm</i>							
BUCBEACH-NREF	1	53	53	112	0 (0)	1 (100)	1 (100)
BUCBEACH-SREF	4	39	53	112	3 (75)	4 (100)	4 (100)
BUCBEACH-S	5	33	53	209	3 (60)	5 (100)	4 (80)
BUCBEACH	5	26	53	166	5 (100)	5 (100)	3 (60)
LA-PSB	5	183	146	123	2 (40)	2 (40)	4 (80)
LA-PCH	5	170	58	139	2 (40)	4 (80)	3 (60)
LA-053	5	117	54	472	4 (80)	4 (80)	2 (40)
LA-CON	5	60	53	117	3 (60)	5 (100)	4 (80)

^A Non-detect values were assigned the value the highest cycle number would yield in accordance with master standard curves.

Results - Dry Weather - HF183

Site ID	N	Geomean Source Identification Marker Concentration (copies/100 mL) ^A			N Non-detects (Percent)		
		HF183	Gull2	DG37	HF183	Gull2	DG37
<i>Open Berm</i>							
BUCBEACH-NREF	13	44	167	112	7 (54)	5 (38)	13 (100)
BUCBEACH-SREF	2	26	53	121	2 (100)	2 (100)	1 (50)
BUCBEACH-S	15	81	280	112	6 (40)	5 (33)	15 (100)
BUCBEACH	15	84	643	113	6 (40)	2 (13)	13 (87)
LA-PSB	15	536	1,168	117	2 (13)	2 (13)	13 (87)
LA-PCH	15	863	217	115	0 (0)	5 (33)	13 (87)
LA-053	15	78	62	127	10 (67)	12 (80)	11 (73)
LA-CON	15	142	145	118	6 (40)	7 (47)	13 (87)
<i>Closed Berm</i>							
BUCBEACH-NREF	1	53	53	112	0 (0)	1 (100)	1 (100)
BUCBEACH-SREF	4	39	53	112	3 (75)	4 (100)	4 (100)
BUCBEACH-S	5	33	53	209	3 (60)	5 (100)	4 (80)
BUCBEACH	5	26	53	166	5 (100)	5 (100)	3 (60)
LA-PSB	5	183	146	123	2 (40)	2 (40)	4 (80)
LA-PCH	5	170	58	139	2 (40)	4 (80)	3 (60)
LA-053	5	117	54	472	4 (80)	4 (80)	2 (40)
LA-CON	5	60	53	117	3 (60)	5 (100)	4 (80)

^A Non-detect values were assigned the value the highest cycle number would yield in accordance with master standard curves.

Results - Dry Weather · Gull2

Site ID	N	Geomean Source Identification Marker Concentration (copies/100 mL) ^A			N Non-detects (Percent)		
		HF183	Gull2	DG37	HF183	Gull2	DG37
<i>Open Berm</i>							
BUCBEACH-NREF	13	44	167	112	7 (54)	5 (38)	13 (100)
BUCBEACH-SREF	2	26	53	121	2 (100)	2 (100)	1 (50)
BUCBEACH-S	15	81	280	112	6 (40)	5 (33)	15 (100)
BUCBEACH	15	84	643	113	6 (40)	2 (13)	13 (87)
LA-PSB	15	536	1,168	117	2 (13)	2 (13)	13 (87)
LA-PCH	15	863	217	115	0 (0)	5 (33)	13 (87)
LA-053	15	78	62	127	10 (67)	12 (80)	11 (73)
LA-CON	15	142	145	118	6 (40)	7 (47)	13 (87)
<i>Closed Berm</i>							
BUCBEACH-NREF	1	53	53	112	0 (0)	1 (100)	1 (100)
BUCBEACH-SREF	4	39	53	112	3 (75)	4 (100)	4 (100)
BUCBEACH-S	5	33	53	209	3 (60)	5 (100)	4 (80)
BUCBEACH	5	26	53	166	5 (100)	5 (100)	3 (60)
LA-PSB	5	183	146	123	2 (40)	2 (40)	4 (80)
LA-PCH	5	170	58	139	2 (40)	4 (80)	3 (60)
LA-053	5	117	54	472	4 (80)	4 (80)	2 (40)
LA-CON	5	60	53	117	3 (60)	5 (100)	4 (80)

^A Non-detect values were assigned the value the highest cycle number would yield in accordance with master standard curves.

Results - Dry Weather · DG37

Site ID	N	Geomean Source Identification Marker Concentration (copies/100 mL) ^A			N Non-detects (Percent)		
		HF183	Gull2	DG37	HF183	Gull2	DG37
<i>Open Berm</i>							
BUCBEACH-NREF	13	44	167	112	7 (54)	5 (38)	13 (100)
BUCBEACH-SREF	2	26	53	121	2 (100)	2 (100)	1 (50)
BUCBEACH-S	15	81	280	112	6 (40)	5 (33)	15 (100)
BUCBEACH	15	84	643	113	6 (40)	2 (13)	13 (87)
LA-PSB	15	536	1,168	117	2 (13)	2 (13)	13 (87)
LA-PCH	15	863	217	115	0 (0)	5 (33)	13 (87)
LA-053	15	78	62	127	10 (67)	12 (80)	11 (73)
LA-CON	15	142	145	118	6 (40)	7 (47)	13 (87)
<i>Closed Berm</i>							
BUCBEACH-NREF	1	53	53	112	0 (0)	1 (100)	1 (100)
BUCBEACH-SREF	4	39	53	112	3 (75)	4 (100)	4 (100)
BUCBEACH-S	5	33	53	209	3 (60)	5 (100)	4 (80)
BUCBEACH	5	26	53	166	5 (100)	5 (100)	3 (60)
LA-PSB	5	183	146	123	2 (40)	2 (40)	4 (80)
LA-PCH	5	170	58	139	2 (40)	4 (80)	3 (60)
LA-053	5	117	54	472	4 (80)	4 (80)	2 (40)
LA-CON	5	60	53	117	3 (60)	5 (100)	4 (80)

^A Non-detect values were assigned the value the highest cycle number would yield in accordance with master standard curves.

Results - Open vs Closed Berm

Wilcoxon Rank-Sum Test Comparing Open-Berm to Closed-Berm Conditions for BUCBEACH and BUCBEACH-S Results

Parameter	Z	P-value (two sided)
<i>Enterococcus</i>	-2.8370	0.0046
<i>E. coli</i>	-3.8494	0.0001
Total Coliform	-3.9097	<0.0001
HF183	-2.8337	0.0046
Gull	-3.7217	0.0002
DG37	1.7093	0.0874

Bold: significant p-values

=> All parameters but DG37 are significantly increased at Buccaneer Beach when the berm is open compared to when it is closed.

Results - Correlations

Significant (p-value < 0.05) Spearman Rank Order Correlations for Dry Weather Samples

Parameter A	Parameter B	N	Spearman Rho	P-Value
HF183	<i>E.coli</i>	185	0.222	0.0024
	Gull2	185	0.477	<0.0001
DG37	Total Coliform	185	0.171	0.0199
	<i>Enterococcus</i>	185	0.157	0.0331
<i>Enterococcus</i>	<i>E. coli</i>	185	0.808	<0.0001
	Total Coliform	185	0.803	<0.0001
<i>E. coli</i>	Total Coliform	185	0.785	<0.0001

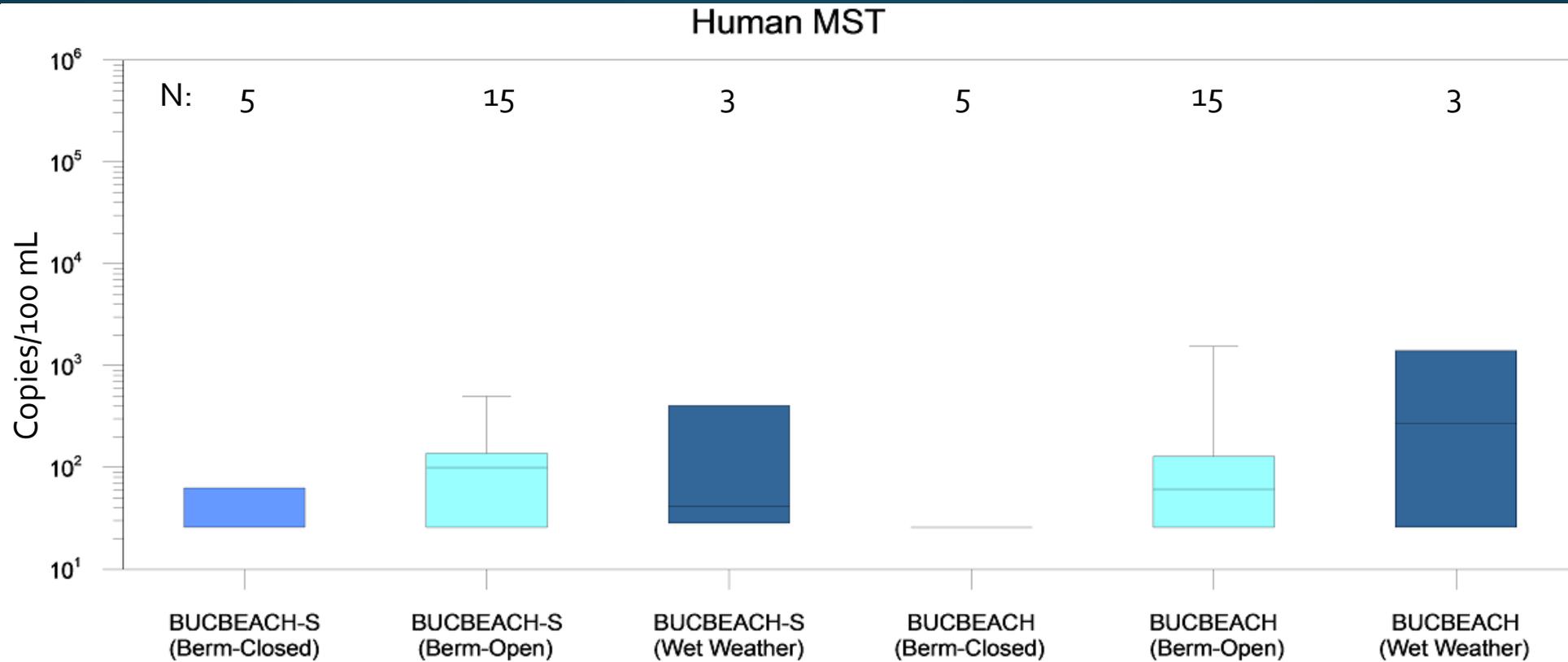
Results - Wet Weather MST

Site ID	N	Average Source Identification Marker Concentration (copies/100 mL) ^A			N Non-detects		
		HF183	Gull2	DG37	HF183	Gull2	DG37
BUCBEACH-NREF	3	2,142	1,405	231	1	1	2
BUCBEACH-S	3	158	1,297	1,963	0	0	0
BUCBEACH	3	650	3,478	112	0	0	3
LA-PSB	3	1,963	5,573	272	0	0	1
LA-PCH	3	4,125	833	136	0	1	1
LA-053	3	10,113	30,134	206	0	0	0
LA-CON	3	4,346	4,770	551	0	0	0
LA-054	3	2,018	1,972	673	0	0	0
LA-DS-GAR	3	4,013	1,000	386	0	0	0
LA-GAR	3	1,857	1,428	623	0	1	0
LA-OS	3	2,566	55	121	0	2	2
LA-029	3	1,180	4,612	268	0	1	0
LA-RDO-SPR	3	3,141	197	161	0	1	0
LA-041	3	1,159	62	260	0	2	1
LA-046	3	4,207	60	872	0	2	0
LA-048	3	1,068	61	1,013	0	1	1

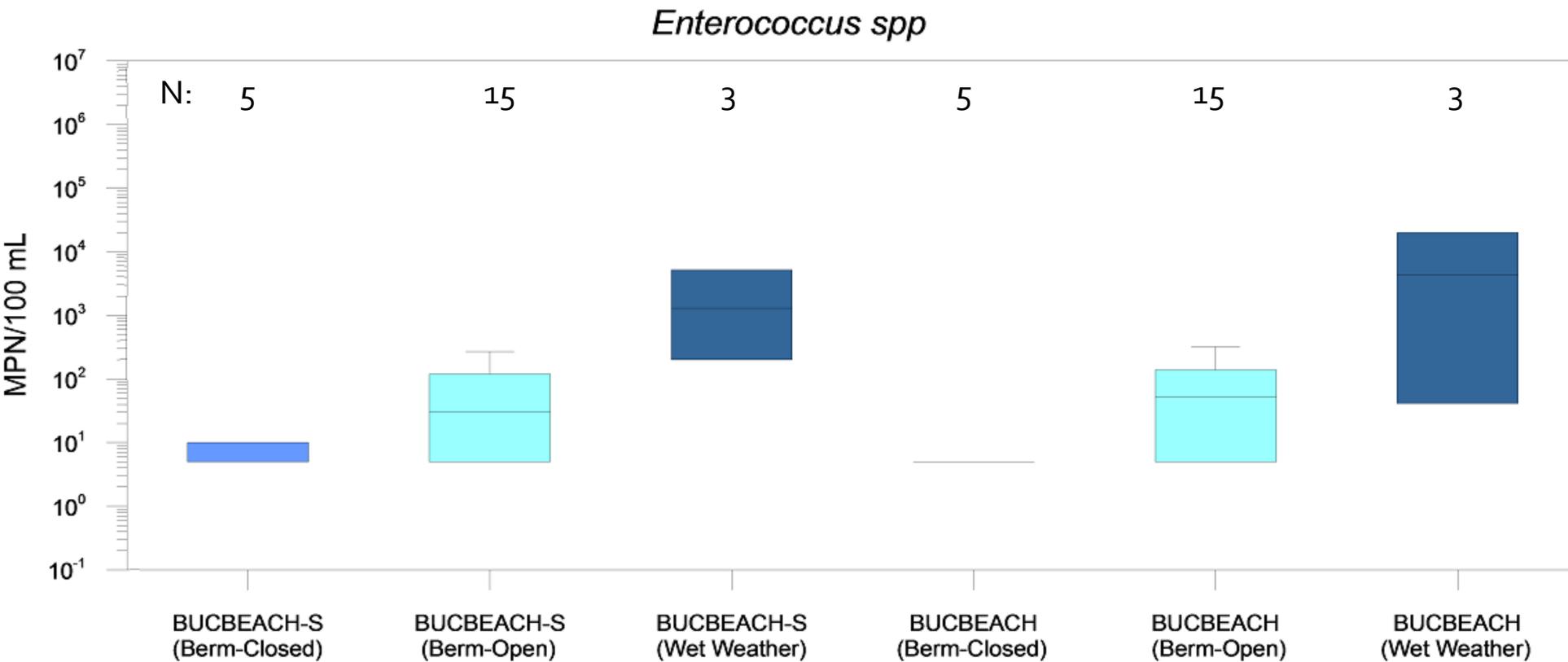
^A Non-detect values were assigned the value the highest cycle number would yield in accordance with master standard curves.

=> The HF183 marker is prevalent throughout the watershed during wet weather

Results – Buccaneer Beach · HF183



Results – Buccaneer Beach · ENT



Results - Loma Alta Creek - MST

Site ID	N	Geomean(A) or Average (B) Source Identification Marker Concentration (copies/100 mL) ^A			N Non-detects		
		HF183	Gull2	DG37	HF183	Gull2	DG37
		(A) Dry Weather - Open Berm					
LA-054	5	33	55	112	3	4	5
LA-DS-GAR	5	72	62	119	3	4	4
LA-GAR	5	71	53	116	3	5	4
LA-OS	5	26	55	126	5	4	4
LA-029	5	826	53	125	1	5	3
LA-RDO-SPR	5	43	53	130	3	5	3
LA-041	5	40	53	160	3	5	4
LA-046	5	37	53	126	4	5	3
LA-048	5	117	53	112	3	5	5
(B) Wet Weather – Open Berm							
LA-054	3	2,018	1,972	673	0	0	0
LA-DS-GAR	3	4,013	1,000	386	0	0	0
LA-GAR	3	1,857	1,428	623	0	1	0
LA-OS	3	2,566	55	121	0	2	2
LA-029	3	1,180	4,612	268	0	1	0
LA-RDO-SPR	3	3,141	197	161	0	1	0
LA-041	3	1,159	62	260	0	2	1
LA-046	3	4,207	60	872	0	2	0
LA-048	3	1,068	61	1,013	0	1	1

^A Non-detect values were assigned the value the highest cycle number would yield in accordance with master standard curves.

Results - Loma Alta Creek · HF183

Site ID	N	Geomean(A) or Average (B) Source Identification Marker Concentration (copies/100 mL) ^A			N Non-detects		
		HF183	Gull2	DG37	HF183	Gull2	DG37
		(A) Dry Weather - Open Berm					
LA-054	5	33	55	112	3	4	5
LA-DS-GAR	5	72	62	119	3	4	4
LA-GAR	5	71	53	116	3	5	4
LA-OS	5	26	55	126	5	4	4
LA-029	5	826	53	125	1	5	3
LA-RDO-SPR	5	43	53	130	3	5	3
LA-041	5	40	53	160	3	5	4
LA-046	5	37	53	126	4	5	3
LA-048	5	117	53	112	3	5	5
(B) Wet Weather – Open Berm							
LA-054	3	2,018	1,972	673	0	0	0
LA-DS-GAR	3	4,013	1,000	386	0	0	0
LA-GAR	3	1,857	1,428	623	0	1	0
LA-OS	3	2,566	55	121	0	2	2
LA-029	3	1,180	4,612	268	0	1	0
LA-RDO-SPR	3	3,141	197	161	0	1	0
LA-041	3	1,159	62	260	0	2	1
LA-046	3	4,207	60	872	0	2	0
LA-048	3	1,068	61	1,013	0	1	1

^A Non-detect values were assigned the value the highest cycle number would yield in accordance with master standard curves.

Results - Loma Alta Creek - Gull2

Site ID	N	Geomean(A) or Average (B) Source Identification Marker Concentration (copies/100 mL) ^A			N Non-detects		
		HF183	Gull2	DG37	HF183	Gull2	DG37
		(A) Dry Weather - Open Berm					
LA-054	5	33	55	112	3	4	5
LA-DS-GAR	5	72	62	119	3	4	4
LA-GAR	5	71	53	116	3	5	4
LA-OS	5	26	55	126	5	4	4
LA-029	5	826	53	125	1	5	3
LA-RDO-SPR	5	43	53	130	3	5	3
LA-041	5	40	53	160	3	5	4
LA-046	5	37	53	126	4	5	3
LA-048	5	117	53	112	3	5	5
(B) Wet Weather – Open Berm							
LA-054	3	2,018	1,972	673	0	0	0
LA-DS-GAR	3	4,013	1,000	386	0	0	0
LA-GAR	3	1,857	1,428	623	0	1	0
LA-OS	3	2,566	55	121	0	2	2
LA-029	3	1,180	4,612	268	0	1	0
LA-RDO-SPR	3	3,141	197	161	0	1	0
LA-041	3	1,159	62	260	0	2	1
LA-046	3	4,207	60	872	0	2	0
LA-048	3	1,068	61	1,013	0	1	1

^A Non-detect values were assigned the value the highest cycle number would yield in accordance with master standard curves.

Results – Low Detection Limits

California MST Manual vs. Optimized Protocol

- Tested 36 beach samples
 - BUCBEACH & BUCBEACH-S
 - 12 events (December 2016 – April 2017)
 - Dry weather and wet weather

	CA MST Manual	Optimized
ND	11	2
Signal Below detection limit	17	3
Detected	8	31
Median concentration	86 copies/100 mL	92 copies/100 mL
LOD:	~ 200 copies/ 100 mL	~20 copies/100 mL

=> Concentrations matter!

Results- Hypotheses

Primary Hypotheses – Impacts from Potential Human Sources

- ✓ H1: Human fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during wet season storm flows from Loma Alta Creek.
- ✓ H2: Human sources contribute to fecal indicator bacteria levels at Buccaneer Beach during dry periods when Loma Alta Creek is flowing to the ocean.
- ✓ H3: Human fecal contamination is present in the Loma Alta Creek during dry weather and the creek is a contributing source of fecal contamination to the Slough.

Results- Hypotheses

Secondary Hypotheses – Impacts from Potential Non-Human Sources

- ✓ H4a: Bird fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during wet season storm flows from Loma Alta Creek.
- ✓ H4b: Dog fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during wet season storm flows from Loma Alta Creek.
- ✓ H5a: Bird fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during dry periods when Loma Alta Creek is flowing to the ocean.
- H5b: Dog fecal contamination contributes to fecal indicator bacteria levels at Buccaneer Beach during dry periods when Loma Alta Creek is flowing to the ocean.
- ✓ H6a: Bird fecal contamination is present in Loma Alta Creek and Loma Alta Slough during dry weather
- ✓ H6b: Dog fecal contamination is present in Loma Alta Creek and Loma Alta Slough during dry weather

Recommendations

1

The study results have shown that a closed berm is effective in maintaining beach water quality at Buccaneer Beach based on fecal indicator and source identification marker measurements.

Recommendations:

- *Continue the best management practice of maintaining the closed berm and treating slough water before it enters the ocean, and potentially increase the use of this BMP.*
- *Investigate the feasibility of increasing usage of the City's ultraviolet treatment system at the slough to treat and recirculate contaminated creek water.*

2

The prevalence of persistently high human-associated source identification marker concentrations demonstrate that waters of Loma Alta Slough are chronically exposed to human fecal contamination.

Recommendations:

- *Investigate the sewer infrastructure in the proximity of the Slough to identify potential leaks.*
- *Investigate the sewer infrastructure at La Salina Wastewater Treatment Plant and laterals from the park bathrooms for potential leaks. Investigate potential transient encampments impacts near the Slough.*

Recommendations

3

The study results indicate a second high priority area of the watershed is the area of the mobile home estates (Sites LA-CON and LA-053), which contributes fecal contamination to the Slough during dry and wet weather.

Recommendations:

- *Investigate the private sewer system of the Mobile Home Estates.*
- *Identify the origins of dry weather flows (e.g., ground water dewatering, over-irrigation, sanitary sewer exfiltration) in the LA-053 drainage area. Investigate potential transient encampment impacts upstream of LA-CON.*

4

The watershed upstream of LA-CON has not been a priority of this study; however, relatively high human marker concentrations have been found throughout the watershed particularly at the outfalls, with site LA-029 being the highest priority.

Recommendation:

- *Conduct upstream source investigation monitoring for sources of human fecal contamination, particularly at LA-029.*

Next Steps

Addressing Impacts: UV Facility & Slough Management

- Decommissioning of La Salina Wastewater Plant (2020 onward)
- Consideration of UV modifications
 - Recirculation
 - Aeration
 - Increased capacity
- “Natural” cleansing - Wetlands
 - Future Grant - wetland expansion concept
 - Feasibility study (expected to begin late 2018)



Loma Alta Wetlands - Eastern Segment Enhancement Concept

Legend

Landbase Layers

- Parcels
- Lagoons
- Streets
- Creeks

Wetland Enhancements

- Wildlife Viewing Area

Vegetation

- SCRUB
- TREE

Habitat Zones

- Emergent Wetland
- Upland Vegetated

Project Area (Updated)

- Flood-ebb Sinuous Channels



Potential pedestrian access and wildlife viewing



Addressing Sources: Upstream Investigations

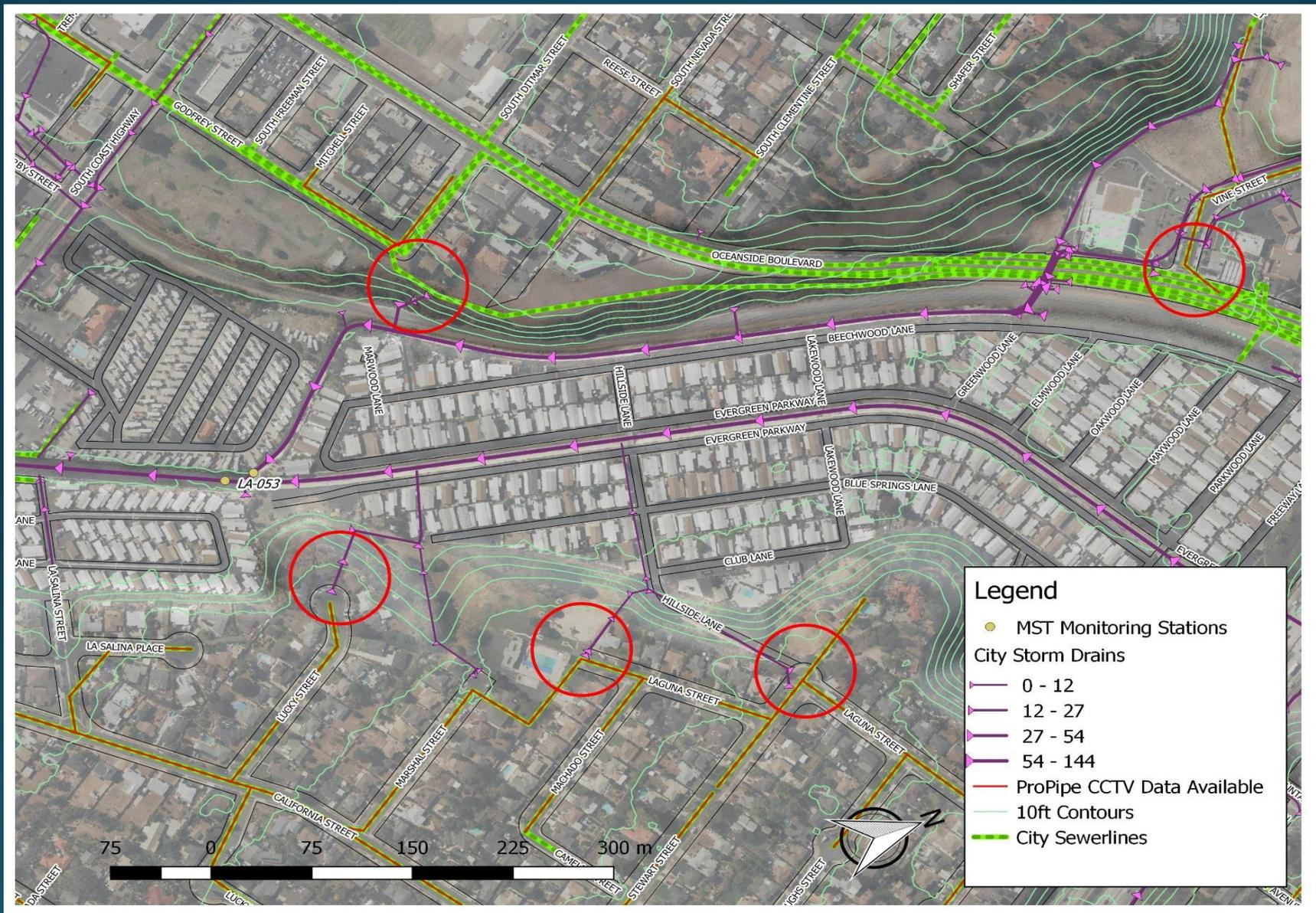
- Early 2018:
 - GIS modeling of sanitary sewer exfiltration probability
 - Depth, groundwater elevation, material, Creek/storm drain proximity
 - Identify subareas for sewer CCTV
- Pipeline Assessment Certification Program (PACP)
 - All Vitrified Clay Pipes surveyed within last two years
 - Prioritize infrastructure by Pipe Rating, local MST results



From Lee et al. (2015)



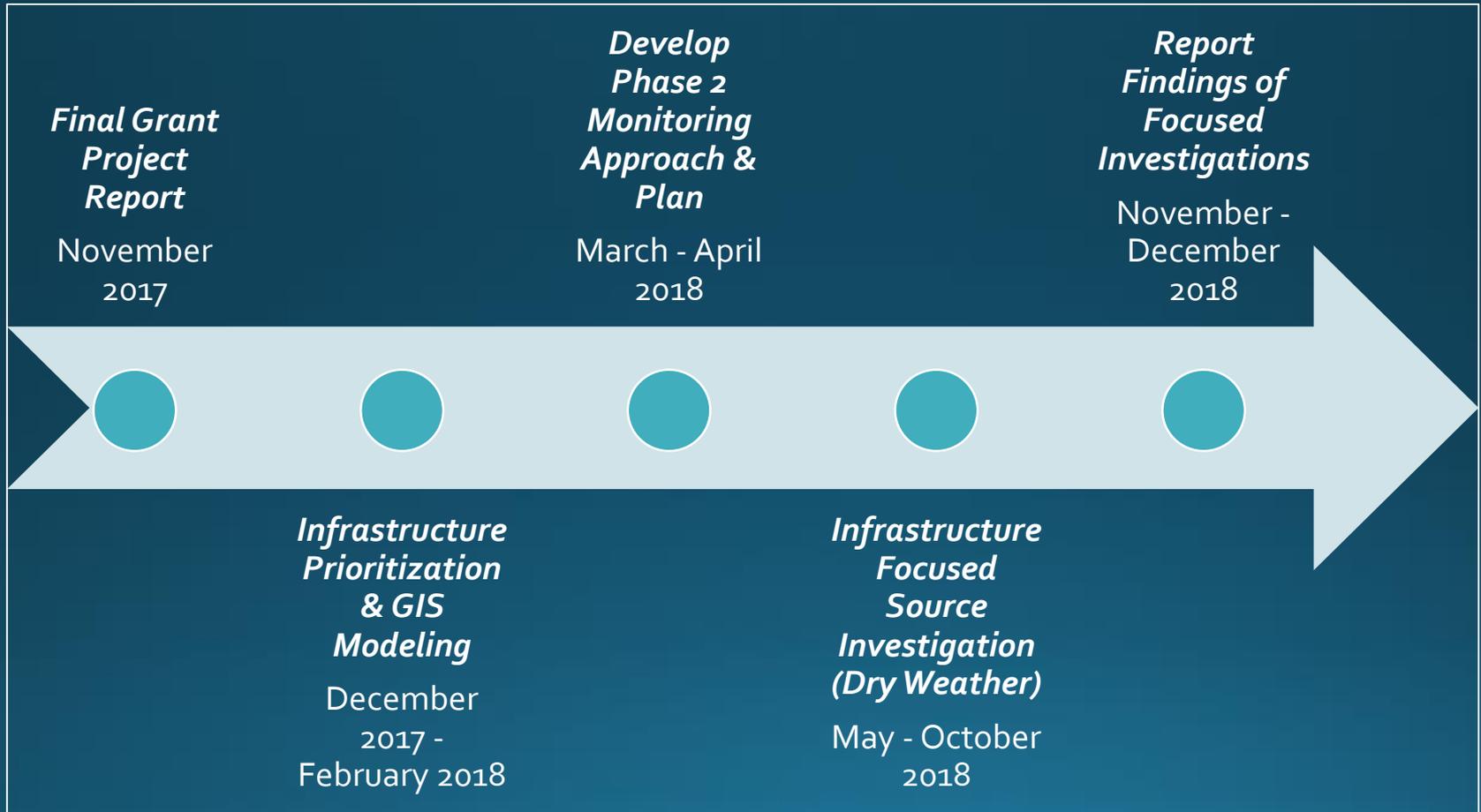
PACP data for vitrified clay pipes near tributary storm drains at Loma Alta Creek



Addressing Sources: Upstream Investigations

- Summer 2018 and beyond (scope contingent on funding):
 - Focused investigations by tributary
 - LA-029, LA-CON, LA-053
 - Additional HF183 sampling where justified
 - CCTV storm drain inspection program – contracting in progress
 - Inspect park public bathroom & plant sewer infrastructure surrounding Loma Alta Slough
 - Explore utility of alternative source tracking markers
 - Rhodamine WT tracing in storm drains (Sercu et al. 2011)
 - Wastewater markers (sucralose, acesulfame, caffeine)
 - Assessment of homelessness in impacted tributaries

“Phase 2” Estimated Schedule



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Thank You

Questions?

