Oso Creek Bacteria Contamination Investigation

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FINAL SUMMARY REPORT

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Oso Creek Bacteria Contamination Investigation

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EXECUTIVE SUMMARY

The lower 25 miles of Oso Creek (Segment 2485A) was placed on the Texas 2002 303(d) and Texas 2004 303(d) lists due to elevated bacteria levels (TCEQ, 2002; TCEQ 2004). A previously completed study, supported by the Texas Commission on Environmental Quality (TCEQ) found high numbers of enterococci at all Oso Creek stations during high flow conditions, which is common for streams during high flow or flooding conditions following storm water runoff events. In addition, the study demonstrated that dry weather samples for upstream sites exceeded the USEPA *Enterococcus* standard of 104 cfu/100mL (Campbell, 2007), indicating that much of the bacteria loading in Oso Creek occurs in the upper section during dry weather (normal) flow conditions.

The aim of this study was to examine all stretches of the creek under normal flow, dry weather conditions in order to identify dry weather inflows that could be impacting bacterial loading into this water body. In addition, enterococci levels were assessed in water from the inflow sites to gain insight into quantitative impacts on bacterial levels loading into the creek.

The objectives of this study were to:

1. Identify and document inflows along Oso Creek which may carry contamination into the creek.
2. Sample any inflows into the creek occurring under low or normal flow conditions and analyze for enterococci levels.
3. Re-sample inflows which carry high levels of enterococci to determine their contribution to enterococci levels in the creek.

During the course of the study 67 potential discharges were observed, photographed, documented and mapped. Of these, 13 exhibited active flow and were sampled weekly or biweekly from the time they were first observed through May 2009. Field parameters were documented for each sampling event. Water samples were analyzed for enterococci using USEPA Method 1600: Membrane filtration test method for *Enterococcus* in water (http://epa.gov/waterscience/methods/biological/1600 *Enterococcus*.pdf).

Of the actively flowing sites the majority was found along the middle and lower stretches of the creek, although there were a number of potential discharge points found upstream. Upstream the main inflow to the creek is from the Robstown WWTP (OCB003). This inflow generally contained low levels of *Enterococcus* (72% samples were within the EPA single sample criterion of 104 cfu/100 mL), with the exception of

two sampling events where numbers exceeded 2000 cfu/100 mL. No potential or active inflows were observed along west Oso Creek.

Enterococcus levels did not show trends among sites during shared sampling events and additionally, most individual sites did not exhibit any trends over time.

The *Enterococcus* levels at most sites fluctuated throughout the sampling period, ranging from very low to very high. For example, the lowest bacterial level at OCB003 was <1 cfu/100mL, but the highest was 2590 cfu/100mL. However, two sites, OCB062 and OCB067, seemed to have relatively stable *Enterococcus* levels over time.

No single site demonstrated very high levels consistently throughout the sampling period but two sites, OCB063 and OCB064, exhibited extremely low levels for each sampling event. Samples from both sites tested negative for residual chlorine during the course of sampling, excluding that as a possible reason for such low numbers.

The proportion of samples which exceeded the EPA single sample criterion of 104 cfu/100mL varied for each site, ranging from <1% (OCB063, OCB064) to 86% (OCB067).

Based on the results of this study, there appears to be some contribution by dry weather inflows to the bacterial loadings into the creek.

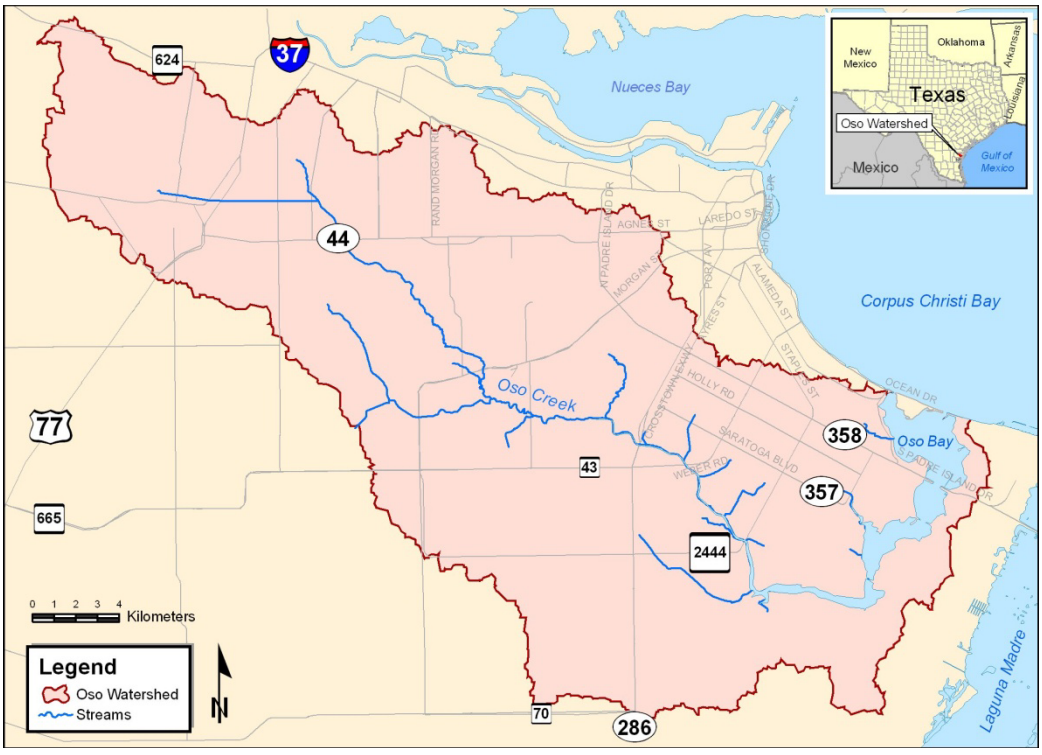
Recommendations for future work include a study to identify the types of sources contributing to bacterial levels at actively discharging inflows that are not permitted WWTP outfalls. The TAMU-CC Environmental Microbiology Lab is currently investigating sources of unknown source *Enterococcus* isolates in the upper Oso Creek watershed within surface water, groundwater, sediment, and soil samples through funding provided by the Texas State Soil and Water Conservation Board.

INTRODUCTION

The lower 25 miles of Oso Creek (Segment 2485A) was placed on the Texas 2002 303(d) and Texas 2004 303(d) lists due to elevated bacteria levels (TCEQ, 2002; TCEQ 2004). A previously completed study, supported by the Texas Commission on Environmental Quality (TCEQ) assessed enterococci levels throughout the Oso Creek/Oso Bay Watershed. High numbers of bacteria were observed at the stations during high flow conditions, which is common for streams during high flow or flooding conditions following storm water runoff events. In addition, the study demonstrated that dry weather samples for upstream sites exceeded the U.S. Environmental Protection Agency (USEPA) *Enterococcus* standard of 104 cfu/100mL (Campbell, 2007), indicating that much of the bacteria loading in Oso Creek occurs in the upper section during dry weather (normal) flow conditions.

Surface waters impaired for bacteria may contain pathogenic microorganisms, which pose a serious health threat to the public. Currently, due to low detection rates and cost limitations, pathogens themselves are not monitored in recreational waters. Fecal indicator organisms, such as enterococci, are utilized to monitor quality of recreational surface waters. Standard bacteriological criteria are defined by levels of fecal indicator organisms and differ for water bodies based on their designated use. These criteria are set by the USEPA and, for Texas, the TCEQ. Water bodies failing to meet these standards are classified as impaired. Further investigations are warranted to remedy the impairment when at all possible.

Figure 1. Study area location map.



Assessments of Oso Creek have implicated loadings of enterococci under normal flow, dry weather conditions. The aim of this study was to examine all stretches of the creek under normal flow, dry weather conditions in order to identify dry weather inflows that could be impacting bacterial loading into this water body. In addition, enterococci levels were assessed in water from the inflow sites to gain insight into quantitative impacts on bacterial levels loading into the creek.

The objectives of this study are to:

1. Identify and document inflows along Oso Creek which may carry contamination into the creek.
2. Sample any inflows into the creek occurring under low or normal flow conditions and analyze for enterococci levels.
3. Re-sample inflows which carry high levels of enterococci to determine their contribution to enterococci levels in the creek.

METHODS

All project procedures followed the approved Quality Assurance Project Plan (Mott and Hay, 2008).

Field Observations

In order to determine locations of potential inflows to Oso Creek, observations were made along the entire length of the creek, examining both banks for possible discharge points.

Mr. John Freeman (USDA NRCS) and Mr. Andy Garcia (TSSWCB) assisted by providing maps and information regarding access as well as contacting landowners (farmers) for permissions to access the upper portions of the creek.. The Nueces County Drainage District #2 Board gave permission for access to their right-of-way to the ditch running from the Robstown treatment plant.

Initial trips were conducted to identify access points at road intersections, bridges etc. The creek was examined in sections, based on access and safety issues. Field personnel kayaked the creek where possible and walked the remaining sections. As the project was focused on unpermitted discharges during normal flow, observations were only made during periods of dry weather; thus, field work was suspended during and following any rainfall events in the watershed.

Field work was initiated August 13, 2008 along the upper section of the creek from Business US77 to SH44. Observation of the upper portion of the creek was completed on Nov 5 (from the Robstown WWTP to Hwy 44). The second section of the creek studied was the lower section from east of the Staples crossing and east of the FM 763 crossing. Due to dense foliage along the section between FM763 and SH44, that section was completed after cold weather caused the vegetation to drop the leaves

facilitating access. West Oso Creek was also observed from its intersection with Oso Creek, upstream to the point where there was no water in the creek bed (at FM 665).

During the course of the observations, field personnel identified, photographed and documented all potential outfalls into Oso Creek. Potential inflows were considered to be any type of discharge point into the creek that could potentially carry water into the main creek body. Each discharge located was assigned a number upon discovery. At each site, a field photo log sheet and discharge location data sheet (Appendix A) were completed. The field photo log sheet documented each photo taken in the field by assigning a photo number and description to each photo. The discharge location data sheet documented the GPS location (UTM Zone 14) and field parameters. After each day of observations in the field, personnel downloaded photographs into electronic data files.

Field Collections

Water samples were collected at each identified outfall when water was present, from when first located through May 2009, in order to establish any pattern in bacterial contribution to the creek. These sites were given unique identifications as OCB0XX (where XX designates the original site number (from 1-67) for laboratory analysis purposes.

All actively flowing discharges were sampled directly from the outflow or from as close to the entry of water into the creek as possible. Field sampling procedures followed those documented in the TCEQ *Surface Water Quality Monitoring Procedures Volume I: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue* (December 2003). Field parameters (water temperature, conductivity, salinity, dissolved oxygen, and pH) were measured with an YSI water quality multi-probe instrument. Flow measurements were also taken, estimations were made following guidelines stated in *Surface Water Quality Monitoring Procedures, Volume I* (RG-415, Dec. 2003) or for WWTP outflows, obtained from TCEQ (for the sites immediately downstream from the

Figure 2. Kayaking down a stretch of the Oso (January 23, 2009).

Robstown and Greenwood WWTPs). Water samples were collected in sterile one liter screw-cap polypropylene bottles and tested for presence of residual chlorine at time of collection. Samples were placed on ice and transported to the lab within six hours to allow for two hours of analysis.

Laboratory Analysis

Samples were delivered to the TAMU-CC Environmental Microbiology Laboratory within the required holding time, accompanied by a standard TCEQ approved Chain-of-Custody form, documenting date and time of sample collection. The receiving analyst checked times of collection to ensure holding times were not exceeded and that the temperature of the trip blank met specifications of the TCEQ *Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue* (December 2003). Receiving procedures followed those required by the National Environmental Laboratory Accreditation Conference standards (NELAC, 2002).

Water samples were analyzed for enterococci using USEPA Method 1600: Membrane filtration test method for *Enterococcus* in water (USEPA 1997, 2000) (http://epa.gov/waterscience/methods/biological/1600*Enterococcus*.pdf). In accordance with the method, bacterial colonies were enumerated from plates 24 hours after incubation. All analytical data were recorded at the time of analysis on bacteriological raw data sheets. Verifications of colonies were performed at a rate of 10 per batch (USEPA 1997, 2000).

Field splits were performed as required by the TCEQ *Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue* (December 2003). Field splits were collected on a 10% basis or one per batch, whichever was greater. Relative percent difference was calculated for all field split results.

Laboratory duplicates were performed at a rate of 10%. The precision criterion for laboratory duplicates was determined as outlined by *Standard Methods for the Examination of Water and Wastewater 21st Edition* (2005). Performance limits are used to determine the acceptability of duplicate analysis, and are outlined in Table 17 (Appendix B).

RESULTS

During the course of field observations on the Oso Creek and West Oso Creek, including permitted discharges (Figure 3) 67 potential inflows were identified (Table 1,

Figure 4). Environmental parameters for sites from which samples were collected are included in Appendix B.

Photos of all 67 inflows are available as an electronic appendix to this report.

Of the 67 potential inflows identified, only 13 were found to be flowing during the course of observations. These were all sampled biweekly or weekly from the date of their first observation; the number of sampling events depended on the date first identified (Table 2,Figure 4).

Active discharges were sampled at each sampling event following initial identification. Samples were collected during 18 sampling events ranging from December 3, 2008 through May 25, 2009. Although OCB067 was originally identified on 11/12/08, the initial observation was no flow. OCB038 and OCB067 are located at the same structure. OCB067 did not start actively discharging until April 2009, when it was assigned a number and sampling was begun for that site.

Table 3 summarizes the bacteriological data from each site for each sampling event. *Enterococcus* levels ranged from <1 cfu/100mL to 3660 cfu/100mL. Approximately 30% of the samples exceeded the EPA single sample criterion of 104 cfu/100 mL.

Table 1. Location of Potential Inflows into Oso Creek (including West Oso Creek).

Outfall Number	Date Found	Location	UTM14E	UTM14N	Actively Flowing (Y/N?)
1	8/13/2008	Between Robstown WWTP and Highway 77	632882	3075804	No
2	8/13/2008	Between Robstown WWTP and Highway 77	632900	3075809	No
3	8/13/2008	Between Robstown WWTP and Highway 77	632950	3075801	Yes
4	8/13/2008	Between Robstown WWTP and Highway 77	632990	3075390	No
5	8/13/2008	Just at Highway 77	633303	3075802	No
6	8/14/2008	Where highway 77 meets Oso Creek	633466	3075807	No
7	8/14/2008	Just East of highway 77	633555	3075791	No
8	8/14/2008	North of Robstown fairgrounds	633617	3075795	No
9	8/14/2008	Just East of highway 77	633641	3075790	No
10	8/14/2008	About 645 m East of Hwy 77	634103	3075792	No
11	8/14/2008	About 760 m East from Hwy 77	634215	3075791	No
12	8/14/2008	About 790 m East of Hwy 77	634228	3075788	No
13	8/14/2008	About 860 m East of Hwy 77	634335	3075791	No
14	8/14/2008	About 900 m East of Hwy 77	634379	3075788	No
15	8/14/2008	About 1.25 km East of Hwy 77	634522	3075789	No
16	8/14/2008	About 1.3 km East of Hwy 77	634572	3075789	No
17	8/14/2008	About 1.2 km East of Hwy 77	634590	3075788	No

Outfall Number	Date Found	Location	UTM14E	UTM14N	Actively Flowing (Y/N?)
18	8/14/2008	1.4 km downstream from Hwy 77	634658	3075787	No
19	8/14/2008	1.6 km downstream from Hwy 77	634893	3075787	No
20	8/14/2008	1.9 km downstream from Hwy 77	635284	3075791	No
21	8/14/2008	About 470 m upstream from CR-1694	635539	3075787	No
22	8/14/2008	About 470 m upstream from CR-1694	635539	3075787	No
23	8/14/2008	About 260 m upstream from CR-1694	635732	3075790	No
24	8/14/2008	At CR-1694	635983	3075768	No
25	8/14/2008	At CR-1694	635984	3075716	No
26	8/14/2008	225m downstream from CR-24	637742	3075824	No
27	8/14/2008	About 320 m downstream from CR 24	637868	3075823	No
28	8/15/2008	At CR-1694	635987	3075788	No
29	8/15/2008	At CR-1694	636005	3075793	No
30	8/15/2008	At CR-1694	636008	3075797	No
31	8/15/2008	800 m downstream from CR-1694, 730 m upstream from CR-24	636820	3075796	No
32	10/20/2008	About 980 m downstream from CR-24	638295	3075282	No
33	10/20/2008	1.3 km downstream from CR-24	638525	3075081	No
34	10/20/2008	1.74 km downstream from CR-24	638686	3074695	No
35	10/20/2008	240 m upstream from Hwy 44	638708	3074316	No
36	10/20/2008	Just upstream from Hwy 44	638650	3074095	No
37	11/5/2008	About 177 m upstream from Hwy 44	638706	3074243	No
38	11/12/2008	About 60 m downstream from Staples St	657749	3060205	Yes
39	11/12/2008	985 m downstream from Staples St.	657827	3059269	No
40	11/19/2008	About 290 m upstream from Staples	657389	3060311	No
41	11/19/2008	Ditch/Oso intersection-1.5 km upstream from Staples. Sampling site- Oso Parkway between Odessa and Cisco (under road)	656798	3061482	Yes
42	11/19/2008	1.66 km upstream from Staples St	656602	3061339	No
43	11/19/2008	1.7 km upstream from Staples St.	656497	3061432	No
44	1/16/2009	1.28 mi upstream from Staples St.	656221	3061562	No
45	1/16/2009	1.3 mi upstream from Staples St	656112	3061714	No
46	1/16/2009	1.5 mi downstream from Weber Rd	655995	3061851	No
47	1/16/2009	1.14 mi downstream from Weber Rd.	655897	3061836	No
48	1/16/2009	Off Sun Valley at Yorktown & Weber	655722	3063195	Yes
49	1/23/2009	Off Sun Valley at Yorktown & Weber	655562	3063199	No
50	1/23/2009	Just behind Cabaniss Field parking lot	655010	3065492	Yes

Outfall Number	Date Found	Location	UTM14E	UTM14N	Actively Flowing (Y/N?)
51	1/23/2009	Kostoryz/Saratoga Intersection	655087	3065647	Yes
52	1/23/2009	0.5 mi upstream from Weber Rd	654071	3064265	No
53	1/23/2009	300 meters downstream from TX-286	653051	3064643	No
54	1/23/2009	Where TX-286 meets Oso Creek	652779	3064681	Yes
55	1/29/2009	About 825m upstream from TX-286	652217	3065227	No
56	1/29/2009	About 950m upstream from TX-286	652139	3065232	No
57	2/26/2009	Between N-bound & S-bound TX-44	638636	3074012	No
58	2/27/2009	125 m downstream from FM-763	647782	3065993	No
59	2/27/2009	About 1.5 km downstream from FM-763	648908	3065967	No
60	2/27/2009	About 2 km downstream from FM-673	649254	3065868	No
61	3/2/2009	About 100 m upstream from CR-57	641082	3072595	No
62	3/10/2009	Corpus Christi Landfill off TX-286. At end of main road in landfill, site is about 370 m NW of locked gate.	651180	3065980	Yes
63	3/27/2009	Just downstream from Old Brownsville Rd.	645503	3068024	Yes
64	3/30/2009	Just upstream from FM-763	647673	3066087	Yes
65	3/30/2009	About 1.7 km upstream from FM-763	646681	3066591	Yes
66	4/9/2009	About 500 m downstream from FM-2292	645024	3068768	Yes
67	11/12/2008	About 60 m downstream from Staples St	657749	3060205	Yes

Table 2. Actively Discharging Outfalls and Number of Sampling Events for Each Outfall.

Outfall Number	Date Identified	Number of Sampling Events Conducted
OCB003	08/13/08	18
OCB041	11/19/08	17
OCB038	11/21/08	15
OCB048	01/16/09	16
OCB051	01/23/09	14
OCB050	01/23/09	14
OCB054	01/23/09	14
OCB063	03/27/09	9
OCB065	03/30/09	9
OCB064	03/30/09	9
OCB062	03/10/09	6
OCB067	11/12/08	7
OCB066	04/09/09	6

Figure 3. Map showing permitted discharges into Oso Creek.

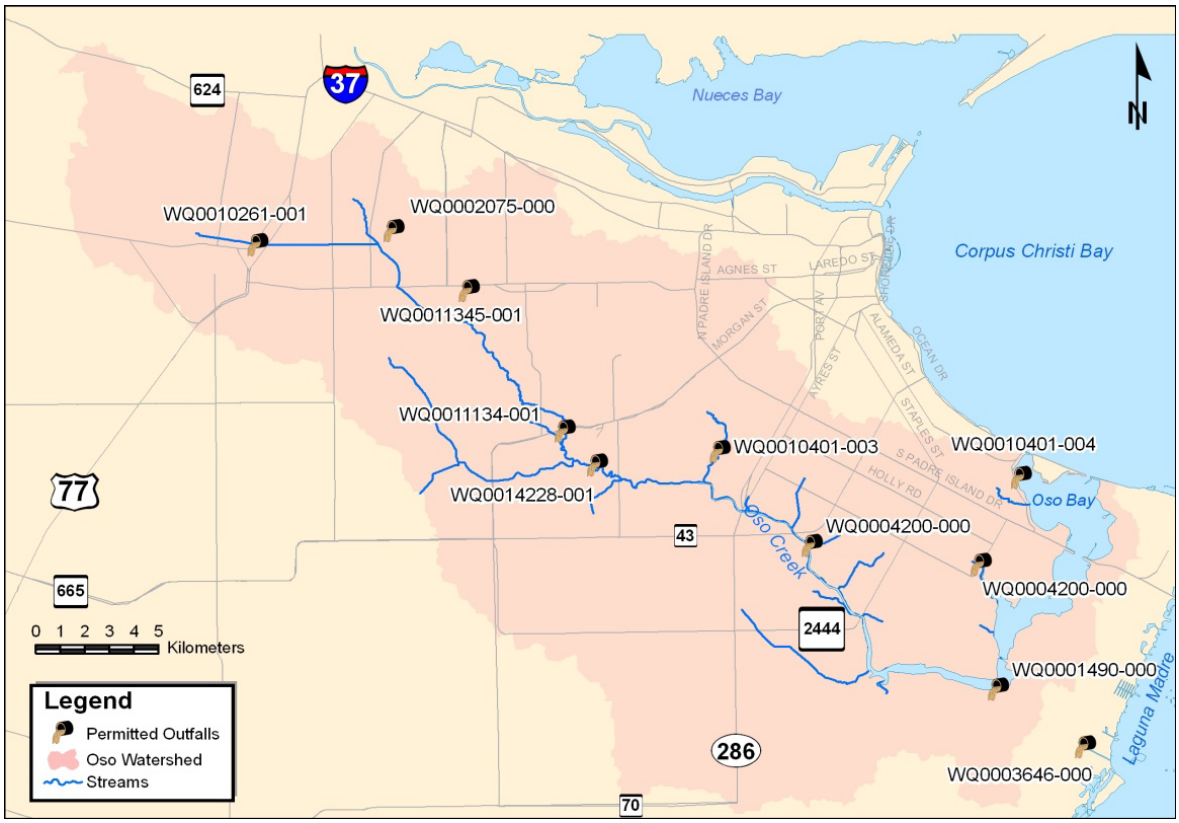


Figure 4. Map showing observed discharge points into Oso Creek.

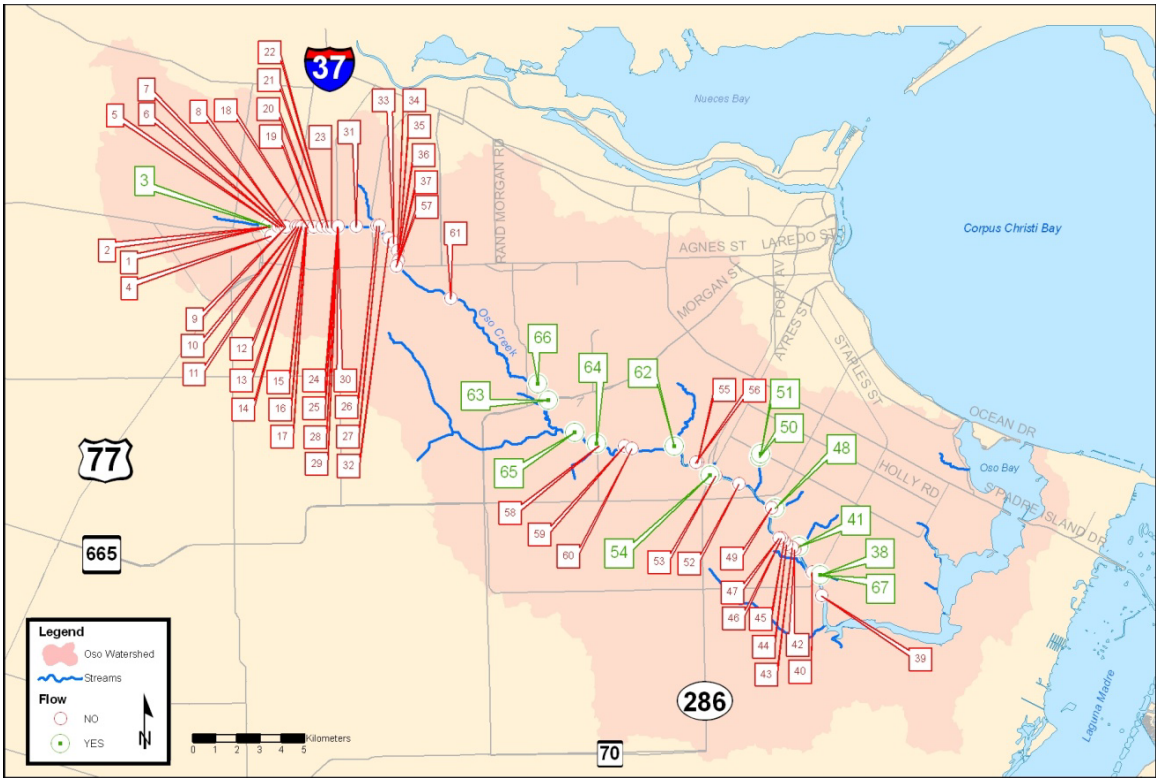


Table 3. Summary of Bacteriological Data from Actively Discharging Outfalls (data is expressed in cfu/100mL).

Site #	Site description	Date	Sample #1	Sample #2	Duplicate
OCB003	Robstown WWTP	12/3/2008	10	6	
OCB041	Oso Parkway	12/3/2008	55	43	41
OCB003	Robstown WWTP	12/17/2008	22	14	
OCB041	Oso Parkway	12/17/2008	6	9	
OCB038	Staples Street, left side	12/17/2008	123	230	90
OCB003	Robstown WWTP	1/22/2009	147	230	
OCB048	Yorktown/Sun Valley	1/22/2009	35	39	37
OCB041	Oso Parkway	1/22/2009	147	190	
OCB038	Staples Street, left side	1/22/2009	190	228	
OCB003	Robstown WWTP	1/28/2009	123	180	
OCB048	Yorktown/Sun Valley	1/28/2009	1300	1360	
OCB041	Oso Parkway	1/28/2009	29	55	

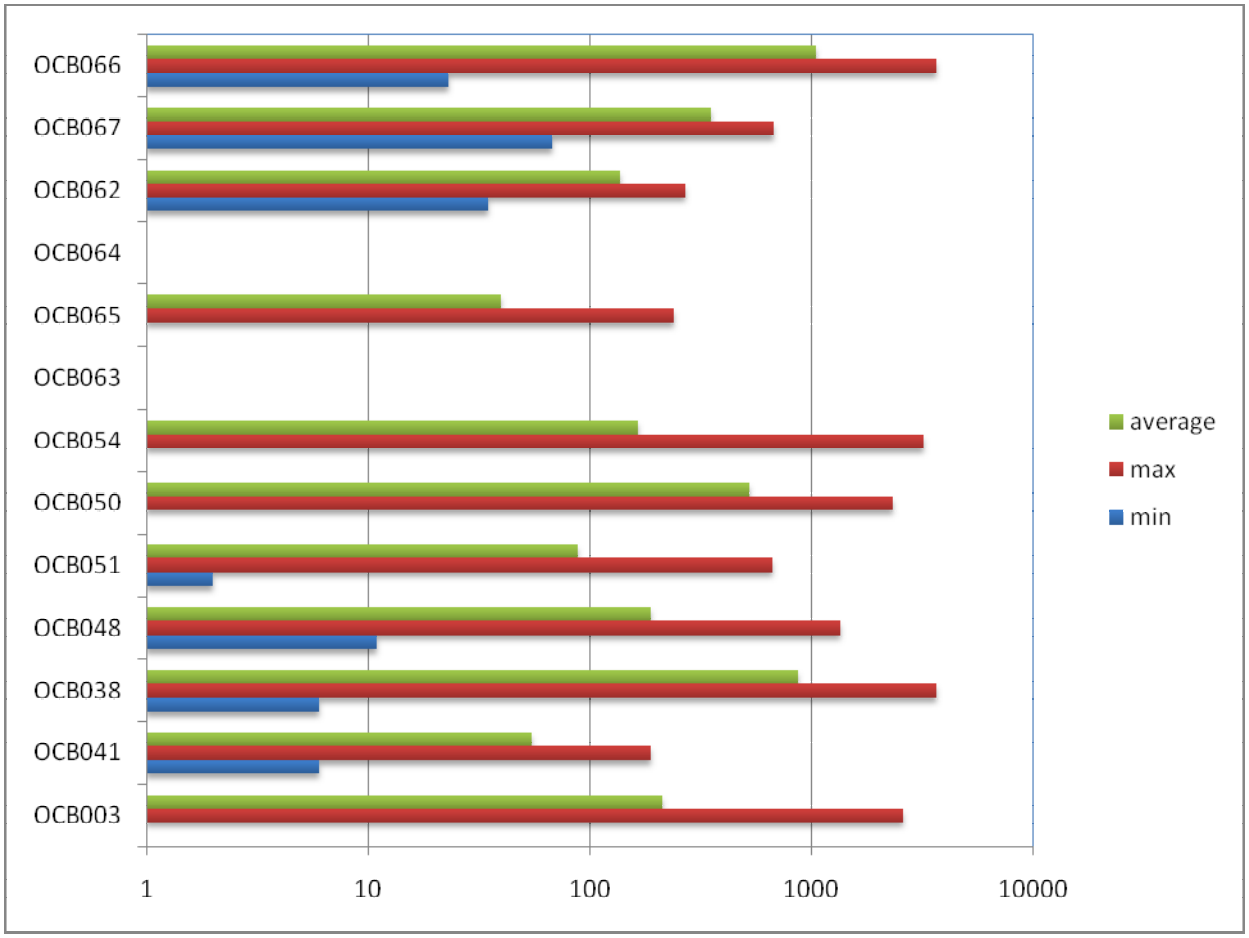
Site #	Site description	Date	Sample #1	Sample #2	Duplicate
OCB038	Staples Street, left side	1/28/2009	2390	2170	2180
OCB003	Robstown WWTP	2/18/2009	>2000	>2000	>2000
OCB051	Kostoryz/Saratoga	2/18/2009	180	145	
OCB050	Cabaniss Field	2/18/2009	530	203	
OCB054	286/Oso Creek	2/18/2009	6	7	
OCB048	Yorktown/Sun Valley	2/18/2009	630	610	
OCB041	Oso Parkway	2/18/2009	12	14	
OCB038	Staples Street, left side	2/18/2009	93	113	
OCB003	Robstown WWTP	2/25/2009	12	9	
OCB051	Kostoryz/Saratoga	2/25/2009	117	83	75
OCB050	Cabaniss Field	2/25/2009	2	3	
OCB054	286/Oso Creek	2/25/2009	170	218	
OCB048	Yorktown/Sun Valley	2/25/2009	53	65	
OCB041	Oso Parkway	2/25/2009	61	80	
OCB038	Staples Street, left side	2/25/2009	49	97	
OCB003	Robstown WWTP	3/4/2009	23	29	
OCB051	Kostoryz/Saratoga	3/4/2009	48	80	
OCB050	Cabaniss Field	3/4/2009	2340	2050	
OCB054	286/Oso Creek	3/4/2009	4	1	2
OCB048	Yorktown/Sun Valley	3/4/2009	26	21	
OCB041	Oso Parkway	3/4/2009	41	48	
OCB038	Staples Street, left side	3/4/2009	40	19	
OCB003	Robstown WWTP	3/11/2009	127	73	
OCB051	Kostoryz/Saratoga	3/11/2009	23	35	
OCB050	Cabaniss Field	3/11/2009	560	590	
OCB054	286/Oso Creek	3/11/2009	36	24	
OCB048	Yorktown/Sun Valley	3/11/2009	22	20	20
OCB041	Oso Parkway	3/11/2009	15	29	
OCB038	Staples Street, left side	3/11/2009	57	40	
OCB003	Robstown WWTP	3/25/2009	130	16	
OCB051	Kostoryz/Saratoga	3/25/2009	20	31	
OCB050	Cabaniss Field	3/25/2009	2	1	
OCB054	286/Oso Creek	3/25/2009	28	39	
OCB048	Yorktown/Sun Valley	3/25/2009	93	54	
OCB041	Oso Parkway	3/25/2009	51	60	46
OCB038	Staples Street, left side	3/25/2009	820	950	
OCB003	Robstown WWTP	4/1/2009	14	6	
OCB063	People's Baptist WWTP	4/1/2009	<1	<1	<1
OCB065	Cuddihy WWTP	4/1/2009	<1	<1	
OCB064	FM763	4/1/2009	<1	<1	
OCB051	Kostoryz/Saratoga	4/1/2009	670	620	
OCB050	Cabaniss Field	4/1/2009	<1	<1	
OCB054	286/Oso Creek	4/1/2009	82	29	

Site #	Site description	Date	Sample #1	Sample #2	Duplicate
OCB048	Yorktown/Sun Valley	4/1/2009	270	320	
OCB041	Oso Parkway	4/1/2009	93	61	
OCB038	Staples Street, left side	4/1/2009	790	800	
OCB003	Robstown WWTP	4/8/2009	2590	2570	
OCB063	People's Baptist WWTP	4/8/2009	<1	<1	
OCB065	Cuddihy WWTP	4/8/2009	< 1	4	
OCB064	FM763	4/8/2009	< 1	< 1	
OCB051	Kostoryz/Saratoga	4/8/2009	< 1	2	
OCB050	Cabaniss Field	4/8/2009	1680	1850	
OCB062	Greenwood Ditch	4/8/2009	38	35	
OCB054	286/Oso Creek	4/8/2009	35	50	3210
OCB048	Yorktown/Sun Valley	4/8/2009	320	55	
OCB041	Oso Parkway	4/8/2009	56	97	
OCB038	Staples Street, left side	4/8/2009	100	90	110
OCB003	Robstown WWTP	4/15/2009	4	11	
OCB063	People's Baptist WWTP	4/15/2009	< 1	< 1	
OCB065	Cuddihy WWTP	4/15/2009	1	< 1	
OCB064	FM763	4/15/2009	< 1	< 1	
OCB051	Kostoryz/Saratoga	4/15/2009	5	4	9
OCB050	Cabaniss Field	4/15/2009	1	1	
OCB062	Greenwood Ditch	4/15/2009	137	103	71
OCB054	286/Oso Creek	4/15/2009	1	3	
OCB048	Yorktown/Sun Valley	4/15/2009	57	57	
OCB041	Oso Parkway	4/15/2009	48	36	
OCB067	Staples Street, right side	4/15/2009	530	680	
OCB003	Robstown WWTP	4/20/2009	< 1	1	
OCB066	Clarkwood Ditch	4/20/2009	47	80	
OCB063	People's Baptist WWTP	4/20/2009	< 1	< 1	
OCB065	Cuddihy WWTP	4/20/2009	1	22	
OCB064	FM763	4/20/2009	< 1	< 1	
OCB051	Kostoryz/Saratoga	4/20/2009	55	90	
OCB050	Cabaniss Field	4/20/2009	320	29	350
OCB062	Greenwood Ditch	4/20/2009	87	107	
OCB054	286/Oso Creek	4/20/2009	59	80	
OCB048	Yorktown/Sun Valley	4/20/2009	25	11	14
OCB041	Oso Parkway	4/20/2009	22	24	
OCB067	Staples Street, right side	4/20/2009	147	113	
OCB003	Robstown WWTP	4/29/2009	1	< 1	
OCB066	Clarkwood Ditch	4/29/2009	208	260	
OCB063	People's Baptist WWTP	4/29/2009	< 1	< 1	
OCB065	Cuddihy WWTP	4/29/2009	< 1	< 1	
OCB064	FM763	4/29/2009	< 1	< 1	< 1
OCB051	Kostoryz/Saratoga	4/29/2009	33	20	
OCB050	Cabaniss Field	4/29/2009	9	4	
OCB062	Greenwood Ditch	4/29/2009	270	260	

Site #	Site description	Date	Sample #1	Sample #2	Duplicate
OCB054	286/Oso Creek	4/29/2009	45	19	30
OCB048	Yorktown/Sun Valley	4/29/2009	51	61	
OCB041	Oso Parkway	4/29/2009	14	14	
OCB038	Staples Street, left side	4/29/2009	53	73	
OCB067	Staples Street, right side	4/29/2009	370	380	
OCB003	Robstown WWTP	5/6/2009	16	16	14
OCB066	Clarkwood Ditch	5/6/2009	40	23	
OCB063	People's Baptist WWTP	5/6/2009	1	1	
OCB065	Cuddihy WWTP	5/6/2009	< 1	< 1	
OCB064	FM763	5/6/2009	< 1	< 1	
OCB051	Kostoryz/Saratoga	5/6/2009	9	39	
OCB050	Cabaniss Field	5/6/2009	< 1	3	
OCB062	Greenwood Ditch	5/6/2009	188	203	
OCB054	286/Oso Creek	5/6/2009	20	24	
OCB048	Yorktown/Sun Valley	5/6/2009	175	133	
OCB041	Oso Parkway	5/6/2009	22	12	10
OCB038	Staples Street, left side	5/6/2009	6	10	
OCB067	Staples Street, right side	5/6/2009	420	673	
OCB003	Robstown WWTP	5/11/2009	< 1	< 1	9
OCB066	Clarkwood Ditch	5/11/2009	3650	3520	
OCB063	People's Baptist WWTP	5/11/2009	< 1	< 1	
OCB065	Cuddihy WWTP	5/11/2009	1	< 1	
OCB064	FM763	5/11/2009	< 1	< 1	
OCB051	Kostoryz/Saratoga	5/11/2009	20	11	
OCB050	Cabaniss Field	5/11/2009	1410	1490	
OCB062	Greenwood Ditch	5/11/2009	117	90	
OCB054	286/Oso Creek	5/11/2009	6	19	
OCB048	Yorktown/Sun Valley	5/11/2009	19	42	
OCB041	Oso Parkway	5/11/2009			
OCB038	Staples Street, left side	5/11/2009	2920	2650	2800
OCB067	Staples Street, right side	5/11/2009	68	90	
OCB003	Robstown WWTP	5/20/2009	26	30	
OCB066	Clarkwood Ditch	5/20/2009	1260	1210	1100
OCB063	People's Baptist WWTP	5/20/2009	< 1	< 1	
OCB065	Cuddihy WWTP	5/20/2009	< 1	240	
OCB064	FM763	5/20/2009	< 1	< 1	
OCB051	Kostoryz/Saratoga	5/20/2009	71	49	
OCB050	Cabaniss Field	5/20/2009	8	1	
OCB062	Greenwood Ditch	5/20/2009	170	173	
OCB054	286/Oso Creek	5/20/2009	33	49	57
OCB048	Yorktown/Sun Valley	5/20/2009	350	165	
OCB041	Oso Parkway	5/20/2009	163	157	
OCB038	Staples Street, left side	5/20/2009	3500	3660	
OCB067	Staples Street, right side	5/20/2009	530	460	
OCB003	Robstown WWTP	5/25/2009	61	63	

Site #	Site description	Date	Sample #1	Sample #2	Duplicate
OCB066	Clarkwood Ditch	5/25/2009	1320	1020	
OCB063	People's Baptist WWTP	5/25/2009	< 1	< 1	
OCB065	Cuddihy WWTP	5/25/2009	< 1	8	
OCB064	FM763	5/25/2009	< 1	< 1	
OCB051	Kostoryz/Saratoga	5/25/2009	47	38	48
OCB050	Cabaniss Field	5/25/2009	157	117	
OCB062	Greenwood Ditch	5/25/2009	NA	NA	
OCB054	286/Oso Creek	5/25/2009	270	450	360
OCB048	Yorktown/Sun Valley	5/25/2009	27	36	
OCB041	Oso Parkway	5/25/2009	87	100	
OCB038	Staples Street, left side	5/25/2009	1040	1050	
OCB067	Staples Street, right side	5/25/2009	260	210	

Figure 5. Minimum, maximum and average Enterococcus levels for each site. Sites without a bar for the minimum level had a value of 1 for the minimum.



Site-by-Site Analysis

Bacteriological data from each site has been summarized both in tabular and graphic form. The sites are described in order of discovery.

OCB003

OCB003 is located in Robstown at the discharge for the Robstown Wastewater Treatment Plant.

Enterococcus levels for this site ranged from <1 to 2590 cfu/100mL. Mean *Enterococcus* level for all samples at this site was 212 cfu/100mL. Median level was 22 cfu/100mL and mode was 14 cfu/100mL.

Figure 6. Photo of OCB003 outflow.

Table 4. Summary of Bacteriological Data for OCB003 (Robstown WWTP)

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB003	12/03/08	10	6		8	1.71
OCB003	12/17/08	22	14		18	1.55
OCB003	01/22/09	147	230		189	1.86
OCB003	01/28/09	123	180		152	1.86
OCB003	02/18/09	>2000	>2000	>2000	>2000	1.55
OCB003	02/25/09	12	9		11	1.55
OCB003	03/04/09	23	29		26	1.86
OCB003	03/11/09	127	73		100	2.02
OCB003	03/25/09	130	16		73	1.86
OCB003	04/01/09	14	6		10	1.86
OCB003	04/08/09	2590	2570		2580	1.86
OCB003	04/15/09	4	11		8	1.86
OCB003	04/20/09	< 1	1		1	1.86
OCB003	04/29/09	< 1	< 1		1	1.71
OCB003	05/06/09	16	16	14	15	2.02
OCB003	05/11/09	< 1	< 1	9	4	2.02
OCB003	05/20/09	26	30		28	1.71
OCB003	05/25/09	61	63		62	1.71

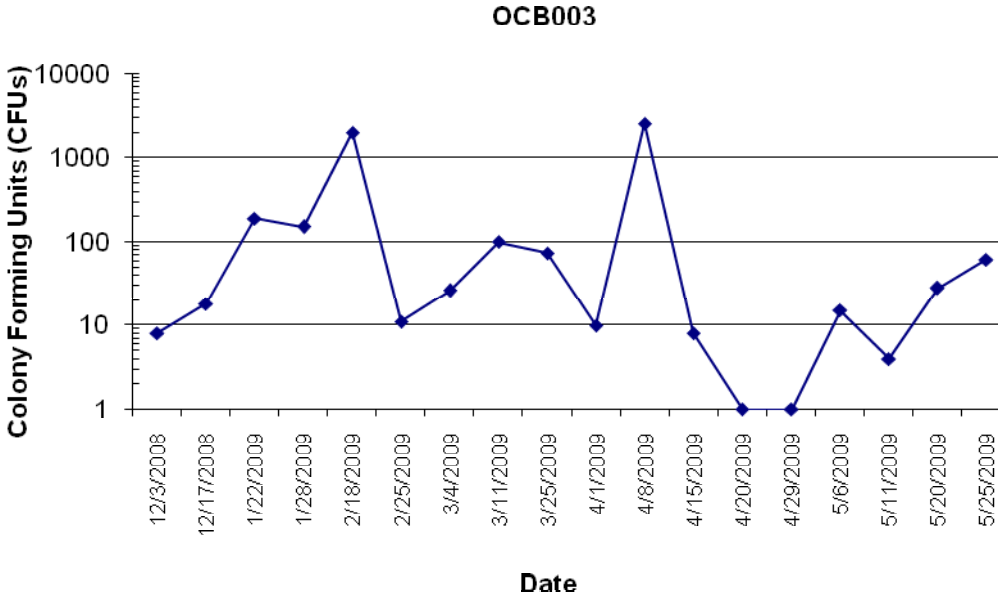


Figure 7. Summary of Bacteriological Data for OCB003.

OCB041

OCB041 is located on Oso Parkway between Odessa Dr and Cisco Circle. This is a large ditch running through the neighborhood that intersects with Oso Creek about 1.5 km upstream from Staples St.

Enterococcus levels at this site ranged from 6 to 190 cfu/100mL. The mean *Enterococcus* level for all samples at this site was 55 cfu/100mL. The median and mode levels were 46 cfu/100mL and 14 cfu/100mL, respectively.

Figure 8. Photo of OCB041 Outflow.

Table 5. Summary of Bacteriological Data for OCB041 (Oso Parkway).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB041	12/03/08	55	43	41	46	0.23
OCB041	12/17/08	6	9		8	0.56
OCB041	01/22/09	147	190		169	0.16
OCB041	01/28/09	29	55		42	0.29
OCB041	02/18/09	12	14		13	0.16
OCB041	02/25/09	61	80		71	0.16
OCB041	03/04/09	41	48		45	0.16
OCB041	03/11/09	15	29		22	0.29
OCB041	03/25/09	51	60	46	52	0.56
OCB041	04/01/09	93	61		77	0.18
OCB041	04/08/09	56	97		77	0.16
OCB041	04/15/09	48	36		42	0.06
OCB041	04/20/09	22	24		23	0.06
OCB041	04/29/09	14	14		14	0.06
OCB041	05/06/09	22	12	10	15	0.06
OCB041	05/11/09	DRY	DRY	NA	NA	NA
OCB041	05/20/09	163	157		160	0.11
OCB041	05/25/09	87	100		94	0.16

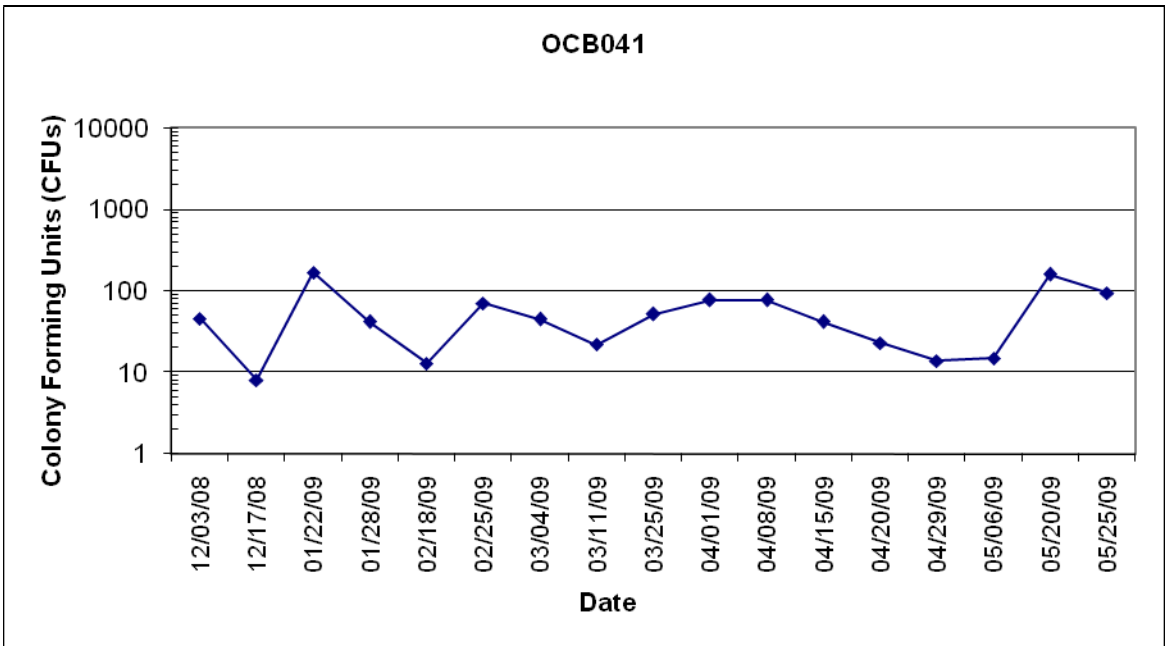


Figure 9. Summary of Bacteriological Data for OCB041.

OCB038

OCB038 is located in the King's Crossing neighborhood off Staples St, and is found behind the houses on Valtourmanche Dr. The drains empty into a small ditch that flows towards the Oso Creek.

The *Enterococcus* levels for this site ranged from 6 to 3660 cfu/100mL. The average level for all samples at this site was 869 cfu/100mL. The median *Enterococcus* level was 157 cfu/100mL and the mode was 90 cfu/100mL.

Figure 10. Photo of OCB038.

Table 6. Summary of Bacteriological Data for OCB038 (Oso Parkway)

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB038	12/17/08	123	230	90	148	0.16
OCB038	01/22/09	190	228		209	0.26
OCB038	01/28/09	2390	2170	2180	2247	0.46
OCB038	02/18/09	93	113		103	0.16
OCB038	02/25/09	49	97		73	0.25
OCB038	03/04/09	40	19		30	0.25
OCB038	03/11/09	57	40		49	0.25
OCB038	03/25/09	820	950		885	0.21
OCB038	04/01/09	790	800		795	0.18
OCB038	04/08/09	100	90	110	100	0.10
OCB038	04/29/09	53	73		63	0.25
OCB038	05/06/09	6	10		8	0.10
OCB038	05/11/09	2920	2650	2800	2790	0.09
OCB038	05/20/09	3500	3660		3580	0.35
OCB038	05/25/09	1040	1050		1045	0.46

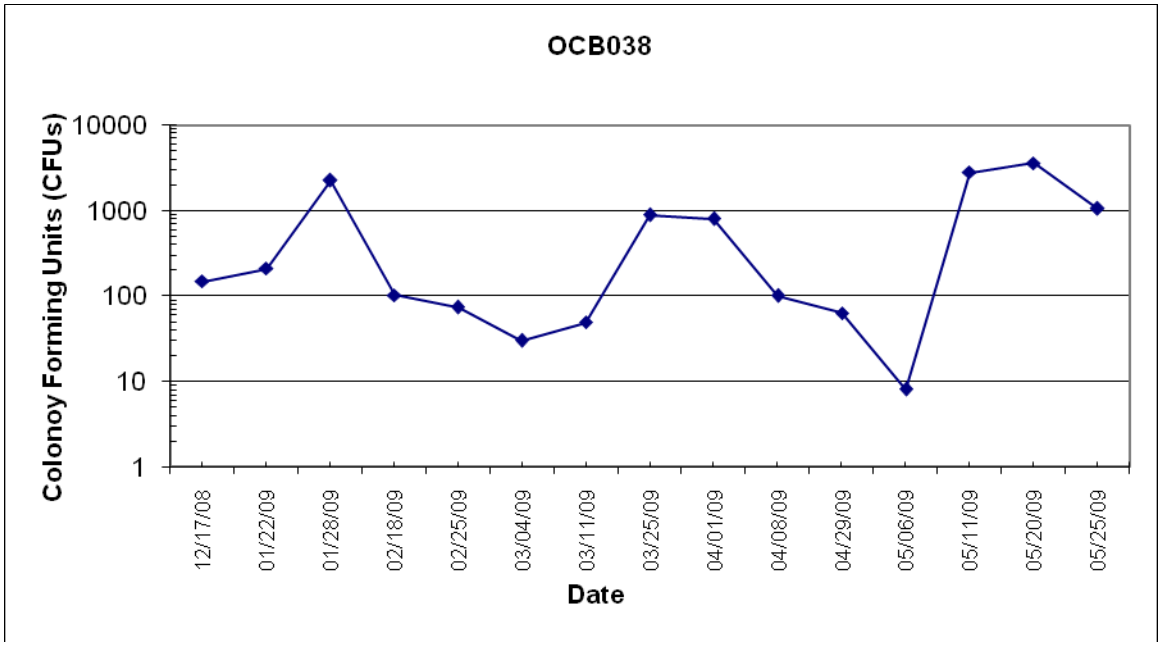


Figure 11. Summary of Bacteriological Data for OCB038.

OCB048

OCB048 is located at Sun Valley Dr near the intersection of Yorktown Blvd and Weber Rd. This is a large ditch running through the neighborhood, starting above Saratoga Blvd.

Levels of *Enterococcus* ranged from 11 to 1360 cfu/100mL at this site. The average level was 188 cfu/100mL. The median and mode levels for *Enterococcus* were 54 and 20 cfu/100mL, respectively.

Figure 12. Photo of OCB048 Outflow.

Table 7. Summary of Bacteriological Data for OCB048 (Sun Valley at Yorktown and Weber).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB048	01/22/09	35	39	37	37	0.36
OCB048	01/28/09	1300	1360		1330	0.07
OCB048	02/18/09	630	610		620	0.03
OCB048	02/25/09	53	65		59	0.02
OCB048	03/04/09	26	21		24	0.07
OCB048	03/11/09	22	20	20	21	0.05
OCB048	03/25/09	93	54		74	0.07
OCB048	04/01/09	270	320		295	0.15
OCB048	04/08/09	320	55		188	0.04
OCB048	04/15/09	57	57		57	0.06
OCB048	04/20/09	25	11	14	17	0.06
OCB048	04/29/09	51	61		56	0.12
OCB048	05/06/09	175	133		154	0.04
OCB048	05/11/09	19	42		31	0.02
OCB048	05/20/09	350	165		258	0.04
OCB048	05/25/09	27	36		32	0.06

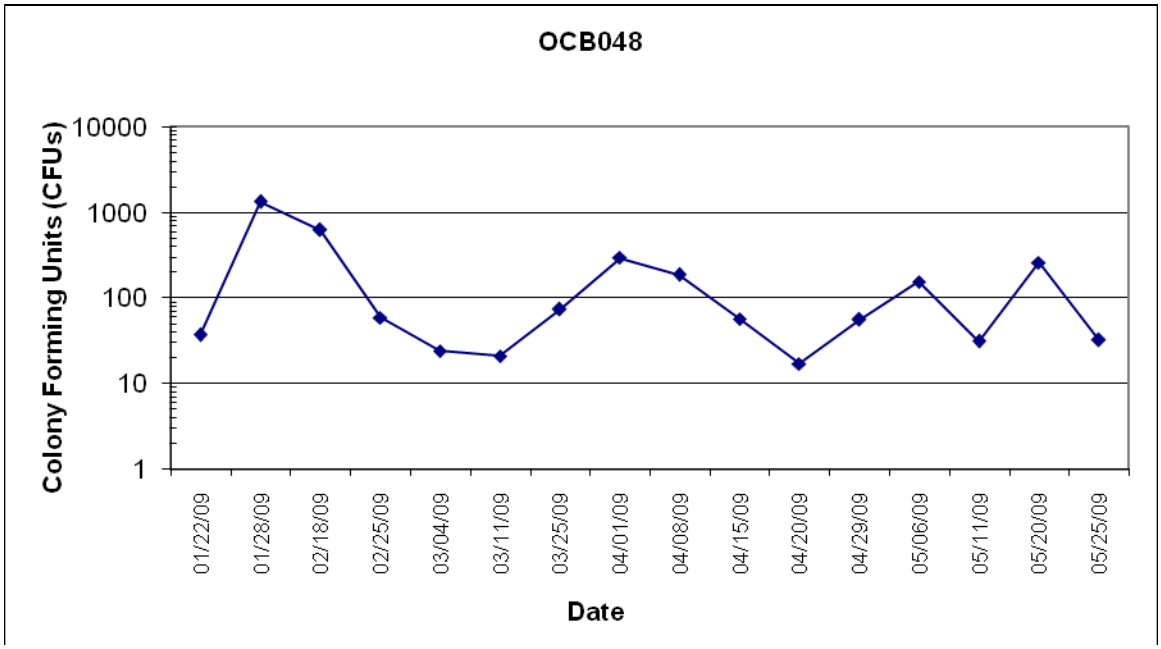


Figure 13. Summary of Bacteriological Data for OCB048

OCB051

OCB051 is located at the Kostoryz Rd and Saratoga Blvd intersection. There are several openings that flow out from under Kostoryz Rd. They flow over a cement slab then empty into a large ditch that flows out to the Oso Creek.

Enterococcus levels ranged from 2 to 670 cfu/100mL at this site. The mean level was 89 cfu/100mL. The median and mode were 43 and 20 cfu/100mL, respectively.

Figure 14. Photo of OCB051.

Table 8. Summary of Bacteriological Data for OCB051 (Kostoryz and Saratoga).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB051	02/18/09	180	145		163	0.15
OCB051	02/25/09	117	83	75	92	0.05
OCB051	03/04/09	48	80		64	0.07
OCB051	03/11/09	23	35		29	0.04
OCB051	03/25/09	20	31		26	0.05
OCB051	04/01/09	670	620		645	0.07
OCB051	04/08/09	< 1	2		2	0.10
OCB051	04/15/09	5	4	9	6	0.01
OCB051	04/20/09	55	90		73	0.01
OCB051	04/29/09	33	20		27	0.06
OCB051	05/06/09	9	39		24	0.03
OCB051	05/11/09	20	11		16	0.01
OCB051	05/20/09	71	49		60	0.08
OCB051	05/25/09	47	38	48	44	0.23

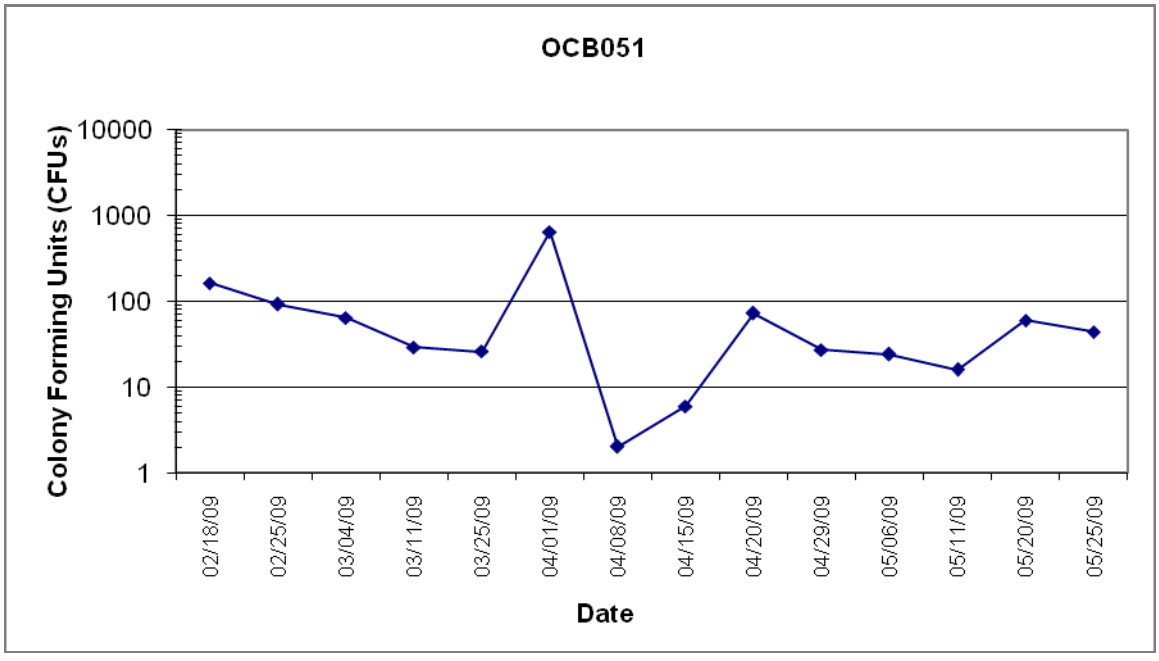


Figure 15. Summary of Bacteriological Data for OCB051.

OCB050

OCB050 is located at near OCB051 off of Cabaniss Pkwy. This is a large plastic pipe that flows into the same ditch as OCB051. The pipe is just behind the Cabaniss Field parking lot.

The *Enterococcus* levels at this site ranged from <1 to 2340 cfu/100mL. The mean level was 527 cfu/100mL. Median *Enterococcus* level was 137 cfu/100mL, and the mode was 1 cfu/100mL.

Figure 16. Photo of OCB050 Outflow.

Table 9. Summary of Bacteriological Data for OCB050 (Cabaniss Field).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB050	02/18/09	530	203		367	0.01
OCB050	02/25/09	2	3		3	<0.01
OCB050	03/04/09	2340	2050		2195	<0.01
OCB050	03/11/09	560	590		575	<0.01
OCB050	03/25/09	2	1		2	<0.01
OCB050	04/01/09	<1	<1		1	<0.01
OCB050	04/08/09	1680	1850		1765	0.01
OCB050	04/15/09	1	1		1	<0.01
OCB050	04/20/09	320	29	350	233	<0.01
OCB050	04/29/09	9	4		7	0.01
OCB050	05/06/09	< 1	3		2	0.01
OCB050	05/11/09	1410	1490		1450	0.01
OCB050	05/20/09	8	1		5	<0.01
OCB050	05/25/09	157	117		137	<0.01

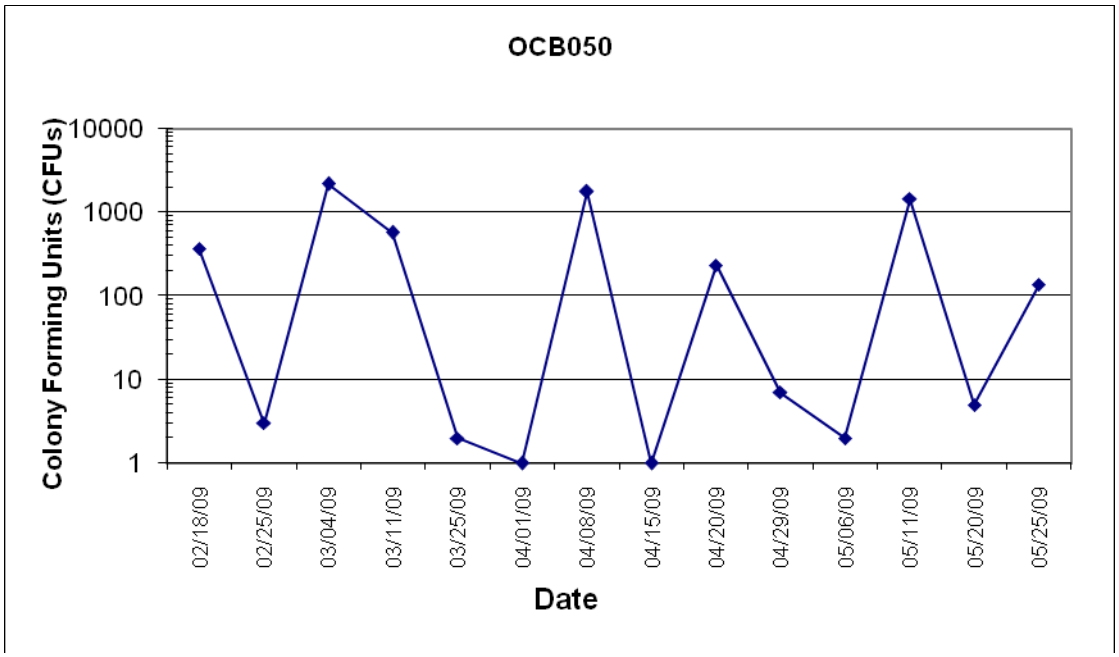


Figure 17. Summary of Bacteriological Data for OCB050.

OCB054

OCB054 is located where TX-286 crosses over the Oso Creek. There is a cement drain that empties into a ditch that leads to the Oso Creek.

Enterococcus levels at this site ranged from <1 to 3210 cfu/100mL. The mean level for *Enterococcus* was 166 cfu/100mL. The median and mode were 33 and 6 cfu/100mL, respectively.

Figure 18. Photo of OCB054.

Table 10. Summary of Bacteriological Data for OCB054 (TX-286 and Oso Creek).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB054	02/18/09	6	7		7	0.05
OCB054	02/25/09	170	218		194	0.05
OCB054	03/04/09	4	1	2	2	0.09
OCB054	03/11/09	36	24		30	0.04
OCB054	03/25/09	28	39		34	0.08
OCB054	04/01/09	82	29		56	0.05
OCB054	04/08/09	35	50	3210	1098	0.05
OCB054	04/15/09	1	3		2	0.05
OCB054	04/20/09	59	80		70	0.13
OCB054	04/29/09	45	19	30	31	0.13
OCB054	05/06/09	20	24		22	0.06
OCB054	05/11/09	6	19		13	0.03
OCB054	05/20/09	33	49	57	46	0.02
OCB054	05/25/09	270	450	360	360	0.03

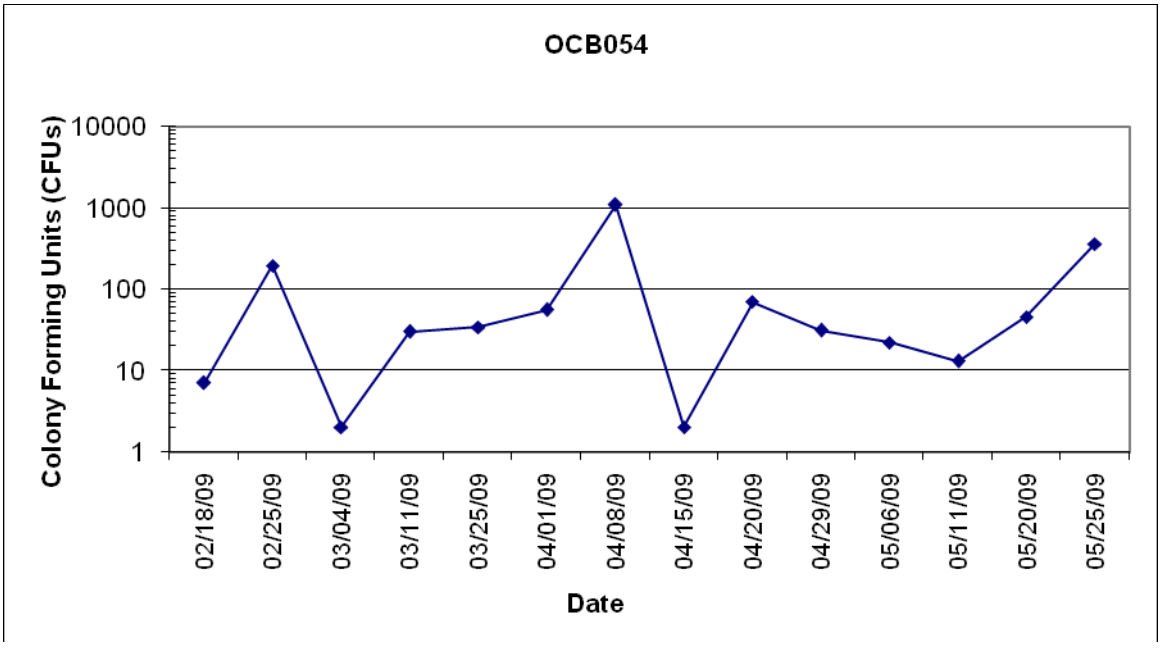


Figure 19. Summary of Bacteriological Data for OCB054.

OCB063

OCB063 is located just downstream from Old Brownsville Rd. This is a small plastic pipe coming from the People's Baptist Church WWTP. The water from this pipe flows down a small embankment into Oso Creek.

Enterococcus levels at this site were extremely low and ranged from <1 to 1 cfu/100mL throughout the sampling events. Mean and median were 1 cfu/100mL, and mode was <1 cfu/100mL.

Figure 20. Photo of OCB063.

Table 11. Summary of Bacteriological Data for OCB063 (People's Baptist WWTP).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB063	04/01/09	<1	<1	<1	<1	0.01
OCB063	04/08/09	<1	<1		<1	0.01
OCB063	04/15/09	< 1	< 1		<1	<0.01
OCB063	04/20/09	< 1	< 1		<1	0.01
OCB063	04/29/09	< 1	< 1		<1	0.01
OCB063	05/06/09	1	1		1	<0.01
OCB063	05/11/09	< 1	< 1		<1	<0.01
OCB063	05/20/09	< 1	< 1		<1	0.01
OCB063	05/25/09	< 1	< 1		<1	0.01

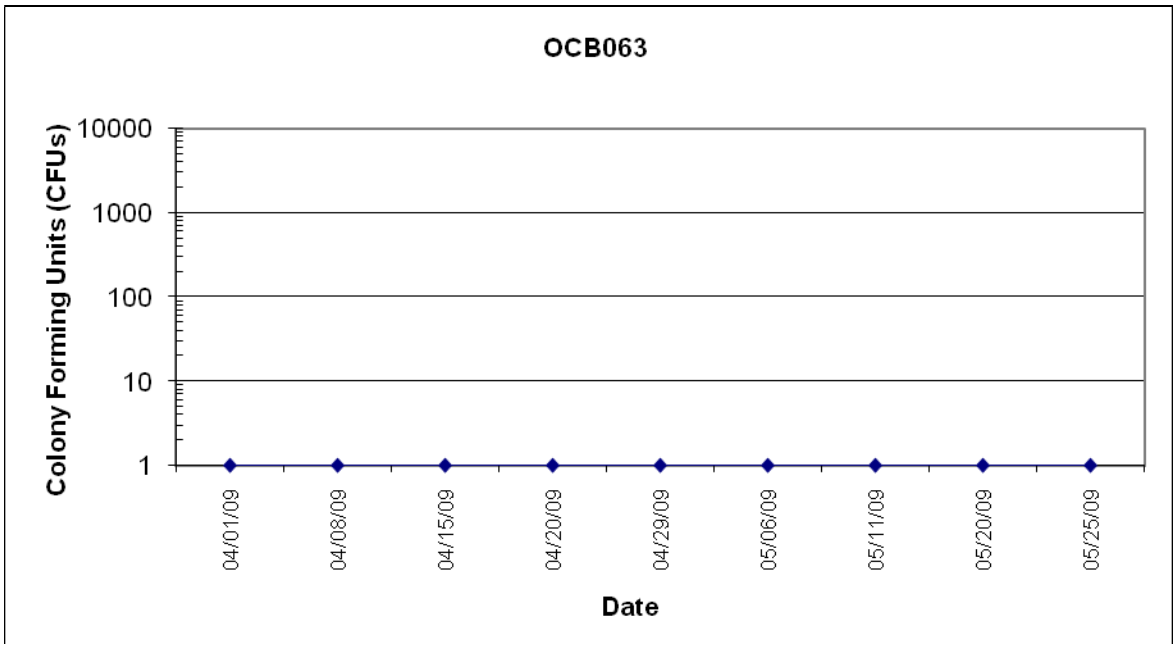


Figure 21. Summary of Bacteriological Data for OCB063.

OCB065

OCB065 is located 1.7 km upstream from FM-763. It is a pipe from the Cuddihy WWTP on the same land as OCB063, which is owned by the People's Baptist Church. A pool of water forms over the pipe and gradually flows down a small path towards Oso Creek.

Enterococcus levels at this site ranged from <1 to 240 cfu/100mL. The average level was 40 cfu/100mL, with a median of 4 cfu/100mL and a mode of <1 cfu/100mL.

Figure 22. Photo of OCB065.

Table 12. Summary of Bacteriological Data for OCB065 (Cuddihy WWTP).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB065	04/01/09	< 1	< 1		< 1	< 0.01
OCB065	04/08/09	< 1	4		3	< 0.01
OCB065	04/15/09	1	< 1		1	0.09
OCB065	04/20/09	1	22		12	0.08
OCB065	04/29/09	< 1	< 1		< 1	0.08
OCB065	05/06/09	< 1	< 1		< 1	0.03
OCB065	05/11/09	1	< 1		1	0.03
OCB065	05/20/09	< 1	240		121	0.02
OCB065	05/25/09	< 1	8		5	0.02

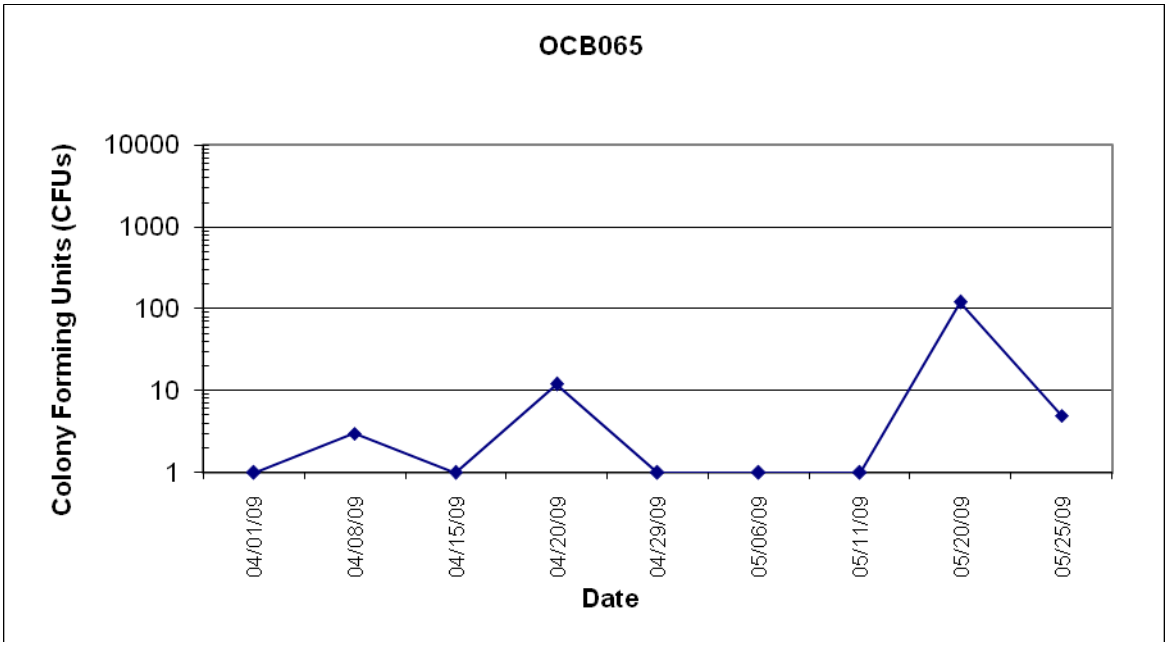


Figure 23. Summary of Bacteriological Data for OCB065.

OCB064

OCB064 is located just upstream from FM-763. There is no apparent pipe, but instead water appears coming out of a hole in the ground. The water flows down the bank of the creek directly into the Oso Creek.

Not a single *Enterococcus* colony was isolated from the nine sampling events at this location. All levels were reported as <1 cfu/100mL, our minimum detectable limit.

Figure 24. Photo of OCB064.

Table 13. Summary of Bacteriological Data for OCB064 (FM763).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB064	04/01/09	< 1	<1		<1	0.01
OCB064	04/08/09	< 1	< 1		<1	0.01
OCB064	04/15/09	< 1	< 1		<1	<0.01
OCB064	04/20/09	< 1	< 1		<1	<0.01
OCB064	04/29/09	< 1	< 1	< 1	<1	<0.01
OCB064	05/06/09	< 1	< 1		<1	<0.01
OCB064	05/11/09	< 1	< 1		<1	<0.01
OCB064	05/20/09	< 1	< 1		<1	0.01
OCB064	05/25/09	< 1	< 1		<1	0.01

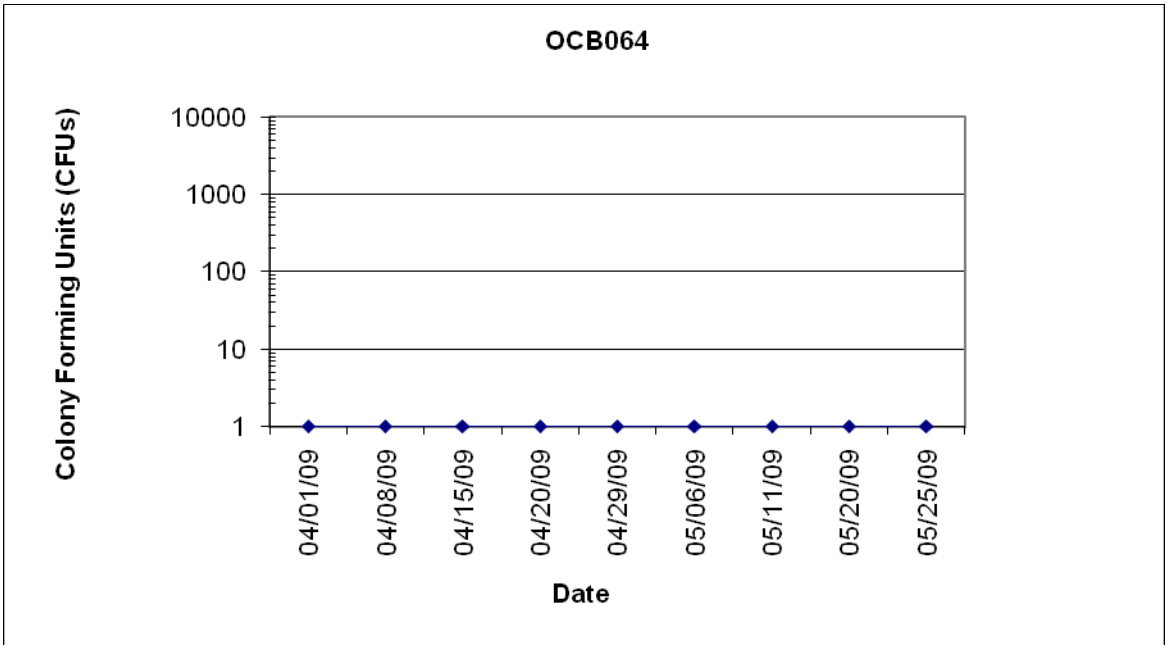


Figure 25. Summary of Bacteriological Data for OCB064.

OCB062

OCB062 is located inside the Corpus Christi landfill off TX-286. The sampling site is 370m NW of the locked gate at the end of the main road in the landfill. It is a large creek that flows from the Cabaniss airport area and passes under Saratoga at Greenwood. The Greenwood WWTP also discharges into this creek. Thus the site is a combination of runoff and outflow from the WWTP. This creek empties into Oso Creek 2.4 km upstream from TX-286.

The *Enterococcus* levels at this site ranged from 35 to 270 cfu/100mL. The mean level was 137 cfu/100mL, with a median of 117 cfu/100mL. Mode for this site is not applicable, as no values were repeated.

Figure 26. Photo of OCB062.

Table 14. Summary of Bacteriological Data for OCB062 (Greenwood Ditch).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB062	04/08/09	38	35		37	8.97
OCB062	04/15/09	137	103	71	104	9.09
OCB062	04/20/09	87	107		97	8.48
OCB062	04/29/09	270	260		265	9.14
OCB062	05/06/09	188	203		195	9.59
OCB062	05/11/09	117	90		104	9.44
OCB062	05/20/09	170	173		172	8.55
OCB062	05/25/09	Access to site closed (landfill)				

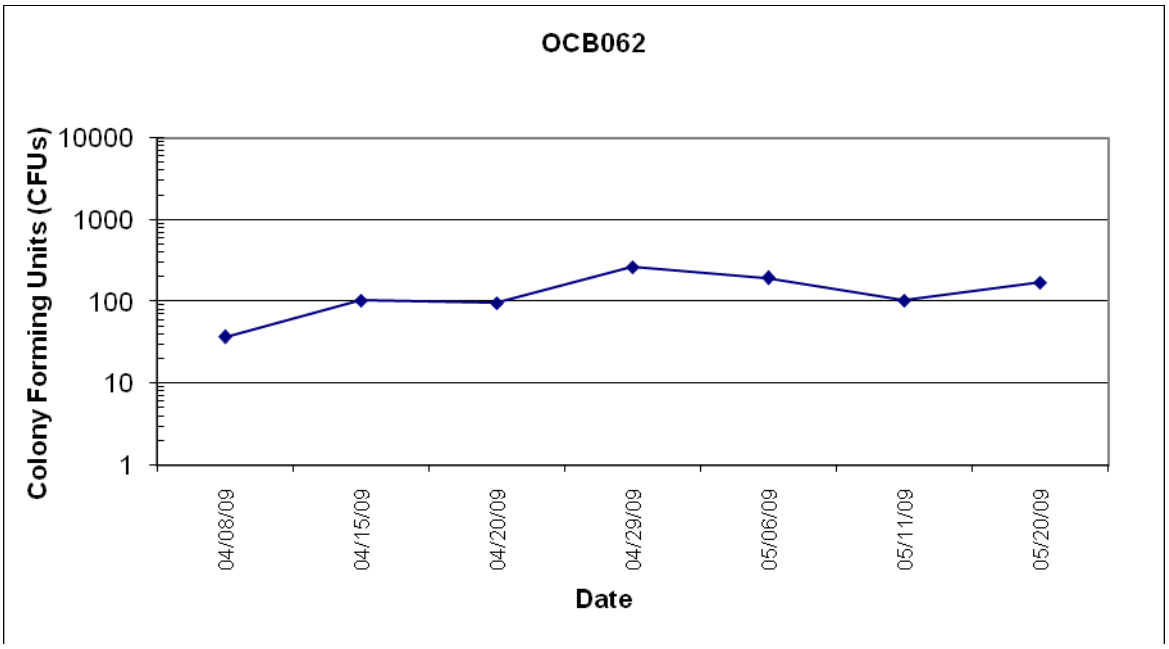


Figure 27. Summary of Bacteriological Data for OCB062.

OCB067

OCB067 is at the same location as OCB038, in the King's Crossing neighborhood off Staples St, and is found behind the houses on Valtourmanche Dr., however a separate flow on the south end of the drainage was noted on 4/15/2009 and sampled as a separate site. The water drains empty into a small ditch that flows towards Oso Creek. *Enterococcus* levels at this site ranged from 68 to 680 cfu/100mL.

The average *Enterococcus* level was 352 cfu/100mL. The median and mode levels were 375 and 530 cfu/100mL, respectively.

Figure 28. Photo of OCB067.

Table 15. Summary of Bacteriological Data for OCB067 (Staples Street, Right Side).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB067	04/15/09	530	680		605	0.21
OCB067	04/20/09	147	113		130	0.01
OCB067	04/29/09	370	380		375	0.01
OCB067	05/06/09	420	673		547	0.01
OCB067	05/11/09	68	90		79	0.01
OCB067	05/20/09	530	460		495	0.01
OCB067	05/25/09	260	210		235	<0.01

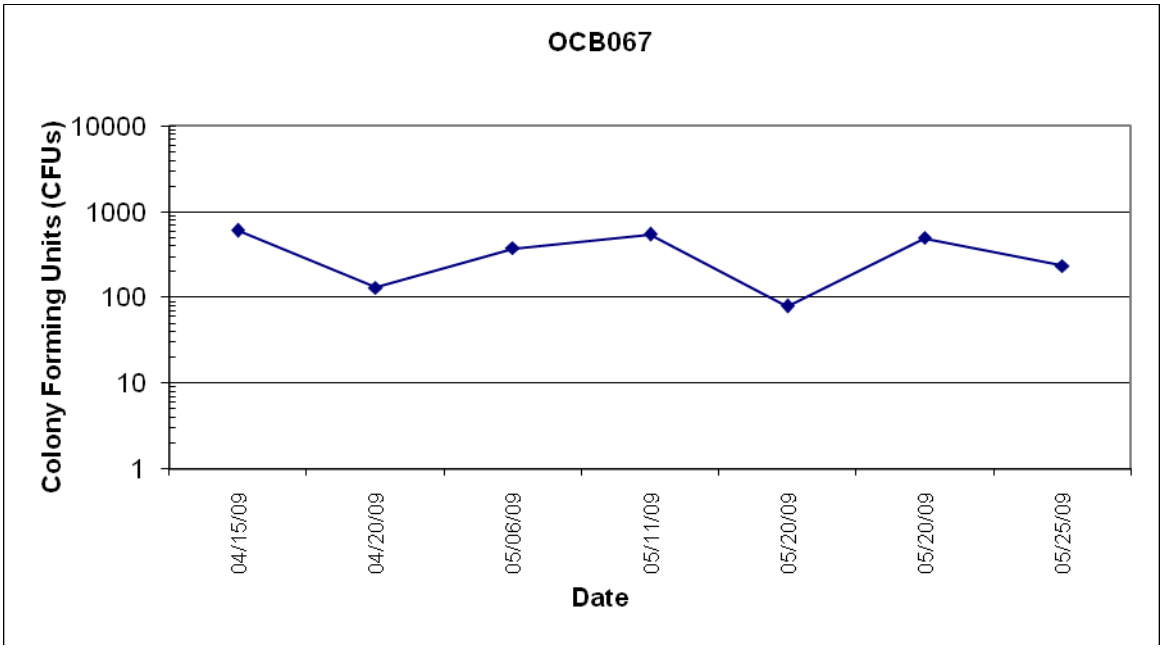


Figure 29. Summary of Bacteriological Data for OCB067.

OCB066

OCB066 is located approximately 500 m downstream from FM-2292. It is a large ditch that empties into Oso Creek between Old Brownsville Rd and FM-2292. For access reasons the samples were taken from a road that crosses the ditch just upstream from the intersection of the ditch and the creek.

The *Enterococcus* levels at this site ranged from 23 to 3650 cfu/100mL. The average level was 1057 cfu/100mL, and the median was 1020 cfu/100mL. The mode is not applicable for this site, as no values were repeated.

Figure 30. Photo of OCB 066.

Table 16. Summary of Bacteriological Data for OCB066 (Clarkwood Ditch).

Site #	Date	Enterococcus CFU/100 ML				Flow cfs
		Sample #1	Sample #2	Duplicate	Average	
OCB066	04/20/09	47	80		64	Stagnant
OCB066	04/29/09	208	260		234	Stagnant
OCB066	05/06/09	40	23		32	Stagnant
OCB066	05/11/09	3650	3520		3585	Stagnant
OCB066	05/20/09	1260	1210	1100	1235	Stagnant
OCB066	05/25/09	1320	1020		1170	Stagnant

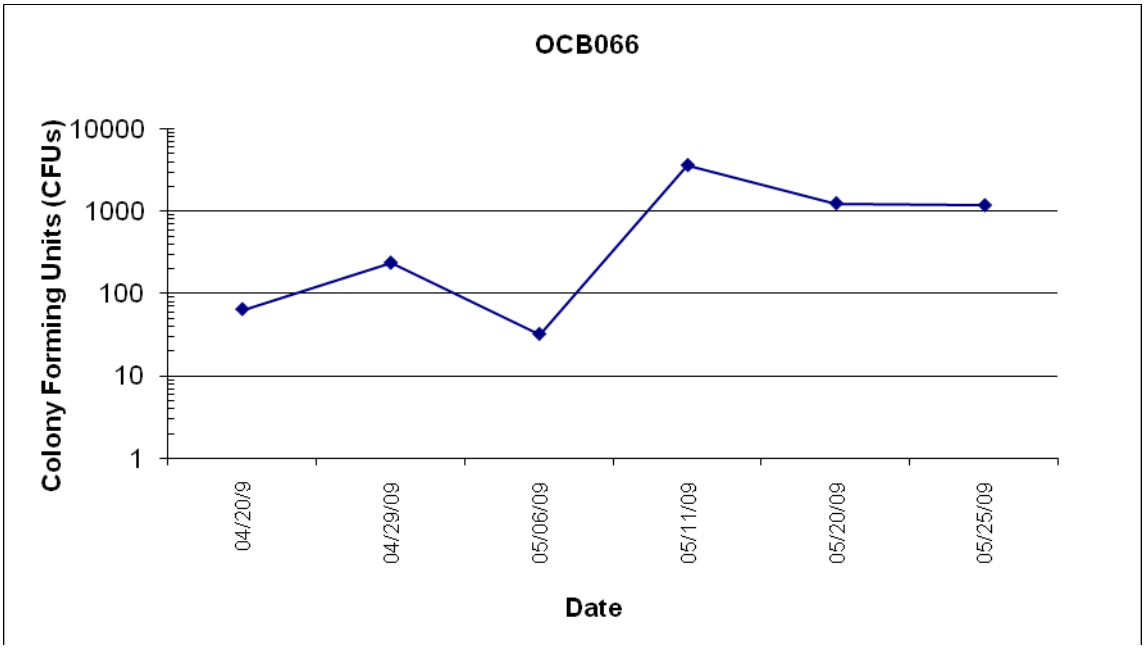


Figure 31. Summary of Bacteriological Data for OCB066.

DISCUSSION

Of the 67 potential inflows found along Oso and West Oso Creeks, only 13 were actively discharging under dry weather conditions, during the course of this project. At one site, OCB067, there was no discharge until five months after its discovery. The reason for the sudden change to actively flowing is unknown. Of the actively flowing sites the majority was found along the middle and lower stretches of the creek, although there were a number of potential discharge points found upstream. Upstream the creek receives inflow from the Robstown WWTP (OCB003). This inflow generally contained low levels of *Enterococcus* (72% samples were within the EPA single sample criterion of 104 cfu/100mL) with the exception of two sampling events where numbers exceeded 2000 cfu/100 mL. No potential or active inflows were observed along west Oso Creek.

Enterococcus levels did not show trends among sites during shared sampling events. In other words, when some sites were high, others were low. There was not a single sampling event where all sites demonstrated very high levels.

Additionally, most individual sites did not exhibit any trends over time. The *Enterococcus* levels at most sites fluctuated throughout the sampling period. These sites had levels that ranged from very low to very high. For example, the lowest bacterial level at OCB003 was <1 cfu/100mL, but the highest was 2590 cfu/100mL. However, two sites, OCB062 and OCB067, seemed to have relatively stable *Enterococcus* levels over time.

No single site demonstrated very high levels consistently throughout the sampling period. Two sites, OCB063 and OCB064, exhibited extremely low levels for each sampling event. Samples from both sites tested negative for residual chlorine during the course of sampling, excluding that as a possible reason for such low numbers.

The proportion of samples which exceeded the EPA single sample criterion of 104 cfu/100mL varied for each site, ranging from <1% (OCB063, OCB064) to 86% (OCB067).

Based on the results of this study, there appears to be some contribution by dry weather inflows, to the bacterial loadings into the creek.

RECOMMENDATIONS FOR FUTURE WORK

Bacterial source tracking should be applied in this watershed to identify the types of sources contributing to the bacterial levels found at actively discharging inflows that are not permitted WWTP outfalls. Identifying these sources could help pinpoint the types of activities that are contributing to the bacterial loadings in the creek under normal flow conditions.

The TAMU-CC EML is currently investigating sources of unknown source *Enterococcus* isolates in the upper Oso Creek watershed within surface water, groundwater, sediment, and soil samples through funding provided by the Texas State Soil and Water Conservation Board.

REFERENCES

American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF), "Standard Methods for the Examination of Water and Wastewater," 20th Edition, 1998

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Mott, J. and R. Hay. 2008. Oso Creek Bacteria Contamination Investigation. Quality Assurance Project Plan. Approved 2008.

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United States Environmental Protection Agency. 1986. Bacterial ambient water quality criteria. Federal Register 51(45): 8012-8016.

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United States Environmental Protection Agency. 2000. Improved enumeration methods for the recreational water quality indicators: Enterococci and *E. coli*. EPA-821/R-97/004. (http://epa.gov/waterscience/methods/biological/1600*Enterococcus*.pdf)

Appendix A.

Field Data Reporting Forms

TEXAS A&M UNIVERSITY
CORPUS CHRISTI

Oso Creek Bacteria Contamination Investigation
Field Photo Log Sheet

Date: _____ Camera Model #: _____

Location Start: _____ Time In: _____ Time Out: _____

Location End: _____ Truck Out: _____ Truck In: _____

GPS Start :_____GPS End:_____ Observation Start:_____Observation End:_____

Photographer Initials: _____ Monitor(s) Name (s): _____

Photo #	Time Taken (CST)	GPS East (UTM)	GPS Northing (UTM)	Download Date	Observations (Looking upstream, downstream, unusual objects)

Other Comments:

TEXAS A&M UNIVERSITY
CORPUS CHRISTI

Oso Creek Bacteria Contamination Investigation
Discharge Location Data Sheet

Date:	Time In: _____ Time Out: _____
GPS Start: _____ GPS End: _____	Truck Out: _____ Truck In: _____
Observation Location Start: _____	Observation Start Time: _____
Observation Location End: _____	Observation End Time: _____
Personnel Initials: _____	Monitor(s) Name (s): _____

VALUE	Parameter	Comments
	Discharge Identifier	
	Time Located (CST)	
	GPS East (UTM)	
	GPS Northing (UTM)	
	# Photos Taken	
	Present Weather 1=Clear (0 to 25%), 2=Cloudy (25 to 99%), 3=Overcast (100%), 4=Rain	
	Water Color 1=Brown, 2=Reddish, 3=Green, 4=Black, 5=Clear, 6=Other	
	Water Odor 1=Sewage, 2=Oily/Chemical, 3=Rotten Eggs, 4=Musky, 5=Fishy, 6=None, 7=Other	
	Water Surface 1=Calm, 2=Ripples, 3=Waves, 4=White Caps	
	Tide Stage 1=Low, 2=Falling, 3=Slack, 4=Rising, 5=High	
	Days Since Last Rainfall	
	Rainfall (Inches past 1 day)	
	Rainfall (Inches past 7days)	

Human Use (Fisherman/Swimmers/Kayakers/Windsurfers):
_____

Other Comments:

Appendix B

Parameters included in the study

Table 17. QAPP Table A7.1 - Measurement Performance Specifications.

PARAMETER	UNITS	METHOD	PARAMETER CODES	AWRL	Lab Reporting Limits	Recovery at Reporting Limits	PRECISION (RPD of LCS/LCSD)	BIAS (% Rec. LCS/LCSD mean)	Laboratory Performing Analysis
Field Parameters (Accessory)									
pH	*pH units*	*EPA 150.1and TCEQ SOP*	*00400*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
DO	*mg/L*	*EPA 360.1and TCEQ SOP*	*00300*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Conductivity	*uS/cm*	*EPA 120.1and TCEQ SOP*	*00094*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Water Temperature	*B C*	*EPA 170.1and TCEQ SOP*	*00010*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Secchi Disk Transparency	*meters*	*TCEQ SOP*	*00078*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Days since last significant rainfall	*days*	*TCEQ SOP*	*72053*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Instantaneous Flow	*cfs*	*TCEQ SOP*	*00061*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Flow measurement method	*1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler*	*TCEQ SOP*	*89835*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Flow Severity	*1-no flow, 2-low, 3-normal, 4-flood, 5-high, 6-dry*	*TCEQ SOP*	*01351*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Total water depth	*meters*	*TCEQ SOP*	*82903*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Salinity	*ppt*	*SM 2520 and TCEQ SOP*	*00480*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Flow estimate	*cfs*	*TCEQ SOP*	*74069*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Maximum pool width	*meters*	*TCEQ SOP*	*89864*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Tide stage	*1-low, 2-falling, 3-slack, 4-rising, 5-high*	*TCEQ SOP*	*89972*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Rainfall (inches past 1 day)	*inches*	*TCEQ SOP*	*82553*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Rainfall (inches past 7 days)	*inches*	*TCEQ SOP*	*82554*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Water color	*1-brown, 2-red, 3-reen, 4-black, 5-clear, 6-other*	*TCEQ SOP*	*89969*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*

PARAMETER	UNITS	METHOD	PARAMETER CODES	AWRL	Lab Reporting Limits	Recovery at Reporting Limits	PRECISION (RPD of LCS/LCSD)	BIAS (% Rec. LCS/LCSD mean)	Laboratory Performing Analysis
Water odor	*1-sewage, 2-oily/chemical 3-rotten eggs, 4-musky, 5-fishy, 6-none, 7-other*	*TCEQ SOP*	*89971*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Water surface	*1-calm, 2-ripple, 3-wave, 4-whitecap*	*TCEQ SOP*	*89968*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Air temperature	*°C*	*TCEQ SOP*	*00020*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Wind intensity	*1-calm, 2-slight, 3-moderate, 4-strong*	*TCEQ SOP*	*89965*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Wind direction	*1-north, 2-south, 3-east, 4-west, 5-northeast, 6-southeast, 7-northwest, 8-southwest*	*TCEQ SOP*	*89010*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Present weather	*1-clear, 2-partly cloudy, 3-cloudy, 4-rain*	*TCEQ SOP*	*89966*	*NA*	*NA*	*NA*	*NA*	*NA*	*field*
Conventional Parameters									
Enterococcus	*CFU/100 mL*	*EPA Method 1600*	31649	*1.0*	1.0	*NA*	3.27 ΣRlog/n*	*NA*	TAMU-CC

*Based on precision calculation method as described in Standard Methods, 20th Edition, Section 9020-B, "QA/QC - Intralaboratory QC Guidelines." This criterion applies to bacteriological duplicates with concentrations >10 org/100 mL.

References for Table A7.1:

United States Environmental Protection Agency (USEPA), "Methods for Chemical Analysis of Water and Wastes," Manual #EPA-600-4-79-020
American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF), "Standard Methods for the Examination of Water and Wastewater," 20th Edition, 1998
TCEQ SOP - *Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue* (December 2003) or subsequent editions.
American Society for Testing and Materials (ASTM) Annual Book of Standards, Vol 11.02

Table 18. Field Parameter Measurements for Sampling Events 12/03/09-01/28/09.

Sample Date	Station ID	Air Temp (°C)	Wind Intensity	Wind Direction	Present Weather	Water Temp (°C)	Conduct. (uS/cm)	Salinity (ppt)	DO (mg/L)	pH (s.u)	Secchi Disk (m)	Water Color	Water Odor	Water Surface	Days since last rainfall	Rainfall past 1 day (in)	Rainfall past 7 days (in)
12/03/2008	OCB003	24.4	strong	South	clear	22.74	1.96	1.00	8.58	7.54	Not available	clear	oily/chemical	ripples	10	0.00	Trace
12/03/2008	OCB041	26.7	strong	South	clear	19.18	11.57	6.62	8.85	7.57	Not available	brown	none	ripples	10	0.00	Trace
12/17/2008	OCB003	7.4	slight	North	overcast	19.76	2.06	1.06	10.31	7.43	0.66	clear	none	ripples	1	Trace	0.15
12/17/2008	OCB041	11.4	slight	North	overcast	12.03	15.10	8.82	9.00	7.6	0.52	brown	none	calm	1	Trace	0.15
12/17/2008	OCB038	14.9	slight	North	overcast	15.90	9.38	5.29	10.46	8.03	0.58	brown	none	calm	1	Trace	0.15
1/22/2009	OCB003	26.0	moderate	South	clear	20.94	2.37	1.22	9.73	7.39	0.16	brown	oily/chemical	waves	5	0.00	Trace
1/22/2009	OCB048	23.4	moderate	Southeast	clear	21.60	8.10	4.60	14.80	8.12	0.24	clear	none	ripples	5	0.00	Trace
1/22/2009	OCB041	23.1	moderate	Southeast	clear	16.03	7.05	3.90	12.19	7.94	0.29	clear	none	ripples	5	0.00	Trace
1/22/2009	OCB038	21.7	moderate	Southeast	clear	15.76	10.66	6.07	11.83	8.08	0.60	clear	none	calm	5	0.00	Trace
1/28/2009	OCB003	7.5	slight	North	cloudy	19.76	2.24	1.15	8.85	7.34	0.51	clear	none	waves	1	0.04	0.04
1/28/2009	OCB048	8.4	slight	North	clear	15.75	7.91	4.41	9.17	7.64	0.56	clear	none	ripples	1	0.04	0.04
1/28/2009	OCB041	8.5	slight	North	clear	14.02	15.41	9.02	9.58	7.67	0.27	clear	none	ripples	1	0.04	0.04
1/28/2009	OCB038	11.6	slight	North	clear	14.89	8.63	4.84	9.56	7.75	0.81	yellow-brown	none	calm	1	0.04	0.04

Table 19. Field Parameter Measurements for Sampling Events 02/18/09-03/04/09.

Sample Date	Station ID	Air Temp (°C)	Wind Intensity	Wind Direction	Present Weather	Water Temp (°C)	Conduct. (uS/cm)	Salinity (ppt)	DO (mg/L)	pH (s.u)	Secchi Disk (m)	Water Color	Water Odor	Water Surface	Days since last rainfall	Rainfall past 1 day (in)	Rainfall past 7 days (in)
2/18/2009	OCB003	23.5	slight	Southeast	cloudy	22.96	2.03	1.04	8.58	7.71	0.35	clear	none	ripples	1	Trace	0.09 + Trace
2/18/2009	OCB051	24.0	slight	Southeast	cloudy	21.26	14.08	8.17	11.73	7.88	0.65	brown	sewage	calm	1.00	Trace	0.09 + Trace
2/18/2009	OCB050	24.5	slight	Southeast	cloudy	21.85	10.91	6.20	8.69	7.28	>1.2	clear	none	ripples	1.00	Trace	0.09 + Trace
2/18/2009	OCB054	25.2	slight	Southeast	cloudy	20.66	19.74	11.79	10.17	7.98	>1.2	clear	sewage	ripples	1.00	Trace	0.09 + Trace
2/18/2009	OCB048	25.1	slight	Southeast	cloudy	21.45	6.46	3.54	8.97	7.82	0.60	clear	none	ripples	1.00	Trace	0.09 + Trace
2/18/2009	OCB041	24.2	slight	Southeast	cloudy	21.21	18.49	10.98	9.12	7.77	0.13	yellow-brown	none	calm	1.00	Trace	0.09 + Trace
2/18/2009	OCB038	26.1	slight	Southeast	cloudy	18.93	9.24	5.20	9.61	8.00	0.85	clear	none	calm	1.00	Trace	0.09 + Trace
2/25/2009	OCB003	21.1	moderate	Southeast	cloudy	21.62	1.82	0.92	8.97	7.56	0.77	clear	none	ripples	4.00	0	Trace
2/25/2009	OCB051	23.6	moderate	Southeast	cloudy	19.49	14.79	8.63	11.03	7.70	0.80	yellow-brown	none	calm	4.00	0.00	Trace
2/25/2009	OCB050	25.1	moderate	Southeast	cloudy	20.92	12.50	7.19	9.34	7.23	>1.2	clear	none	calm	4.00	0.00	Trace
2/25/2009	OCB054	25.3	moderate	Southeast	cloudy	19.92	32.74	20.57	11.46	7.87	0.26	clear	none	calm	4.00	0.00	Trace
2/25/2009	OCB048	24.5	moderate	Southeast	cloudy	20.36	7.50	4.19	10.57	7.82	0.64	clear	none	ripples	4.00	0.00	Trace
2/25/2009	OCB041	25.8	moderate	Southeast	cloudy	19.69	19.42	11.58	8.25	7.56	0.36	clear	none	calm	4.00	0.00	Trace
2/25/2009	OCB038	27.3	moderate	Southeast	cloudy	17.32	9.16	5.16	11.37	7.97	0.65	clear	none	calm	4.00	0.00	Trace
3/4/2009	OCB003	20.8	moderate	Southeast	clear	21.14	1.97	1.01	9.08	7.67	0.91	clear	none	waves	4.00	0.00	Trace
3/4/2009	OCB051	25.0	moderate	Southeast	clear	19.40	15.70	9.20	14.37	7.91	0.31	brown	none	calm	4.00	0.00	Trace
3/4/2009	OCB050	24.0	moderate	Southeast	clear	20.85	12.19	6.99	13.34	7.42	1.14	clear	none	calm	4.00	0.00	Trace
3/4/2009	OCB054	24.9	moderate	Southeast	clear	17.85	33.92	21.34	11.81	7.76	0.39	clear	none	calm	4.00	0.00	Trace
3/4/2009	OCB048	24.8	moderate	Southeast	clear	19.43	8.47	4.74	11.68	7.89	0.38	clear	none	ripples	4.00	0.00	Trace
3/4/2009	OCB041	26.7	moderate	Southeast	clear	17.68	20.16	12.09	10.06	7.81	0.35	clear	none	calm	4.00	0.00	Trace
3/4/2009	OCB038	26.0	moderate	Southeast	clear	16.64	11.51	6.58	11.10	8.07	0.41	clear	none	calm	4.00	0.00	Trace

Table 20. Field Parameter Measurements for Sampling Events 03/11/09-04/01/09.

Sample Date	Station ID	Air Temp (°C)	Wind Intensity	Wind Direction	Present Weather	Water Temp (°C)	Conduct. (uS/cm)	Salinity (ppt)	DO (mg/L)	pH (s.u)	Secchi Disk (m)	Water Color	Water Odor	Water Surface	Days since last rainfall	Rainfall past 1 day (in)	Rainfall past 7 days (in)
03/11/09	OCB003	23.2	slight	Southeast	overcast	23.91	1.83	0.93	8.45	7.68	0.94	clear	oily/chemical	waves	11.00	0.00	0.00
03/11/09	OCB051	25.1	slight	Southeast	cloudy	22.61	17.51	10.33	11.09	7.79	0.47	yellowish	none	calm	11.00	0.00	0.00
03/11/09	OCB050	26.2	slight	Southeast	cloudy	22.11	12.29	7.05	9.76	7.36	>1.2	clear	none	calm	11.00	0.00	0.00
03/11/09	OCB054	25.1	slight	Southeast	cloudy	20.98	33.31	20.89	9.38	7.75	>1.2	clear	none	calm	11.00	0.00	0.00
03/11/09	OCB048	27.0	slight	Southeast	cloudy	24.24	8.90	4.97	9.08	7.77	0.34	clear	none	ripples	11.00	0.00	0.00
03/11/09	OCB041	26.8	slight	Southeast	cloudy	22.44	19.42	11.58	8.98	7.77	0.21	clear	none	calm	11.00	0.00	0.00
03/11/09	OCB038	24.7	slight	Southeast	cloudy	19.75	11.13	6.34	10.04	8.09	1.00	yellow-brown	none	calm	11.00	0.00	0.00
3/25/2009	OCB003	22.5	moderate	East	overcast	23.80	1.99	1.00	Not Available*	7.66	1.39	clear	none	waves	1.00	0.02	0.02
3/25/2009	OCB051	23.3	moderate	South	overcast	21.63	12.32	7.07	Not Available*	7.80	0.73	yellow-brown	none	calm	1.00	0.02	0.02
3/25/2009	OCB050	23.0	moderate	South	overcast	21.86	12.81	7.37	Not Available*	7.49	>1.20	clear	none	calm	1.00	0.02	0.02
3/25/2009	OCB054	24.2	slight	Southeast	overcast	21.28	32.87	20.59	Not Available*	7.87	1.20	clear	none	calm	1.00	0.02	0.02
3/25/2009	OCB048	23.4	slight	Southeast	overcast	23.57	3.22	1.68	Not Available*	7.95	0.42	yellow	none	ripples	1.00	0.02	0.02
3/25/2009	OCB041	25.3	slight	Southeast	overcast	22.59	6.51	3.56	Not Available*	8.10	0.26	clear	none	calm	1.00	0.02	0.02
3/25/2009	OCB038	26.1	slight	Southeast	overcast	19.81	10.74	6.10	Not Available*	8.06	0.98	clear	none	calm	1.00	0.02	0.02
4/1/2009	OCB003	20.0	moderate	Southeast	overcast	22.70	2.05	1.05	9.19	7.54	0.72	clear	oily/chemical	waves	5.00	0.00	0.44
4/1/2009	OCB063	21.3	moderate	Southeast	overcast	20.88	1.01	0.50	8.62	7.88	0.88	clear	none	ripples	5.00	0.00	0.44
4/1/2009	OCB065	21.9	moderate	Southeast	cloudy	19.61	1.18	0.59	9.04	7.68	0.48	clear	chlorine	calm	5.00	0.00	0.44
4/1/2009	OCB064	21.2	moderate	Southeast	cloudy	20.57	0.95	0.47	7.81	7.67	1.15	clear	none	ripples	5.00	0.00	0.44
4/1/2009	OCB051	21.3	moderate	Southeast	overcast	18.59	13.42	7.77	14.05	8.06	0.83	clear	none	calm	5.00	0.00	0.44
4/1/2009	OCB050	22.7	moderate	Southeast	overcast	20.23	12.61	7.26	10.53	7.56	>1.20	clear	none	calm	5.00	0.00	0.44
4/1/2009	OCB054	22.3	moderate	Southeast	overcast	19.19	32.59	20.41	11.69	7.97	>1.20	clear	none	calm	5.00	0.00	0.44
4/1/2009	OCB048	23.2	moderate	Southeast	overcast	20.58	1.44	0.72	9.26	8.18	0.20	yellow-brown	none	ripples	5.00	0.00	0.44
4/1/2009	OCB041	23.3	moderate	Southeast	overcast	18.56	1.99	1.02	10.15	8.19	0.13	brown	none	calm	5.00	0.00	0.44
4/1/2009	OCB038	23.3	moderate	Southeast	overcast	18.26	9.90	5.60	10.04	8.16	0.62	yellow-brown	none	calm	5.00	0.00	0.44

Table 21. Field Parameter Measurements for Sampling Events 04/08/09-04/15/09.

Sample Date	Station ID	Air Temp (°C)	Wind Intensity	Wind Direction	Present Weather	Water Temp (°C)	Conduct. (uS/cm)	Salinity (ppt)	DO (mg/L)	pH (s.u)	Secchi Disk (m)	Water Color	Water Odor	Water Surface	Days since last rainfall	Rainfall past 1 day (in)	Rainfall past 7 days (in)
4/8/2009	OCB003	16.7	slight	Southeast	clear	21.82	1.98	1.01	8.90	7.62	0.25	yellow-brown	none	waves	12.00	0.00	0.00
4/8/2009	OCB063	21.1	slight	Southeast	clear	19.86	0.88	0.43	9.60	7.83	0.80	clear	none	ripples	12.00	0.00	0.00
4/8/2009	OCB065	23.8	slight	Southeast	clear	19.36	1.22	0.61	10.28	7.84	0.50	clear	none	calm	12.00	0.00	0.00
4/8/2009	OCB064	23.5	moderate	Southeast	clear	20.63	1.04	0.51	9.16	7.70	> 1.20	clear	none	calm	12.00	0.00	0.00
4/8/2009	OCB051	22.3	moderate	Southeast	clear	19.81	19.41	11.58	16.24	8.08	0.31	clear	none	calm	12.00	0.00	0.00
4/8/2009	OCB050	24.6	moderate	Southeast	clear	20.67	11.80	6.75	13.40	7.39	>1.20	clear	none	calm	12.00	0.00	0.00
4/8/2009	OCB062	27.6	slight	Southeast	clear	21.53	3.22	1.69	8.01	7.46	Data not available	brown	none	calm	12.00	0.00	0.00
4/8/2009	OCB054	27.7	moderate	Southeast	clear	18.93	34.03	21.41	12.36	7.87	0.72	clear	none	calm	12.00	0.00	0.00
4/8/2009	OCB048	27.6	slight	Southeast	clear	23.63	3.46	1.82	9.99	7.97	0.23	clear	none	ripples	12.00	0.00	0.00
4/8/2009	OCB041	26.5	moderate	Southeast	clear	22.78	3.64	1.92	10.52	8.00	0.37	yellow-brown	none	calm	12.00	0.00	0.00
4/8/2009	OCB038	29.2	moderate	Southeast	clear	17.86	12.43	7.18	12.59	8.10	0.24	yellowish	none	calm	12.00	0.00	0.00
4/15/2009	OCB003	21.8	moderate	East	clear	23.67	1.87	0.95	8.66	7.56	>1.20	clear	none	waves	3.00	0.00	0.03
4/15/2009	OCB063	24.5	slight	Southeast	clear	21.85	1.04	0.52	8.79	7.84	1.08	clear	none	ripples	3.00	0.00	0.03
4/15/2009	OCB065	25.6	slight	Southeast	clear	21.09	1.20	0.60	9.16	7.62	0.46	clear	none	calm	3.00	0.00	0.03
4/15/2009	OCB064	25.0	slight	Southeast	clear	21.53	0.01	0.00	7.99	7.57	> 1.20	clear	none	calm	3.00	0.00	0.03
4/15/2009	OCB051	26.9	slight	Southeast	clear	23.47	17.55	10.35	16.73	8.21	0.37	clear	none	calm	3.00	0.00	0.03
4/15/2009	OCB050	26.8	slight	Southeast	clear	22.34	12.72	7.32	12.01	7.57	> 1.20	clear	none	calm	3.00	0.00	0.03
4/15/2009	OCB062	28.8	slight	Southeast	clear	23.86	3.07	1.60	6.58	7.46	0.24	brown	none	calm	3.00	0.00	0.03
4/15/2009	OCB054	28.8	slight	Southeast	clear	22.82	16.52	9.70	13.23	8.00	> 1.20	clear	none	calm	3.00	0.00	0.03
4/15/2009	OCB048	26.5	slight	Southeast	clear	25.25	6.72	3.67	8.82	7.78	0.32	yellowish	none	calm	3.00	0.00	0.03
4/15/2009	OCB041	26.5	moderate	Southeast	clear	24.90	5.47	2.94	10.30	8.05	0.38	yellow-brown	none	calm	3.00	0.00	0.03
4/15/2009	OCB067	26.6	moderate	Southeast	clear	21.46	8.99	5.04	9.60	8.10	0.39	clear	none	ripples	3.00	0.00	0.03

Table 22. Field Parameter Measurements for Sampling Events 04/20/09-04/29/09.

Sample Date	Station ID	Air Temp (°C)	Wind Intensity	Wind Direction	Present Weather	Water Temp (°C)	Conduct. (uS/cm)	Salinity (ppt)	DO (mg/L)	pH (s.u)	Secchi Disk (m)	Water Color	Water Odor	Water Surface	Days since last rainfall	Rainfall past 1 day (in)	Rainfall past 7 days (in)
4/20/2009	OCB003	20.1	slight	Northeast	clear	24.24	1.81	0.92	8.44	7.64	0.80	clear	none	waves	2.00	0.00	0.07
4/20/2009	OCB066	23.5	slight	Northeast	clear	18.85	24.23	14.76	7.15	7.15	0.18	yellow-brown	none	calm	2.00	0.00	0.07
4/20/2009	OCB063	23.4	slight	Northeast	clear	22.64	1.01	0.50	9.21	7.87	0.80	clear	none	ripples	2.00	0.00	0.07
4/20/2009	OCB065	24.1	slight	Northeast	clear	21.81	1.20	0.60	8.81	7.71	0.88	clear	none	calm	2.00	0.00	0.07
4/20/2009	OCB064	23.9	slight	Northeast	clear	22.53	0.92	0.45	7.79	7.62	> 1.20	clear	none	calm	2.00	0.00	0.07
4/20/2009	OCB051	26.1	slight	Northeast	clear	24.42	15.10	8.78	15.18	8.18	0.39	yellow	none	calm	2.00	0.00	0.07
4/20/2009	OCB050	27.0	slight	Northeast	clear	22.26	12.86	7.40	12.45	7.62	> 1.20	clear	none	calm	2.00	0.00	0.07
4/20/2009	OCB062	25.6	slight	Northeast	clear	24.00	3.03	1.57	8.95	7.78	0.42	yellow-brown	none	calm	2.00	0.00	0.07
4/20/2009	OCB054	27.5	slight	Northeast	clear	21.91	31.82	19.86	12.81	8.03	0.95	clear	none	calm	2.00	0.00	0.07
4/20/2009	OCB048	28.1	slight	Northeast	clear	26.85	6.32	3.43	10.44	8.01	0.72	yellow	none	ripples	2.00	0.00	0.07
4/20/2009	OCB041	27.6	slight	Northeast	clear	25.61	7.51	4.13	9.90	7.90	0.47	yellow-brown	none	calm	2.00	0.00	0.07
4/20/2009	OCB067	28.8	slight	Northeast	clear	21.65	8.95	5.01	13.71	8.20	0.46	clear	none	calm	2.00	0.00	0.07
4/29/2009	OCB003	25.3	moderate	Southeast	cloudy	25.58	1.88	0.95	NA	7.58	0.85	clear	oily/chemical	waves	13.00	Trace	Trace
4/29/2009	OCB066	27.2	moderate	Southeast	cloudy	24.72	29.88	18.50	NA	6.98	0.38	brown	none	calm	13.00	Trace	Trace
4/29/2009	OCB063	26.4	moderate	Southeast	cloudy	24.53	1.13	0.56	NA	7.86	0.45	clear	none	ripples	13.00	Trace	Trace
4/29/2009	OCB065	27.3	moderate	Southeast	cloudy	23.35	1.27	0.63	NA	7.45	0.91	clear	none	calm	13.00	Trace	Trace
4/29/2009	OCB064	27.6	moderate	Southeast	cloudy	24.22	1.04	0.51	NA	7.61	> 1.20	clear	none	calm	13.00	Trace	Trace
4/29/2009	OCB051	29.6	moderate	Southeast	cloudy	26.21	17.86	10.52	NA	8.14	0.43	brown	none	calm	13.00	Trace	Trace
4/29/2009	OCB050	29.2	moderate	Southeast	cloudy	24.52	12.97	7.46	NA	7.60	> 1.20	clear	none	calm	13.00	Trace	Trace
4/29/2009	OCB062	29.2	moderate	Southeast	cloudy	26.29	2.95	1.53	NA	7.40	0.67	clear	none	calm	13.00	Trace	Trace
4/29/2009	OCB054	29.1	moderate	Southeast	cloudy	24.33	33.54	21.02	NA	7.79	0.53	clear	none	calm	13.00	Trace	Trace
4/29/2009	OCB048	29.8	moderate	Southeast	cloudy	27.08	7.24	3.95	NA	7.99	0.34	brown	none	calm	13.00	Trace	Trace
4/29/2009	OCB041	29.3	moderate	Southeast	cloudy	26.70	9.50	5.30	NA	7.79	0.26	yellow	none	ripples	13.00	Trace	Trace
4/29/2009	OCB038	30.2	moderate	Southeast	cloudy	23.14	11.96	6.84	NA	8.10	0.30	yellow	none	calm	13.00	Trace	Trace
4/29/2009	OCB067	30.2	moderate	Southeast	cloudy	23.26	10.77	6.10	NA	8.18	0.10	yellow	none	calm	13.00	Trace	Trace

Table 23. Field Parameter Measurements for Sampling Events 05/06/09-05/11/09.

Sample Date	Station ID	Air Temp (°C)	Wind Intensity	Wind Direction	Present Weather	Water Temp (°C)	Conduct. (uS/cm)	Salinity (ppt)	DO (mg/L)	pH (s.u)	Secchi Disk (m)	Water Color	Water Odor	Water Surface	Days since last rainfall	Rainfall past 1 day (in)	Rainfall past 7 days (in)
5/6/2009	OCB003	27.7	moderate	Southeast	cloudy	26.76	1.77	0.89	7.92	7.67	0.73	yellow	oily/chemical	waves	7.00	0.00	Trace
5/6/2009	OCB066	28.5	moderate	Southeast	cloudy	25.31	31.63	19.69	3.34	6.94	0.21	brown	none	calm	7.00	0.00	Trace
5/6/2009	OCB063	28.6	moderate	Southeast	cloudy	25.51	1.07	0.53	8.00	7.78	0.81	clear	none	calm	7.00	0.00	Trace
5/6/2009	OCB065	28.6	slight	Southeast	cloudy	24.40	1.24	0.61	8.00	7.37	> 1.20	clear	none	calm	7.00	0.00	Trace
5/6/2009	OCB064	29.5	moderate	Southeast	cloudy	25.47	0.58	0.26	6.99	7.55	NA	clear	none	calm	7.00	0.00	Trace
5/6/2009	OCB051	30.2	slight	Southeast	cloudy	28.68	19.21	11.36	9.98	7.82	1.05	clear	none	calm	7.00	0.00	Trace
5/6/2009	OCB050	29.7	slight	Southeast	cloudy	25.62	6.59	3.59	12.63	7.69	> 1.20	clear	none	calm	7.00	0.00	Trace
5/6/2009	OCB062	32.5	slight	Southeast	cloudy	26.95	2.91	1.50	5.60	7.32	0.25	brown	none	calm	7.00	0.00	Trace
5/6/2009	OCB054	31.8	slight	Southeast	cloudy	26.26	9.30	5.19	10.43	8.14	0.71	clear	none	calm	7.00	0.00	Trace
5/6/2009	OCB048	30.5	moderate	Southeast	cloudy	29.15	8.48	4.69	8.30	7.82	0.59	clear	none	calm	7.00	0.00	Trace
5/6/2009	OCB041	35.4	moderate	Southeast	clear	30.44	6.24	3.37	8.85	7.87	0.57	brown	none	calm	7.00	0.00	Trace
5/6/2009	OCB038	33.8	moderate	Southeast	clear	27.10	0.16	0.07	13.13	8.13	0.70	clear	none	calm	7.00	0.00	Trace
5/6/2009	OCB067	33.8	moderate	Southeast	clear	24.49	10.29	5.80	8.94	8.12	> 1.20	clear	none	calm	7.00	0.00	Trace
5/11/2009	OCB003	27.3	slight	Southeast	cloudy	27.40	1.60	0.80	9.16	7.56	0.92	clear	oily/chemical	waves	12.00	0.00	Trace
5/11/2009	OCB066	30.2	slight	Southeast	cloudy	26.71	29.85	18.44	4.87	7.02	0.27	brown	none	calm	12.00	0.00	Trace
5/11/2009	OCB063	29.7	slight	Southeast	cloudy	26.62	0.42	0.21	8.18	7.64	> 1.20	clear	none	calm	12.00	0.00	Trace
5/11/2009	OCB065	29.0	slight	Southeast	cloudy	25.36	1.23	0.61	8.71	7.21	1.09	clear	chlorine	calm	12.00	0.00	Trace
5/11/2009	OCB064	29.5	slight	Southeast	cloudy	26.26	1.02	0.50	7.28	7.36	0.95	clear	none	ripples	12.00	0.00	Trace
5/11/2009	OCB051	31.0	slight	Southeast	cloudy	28.56	18.43	10.85	9.95	7.67	0.67	clear	none	calm	12.00	0.00	Trace
5/11/2009	OCB050	31.1	slight	Southeast	cloudy	26.72	4.23	2.24	8.30	7.53	0.19	clear	chlorine	calm	12.00	0.00	Trace
5/11/2009	OCB062	31.7	slight	Southeast	cloudy	27.73	2.90	1.49	6.56	7.39	0.53	brown	none	calm	12.00	0.00	Trace
5/11/2009	OCB054	31.8	slight	Southeast	cloudy	29.38	32.21	19.99	9.14	8.05	1.00	clear	none	calm	12.00	0.00	Trace
5/11/2009	OCB048	31.1	slight	Southeast	cloudy	30.81	0.13	0.06	8.11	8.17	0.81	clear	none	calm	12.00	0.00	Trace
5/11/2009	OCB038	32.7	slight	Southeast	cloudy	25.49	13.76	7.95	11.02	8.10	0.23	clear	none	calm	12.00	0.00	Trace
5/11/2009	OCB067	32.7	slight	Southeast	cloudy	25.20	9.22	5.76	9.51	8.09	0.17	clear	none	calm	12.00	0.00	Trace

Table 24. Field Parameter Measurement for Sampling Events.

Sample Date	Station ID	Air Temp (°C)	Wind Intensity	Wind Direction	Present Weather	Water Temp (°C)	Conduct. (uS/cm)	Salinity (ppt)	DO (mg/L)	pH (s.u)	Secchi Disk (m)	Water Color	Water Odor	Water Surface	Days since last rainfall	Rainfall past 1 day (in)	Rainfall past 7 days (in)
5/20/2009	OCB003	24.40	slight	ENE	clear	25.33	0.87	0.43	N/A	7.54	> 1.20	clear	none	waves	4.00	0.00	0.35
5/20/2009	OCB066	25.70	slight	ENE	clear	21.48	28.72	17.75	N/A	6.93	0.36	brown	none	calm	4.00	0.00	0.35
5/20/2009	OCB063	26.50	slight	ENE	clear	24.61	1.77	0.89	N/A	7.83	> 1.20	clear	none	calm	4.00	0.00	0.35
5/20/2009	OCB065	28.70	slight	ENE	clear	24.05	1.29	0.64	N/A	7.34	0.59	clear	chlorine	calm	4.00	0.00	0.35
5/20/2009	OCB064	26.10	slight	ENE	clear	24.79	0.53	0.25	N/A	7.38	> 1.20	clear	none	calm	4.00	0.00	0.35
5/20/2009	OCB051	29.80	slight	East	clear	25.66	4.02	2.12	N/A	8.17	0.58	yellow	none	calm	4.00	0.00	0.35
5/20/2009	OCB050	26.90	slight	East	clear	23.30	12.61	7.23	N/A	7.59	> 1.20	clear	none	calm	4.00	0.00	0.35
5/20/2009	OCB062	31.10	slight	East	clear	25.83	3.14	1.63	N/A	7.40	0.67	clear	none	calm	4.00	0.00	0.35
5/20/2009	OCB054	30.90	slight	East	cloudy	24.88	26.84	16.44	N/A	8.14	1.10	clear	none	calm	4.00	0.00	0.35
5/20/2009	OCB048	30.70	slight	East	cloudy	27.70	2.61	1.34	N/A	7.75	0.28	yellow	none	calm	4.00	0.00	0.35
5/20/2009	OCB041	29.20	slight	East	cloudy	27.02	2.90	1.50	N/A	8.22	0.30	yellow	none	calm	4.00	0.00	0.35
5/20/2009	OCB038	28.60	slight	East	cloudy	23.80	4.60	2.45	N/A	7.96	0.15	yellow	none	calm	4.00	0.00	0.35
5/20/2009	OCB067	28.60	slight	East	cloudy	22.79	8.84	4.94	N/A	8.11	> 1.20	clear	none	calm	4.00	0.00	0.35
5/25/2009	OCB003	28.10	slight	Southeast	clear	27.23	1.55	0.78	N/A	7.31	0.75	clear	none	ripples	1.00	0.07	0.31
5/25/2009	OCB066	30.00	slight	Southeast	clear	24.46	27.40	16.82	N/A	6.86	0.51	clear	none	calm	1.00	0.07	0.31
5/25/2009	OCB063	30.00	slight	Southeast	clear	26.23	1.15	0.57	N/A	7.60	1.07	clear	none	calm	1.00	0.07	0.31
5/25/2009	OCB065	30.30	slight	Southeast	clear	25.41	1.24	0.61	N/A	7.16	0.79	clear	chlorine	calm	1.00	0.07	0.31
5/25/2009	OCB064	30.50	slight	Southeast	clear	26.05	1.00	0.49	N/A	7.48	> 1.20	clear	none	calm	1.00	0.07	0.31
5/25/2009	OCB051	30.60	slight	Southeast	cloudy	26.49	9.12	5.09	N/A	7.60	0.53	yellow-brown	none	calm	1.00	0.07	0.31
5/25/2009	OCB050	33.00	slight	Southeast	cloudy	26.51	12.75	7.30	N/A	7.50	> 1.20	clear	none	calm	1.00	0.07	0.31
5/25/2009	OCB054	32.10	slight	Southeast	cloudy	25.61	4.55	2.42	N/A	8.16	0.83	yellow	none	calm	1.00	0.07	0.31
5/25/2009	OCB048	32.10	slight	Southeast	cloudy	30.09	3.55	1.85	N/A	7.65	0.45	yellow	none	calm	1.00	0.07	0.31
5/25/2009	OCB041	31.80	slight	Southeast	cloudy	29.48	1.98	1.00	N/A	7.85	0.37	brown	none	calm	1.00	0.07	0.31
5/25/2009	OCB038	34.30	slight	Southeast	cloudy	26.40	5.23	2.81	N/A	7.88	> 1.20	yellow-brown	none	calm	1.00	0.07	0.31
5/25/2009	OCB067	34.30	slight	Southeast	cloudy	24.19	4.70	2.49	N/A	8.18	> 1.20	yellow-brown	none	calm	1.00	0.07	0.31