Tijuana River WMA

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12.1 Tijuana River Watershed Management Area Descriptions

The Tijuana River Watershed Management Area (WMA) (HU 911.00) is the largest of the San Diego watersheds covering over 1.1 million acres (Figure 12-1). The Tijuana River is formed by two drainage networks that merge in the City of Tijuana, then flow across the U.S. border into the Tijuana River Estuary, and finally the Pacific Ocean. The watershed is divided by the U.S. / Mexico border with just over 27% lying within the San Diego Region. The watershed is comprised of the following hydrologic areas: Tijuana Valley, Potrero, Barrett Lake, Monument, Morena, Cottonwood, Cameron, and Campo. Major water bodies include the Tijuana River, Cottonwood Creek, and the Tijuana River Estuary. Annual precipitation varies from less than 10.5 inches near the coast to more than 22.5 inches in the inland areas (Figure 12-1).

Population within the U.S. areas of the watershed is sparse with the major population centers located at Campo and San Ysidro. The cities of Tecate and Tijuana are the major population centers on the Mexican side of the watershed. The population for the entire watershed is approximately one million (San Diego County, 2002).

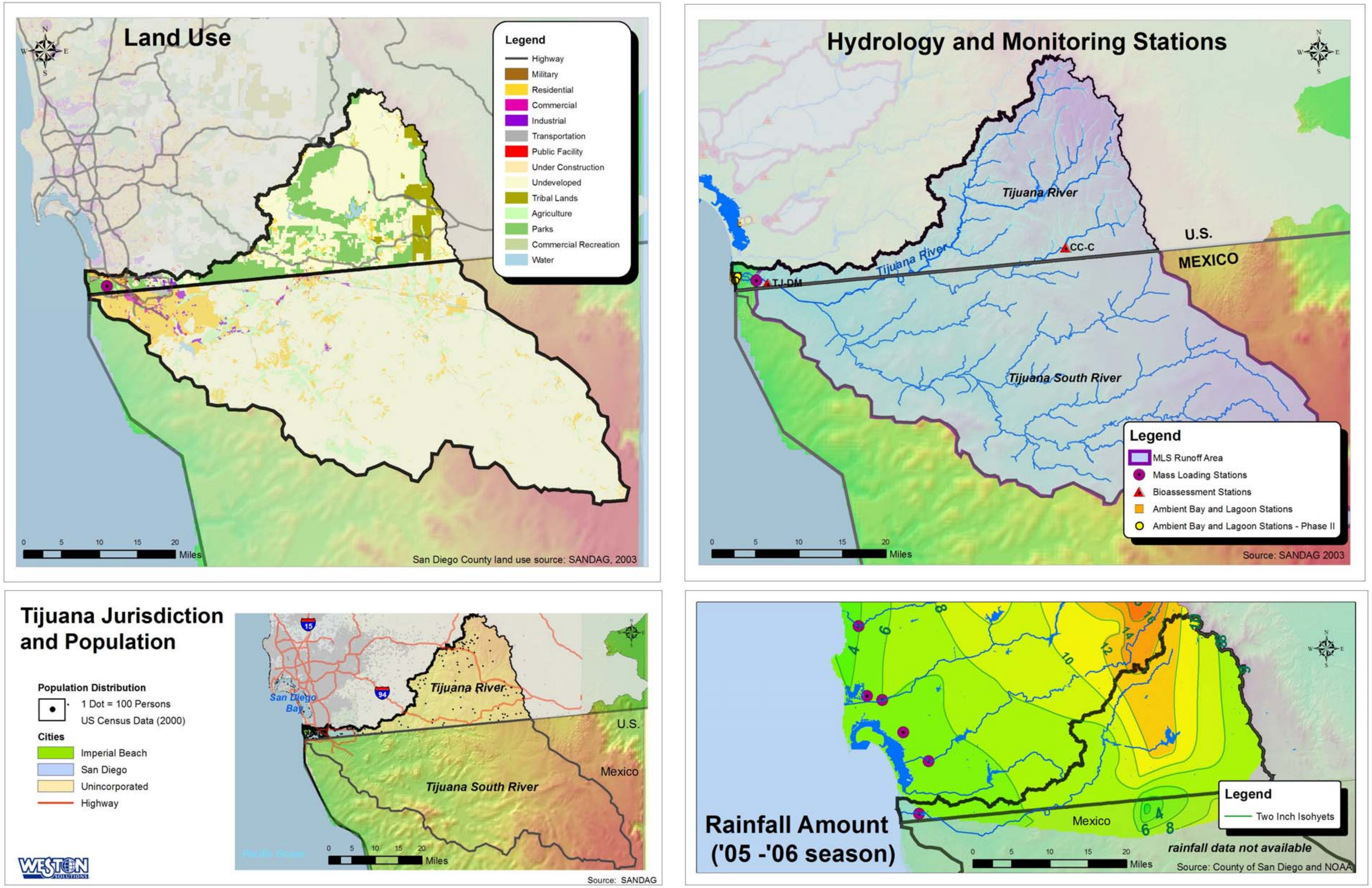


Figure 12-1. Tijuana River Watershed Management Area.

Tijuana River WMA

12.1.1 Land Use

Mexico governs the majority of the Tijuana River Watershed, *Tijuana South River* subwatershed (73%) with the remaining areas belonging to the United States, *Tijuana River* subwatershed. Undeveloped/vacant areas of land use account for 58.4% of U.S. lands, with another 24.6% devoted to parks. Other land uses are described as Tribal lands (6.5%), agriculture (3.5%), residential (2.8%), transportation (2.4%) and commercial, industrial, and public facilities equal to less than 1% (Figure 12-2). Mexico's lands are predominately undeveloped/vacant land use (81.8%). It should be noted that much of the land classified as undeveloped is used for low intensity cattle and goat grazing (SANDAG, 2003).

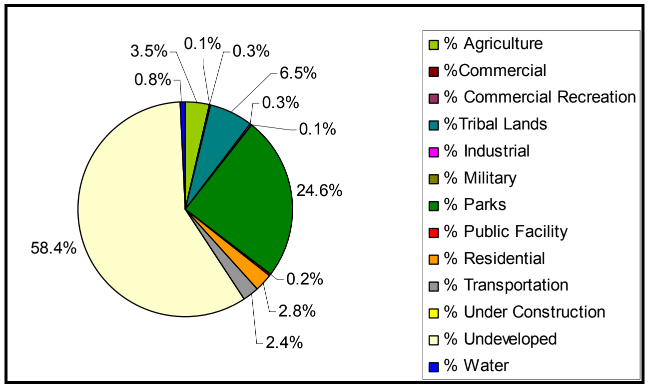


Figure 12-2. Percent Land Use for Tijuana River WMA

12.1.2 Beneficial Uses

The Tijuana River Watershed provides a variety of beneficial uses and sensitive habitats, including the Tijuana River Estuary, which is a National Estuarine Sanctuary (Table 12-1). The major aquifer in the watershed is the Lower Tijuana River Valley Basin.

Table 12-1. Beneficial uses within the Tijuana River Watershed.

Beneficial Uses	Inland Surface Waters	Coastal Waters [(a)]	Reservoirs and Lakes	Ground Waters
Municipal and Domestic Supply	●		●	●
Agricultural Supply	●		●	●
Industrial Service Supply	●		●	●
Industrial Process Supply	●		●	
Navigation				
Commercial & Sport Fishing		●		
Freshwater Replenishment	●		●	
Contact Water Recreation	●	●	●	
Non-Contact Water Recreation	●	●	●	
Biological Habitats of Special Significance		●		
Warm Freshwater Habitat	●		●	
Cold Freshwater Habitat	●		●	
Estuarine Habitat		●		
Wildlife Habitat	●	●	●	
Rare, Threatened, or Endangered Species	●	●	●	
Marine Habitat		●		
Migration of Aquatic Organisms		●		
Aquaculture				
Shellfish Harvesting		●		
Spawning, Reproduction, and/or Early Development				

[(a)] Tijuana River Estuary
Source: Basin Plan September 8, 1994 (Tables 2-2, 2-3, 2-4, 2-5)

12.1.3 Regulatory Water Quality Challenges

The Tijuana River Watershed suffers from a wide variety of water quality problems. Major impacts to the watershed include surface water quality degradation, trash, sedimentation, eutrophication, habitat degradation and loss, flooding, erosion, and invasive species (San Diego County, 2006). Constituents that have been placed on the SWRCB 2002 303(d) list for water bodies throughout the watershed include bacteria indicators, eutrophic conditions, trace elements, pesticides, solids, synthetic organics, low dissolved oxygen, and trash (Table 12-2). The sources of the pollutants are varied including urban runoff, sewage spills, industrial discharges, agricultural/orchards, livestock/domestic animals, natural sources, and septic systems (San Diego County, 2006). The RWQCB has 303(d) listed the Pacific Ocean Shoreline for bacterial indicators (RWQCB, 2003).

Table 12-2. Water bodies on the SWRCB 303(d) list in the Tijuana River Watershed.

Water Body Name	Hydrologic Sub Area (HSA)	HSA #	Pollutant/Stressor
Tijuana River	Tijuana Valley	911.11	Bacteria Indicators, Eutrophic conditions, Low Dissolved Oxygen, Pesticides, Solids, Synthetic Organics, Trace Elements, Trash
Tijuana River Estuary	Tijuana Valley	911.11	Bacteria Indicators, Eutrophic conditions, Lead, Low Dissolved Oxygen, Nickel, Pesticides, Thallium, Trash
Pacific Ocean Shoreline, Tijuana HU	Tijuana Valley	911.11	Bacteria Indicators
Pine Valley Creek (Upper)	Monument	911.41	Enterococci

Source: SWRCB 2003

The 2006 303(d) list is in the process of being finalized by the State Water Resources Control Board (SWRCB). The list includes several additions to the Tijuana River Watershed. This list has not been formally adopted by the SWRCB but can be found on the SWRCB website (http://www.waterboards.ca.gov/tmdl/303d_lists2006.htmL).

12.1.4 Mass Loading Station Site Description

The Tijuana River (TJR) mass loading station is located under the Hollister Street Bridge in San Diego, downstream from the International Boundary and Water Commission's diversion structure and treatment plant. During periods of low flow the river is diverted through the treatment plant. The River flows freely once the water level rises over the diversion structure. The Tijuana River at the sampling site is an unimproved channel. The River flows through Tijuana, Mexico and runoff contributions come from both Mexico and the United States.

Flow was calculated at this monitoring location during the 2005-2006 wet weather monitoring season utilizing a geometric equation that produced an estimated flow by gauging the height of the stream, velocity of the stream, and known dimensions of the channel. This was similar to previous years. One storm was successfully monitored under this configuration, however, during the January 2, 2006 storm event a substantial amount of suspended solids buried the instream monitoring equipment under several inches of silt/sediment that resulted in a sample being collected that possessed a high concentration of solids. This sample was deemed not representative of the actual conditions of the water quality in comparison and was discarded. Hence, it was determined that the instream monitoring equipment needed to be relocated. To avoid this problem in future monitoring events one of the columns of the bridge was selected as the new location for the instream flow monitoring equipment and sample intake strainer. The submerged pressure transducer area-velocity meter was relocated laterally and slightly downstream and attached to the bridge column. The new location was selected as the best available point to monitor flow without substantially altering the location of the mass loading station.

Flow continued to be calculated at this monitoring location during the 2005-2006 wet weather monitoring season utilizing a geometric equation that produced an estimated flow by gauging the height of the stream, velocity of the stream, and the surveyed dimensions of the channel. This position allows for collection of a representative water quality sample while removing the sample intake strainer from the center portion of the stream which possesses the greatest potential for impact with large debris. This is one of two sites that utilize a landline telephone to monitor telemetry remotely. This phone line was cut once during the 2005-2006 wet weather monitoring season, the cause was undetermined and the line had to be repaired.

An additional point of interest is that during previous years' monitoring, this site has been dry prior to the first significant rainfall of the wet weather season and is typically dry by the time equipment is demobilized in April of each year. During preparation for the 2005-2006 wet weather monitoring season in September 2005, approximately four feet of slow moving water was observed. Several feet of water was also present when the site was demobilized in April 2006.

12.1.5 Stream Bioassessment Site Description

Stream Bioassessment monitoring in the Tijuana River WMA has occurred at three urban affected sites. The upstream sites are located in Cottonwood Creek at the USGS Gauging station on Highway 94, and in Campo Creek at the Highway 94 crossing in the town of Campo. The Cottonwood Creek site does not flow in the dry season, but the Campo Creek site does, and will likely be sampled regularly in the future. The downstream monitoring reach is between Dairy Mart Road and the International Boundary in San Ysidro. This reach is low gradient with a substrate of unconsolidated sand and cobble. Pollution from the City of Tijuana has a substantial impact here, and the stream bed is highly susceptible to erosion. Due to river diversion to the International Wastewater Treatment Plant (IWTP), flow at this site does not occur during the dry season. There was adequate flow in May of 2005, and the site was sampled for the second time since the current program began.

12.1.6 Ambient Bay and Lagoon Monitoring Site Description

The Tijuana River flows into the Tijuana River Estuary before it enters the ocean. The Estuary is located in the southwestern corner of San Diego County, between the City of Imperial Beach and Tijuana, Mexico. The Estuary is large, encompassing 1,780 acres of wetland habitat, all of which is contained within the Tijuana River National Estuarine Sanctuary (Coastal Conservancy, 2000). The Estuary consists of three major areas: the main stem in the center of the Estuary, a northern arm known as Tijuana Slough, and a southern arm, which lies in Border Field State Park. The northern and southern arms roughly parallel the beach in a series of narrow, shallow channels. Two of the three sites selected to be assessed in the Ambient Bay and Lagoon Monitoring Program were located in the mainstream (Figure

12-1). The other was located in a small side channel adjacent to the mainstream. The Tijuana River is the primary source of fresh water to the Estuary, although an unconfined aquifer underlying the river valley can contribute fresh water periodically. The ocean inlet is relatively shallow and restricts the tidal prism of the Estuary, but there are no anthropogenic obstructions to flow. Raw sewage has been discharged to the River and side channels intermittently for over fifty years and water quality has been a concern. The Tijuana River Estuary is listed on the SWRCB 2002 303(d) list for several constituents, including bacteria indicators, eutrophic conditions, lead, low dissolved oxygen levels, nickel, pesticides, thallium, and trash (Table 12-2).

12.2 Watershed Water Quality Monitoring

Watershed water quality monitoring data is one leg of the triad approach used in performing the watershed management assessments. This includes the analysis of chemistry, bacteria, and toxicity data collected from three storm water events at the MLS, dry weather data collected during the 2005 dry weather monitoring program, and available/relative third party data.

12.2.1 2005-2006 Storm Water Monitoring and Results

Three storm events were monitored at the MLS on Tijuana River during the 2005-2006 storm season. These storm events occurred on October 18, 2005, February 19 and 28, 2006. The results from these storms are discussed in the following section (12.2.1) and presented in Table 12-3. A comparison of these results to previous years is provided in Section 12.2.2.

12.2.1.1 Storm Water Monitoring Event Summary

The first storm of the 2005-2006 wet weather monitoring season occurred on October 18, 2005. The storm moved into northern San Diego County from the northeast on October 16, 2005. This was an unusual pattern for a storm to approach San Diego County, typically storms approach primarily from the northwest and occasionally from the southwest. This storm was characterized by rainfall that began in the east and spread generally southwest. Rainfall began in the mountains and worked toward the coastal areas in contrast to the usual pattern of rain beginning at the coast and working into the mountains. Eventually, after two days of slow movement the storm system began to produce sufficient rainfall in the Tijuana River Watershed to provide runoff and monitoring was initiated. The storm produced a total of 0.29" of rainfall. Rainfall statistics for monitored storm events for the Tijuana River MLS area are presented in Table 12-4. Eighteen one-liter composite sample aliquots were collected at a pace of one sample for every 70,000 cubic feet of water that passed by the monitoring station. Grab samples for those constituents not conducive to composite sampling were collected. Monitoring was conducted over a 9-hour period which captured the rise and initial peak of the runoff produced by the storm.

The second storm monitored at the Tijuana MLS during the 2005-2006 wet weather monitoring season occurred on February 18, 2006. After monitoring the storm for over a day, the storm began to produce sufficient rainfall to provide runoff in the Tijuana River Watershed and monitoring was initiated. The storm produced a total of 0.18" of rainfall. Rainfall statistics for monitored storm events for the Tijuana River MLS area are presented in Table 12-4. Twenty-five one-liter composite sample aliquots were collected at a pace of one sample for every 150,000 cubic feet of water that passed by the monitoring station. Grab samples were collected for those constituents not conducive to composite sampling. Monitoring was conducted over a 20-hour period which captured the rise and initial peak of the runoff produced by the storm.

Table 12-3. Analytes measured at the Tijuana River mass loading station.

ANALYTE	UNITS	WQO	SOURCE	2001-2002			2002-2003			2003-2004			2004-2005			2005-2006			Frequency Above WQO	Mean Ratio to WQO
				01/29/02	02/17/02	03/17/02	11/08/02	02/11/03	02/25/03	11/12/03	01/25/04	02/03/04	10/27/04	02/11/05	02/18/05	10/18/05	02/19/06	02/28/06		
General / Physical / Organic																				
Electrical Conductivity	umhos/cm			1610	2300	2490	1664	1830	2890	1174	1471	25000	430	1449	1075	1715	1806	752		
Oil and Grease	mg/L	15	USEPA Multi-Sector General Permit	4	2	1	3.93	1.23	8.56	9.1	2.38	6.44	2	4.69	5.28	2.5	1.32	2.9	0%	0.25
pH	pH Units	6.5-8.5	Basin Plan	7.4	8.1	7.6	7.30	8.51	7.32	7.43	7.76	7.96	7.75	7.65	7.43	7.56	7.82	7.87	7%	0.07
Bacteriological																				
Enterococci	MPN/100 mL			170,000	500,000	17,000	2,400,000	50,000	30,000	500,000	5,000,000	2,400,000	800,000	3,000,000	1,700,000	5,000,000	800,000	500,000		
Fecal Coliform	MPN/100 mL	4000	Basin Plan	800000c	300000c	300000c	5,000,000	500,000	16,000,000	1,700,000	800,000	800,000	5,000,000	2,400,000	2,200,000	>16,000,000	9,000,000	500,000	100%	1021.67
Total Coliform	MPN/100 mL			1,700,000	800,000	1,100,000	>16,000,000	1,300,000	16,000,000	3,000,000	2,800,000	1,300,000	5,000,000	5,000,000	9,000,000	>16,000,000	16,000,000	2,200,000		
Wet Chemistry																				
Ammonia As N	mg/L			8	7.2	6.4	5.22	8.00	10.40	1.9	8.05	6.4	4.5	8.14	3.28	16	4.38	7.21		
Un-ionized Ammonia as N	µg/L	25 (a)	Basin Plan				39.2	636	63.0	16.7	127	124	24.1	86.1	42.7	186.0	68.5	145.0	83%	5.19
Biochemical Oxygen Demand	mg/L	30	USEPA Multi-Sector General Permit	27.3	46.2	33.3	3.56	86.4	23.2	70.9	72.5	98.6	23.9	67	26.6	23.1	28	25	47%	1.46
Chemical Oxygen Demand	mg/L	120	USEPA Multi-Sector General Permit	95	263	122	152	257	113	319	217	903	76	197	50	170	140	141	73%	1.79
Dissolved Organic Carbon	mg/L						30.6	35.7	23.4	45.8	29.3	14.4	39.2	20.3	8.65	30.2	37.9	82.4		
Dissolved Phosphorus	mg/L	2	USEPA Multi-Sector General Permit	2.2	2.9	2.28	1.75	1.90	0.93	1.56	3.41	1.99	1.69	1.73	1.26	1.23	1.76	1.72	27%	0.94
Nitrate As N	mg/L	10	Basin Plan	1.6	0.8	1.1	3.12	0.72	0.44	8.75	1.72	1.5	4.08	1.97	2.12	3.54	2.65	1.45	0%	0.24
Nitrite As N	mg/L	1	Basin Plan	0.34	1.44	0.6	0.98	0.37	0.13	0.42	0.59	0.34	0.11	0.37	<0.05	0.81	0.66	0.29	7%	0.50
Surfactants (MBAS)	mg/L	0.5	Basin Plan	<0.5	3.3	0.7	0.3	2.0	<0.1	<0.5	1.7	<0.5	<0.5	0.7	0.5	0.5	0.6	<0.5	40%	1.55
Total Dissolved Solids	mg/L	2500	Basin Plan	737	1080	965	885	883	794	650	476	491	400	938	664	1290	532	720	0%	0.31
Total Kjeldahl Nitrogen	mg/L			10.3	12	16.8	9.5	13.6	22.0	16.4	19.8	19.5	19.4	18.2	10.4	16.3	14.7	7.5		
Total Organic Carbon	mg/L						47.5	51.0	18.6	41.8	69.1	72.9	55.5	25.7	23.5	69.7	51.7	136		
Total Phosphorus	mg/L	2	USEPA Multi-Sector General Permit	3.2	4.7	2.52	2.37	2.04	2.38	1.8	3.41	2.97	1.73	2.7	1.74	2.45	1.98	1.83	67%	1.26
Total Suspended Solids	mg/L	100	USEPA Multi-Sector General Permit	240	48	176	160	97	1070	590	120	128	7440	890	2900	764	8140	7780	87%	20.36
Turbidity	NTU	20	Basin Plan	48.4	19.9	54.7	141	72.8	1000	383	90.6	3270	4540	60.2	537	129	192	147	93%	35.62
Pesticides																				
Chlorpyrifos	µg/L	0.02	CA Dept. of Fish & Game	0.06	0.08	0.09	0.168	<0.03*	<0.03*	<0.01	0.085	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	38%	2.05
Diazinon	µg/L	0.08	CA Dept. of Fish & Game	0.74	0.53	0.57	0.372	0.506	0.339	0.584	0.276	0.907	<0.01	0.394	0.169	0.241	0.278	0.128	93%	5.03
Malathion	µg/L	0.43	CA Dept. of Fish & Game				1.00	0.88	0.27	1.46	0.788	0.284	<0.01	0.498	<0.01	0.641	<0.02	<0.02	50%	1.13
Hardness																				
Total Hardness	mg CaCO3/L			970	352	286	279	334	395	328	308	417	702	376	350	544	706	496		
Total Metals																				
Antimony	mg/L	0.006	Basin Plan	0.003	0.003	0.003	<0.002	0.002	0.003	<0.005	<0.006	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0%	0.45
Arsenic	mg/L	0.34/0.05	40 CFR 131/ Basin Plan	0.007	0.008	0.006	0.005	0.008	0.018	0.011	0.009	0.055	0.013	0.01	0.003	0.014	0.019	0.012	7%	0.26
Cadmium	mg/L	(b)	40 CFR 131	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.005	0.001	<0.001	<0.001	<0.001	0.006	0.001	0%	0.18
Chromium	mg/L	(b)	CTR (Cr VI)	0.02	0.013	0.006	<0.005	0.006	0.049	0.026	<0.005	0.189	<0.005	0.014	0.006	<0.005	0.006	0.006	0%	0.04
Copper	mg/L	(b)	40 CFR 131	0.028	0.013	0.016	0.008	0.021	0.053	0.058	0.02	0.197	0.017	0.038	0.043	0.013	0.082	0.011	40%	1.43
Lead	mg/L	(b)	40 CFR 131	0.025	0.005	0.009	0.004	0.011	0.045	0.048	0.007	0.278	0.009	0.057	0.056	0.009	0.089	0.008	47%	2.52
Nickel	mg/L	(b)/0.1	40 CFR 131/ Basin Plan	0.044	0.033	0.028	0.003	0.021	0.040	0.029	0.013	0.101	0.051	0.015	0.019	0.025	0.05	0.017	7%	0.33
Selenium	mg/L	0.02	40 CFR 131	<0.002	0.008	<0.002	<0.004	<0.004	<0.004	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0%	0.14
Zinc	mg/L	(b)	40 CFR 131	0.120	0.041	0.062	<0.020	0.077	0.269	0.288	0.056	1.53	0.165	0.392	0.337	0.109	1.100	0.176	20%	0.84
Dissolved Metals																				
Antimony	mg/L	(e)	40 CFR 131	<0.002	<0.002	0.002	0.004	0.003	0.004	<0.005	<0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		
Arsenic	mg/L	0.34 (c)	40 CFR 131	0.005	0.004	0.005	0.010	0.008	0.005	0.003	0.006	0.006	<0.002	<0.002	<0.002	0.007	0.003	<0.001	0%	0.01
Cadmium	mg/L	(b)	40 CFR 131	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0%	0.10
Chromium	mg/L	(b)	40 CFR 131	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0%	0.01
Copper	mg/L	(b)	40 CFR 131	0.008	<0.005	<0.005	0.011	0.060	0.013	0.005	0.01	0.005	0.005	<0.005	<0.005	0.008	0.012	0.009	7%	0.40
Lead	mg/L	(b)	40 CFR 131	<0.002	0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	0%	0.14
Nickel	mg/L	(b)	40 CFR 131	0.033	0.028	0.024	0.018	0.017	0.013	0.003	0.011	0.007	0.006	0.009	0.006	0.014	0.013	0.008	0%	0.09
Selenium	mg/L	0.02 (d)	40 CFR 131	<0.002	<0.002	<0.002	<0.004	<0.004	<0.004	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0%	0.01
Zinc	mg/L	(b)	40 CFR 131	<0.020	0.026	0.057	0.062	0.130	0.046	<0.02	<0.02	<0.02	<0.02	0.023	<0.020	0.033	0.031	<0.020	0%	0.10
Toxicity																				
Ceriodaphnia 96-hr	LC50 (%)	100		36.11	17.36	32.99	19.5	10.15	32.98	14.36	18.95	17.68	50	25	25	25	35.36	35.36	100%	4.48
Ceriodaphnia 7-day survival	NOEC (%)	100		12.5	12.5	12.5	12.5	6.25	12.5	6.25	12.5	6.25	25	25	25	12.5	12.5	12.5	100%	8.80
Ceriodaphnia 7-day reproduction	NOEC (%)	100		6.25	12.5	6.25	12.5	6.25	12.5	6.25	12.5	12.5	50	25	25	12.5	12.5	12.5	100%	9.20
Hyalella 96-hr	NOEC (%)	100		100	100	100	100	100	50	50	100	50	100	100	100	50	50	100	33%	1.33
Selenastrum 96-hr	NOEC (%)	100		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0%	1.00

See last page for footnotes and source references.

Table 12-3. Analytes measured at the Tijuana River mass loading station.

Blank spaces have been verified and no data is available due to changes in the monitoring program.

(a) Un-ionized Ammonia is a calculated value, non-detectable values calculated at the detection limit. Basin Plan WQO is 0.025 mg/L; values shown here have been converted to μg/L.
(b) Water Quality Objective for dissolved metal fractions are based on total hardness and are calculated as described by the USEPA Federal Register Doc. 40 CFR Part 131, May 18, 2000.
(c) Water Quality Objectives for dissolved metal fractions are based on water effects ratios (WER) and are calculated as described by the USEPA Federal Register Doc. 40 CFR Part 131, May 18, 2000.
(d) Water Quality Objective is based on the total recoverable form as described by the USEPA Federal Register Doc. 40 CFR Part 131, May 18, 2000.
(e) USEPA has not published an aquatic life criterion value.

Shaded text – bold values exceed the **CCC** water quality objective and bold/underlined results exceed the **CMC** water quality objective.

* Indicates detection limit exceeds water quality objective.

Sources
USEPA National Pollutant Discharge Elimination System (NPDES) Storm Water Multi-Sector General Permit for Industrial Activities, 65 Federal Register (FR) 64746, Final Reissuance, October 30, 2000. Table 3 - Parameter benchmark values
Siepmann and Finlayson 2000.
Basin Plan, September 8, 1994.
Assembly Bill 411 - Title 17 of the California Code of Regulations, Section 7958.
USEPA Federal Register Document 40 CFR Part 131, May 18, 2000.

Table 12-4. 2005-2006 Rainfall Statistics for Monitored Storm Events for the Tijuana River Mass Loading Station.

Date Start	Total Rain (in)	Duration (hr)	Intensity (in/hr)	Antecedent Dry Days
10/18/2005	0.29	18	0.02	28
2/18/2006	0.18	6	0.03	47
2/27/2006	1.18	29	0.04	55

The third storm monitored at the Tijuana MLS during the 2005-2006 wet weather monitoring season occurred on February 28, 2006. On February 27, 2006 a fast moving storm moved into San Diego County. The storm quickly began to produce sufficient rainfall to provide runoff in the Tijuana River Watershed and monitoring was initiated. The storm produced a total of 1.18" of rainfall. Rainfall statistics for monitored storm events for the Tijuana River MLS area are presented in Table 12-4. Twenty-two one-liter composite sample aliquots were collected at a pace of one sample for every 200,000 cubic feet of water that passed by the monitoring station. Grab samples for those constituents not conducive to composite sampling were collected. Monitoring was conducted over a 13-hour period which captured the rise and initial peak of the runoff produced by the storm.

12.2.1.2 Storm Water Monitoring Results

Analytical results from the 2005-2006 wet weather monitoring period at the Tijuana River MLS are presented with the historical results in Table 12-3. Sample results are compared to the water quality objectives (WQO) that are also provided in the table. A detailed description of the WQO sources and the technical reasoning of how the results are compared to the WQO are provided in Section 3.4. Discussion of sample results occur in groups; conventional parameters, bacteriological, pesticides, metals, and toxicity. A comparison of these results to previous monitoring data is presented in Section 12.2.2.

Conventional constituents were detected in every sample during all three monitoring events with the exception of one result for surfactants (MBAS) which was below the detection limit (February 28, 2006). Conventional constituents with results above their respective WQO include un-ionized ammonia, chemical oxygen demand (COD), MBAS, total phosphorus, total suspended solids (TSS), and turbidity. Un-ionized ammonia, COD, TSS, and turbidity results were above their respective WQO during all three monitoring events. MBAS was just above the WQO of 0.5 mg/L during only the February 19, 2006 monitoring event (0.6 mg/L). Total phosphorus was just above the WQO of 2.0 mg/L during only the October 18, 2005 monitoring event (2.45 mg/L).

All three of the bacterial indicators, total and fecal coliform, and enterococcus, had extremely elevated densities during all three storm events. Fecal coliform results were consistently above the Basin Plan objective of 400 MPN/100 mL with maximum observed densities of >16,000,000 MPN/100 mL.

Diazinon results were above the WQO during all three monitoring events during the 2005-2006 wet weather season. Malathion was detected during only the October 18, 2005 monitoring event (0.641 µg/L). This result was above the WQO of 0.43 µg/L. Chlorpyrifos was not detected in any samples from the Tijuana River MLS during the 2005-2006 monitoring season.

All of the total metals were detected during at least one storm event in samples from the Tijuana River MLS during the 2005-2006 monitoring season with the exception of selenium which was not detected during any of the three events. Only three metals had results above their respective WQO which occurred only during the February 19, 2006 monitoring event. Total copper (0.082 mg/L) and total zinc (1.10 mg/L) results were above both their respective hardness based acute and chronic WQO, while total lead was above only the hardness based chronic WQO. Several dissolved metals were detected during all three monitoring events during the 2005-2006 monitoring season. However, no dissolved metal was above either the hardness based acute or chronic WQO.

Toxicity was observed for the acute, chronic, and reproductive endpoints for *Ceriodaphnia dubia* during all three sample events of the 2005-2006 wet weather monitoring season. The NOEC for the 96-hour survival for *C. dubia* was 25%, 35.4%, and 35.4% of the test sample for the three storms respectively; the NOEC for the 7-day survival and the 7-day reproduction for *C. dubia* was 12.5% of the test sample for each of the three monitoring events. Toxicity was observed for the acute endpoint for *Hyalella azteca* during the first two monitoring events but not in the third monitoring event. The NOEC for the 96-hour survival for *H. azteca* was 50% of the test sample during the October 18, 2005 and February 19, 2006 monitoring events. Toxicity was not observed to *Selenastrum capricornutum* at the Tijuana River MLS during the three sample events of the 2005-2006 wet weather monitoring season.

12.2.2 Relationships/Analyses

An evaluation of storm water monitoring data collected at the Tijuana River MLS over the past five years was performed. Several constituents have frequently had analytical results measured above their respective WQO.

Conventional constituents that have had concentrations frequently measured above their respective WQO (>50%) are presented below with their respective frequency of occurrence above the WQO:

- Un-ionized ammonia – 83% (n=10/12)
- Chemical oxygen demand (COD) – 73% (n=11/15)
- Total phosphorus – 67% (n=10/15)
- Total suspended solids (TSS) – 87% (n=13/15)
- Turbidity – 93% (n=14/15)

Several other constituents have had results above the WQO, but less frequently, over the past five monitoring seasons and are presented below:

- Biochemical oxygen demand (BOD) – 47% (n=7/15)
- Dissolved phosphorus– 27% (n=4/15)
- Nitrite as N – 7% (n=1/15)
- Surfactants (MBAS) – 40% (n=6/15)

BOD results were below the WQO during all three monitoring events during the 2005-2006 monitoring season. However, the presence of elevated BOD, COD, TSS, and turbidity in combination with elevated bacterial densities are indicative of the presence of untreated wastewater. A review of the scatterplots and trends for conventional parameters (Appendix C) shows that TSS has a statistically significant ($p<0.05$) increasing trend ($R^2=0.46$) at the Tijuana River MLS. Total phosphorus shows a statistically significant ($p<0.05$) decreasing trend ($R^2=0.3$).

All bacterial indicators show persistent, extremely elevated density levels in all 15 storms monitored during the past 5 years. A review of the scatterplots and trends for bacterial indicators shows a statistically significant ($p<0.05$) increasing trend for enterococcus ($R^2=0.33$) and total coliform ($R^2=0.27$) at the Tijuana River MLS.

Pesticides have also been consistently present in the water. Diazinon results were above the WQO during 14 of 15 storms monitored since 2001 (93%). Chlorpyrifos results were above the WQO in 5 of 13 storms (38%-two samples were not evaluated due to the detection limit above the WQO). However, Chlorpyrifos has not been detected over the past two monitoring seasons. Malathion results were above the WQO during 6 of 12 monitoring events (50%) including one result during the first monitoring event on October 18, 2005. However, Malathion was not detected during the remaining two monitoring events.

The total metals copper, lead, and zinc are the most frequent metals found above either their respective hardness based acute or chronic WQO. Total copper results have been above WQO during 6 of 15 monitoring events (40%) of which four results were above both the acute and chronic WQO while two were above only the chronic WQO. Total lead results have been above only the chronic WQO during 7 of 15 monitoring events (47%). Total zinc results were above both the acute and chronic WQO during 3 of 15 monitoring events (20%). There was a single result for total arsenic and total nickel found above the WQO representing 1 of 15 monitoring events (7%). Only one dissolved metal was found above the WQO during the past five monitoring seasons. Dissolved copper, while frequently detected, was above the hardness based acute and chronic WQO during only 1 of 15 monitoring events (7%) and has not exceeded the WQO over the past three monitoring seasons. Statistically significant ($p<0.05$) increasing or decreasing trends were not evident for total or dissolved metals at the Tijuana River MLS with the exception of dissolved nickel. A review of the scatterplots and trends for metals (Appendix C) shows that dissolved nickel has a statistically significant ($p<0.05$) decreasing trend ($R^2=0.51$) at the Tijuana River MLS.

All of the *Ceriodaphnia dubia* toxicity tests have shown toxicity in all 15 storm events. However, a review of the scatterplots and trends for *C. dubia* survival (Appendix C) shows that acute survival endpoint has a statistically significant ($p<0.05$) increasing trend ($R^2=0.27$) at the Tijuana River MLS. This is likely attributable to the decreasing concentrations of Diazinon found in the Tijuana River MLS over the past five years. Results of regression and threshold analyses performed in Section 13 shows that Diazinon is significant at a threshold of 0.26 μg/L for acute survival towards *C. dubia.* Toxicity has been observed for *Hyalella azteca* during 5 of 15 monitoring events (33%) with two of these events occurring within the 2005-2006 monitoring season. Toxicity has never been observed for the fresh water algae *Selenastrum capricornutum* at the Tijuana River MLS over the past 5 years of monitoring.

In order to illustrate the magnitude of the water quality exceedances for 2005-2006, the ratio of water quality results to the WQOs were plotted for several of the most common constituents of concern. The results are shown in Figure 12-3. The largest single exceedance was for fecal coliform, which was approximately 4000 times the WQO during the October 18, 2005 storm event. As previously mentioned, the Tijuana River suffers from discharges of raw wastewater. The average magnitude of water quality exceedances was also determined for each constituent by calculating the mean ratio of water quality results to the WQOs from all storm events from October 2001 through April 2005. Mean ratios are illustrated in Figure 12-3. The largest mean ratio exceedance for the period of record was for fecal coliform, which exceeded the WQO by nearly 1000 times. Other notable mean ratio exceedances include TSS, turbidity, toxicity to the acute, chronic, and reproductive endpoints for C. dubia, Diazinon, and ammonia. Constituent results for the 2005-2006 monitoring season were fairly consistent with the mean ratio exceedances with the exception of ammonia and Chlorpyrifos which were below the WQO during all three monitoring events.

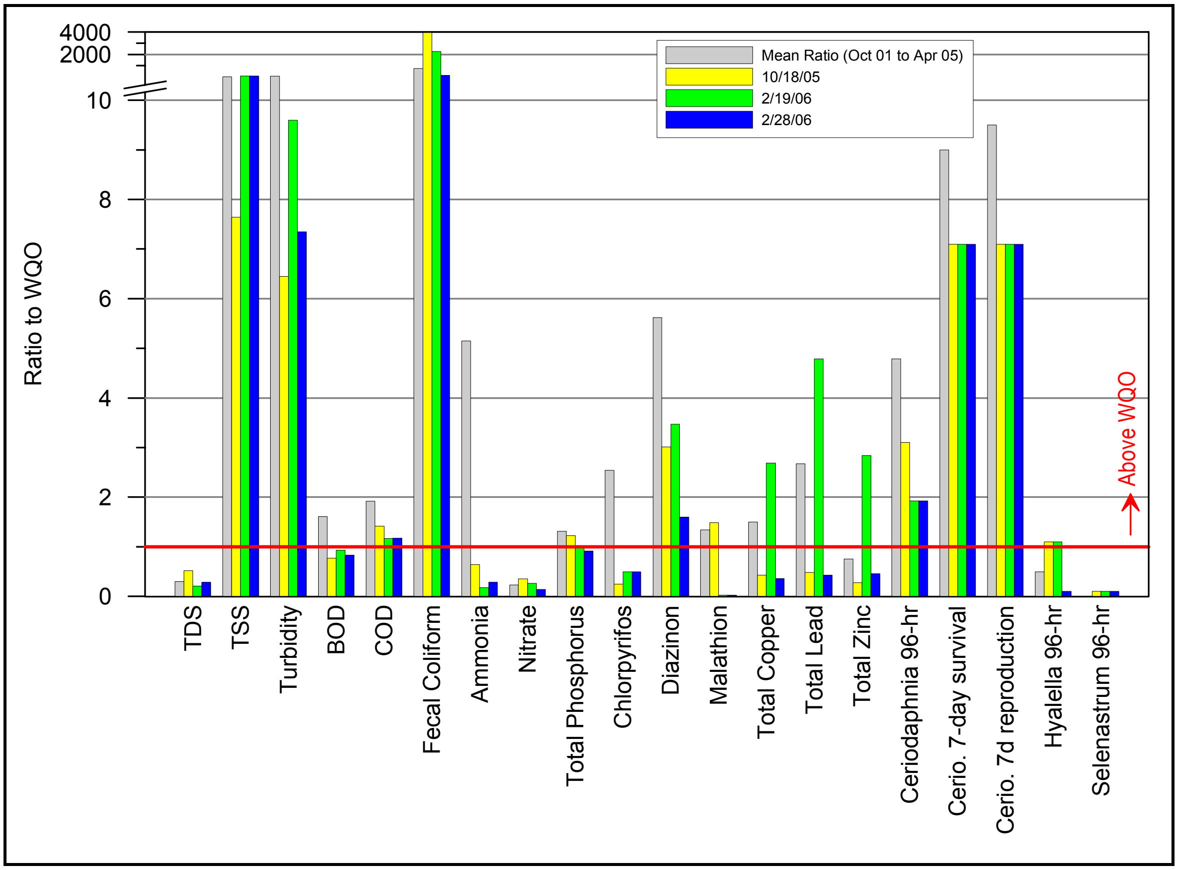


Figure 12-3. Tijuana River water quality ratios.

12.2.3 Wet Weather Constituent Loadings Analysis

Loading values for each constituent sampled were derived using the event mean concentration (EMC) values obtained from composite samples collected at the Tijuana River MLS site and the recorded volume of water discharged during the sampling period. For each of the three storm events, the mean and coefficient of variation were calculated and are reported in Table 12-5.

Table 12-5. Loading Statistics for Tijuana River (TJR) mass loading station.

Constituent	Units	Mean TJR Load	Coefficient of Variation (%)	Mean TJR WQO Load
General/ Physical/Organic				
Flow	cfs	39	2	-
Oil and Grease (O&G)	kg/day	214	35	1,437
Bacteriological				
Total Coliform	MPN/day	1.10E+16	70	na
Fecal Coliform	MPN/day	**8.23E+15**	91	3.83E+12
Enterococci	MPN/day	2.03E+15	120	na
Wet Chemistry				
Total Dissolved Solids (TDS)	kg/day	**81,301**	48	47,906
Total Suspended Solids (TSS)	kg/day	**530,470**	75	9,581
Phosphorus, Total	kg/day	**200**	17	192
Phosphorus, Dissolved	kg/day	150	18	192
Nitrate	kg/day	245	43	958
Nitrite	kg/day	57	47	96
Total Kjeldahl Nitrogen (TKN)	kg/day	1,236	38	na
Ammonia	kg/day	883	67	na
Biochemical Oxygen Demand, 5-day (BOD_5)	kg/day	2,431	11	2,874
Chemical Oxygen Demand (COD)	kg/day	**14,414**	12	11,497
Total Organic Carbon (TOC)	kg/day	8,156	49	na
Dissolved Organic Carbon (DOC)	kg/day	4,766	54	na
Methylene Blue Active Substances (MBAS)	kg/day	43	42	48
Pesticides				
Diazinon	kg/day	**0.021**	38	0.008
Chlorpyrifos	kg/day	0.001	2	0.002
Malathion	kg/day	0.021	165	0.041
Total Metals				
Antimony (Sb), Total	kg/day	0.32	45	0.57
Arsenic (As), Total	kg/day	1.44	26	4.79
Cadmium (Cd), Total	kg/day	0.24	123	0.70
Chromium (Cr), Total	kg/day	0.46	41	61.72
Copper (Cu), Total	kg/day	**3.42**	115	2.92
Lead (Pb), Total	kg/day	**3.42**	132	1.78
Nickel (Ni), Total	kg/day	2.96	58	9.58
Selenium (Se), Total	kg/day	0.24	2	1.92
Zinc (Zn), Total	kg/day	**44.65**	121	37.16
Dissolved Metals				
Antimony (Sb), Dissolved	kg/day	0.24	2	na
Arsenic (As), Dissolved	kg/day	0.35	84	32.58
Cadmium (Cd), Dissolved	kg/day	0.10	88	0.60
Chromium (Cr), Dissolved	kg/day	0.24	2	19.50
Copper (Cu), Dissolved	kg/day	0.93	23	2.81
Lead (Pb), Dissolved	kg/day	0.10	2	1.05
Nickel (Ni), Dissolved	kg/day	1.12	29	16.12
Selenium (Se), Dissolved	kg/day	0.24	2	1.92
Zinc (Zn), Dissolved	kg/day	2.38	53	36.34

The storm event constituent loads at the Tijuana River MLS site were compared to the mean water quality objective (WQO) load calculated by multiplying the mean flow (Table 12-5) by the WQO for each constituent. This comparison shows that mean EMC loads were greater than mean WQO loads for fecal coliform, TDS, TSS, total phosphorus, COD, Diazinon, total copper, total lead, and total zinc. EMC values for total phosphorus, total copper, total lead, and total zinc were above their respective WQOs only one time out of three wet weather events (the second event, 02/19/2006). This result was of great enough magnitude to cause the mean EMC loads to exceed the mean WQO loads. The fecal coliform mean EMC load of 8.23 quadrillion MPN/day exceeded the mean WQO load of 3.83 trillion MPN/day by three orders of magnitude. The next highest ration of mean EMC load to WQO was for TSS, which had a mean EMC load of 530,470 kg/day 55 times greater than its WQO load of 9,581 kg/day. Diazinon had a mean EMC load of 0.021 kg/day, 2.6 times higher than its WQO load of 0.008 kg/day. TDS, total phosphorus, COD, total copper, total lead, and total zinc each had a ratio of mean EMC load to WQO load of less than two.

These loading estimates do not include additional loading delivered to the receiving water after the composite sample collection was completed since continual base flows have not been monitored under this program. Continual flow monitoring will be performed during the 2006-2007 wet weather monitoring season in order to capture the annual base flow conditions. Constituent concentrations during base flow conditions will not be monitored until the 2007-2008 season after the adoption of the revised storm water permit (Order R9-2006-0011). Annual loading estimates will be performed in future reports when this data is available.

12.2.4 Watershed Storm Water Modeling

The estimated average pollutant storm load and the expected loads are compared in this section and are based on the modeling methods provided in Section 3. This comparison can provide watershed managers with additional information on what pollutants are causing unexpectedly high loads.

Figure 12-4 shows the mean modeled loads calculated in GIS for the Tijuana River Watershed based on the rainfall from the three monitored events, land use impervious values, and assumed constituent concentrations. Both load estimates base the runoff volume on the storm rainfall interpolated across the watershed from the County's ALERT rain gage network and the watershed's imperviousness. The loads represent the average amount during the monitored events. The measured loads are calculated by using the mean measured concentrations found during the 2005-2006 storm season. The modeled loads are calculated by assuming the concentrations running off of the different land uses in the watershed correspond to the median land use event mean concentrations found in the National Stormwater Quality Database. A more detailed description of the modeling methods is provided in Section 3.

Almost every constituent load based on measured constituent concentrations is higher than might be expected given Tijuana River Watershed's land use distribution. The numerous constituents listed on the 303(d) list for the Tijuana Valley Subwatershed appears to confirm this broad pollutant loading problem. The fecal coliform load is a thousand times greater than the load estimated from land use. The total suspended solids load is more than a hundred times greater than what might be predicted from land use concentrations in the National Stormwater Quality Database.

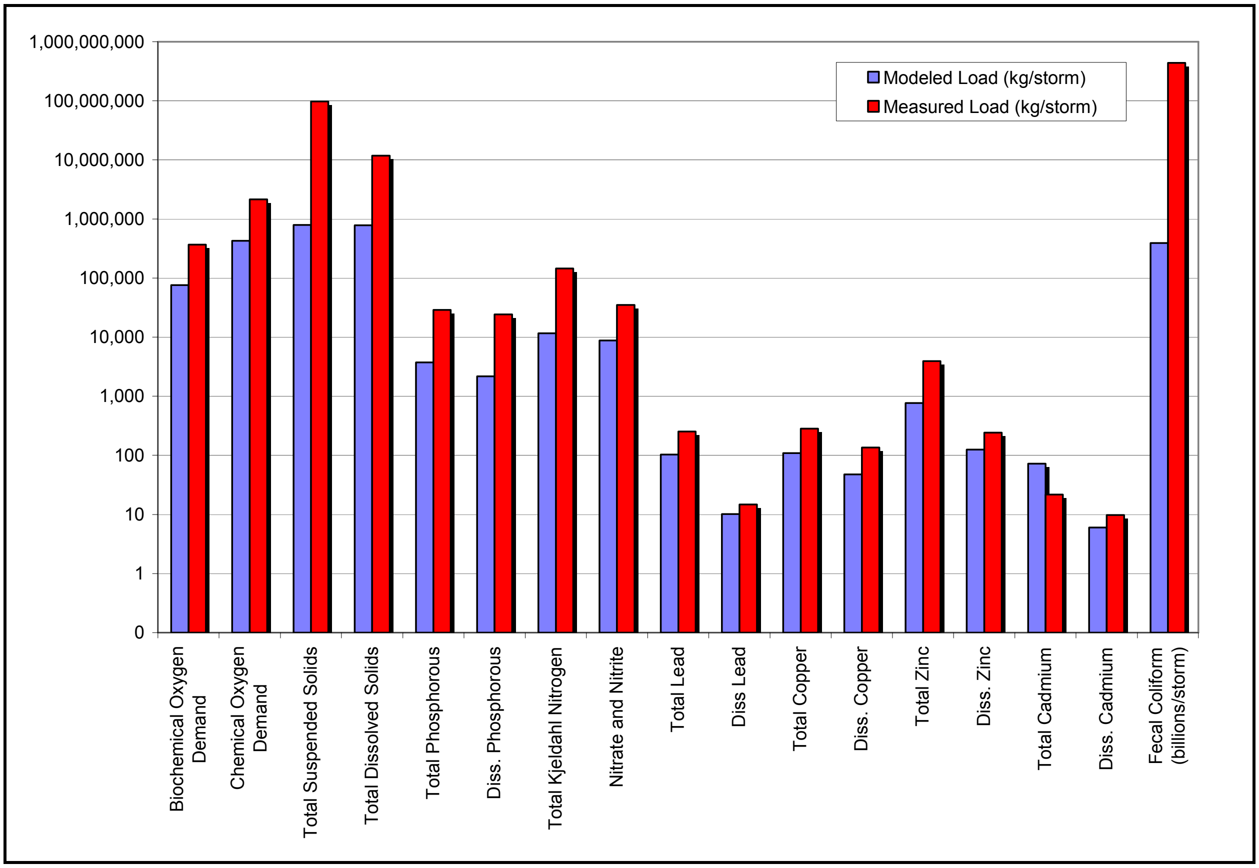


Figure 12-4. Mean modeled and measured loads for the Tijuana River Watershed.

12.2.5 2005 Dry Weather Monitoring Data Evaluation

In addition to the wet weather monitoring discussed above, a separate dry weather monitoring program is carried out by each jurisdiction. Dry weather monitoring reports are provided separately by each jurisdiction in its Jurisdictional Urban Runoff Management Program (JURMP) Annual Report. Dry weather data is also provided in a regional data sharing format which is used for the watershed management area assessments and regional comparisons in this report as described in Section 3. Dry weather monitoring sites with field parameter and chemistry results are presented in this section and are shown on Figure 12-5.

Water quality monitoring was performed at 38 locations in the Tijuana River WMA during the 2005 dry weather monitoring program. Of these, 16 sites are located upstream of the mass loading station in the Tijuana River. A summary of the 2005 dry weather monitoring results for the Tijuana River WMA is presented below in Table 12-6.

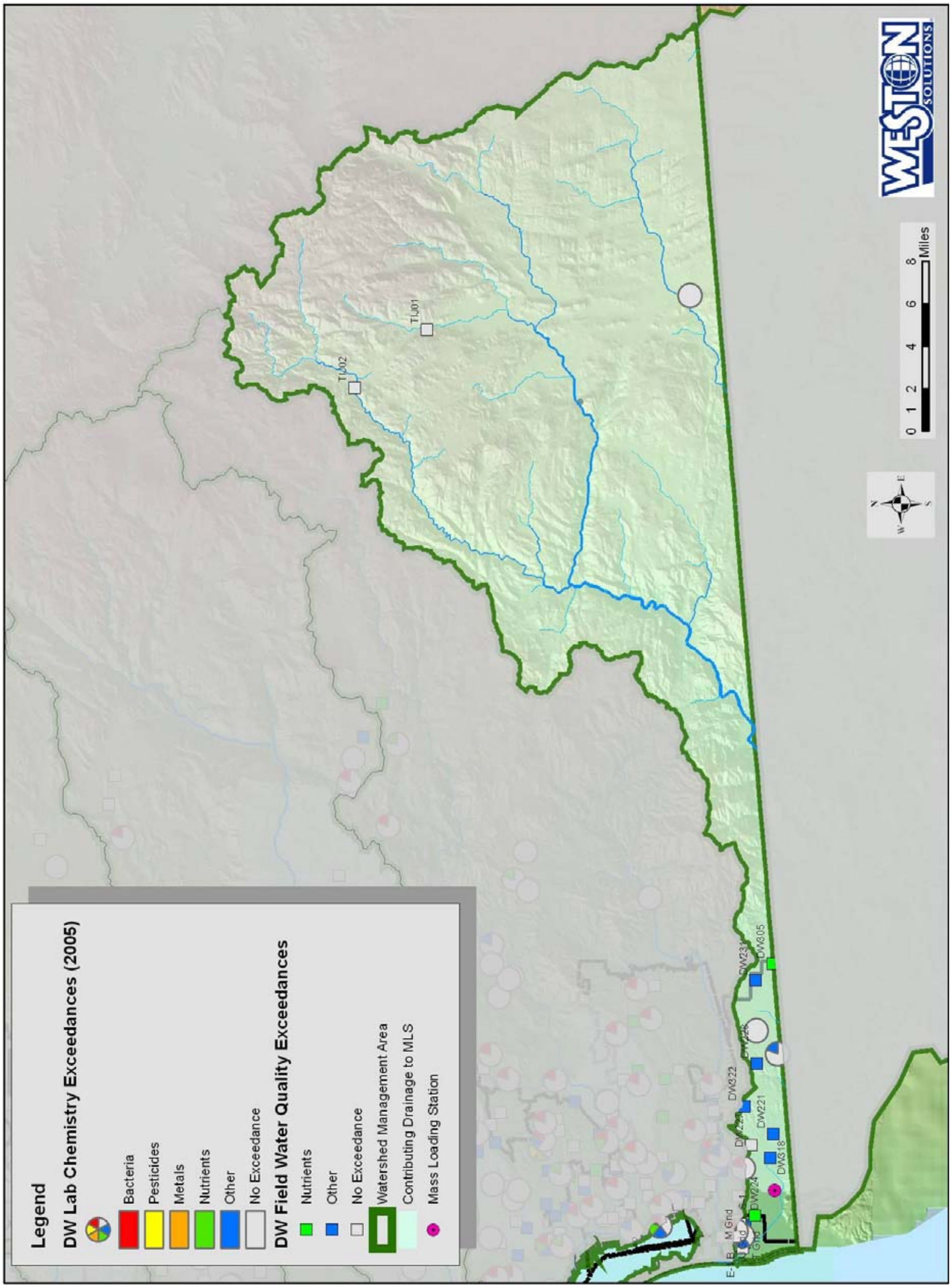


Figure 12-5. Tijuana River WMA dry weather exceedance map.

Table 12-6. Summary of the 2005 dry weather monitoring results for the Tijuana River WMA.

Analyte	Units	DW Action Level	No. Samples	Minimum	Mean	Maximum
Conductivity*	mS/cm		37	0.4	1.6	3.4
Oil & Grease	mg/L	15	6	1.9	4.1	10.1
pH	pH units	6.5-8.5	38	6.9	8.0	9.1
Enterococcus	MPN/100mL	10,000	10	1	4,515	24,200
Fecal Coliform	MPN/100mL	20,000	9	10	2,840	11,000
Total Coliform	MPN/100mL	50,000	10	20	162,787	900,000
Ammonia (NH3-N)	mg/L	1	32	<0.1	1.2	7.2
Nitrate (NO3-N)	mg/L	10	28	<0.1	0.6	3.0
MBAS	mg/L	1	7	0.2	0.5	1.0
Ortho-phosphate (PO4-P)	mg/L	2	37	<0.05	1.1	7.0
Turbidity	NTU	20	25	1.0	47.1	551
Chlorpyrifos	µg/L	0.5	6	<0.05	<0.05	<0.05
Diazinon	µg/L	0.5	6	<0.05	<0.05	<0.05
Total Hardness	mg CaCO3/L		6	295	438	578
Cadmium, Diss	µg/L	(a)	6	<5	na	<5
Copper, Diss	µg/L	(a)	6	<5	15.59	76.0
Lead, Diss	µg/L	(a)	6	<5	na	<5
Zinc, Diss	µg/L	(a)	6	<10	9.57	31.0

* All data are as reported by co-permittees. No unit conversions were made
Mean values are calculated including non-detect results at half the reporting limit. If the mean value was less than the reporting limit, then the mean was not included in the table
(a) Dry weather action level for dissolved metal fraction based on total hardness and calculated as described by the USEPA Federal Register Doc. 40 CFR Part 131, May 18, 2000 If Total Hardness was greater than 400 mg/L, then 400 mg/L was used to calculate dissolved metals water quality objectives

Table 12-7 summarizes all of the 2005 Dry Weather Program constituent exceedances for the Tijuana River WMA. Constituent results that were above the dry weather action level at the dry weather monitoring sites include ammonia, dissolved copper, total and fecal coliform, enterococcus, MBAS, ortho-phosphate, pH, and turbidity.

Table 12-7. Tijuana River WMA 2005 Dry Weather Exceedance Matrix.

Constituent	Number of Exceedances	Number of Samples Collected	Average Ratio of Exceedance*	St. Dev. Ratio of Exceedance
Ammonia	7	32	0.96	1.52
Dissolved Copper	1	6	0.24	0.42
Total Coliform	4	10	11.60	15.10
Fecal Coliform	3	9	10.24	19.71
Enterococcus	3	10	2.37	5.06
MBAS	2	7	0.58	0.39
Ortho-phosphate	4	37	0.52	0.74
pH	2	38	0.11	0.22
Turbidity	10	25	2.35	5.44

* Average ratio of exceedance is equal to the average concentration for all samples collected divided by the dry weather action level.

Constituents with average ratios of exceedance and standard deviations greater than one indicate more frequent and wider ranges of exceedances. Constituents with average ratios of exceedance and standard deviations less than one indicate exceedances that occur on a more random and infrequent basis. In the Tijuana River WMA, total and fecal coliform, enterococcus, and turbidity had average ratios of exceedance greater than one.

Figure 12-5 depicts the 2005 dry weather program monitoring sample locations. Locations shown with circles have both field parameters and laboratory sample results. Locations shown as squares have field parameter results only. Pie symbols appear at dry weather stations that have had dry weather action level exceedances. The colored slices of the pie show the different constituent groups that contributed to the exceedances.

12.2.6 TIEs

Toxicity identification evaluation (TIE) testing was not performed on Tijuana River samples during the 2005-2006 monitoring season. TIE may be useful in determining the specific contaminants. However, given the presence of Diazinon exceeding the WQO during the each storm event, it is likely that Diazinon was a contributor to the toxicity of the Tijuana River samples to *Ceriodaphnia*. Diazinon (log Kow=3.81) has a low solubility and a tendency to bind to organic matter and sediments (Ladaa et al., 1998). In addition, the threshold analyses performed in Section 13, indicate that Diazinon is within this threshold.

Non-polar organic compounds were identified in the 2002-2003 and 2003-2004 TIE testing. Diazinon was the suspect contaminant in these testing periods as determined by methanol fractionation procedures.

TIEs are not recommended for future monitoring seasons in the Tijuana River MLS samples unless notable declines in the concentration of diazinon are observed and toxicity remains persistent.

12.2.7 Watershed Water Quality Monitoring Summary

Constituents most prevalent in Tijuana River that pose the greatest concern are typical of conditions found with untreated wastewater. BOD, COD, TSS, turbidity, and nutrients (un-ionized ammonia-N and total phosphorus) consistently exceeded water quality objectives. Although total coliform and enterococci do not have corresponding water quality objectives, they consistently have highly elevated densities and are also indicative of conditions found with untreated wastewater. In addition, pesticides are also prevalent in elevated concentrations. Diazinon, in particular, has exceeded water quality objectives in 14 of the last 15 storms and has been identified as the likely cause of toxicity in the Tijuana River.

12.3 Stream Bioassessment

Stream bioassessment monitoring in the Tijuana River WMA was conducted at a single site in October 2005, Campo Creek at the Highway 94 overcrossing in the town of Campo (CC-C). Two sites were sampled in May 2006, including the Campo Creek site and a site on the Tijuana River at Dairy Mart Road (TJ-DM). The Tijuana River site could not be sampled in October 2005 due to dry conditions.

In addition to the Index of Biotic Integrity, a new analysis tool has recently become available for summarizing benthic macroinvertebrate communities in California. Known as the O/E ratio, it is the ratio of organisms observed at a site (O) to the organisms expected to occur at a site (E). The "expected" value is based on percent probability of capture of specific taxa under reference conditions and also accounts for factors such as temperature, precipitation, and geology. An O/E ratio of 0.80 or higher represents an unimpacted benthic community. This represents a 20 percent loss of the biodiversity expected in the benthic community.

12.3.1 Results and Discussion

Relative WMA Ranking and Trends Over Time

In order to graphically represent how each WMA test sites are ranked by benthic community quality within the County, rescaled IBIs based on the percent deviation from the median County score is presented in Figure 12-6 (see Section 3.2.7 for a detailed explanation of the re-scaling procedure). Relative ranking of the Tijuana River WMA sites (highlighted in blue) show the two sites were quite different from one another, which is not surprising since the sites had very different runoff characteristics. Campo Creek in Campo (CC-C) was the highest ranked test site in the County program and was 30 percent higher than the County median. Tijuana River at Dairy Mart Road (TJ-DM) was ranked about eight percent below the County median.

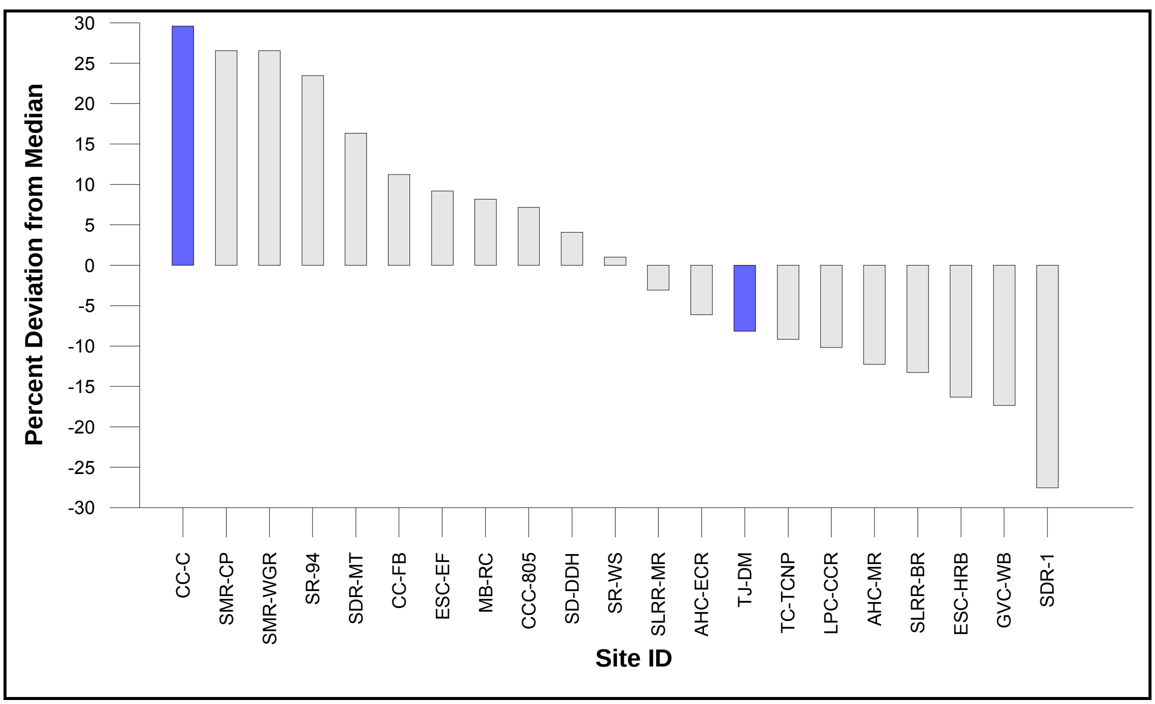


Figure 12-6. Relative Ranking of Rescaled IBI Scores for Tijuana River WMA

Figure 12-7 shows the IBI scores for the Tijuana River WMA sites in comparison with the San Diego County-wide average IBI score, excluding reference sites. Unlike the other WMAs, the upper and lower watershed sites were not averaged due to the great difference in runoff characteristics between the two areas. IBI scores in the upper Tijuana River WMA (Campo Creek) were highly variable and ranged from 4 to 27. IBI scores in the lower Tijuana River WMA (below the city of Tijuana) ranged from 5 to 17.

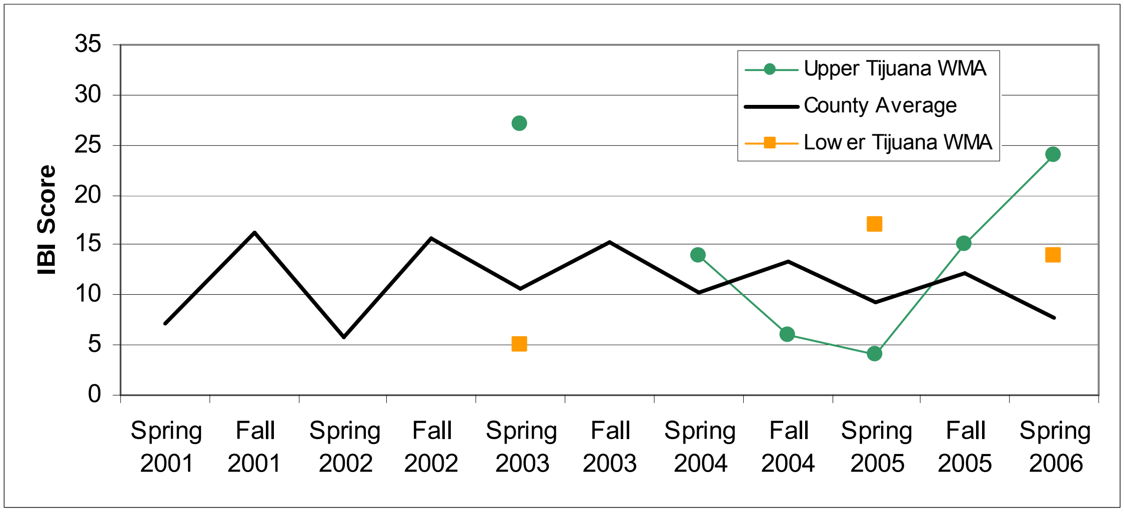


Figure 12-7. Index of Biotic Integrity Scores, WMA Average Over Time

Campo Creek monitoring site: CC-C

The Campo Creek monitoring site had a benthic macroinvertebrate community with an Index of Biotic Integrity rating of Poor for both surveys and IBI scores of 15 and 24, respectively (Table 12-8). There were 19 and 23 different taxa collected, including 6 and 3 different EPT taxa in October and May, respectively. There were several organisms collected in low numbers that are highly intolerant to impairment, including the caddisfly *Rhyacophila* and an immature Chloroperlid stonefly. The percent tolerant taxa comprised 20 and 71 percent of the community per survey.

Preliminary results of the O/E analysis show that the Campo Creek monitoring site had a ratio of 0.74 (Appendix B.9). This implies that the benthic community has lost an estimated 26 percent of the biodiversity expected to occur at the site. This O/E ratio was higher than two of the reference sites.

The physical habitat of the monitoring reach was sub-optimal. The monitoring reach was relocated approximately 200 yards downstream from previous surveys, to an area with a less disturbed riparian zone and better riffle habitat. The stream bed had a high amount of sand and silt, but there was a moderate amount of cobble, boulder, emergent vegetation, and tree roots that provided stable habitat.

Specific conductance was relatively low with values of 1.316 and 1.451 mS/cm. Values for pH were 8.3and 7.8. Water temperatures were lower than the other urban sites in the program, with values of 12.2° and 14.6° C.

Table 12-8. Selected Biological Metrics and Physical Measures of the Tijuana River WMA.

Tijuana River Watershed Management Area	Campo Creek in Campo (CC-C)		Tijuana River-Dairy Mart Road (TJ-DM)
Survey	**Oct-05**	**May-06**	**May-06**
Index of Biotic Integrity/ Qualitative Rating	**15** **Poor**	**24** **Poor**	**14** **Poor**
O/E Ratio		**0.74**	**0.46**
Metrics			
Taxa Richness	19	23	13
EPT Taxa (mayflies, stoneflies, and caddisflies)	6	3	0
% Intolerant Taxa	0.2%	0.4%	0%
% Tolerant Taxa	20%	71%	59%
Average Tolerance Value	6.3	7.3	7.1
% Collector Filterers +Collector Gatherers	88%	69%	58%
Physical Measures			
Elevation	2550		25
Physical Habitat Score	142	128	119
Riffle Velocity (ft/sec)	0.4	0.6	2.3
Substrate Composition			
Silt	17%	27%	43%
Sand	25%	31%	3%
Gravel	2%	3%	5%
Cobble		5%	47%
Boulder	20%	7%	2%
Roots	30%	17%	
Bedrock/Solid	6%	10%	
Water Quality			
Temperature (°C)	12.2	14.6	17.0
pH	8.3	7.8	7.3
Specific Conductance (mS/cm)	1.316	1.451	3.641
Dissolved Oxygen (mg/L)	9.49	4.87	9.47

*Very Poor: 0-13, Poor: 14-26, Fair: 27-40, Good: 41-55, Very Good: 56-70

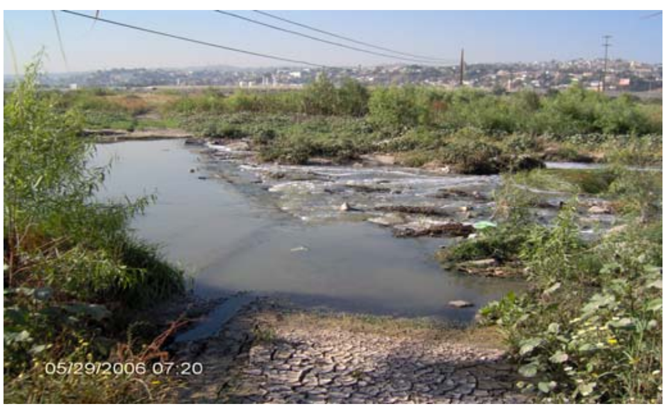
The benthic community was seasonally variable. In October the benthic community was dominated by Chironomid midges and the black fly *Simulium* (Table 12-9). Ostracods and the Amphipod *Hyalella* were also abundant, likely due to the high levels of fine particulate organic matter. In May, the dominant taxa were Hyalella and the snail Physa, with high numbers of Chironomids and Ostracods. Several organisms were collected at the site that are typically collected only at reference sites. These included an immature stonefly (family Chloroperlidae), and the caddisflies Ochrotrichia and Rhyacophila.

The Tijuana River mass loading station was too spatially disconnected from Campo Creek to correlate any of the storm water information with the benthic community.

Table 12-9. Macroinvertebrate Community Summary: Five Most Abundant Taxa for the Tijuana River WMA

		Taxon	Common Name	Percent Composition	Tolerance Value	Functional Feeding Group
Campo Creek in Campo (CC-C)	**Oct-05**	**Chironomidae**	**non-biting midges**	**32%**	**6**	**Collector Gatherer/Filterer**
		Simulium	black fly	29%	6	Collector Filterer
		Hyalella	amphipod	9%	8	Collector Gatherer
		Ostracoda	seed shrimp	7%	8	Collector Gatherer
		Argia	dancer damselfly	6%	7	Predator
Campo Creek in Campo (CC-C)	**May-06**	***Hyalella***	**amphipod**	**29%**	**8**	**Collector Gatherer**
		Physa	aquatic snail	22%	8	Scraper
		Chironomidae	non-biting midges	18%	6	Collector Gatherer/Filterer
		Ostracoda	seed shrimp	18%	8	Collector Gatherer
		Oligochaeta	earth worm	2%	5	Collector Gatherer
Tijuana River at Dairy Mart Road (TJ-DM)	**May-06**	***Physa***	**aquatic snail**	**31%**	**8**	**Scraper**
		Ostracoda	seed shrimp	20%	8	Collector Gatherer
		Chironomidae	non-biting midges	15%	6	Collector Gatherer/Filterer
		Oligochaeta	earth worm	14%	5	Collector Gatherer
		Fossaria	snail	6%	8	Scraper

Tijuana River at Dairy Mart Road: TJ-DM



The Tijuana River monitoring site had a benthic macroinvertebrate community with an Index of Biotic Integrity rating of Poor for the May 2005 survey (Table 12-8). The IBI score was 14, making this one of the higher rated urban sites in the county program. This ranking is not representative of the true quality of the benthic community of the site, as the site is actually severely degraded.

Preliminary results of the O/E analysis show that the Tijuana River monitoring site had a ratio of 0.46 (Appendix B.9). This implies that the benthic community has lost an estimated 54 percent of the biodiversity expected to occur at the site.

The monitoring reach had sub-optimal physical habitat conditions. There was good current flow with a cobble substrate and emergent vegetation at the margins. The site lacked canopy cover and is subject to erosion during high storm flows. It was also noted that overall flow was much greater than in the past several years.

The investigators in this study felt that the IBI score for the Tijuana River site is not representative of the benthic community quality and that the site was, in fact, the most degraded in the County program. Several factors contributed to this conclusion. During field sampling, it was noted that the river had an unpleasant odor that persisted on field sampling gear, the substrates were covered with a blue-gray "biofilm", and there were considerable deposits of fine anoxic silt in the riverbed. Organism abundance was extremely low for two of the three replicate samples, with seven and six total organisms collected in replicates two and three, respectively. The IBI is based upon a 500 organism sample count, and other projects have noted that when sample abundance is very low, the IBI does not give accurate results (SWIA, 2006). Sample replicate one had an estimated 1937 organisms, and field biologists observed that replicate one was dominated by runoff from a sod farm that was adjacent to the monitoring reach, not ambient Tijuana River water. Replicate one was dominated by the highly tolerant snail Physa which contributed ten points for the IBI metric score for Percent Collector Filterers plus Collector Gatherers (Physa is a Scraper, and the Doane Creek reference site was the only other site in May 2006 that received 10 points for this metric). Additionally, there were no EPT taxa collected at the site, and the community was dominated by Dipteran (true flies) and non-insect taxa. The fly *Psychoda* was relatively abundant, and this organism thrives in the presence of organic pollution.

Information from the mass loading stations have indicated high levels of pesticides (primarily diazinon) in the river, exceedances for total suspended solids, un-ionized ammonia, nutrients, and some metals, and there has been persistent toxicity to *Ceriodaphnia dubia* (Table 12-3). Additionally, bacteria levels were extremely high, with elevated BOD and COD indicating probable raw wastewater discharges. These indicators of very poor water quality confirm the assertion that the IBI score for the site is higher than the actual benthic community quality.

12.3.2 Summary and Conclusions

Two stream bioassessment monitoring sites were sampled in the Tijuana River WMA. One site in Campo Creek was sampled in October and May and one site in the Tijuana River at Dairy Mart Road was sampled in May 2006 only. The Index of Biotic Integrity rating for the Campo Creek site was Poor for both surveys, and there were several organisms collected that were otherwise found only at reference sites, and specific conductance was relatively low. The Tijuana River site was rated Poor, but based on an assessment of individual metrics and observations made in the field, the investigators in this study feel that this rating is much higher than the actual benthic community quality.

12.4 Ambient Bay and Lagoon Monitoring Program

12.4.1 Results and Discussion

12.4.1.1 Phase I Results and Discussion

Sediment samples were collected in the Tijuana River Estuary for the 2005 ABLM Program on June 16, 2005 (See Section 3.3 for details on the sampling approach). The nine sites sampled as part of the Phase I assessment are shown in Figure 12-8. The fines fraction of the sediment among the nine sites ranged from 4.61% at Site 1M-1 in the outer stratum to 57% at Site 3M-1 in the inner stratum. Sand was the dominant sediment constituent at all sites. TOC content ranged from 0.03% at Site 2M-5 to 0.95% at Site 1L-3.

Sites 1L-3 in the outer stratum, 3M-1 and 3R-2 in the inner stratum of the Estuary were selected for Phase II assessment (Table 12-10).

Table 12-10. Results of Phase I sediment analyses and subsequent ranking for Phase II site selection at the Tijuana River Estuary.

Sampling Site	TOC and Grain Size Distribution in Phase I								Ranking for Phase II				
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Median (µm)	Mean (µm)	Fines (%)	TOC (%)	Fines Rank	TOC Rank	Rank Sum	Highest Rank	Phase II
TRE 1L3	1.23	77.1	6.46	15.19	279	49	21.65	0.95	7	9	16	*	Yes
TRE 1M1	0.00	95.4	2.15	2.46	156	154	4.61	0.13	1	3	4		
TRE 1R1	0.00	93.3	3.18	3.50	146	135	6.68	0.23	4	6	10		
TRE 2L2	0.07	94.2	2.2	3.5	226.33	205.08	5.71	0.22	2	5	7		
TRE 2M5	0.09	93.7	2.83	3.42	375	309	6.25	0.03	3	1	4		
TRE 2R5	0.00	58.2	15.5	26.3	85	15.4	41.83	0.17	8	4	12		
TRE 3L1	0.03	89.8	2.8	7.4	341.8	332.3	10.13	0.08	5	2	7		
TRE 3M1	0.05	42.9	23.6	33.4	31.8	8.7	57.00	0.90	9	8	17	*	Yes
TRE 3R2	0.75	85.0	3.46	10.8	347	300.8	14.21	0.70	6	7	13	*	Yes
Mean of all sites	0.25	81.08	6.91	11.76	220.91	167.74	18.67	0.38					

Figure 12-8. Map of Phase I site locations in the Tijuana River Estuary. Sites with yellow triangles were selected for Phase II assessment.

12.4.1.2 Phase II Results and Discussion

The three sites selected in the Tijuana River Estuary as part of Phase I were sampled in Phase II on July 13, 2005. Sediments from Sites 1L-3, 3M-1 and 3R-2 were composited and analyzed for chemistry, toxicity, and benthic community structure. The results are summarized in Table 12-11.

Sediment Chemistry. Sediments from each of the 12 coastal embayments in the ABLM Program were analyzed for four categories of constituents: metals, PCBs, PAHs, and pesticides. Of these, seven metals that were common to all the embayments were detected above the detection limit in the Tijuana River Estuary: arsenic, cadmium, chromium, copper, lead, nickel, and zinc (Table 12-11).

Concentrations of all metals were low, well below their respective ERL and ERM sediment quality values. The same metals were detected during the 2003 and 2004 ABLM Programs with the exception of cadmium. All of the metal concentrations during the 2003 and 2004 Programs were also low and well below their respective ERL values. There were no PAHs found above the detection limit in the Tijuana River Estuary samples collected. For pesticides, 1.94 μg/kg of 4,4'-DDE were detected at the Estuary. This concentration does not exceed the ERL value of 2.2 μg/kg for 4,4'-DDE.

The mean ERM-Q value, which is a measure of the cumulative effects of the constituents for which ERMs are available, was 0.09. This value was below the threshold of 0.10. Sediments with mean ERM-Q values above this threshold have a higher probability of producing adverse biological effects (Long et al., 1998). The mean ERM-Q has varied during the ABLM Program in Tijuana River Estuary; in 2003 the mean ERM-Q value was 0.05 while in 2004 the mean ERM-Q value was 0.13 and above the threshold of 0.10.

Toxicity. The mean percent survival of *E. estuarius* exposed to the Tijuana River Estuary sediments in a 10-day acute toxicity test was 94% and not significantly different from that of the Control (97%); suggesting that the Tijuana River Estuary sediments were not toxic to the test organisms (Table 12-11). This is similar to the results from the 2003 and 2004 ABLM Programs where no toxicity was observed.

Table 12-11. Summary of chemistry, toxicity, and benthic community structure in the Tijuana River Estuary.

CHEMISTRY*				
Analyte	ERL	ERM	Result	ERM-Q
METALS (mg/kg)				
Antimony	NA	NA	<0.905	NA
Arsenic	8.2	70	3.5	0.05
Cadmium	1.2	9.6	0.27	0.03
Chromium	81	370	20.6	0.06
Copper	34	270	13.4	0.05
Lead	46.7	218	19.3	0.09
Nickel	20.9	51.6	7.53	0.15
Selenium	NA	NA	<0.905	NA
Zinc	150	410	80.6	0.20
PCBs (μg/kg)	NA_I	NA_I	ND	NA
PAHs (μg/kg)	NA_I	NA_I	ND	NA
PESTICIDES (μg/kg)				
4,4'-DDE	2.2	27	1.94	0.07
Mean ERM-Q				0.09

TOXICITY*
Percent Survival
94.0% Not Significantly Different from Control

BENTHIC COMMUNITY						
Index	1L-3	3M-1	3R-2	Mean	St. Dev.	Total
Abundance	5851	15	1070	2312	3110	6936
Richness	27	6	20	17.67	10.69	44
Diversity	1.20	1.53	1.26	1.33	0.18	NA
Evenness	0.36	0.85	0.42	0.55	0.27	NA
Dominance	2	3	2	2.33	0.58	NA

* Analysis performed on composite samples from the three sites.
NA-Not applicable
NA_I- ERL and ERM values are presented for detected analytes only. Refer to sediment quality guidelines for individual values
ND-Not detected
Bold – exceeds ERL or ERM value

Simultaneously Extracted Metals/Acid-Volatile Sulfides Ratio. In the Tijuana River Estuary sediment, the SEM:AVS ratio was 2.14, indicating that the concentration of SEM was slightly higher than the concentration of AVS in this sediment sample. These results indicate that not all of the metals in the Estuary sediment were bound up by AVS and therefore may be bioavailable and potentially toxic to benthic organisms. Survival of *E. estuarius* (94%) in the Tijuana River Estuary sediment was not significantly different as compared to Control sediment (97%). This indicates that bioavailable metals found in Tijuana River Estuary sediment collected were not toxic to the amphipod *E. estuarius*.

Benthic Community Structure. A total of 6,936 organisms were collected from the Tijuana River Estuary, representing 44 taxa (Table 12-12). In contrast, during the 2003 ABLM Program a total of 1,354 organisms were collected, representing 33 taxa while in the 2004 ABLM Program a total of 983 organisms were collected, representing 39 taxa.

Taxa abundance and richness were higher at Site 1L-3 at the entrance of the Estuary than the other two sites, while evenness and diversity were higher at Site 3M-1. Dominance was similar at all sites.

In the 2005 sampling of the benthic community in the Tijuana River Estuary the gammarid amphipod, *Grandidierella japonica*, accounted for 52% of the benthic community (Table 12-12). Second in abundance was the polychaete worm *Polydora nuchalis* which accounted for 24% of the population. Another polychaete worm *Streblospio benedicti*, made up 8% of the sampled population. In the 2004 sampling, the community was dominated by *Streblospio benedicti*, followed in abundance by *Grandidierella japonica*, and finally *Polydora nuchalis*. During the 2003 ABLM Program the Tijuana River Estuary benthic community was co-dominated by three taxa: the polychaete worm *Pseudopolydora paucibranchiata,* the mollusk *Protothaca sp.*, and *Grandidierella japonica.* In this estuary, the differences in dominant species through the three years of the program are most likely due to sampling in different sections of the estuary than to actual changes in community.

Table 12-12. Dominant infaunal species found in the Tijuana River Estuary during the 2005 ABLM Program.

Embayment	Taxa (Species)	Higher Taxa	Abundance	Percent Composition
TRE	*Grandidierella japonica*	Crustacea	3693	52
	Polydora nuchalis	Polychaeta	1636	24
	Streblospio benedicti	Polychaeta	557	8

Values were calculated from the total of all sites assessed.

Lagoons were analyzed using the Benthic Response Index (BRI) and Relative Benthic Index (RBI) scores as a primary indicator of lagoon health. The BRI is the abundance-weighted average pollution tolerance score of organisms occurring in a sample and is most applicable to marine environments (Smith et al., 2001; Smith et al., 2003; Ranasinghe et al., 2004). The RBI is the weighted sum of three measures of abundance: 1) total number of species, number of crustacean species, number of crustacean individuals, and number of mollusk species; 2) abundance of three positive and 3) two negative indicator organisms (Hunt et al., 2001). The RBI was included because it is less dependent on marine benthic species, and more applicable to lagoons. In each of the sampling periods, the two indices give similar indications of biological conditions (Table 12-13); a lower BRI score indicates better conditions, while a higher RBI score relates to better conditions.

Table 12-13. Indices of Sediment Biological Health found in the Tijuana River Estuary during the ABLM Program.

Index	2003	2004	2005
BRI	11	46	43
RBI	0.69	0.54	0.49

* BRI-Good <31, Fair 31-53, Poor >53
RBI-Good >0.61, Fair 0.31-0.60, Poor <0.30

Triad Relationships. The Triad method was used to assess the relationships between chemistry, biology, and toxicity for the lagoon sediments. This method is an integrated approach that depends on "weight of evidence" (Chapman, 1996) and integrates chemistry, biological observation, and toxicity endpoints, allowing the user to classify results based on a decision framework.

The results of the chemistry, toxicity, and benthic community assessments for Tijuana River Estuary are presented in Figure 12-9 for the 2003, 2004 and 2005 ABLM Monitoring Programs. These relationships have varied over the ABLM program as shown in Figure 12-9; in 2005 the Tijuana River Estuary scored good for toxicology, fair for biology and good for chemistry.

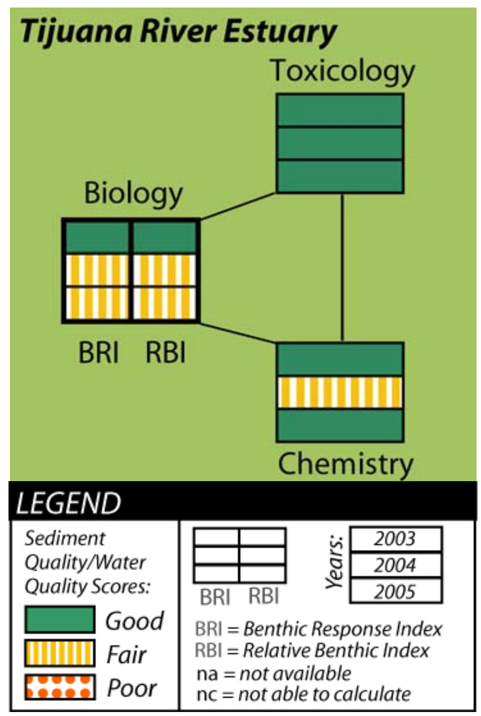


Figure 12-9. Triad relationships for Tijuana River Estuary.

12.4.1.3 ABLM Summary and Conclusions

Sediments in Tijuana River Estuary were monitored as part of the 2005 ABLM Program to assess the potential for adverse effects from the watershed and to compare sediment quality with other coastal embayments in San Diego County. In Phase I, a stratified random approach was used to identify the three sites where COC were most likely to be found (i.e., those with the highest TOC and smallest grains size). In the Tijuana River Estuary, one site was located in the outer stratum, 1L-3 and two in the inner stratum 3M-1 and 3R-2. These sites were sampled in Phase II of the assessment and analyzed for sediment chemistry, toxicity, and benthic community structure. The results of the chemistry assessment indicated that seven metals common to all embayments were also found in the Tijuana River Estuary sediments. Concentrations were low and none exceeded their respective ERL and ERM sediment quality values. In addition, there were no PAHs found in the Estuary above the detection limit. 4,4'-DDE was detected at the Estuary at a concentration below the ERL sediment quality value. The mean ERM-Q value for the Estuary was 0.09 and below the threshold of 0.10. The mean percent survival of test organisms exposed to the Tijuana River Estuary sediments was 94%; therefore test organisms displayed a non-toxic response to the Estuary sediment collected. Correlated with the SEM:AVS Ratio, it was determined that bioavailable metals found in the Tijuana River Estuary sediment were not toxic to the amphipod *E. estuarius*. The infaunal community was dominated by a gammarid amphipod and a common polychaete worm. For the 2005 ABLM sampling, the Tijuana River Estuary scored good for toxicology, fair for biology and good for chemistry.

12.5 Tijuana River WMA Assessment

The Tijuana River Watershed Management Area was assessed utilizing chemistry and toxicity data collected during storm events from a single MLS, chemistry data collected from 16 dry weather monitoring sites upstream of the MLS, and IBI scores generated at three bioassessment sites. The watershed management area assessment methods presented in Section 3.4 were applied to these data to determine which constituents were of concern and to develop a high, medium, or low frequency of occurrence for these constituents. The results of this assessment are presented in Table 12-14.

12.5.1 Tijuana River WMA Criterion Assessment

Six constituents were found to have a high frequency of occurrence and are listed below as a constituent of concern. All of these constituents received a rating of three diamonds based on Criteria No. 1. These include:

- Total Coliform
- Fecal Coliform
- Enterococcus
- Total suspended solids
- Turbidity
- Diazinon

Three constituents were found to have a medium frequency of occurrence and were assigned two diamonds based on Criteria No. 6. These constituents include:

- COD
- Un-Ionized Ammonia
- Total Phosphorus

Four constituents were found to have a low frequency of occurrence and were assigned one diamond based on Criteria No. 9. These include:

- BOD
- Surfactants (MBAS)
- Malathion
- Total Copper

BOD and COD are unique among the constituents assessed in the storm water program because they provide an indirect measure of the total oxidizable material available in the water column due to other factors, including anthropogenic contaminants as well as natural processes (as opposed to other methods which only provide results for the specific analyte tested). The presence of BOD or COD above their respective water quality criteria indicates the presence of other contaminants that may have caused the exceedance. Thus, management actions aimed at reducing BOD or COD may be most effective if the source or sources of the elevated levels are addressed directly. In this way, a reduction in BOD or COD levels would be a by-product of actions taken against more easily rectified constituents.

Potential contaminants of concern are other synthetic organics, trace elements and trash as indicated by the SWRCB 303(d) list for the Tijuana River. The SWRCB 303(d) list also specifies lead, nickel and thallium as COC for the Tijuana River Estuary, downstream of the MLS.

Table 12-14. Constituent exceedances in the Tijuana River WMA.

Tijuana River																
CONSTITUENTS WITH ANY WET WEATHER (MLS) WQO OR DRY WEATHER ACTION LEVEL EXCEEDANCE	MLS (Wet Weather) Results												Dry Weather Results *		Frequency of Occurrence	Criterion No.
	2001/2002		2002/2003		2003/2004		2004/2005		2005/2006		CUMULATIVE		2005			
	#/3	%	#/3	%	#/3	%	#/3	%	#/3	%	#/15	%	#	%		
Conventional Parameters																
pH	0	0	1	33	0	0	0	0	0	0	1	7	1	6	-	-
BOD	2	67	1	33	3	100	1	33	0	0	7	47	NA	NA	♦	9
COD	2	67	2	67	3	100	1	33	3	100	11	73	NA	NA	♦♦	6
Surfactants (MBAS)	2	67	1	33	1	33	1	33	1	33	6	40	0	0	♦	9
Total Suspended Solids	2	67	2	67	3	100	3	100	3	100	13	87	NA	NA	♦♦♦	1
Turbidity	2	67	3	100	3	100	3	100	3	100	14	93	8	50	♦♦♦	1
Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	1	6	-	-
Un-ionized Ammonia as N	NA	NA	3	100	2	67	2	67	3	100	10	67	NA	NA	♦♦	6
Nutrients																
Dissolved Phosphorus	3	100	0	0	1	33	0	0	0	0	4	27	NA	NA	-	-
Total Phosphorus	3	100	3	100	2	67	1	33	1	33	10	67	NA	NA	♦♦	6
Bacteriological																
Total Coliform	3	100	3	100	3	100	3	100	3	100	15	100	0	0	♦♦♦	1
Fecal Coliform	3	100	3	100	3	100	3	100	3	100	15	100	0	0	♦♦♦	1
Enterococcus	3	100	3	100	3	100	3	100	3	100	15	100	0	0	♦♦♦	1
Pesticides																
Chlorpyrifos	3	100	1	33	1	33	0	0	0	0	5	33	0	0	-	-
Diazinon	3	100	3	100	3	100	2	67	3	100	14	93	0	0	♦♦♦	1
Malthion	NA	NA	2	67	2	67	1	33	1	33	6	40	NA	NA	♦	9
Total Metals																
Arsenic	0	0	0	0	1	33	0	0	0	0	1	7	NA	NA	-	-
Copper	0	0	1	33	2	67	0	0	1	33	4	27	NA	NA	♦	9
Lead	0	0	0	0	0	0	2	67	1	33	3	20	NA	NA	-	-
Nickel	0	0	0	0	1	33	0	0	0	0	1	7	NA	NA	-	-
Zinc	0	0	0	0	1	33	1	33	1	33	3	20	NA	NA	-	-
Dissolved Metals																
Copper	0	0	1	33	0	0	0	0	0	0	1	7	0	0	-	-
Toxicity															EVIDENCE OF PERSISTENT TOXICITY?	
Ceriodaphnia 96-hour	3	100	3	100	3	100	3	100	3	100	15	100	NA	NA	Yes	
Ceriodaphnia 7-day survival	3	100	3	100	3	100	3	100	3	100	15	100	NA	NA	Yes	
Ceriodaphnia 7-day reproduction	3	100	3	100	3	100	3	100	3	100	15	100	NA	NA	Yes	
Hyalella 96-hour	0	0	1	33	2	67	0	0	2	67	5	33	NA	NA	No	
Bioassessment	IBI Rating														EVIDENCE OF BENTHIC ALTERATION?	
Campo Creek	NA		NA		Poor		Very Poor		Poor		Poor		NA		No	
Tijuana River, at Dairy Mart Rd.	NA		Very Poor		NA		Poor		Poor		Poor		NA			

* = Total number of observations varied among constituents.
NA = Not assessed
\- = Constituent results are below the defined requirements for a Low Frequency of Occurrence rating.
♦ = Low Frequency of Occurrence rating.
♦♦ = Medium Frequency of Occurrence rating.
♦♦♦ = High Frequency of Occurrence rating.

All of the bioassay tests conducted on *Ceriodaphnia dubia* have shown evidence of persistent toxicity in all five years of monitoring. Although there has been toxicity to *Hyalella azteca* during some of the storm events, there is no evidence of persistent toxicity to *Hyalella* based on the assessments at this time.

Cumulative IBI scores resulting from bioassessment monitoring on the Tijuana River throughout the monitoring period indicated a rating of poor or very poor at both sites, but does not suggest evidence of benthic alteration. It should be noted, though, that the bioassessment monitoring site in Campo is spatially segregated from the water quality monitoring stations located much further downstream. The bioassessment site in Campo is not affected by the communities of Tijuana, Mexico.

Figure 12-10 summarizes the number of water quality exceedances for six categories of constituents. Categories include conventionals, nutrients, bacteria, pesticides, metals and toxicity. The stacked bars were developed using number of exceedances from values in Table 12-14 for each constituent category. The overall number of water quality objectives exceedances at the Tijuana River MLS has been consistently high and has the highest number of exceedances in comparison to all other MLS sites. A slight increase in the total number of exceedances was exhibited during the 2005-2006 monitoring period, but with very little relative change within the different constituent categories in comparison to the last three monitoring seasons.

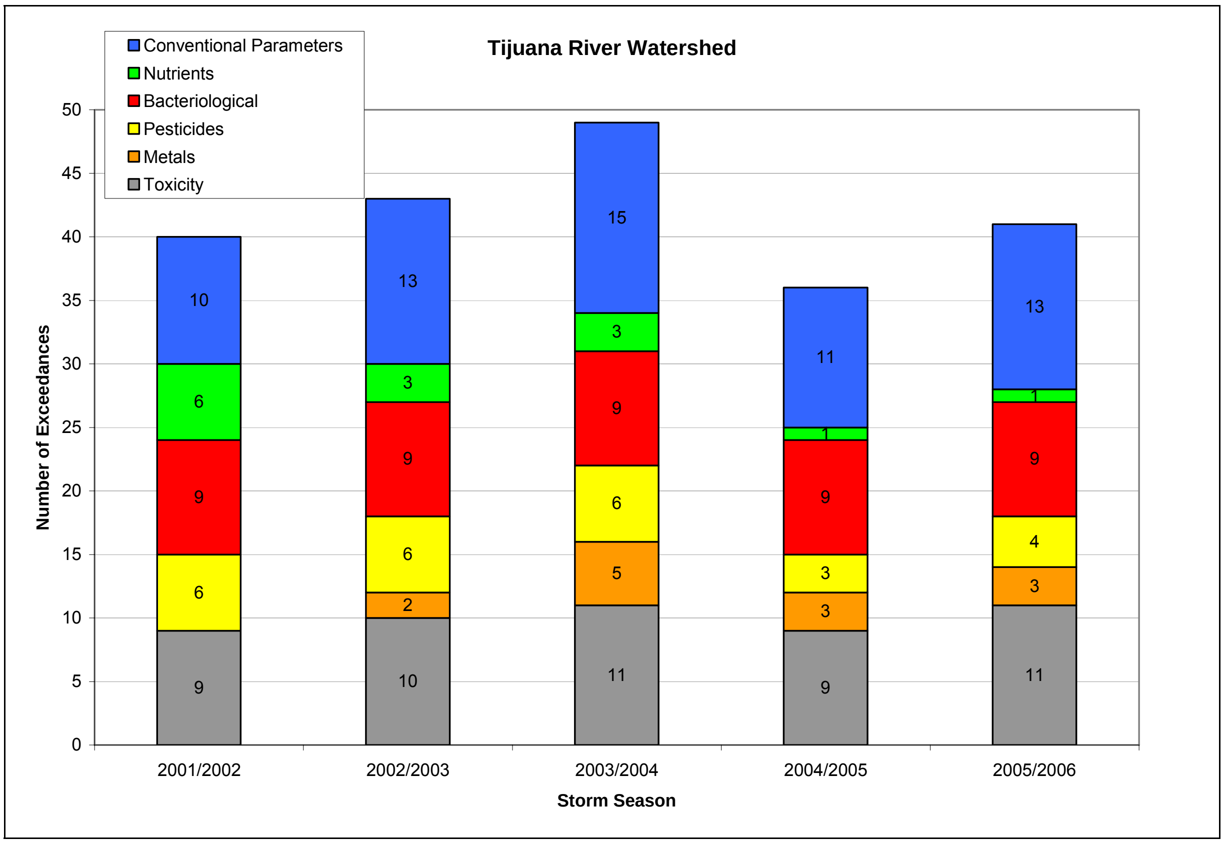


Figure 12-10. Stacked bar chart of the number of wet weather exceedances of constituent groups in Tijuana River.

Evaluation of scatterplots for the Tijuana River presented in Appendix C indicate statistically significant ($p<0.05$) increasing trends for total suspended solids ($R^2=0.46$), Enterococcus ($R^2=0.33$), total coliform ($R^2=0.27$), and acute *Ceriodaphnia dubia* survival ($R^2=0.27$). It should be noted that the increased *C. dubia* survival trend is a positive indication. Statistically significant ($p<0.05$) decreasing trends are evident for total phosphorus ($R^2=0.30$) and dissolved nickel ($R^2=0.51$).

12.5.2 Triad Decision Matrix

The triad decision matrix combines the occurrence of COC with the toxicity and bioassessment results to determine possible conclusions about the watershed and provide possible actions for future monitoring or assessment. Table 12-15 summarizes these results and lists possible conclusions and actions.

Table 12-15. Triad Decision Matrix Results for the Tijuana River Watershed.

Chemistry	Toxicity	Benthic Alteration	Possible Conclusion(s)	Possible Actions or Decisions
Persistent exceedance of water quality objectives high frequency COC identified)	Evidence of persistent toxicity	No indications of alteration	Toxic contaminants are bioavailable, but in situ effects are not demonstrable Benthic analysis not sensitive enough to detect impact Potentially harmful pollutants not yet concentrated enough to change community	1) Determine if chemical and toxicity tests indicate persistent degradation. 2) Recheck benthic analyses; consider additional data analyses. 3) Toxicity tests at higher dilutions to better quantify toxicity: • If recheck indicates benthic alteration, perform TIE to identify contaminants of concern, based on TIE metric. Evaluate/investigate upstream source as a high priority. • If recheck shows no effect, use TIE to identify contaminants of concern, based on TIE metric. Evaluate/investigate upstream source identification as a medium priority.

The water quality degradation and persistent toxicity observed from monitoring at the MLS in the lower Tijuana River may cause benthic alterations. Unfortunately, without bioassessment data downstream of the MLS, this conclusion cannot be confirmed. As mentioned earlier in this section, hydrologic conditions prevented bioassessment monitoring lower in the Tijuana River.

12.5.3 Water Quality Priority Ratings for the Tijuana River WMA

The purpose of the water quality priority ratings is to identify water quality priorities within a watershed based on weighted averages of the sub-watershed ratings. Because it is a weighted average, larger sub-watersheds will have a greater influence in the overall watershed rating.

The water quality priority ratings presented in Table 12-16 are based on the methodology presented in the BLTEA report (WESTON, MOE, & LWA, 2005) and are presented in the Methods Section 3.4. Constituent groups and stressor groups are given a ranking from A to D with A being the highest priority rating and D the lowest priority rating. Items ranked with a D indicate that the constituent group or stressor is a low priority or does not have sufficient data to support a higher ranking. The ratings were based on current results presented in this 2004-2005 annual report and data from the following programs:

- Storm Water Mass Loading Monitoring (MLS) – Wet Weather Data (2000-2006)
- Co-permittee Dry Weather Data Monitoring (2003-2005)
- Ambient Bay, Lagoon, and Coastal Receiving Water Monitoring (2003-2005)
- Urban Stream Bioassessment Monitoring (2000-2006)

- Triad Assessment – Toxicity Testing of Storm water (2000-2006)
- 303(d) Listing (2003)

Table 12-16. Updated Water Quality Priority Ratings for the Tijuana River WMA

Watersheds/Sub-watersheds	Percentage of Total Area	Priority Ratings*										
		Constituent Groups									Stressor Groups	
		Heavy Metals	Dissolved Minerals	Organics	Oil and Grease	Sediments	Pesticides	Nutrients	Gross Pollutants	Bacteria/ Pathogens	Benthic Alterations	Toxicity
Tijuana WMA	**100%**	***B***	***D***	***D***	***D***	***B***	***B***	***C***	***C***	***B***	***B***	***B***
Tijuana Valley HA (911.10)	7%	*A*	*D*	*A*	*D*	*A*	*A*	*A*	*A*	*A*	*A*	*B*
Potrero HA (911.20)	18%	*B*	*D*	*D*	*D*	*B*	*B*	*B*	*B*	*B*	*B*	*B*
Barrett Lake HA (911.30)	20%	*B*	*D*	*D*	*D*	*C*	*B*	*C*	*C*	*B*	*B*	*B*
Monument HA (911.40)	8%	*C*	*D*	*D*	*D*	*A*	*C*	*C*	*C*	*A*	*B*	*B*
Morena HA (911.50)	5%	*B*	*D*	*D*	*D*	*B*	*B*	*B*	*B*	*B*	*B*	*B*
Cottonwood HA (911.60)	10%	*C*	*D*	*D*	*D*	*B*	*C*	*C*	*C*	*C*	*B*	*B*
Cameron HA (911.70)	10%	*B*	*D*	*D*	*D*	*B*	*B*	*B*	*B*	*B*	*B*	*B*
Campo HA (911.80)	23%	*C*	*D*	*D*	*D*	*A*	*C*	*C*	*C*	*C*	*B*	*B*
Frequency of Occurrence Rating High[1]						♦♦♦	♦♦♦			♦♦♦		
Constituents of Concern						TSS Turbidity	Diazinon			Total Coliform Fecal Coliform Entero-coccus		

1. High frequency of occurrence ratings are derived from the constituent exceedances tables and are provided for comparison purposes.

Notes:

** = Rating Calculated Based on Area Weighted Averages of Score Value from the sub-watershed areas.*

*** = Priority Level (Highest-A to Lowest-D)*

High Priority Level Based on Data

303d listing

The Tijuana River WMA did not have any high priority (A) ratings for the overall WMA. The highest rated constituents were heavy metals, sediments, pesticides, bacteria, benthic alteration, and toxicity which were all assigned a B priority rating. All other categories received either a C or D priority rating. A regional evaluation and summary of the BLTEA process is presented in the Regional Assessment Section 13. The complete tables used to calculate the ratings are presented in Appendix G.

The Tijuana Valley sub-watershed which accounts for only 7% of the watershed had several high priority (A) rated constituents primarily due to 303(d) listings and wet weather monitoring data which include, heavy metals, organics, sediments, pesticides, nutrients, gross pollutants, bacteria, and benthic alteration. Dissolved minerals and oil and grease were found to have a low priority (D) rating in this sub-watershed. Other high priority (A) ratings include sediment in the Monument and Campo Sub-watersheds and for bacteria in the Monument Sub-watershed due to bacteria being on the 303(d) list in this area. Because the assessment is based on a weighted average, larger sub-watersheds will have a greater influence in the overall watershed rating. The Tijuana River WMA has only limited data from the upper watersheds which results in lower priority ratings. Other challenges include the fact that a large portion of the watershed lies outside of the regulatory controls of this program.

High frequency of occurrence ratings from the WMA criterion assessments were also included in the water quality priority rating summary table above. High frequency of occurrence ratings were determined for TSS, turbidity, Diazinon, and all three bacterial indicators for the Tijuana River WMA. In comparison, the water quality priority ratings found B priority ratings for these categories, suggesting that the major water quality concerns are primarily focused in the area downstream of the urban population center of Tijuana, Mexico in the Tijuana Valley Sub-watershed.

A list of potential likely or unknown sources for the heavy metals, sediments, pesticide, and bacteria categories in the Tijuana River WMA that are based on the threat to water quality inventory ratings tables from the BLTEA report (WESTON, MOE, & LWA, 2005) were ranked and are provided below in Table 12-17, Table 12-18, Table 12-19, and Table 12-20 respectively. These inventories provide insight into the activities that may contribute a threat to water quality on the U.S. side of the border. The number of potential sources would likely be much higher if inventories from Tijuana, Mexico existed and were included. The tables are not an all inclusive summary of sources in each WMA (e.g., does not consider naturally occurring sources). The tables were developed from the following list of potential sources that were agreed upon by the Copermittee Long-Term Effectiveness workgroup:

- Copermittees developed inventories
- County Department of Environmental Health Hazardous Material Database
- County Agriculture, Weights & Measures Database
- County Department of Environmental Health Food and House Database
- Thomas Brothers Maps
- Online Yellow Pages
- State Water Board list of dischargers subject to construction and industrial storm water general permit.
- Pretreatment Records

The basis of the source list was to identify sources that can be regulated and have the potential to discharge the pollutant types that are of focus of the urban runoff management programs.

Table 12-17. List of potential likely and unknown heavy metals sources for the Tijuana River WMA.

Potential Heavy Metals Sources	Number of Sources	Source Loading Potential
Auto mechanical repair, maintenance, fueling, or cleaning	31	Likely
Motor Freight	19	Likely
Botanical or zoological gardens and nurseries/greenhouses	7	Likely
Fabricated metal	5	Likely
Primary metal	3	Likely
Corporate yards (incl. maintenance/storage yards)	2	Likely
Boat mechanical repair, maintenance, fueling, or cleaning	1	Likely
Automobile and other vehicle body repair and painting	1	Likely
Automobile wholesale	1	Likely
Mobile automobile or vehicle washing	-	Likely
Auto parking lots and storage facilities	-	Likely
Home automobile associated activities, home and garden care activities, waste disposal	-	Likely
Roads, streets, highways, and parking facilities	-	Likely
Retail or wholesale fueling	28	Unknown
Development subject to SUSMPs	10	Unknown
Active or closed municipal landfills	2	Unknown
Chemical and allied products	1	Unknown
Airfields	1	Unknown
POTWs (water and wastewater)	1	Unknown
Park and Recreational facilities	-	Unknown
Sites for disposing and treating sewage sludge	-	Unknown

Source: Baseline Long-Term Effectiveness Assessment Report (Weston, MOE, & LWA, 2005).
"-" signifies that no inventory information is available
Based on limited inventory data provided by Copermittees in 2005

Table 12-18. List of potential likely and unknown sediment sources for the Tijuana River WMA.

Potential Sediment Sources	Number of Sources	Source Loading Potential
General contractors for home/commercial improvements (e.g. cement mixing, masonry, painting, etc.)	-	Likely
Construction Sites	120	Likely
Botanical or zoological gardens and nurseries/greenhouses	7	Likely
Animal Facilities	4	Likely
Corporate yards (incl. maintenance/storage yards)	2	Likely
Automobile wholesale	1	Likely
Mobile automobile or vehicle washing	-	Likely
Auto parking lots and storage facilities	-	Likely
Home automobile associated activities, home and garden care activities, waste disposal	-	Likely
Roads, streets, highways, and parking facilities	-	Likely
Flood management projects and flood control devices	-	Likely
MS4s	-	Likely
Retail or wholesale fueling	28	Unknown
Motor Freight	19	Unknown
Development subject to SUSMPs	10	Unknown
Fabricated metal	5	Unknown
Primary metal	3	Unknown
Active or closed municipal landfills	2	Unknown
Chemical and allied products	1	Unknown
Airfields	1	Unknown
POTWs (water and wastewater)	1	Unknown
Park and Recreational facilities	-	Unknown
Sites for disposing and treating sewage sludge	-	Unknown

Source: Baseline Long-Term Effectiveness Assessment Report (Weston, MOE, & LWA, 2005).
"-" signifies that no inventory information is available
Based on limited inventory data provided by Copermittees in 2005

Table 12-19. List of potential likely and unknown pesticide sources for the Tijuana River WMA.

Potential Pesticide Sources	Number of Sources	Source Loading Potential
Botanical or zoological gardens and nurseries/greenhouses	64	Likely
Landscaping - parks, golf courses, cemeteries, etc.	1	Likely
Pest Control Services	17	Likely
Home automobile associated activities, home and garden care activities, waste disposal	-	Likely
Eating or drinking establishments	89	Unknown
Development subject to SUSMPs	10	Unknown
Fabricated metal	5	Unknown
Animal Facilities	2	Unknown
Motor Freight	1	Unknown
Auto parking lots and storage facilities	-	Unknown
Flood management projects and flood control devices	-	Unknown
Park and Recreational facilities	-	Unknown
Sites for disposing and treating sewage sludge	-	Unknown

Source: Baseline Long-Term Effectiveness Assessment Report (Weston, MOE, & LWA, 2005).
"-" signifies that no inventory information is available
Based on limited inventory data provided by Copermittees in 2005

Table 12-20. List of potential likely and unknown bacteria sources for the Tijuana River WMA.

Potential Bacteria Sources	Number of Sources	Source Loading Potential
Eating or drinking establishments	223	Likely
Botanical or zoological gardens and nurseries/greenhouses	7	Likely
Animal Facilities	4	Likely
POTWs (water and wastewater)	1	Likely
Home automobile associated activities, home and garden care activities, waste disposal	-	Likely
Roads, streets, highways, and parking facilities	-	Likely
Sites for disposing and treating sewage sludge	-	Likely
Motor Freight	19	Unknown
Development subject to SUSMPs	10	Unknown
Active or closed municipal landfills	2	Unknown
Automobile wholesale	1	Unknown
Auto parking lots and storage facilities	-	Unknown
Pest Control Services	41	Unknown
Flood management projects and flood control devices	-	Unknown
MS4s	-	Unknown
Park and Recreational facilities	-	Unknown

Source: Baseline Long-Term Effectiveness Assessment Report (Weston, MOE, & LWA, 2005).
"-" signifies that no inventory information is available
Based on limited inventory data provided by Copermittees in 2005

12.6 Conclusions and Recommendations

The Tijuana River WMA is the largest of the San Diego watersheds covering over 1.1 million acres. Mexico governs the majority of the Tijuana River Watershed (73%) with the remaining areas belonging to the United States. Undeveloped areas account for 58% of U.S. lands, with another 25% devoted to parks. The River flows through Tijuana, Mexico and runoff contributions come from both Mexico and the United States.

For the Tijuana River WMA, all three bacterial indicators, TSS, turbidity, and Diazinon were identified as high frequency of occurrence COC, followed by COD, un-ionized ammonia, and total phosphorus which were identified as medium frequency of occurrence COC. BOD, MBAS, Malathion, and total copper were identified as low frequency of occurrence COC. The elevated densities of all three bacterial indicators and elevated levels of BOD, COD, un-ionized ammonia, and nutrients (total phosphorus) are indicative of raw wastewater discharges. Pesticides (primarily Diazinon) are also persistently found above WQOs in the watershed and are likely the major cause of toxicity observed towards the freshwater amphipods *Ceriodaphnia dubia* and *Hyalella azteca*.

A review of the scatterplots and trends shows statistically significant increasing trends for TSS, enterococcus, total coliform, and the acute survival endpoint for *Ceriodaphnia dubia*. The increasing trend for *C. dubia* survival indicates a decrease in the toxicity to this species. Statistically significant decreasing trends are evident for total phosphorus and dissolved nickel.

The storm event constituent loads at the Tijuana River MLS site were compared to the mean water quality objective (WQO) load calculated by multiplying the mean flow by the WQO for each constituent. This comparison shows that mean EMC loads were greater than the mean WQO loads for fecal coliform, TDS, TSS, total phosphorus, COD, Diazinon, total copper, total lead, and total zinc. EMC values for total phosphorus, total copper, total lead, and total zinc were above their respective WQOs only one time out of three wet weather events (the second event, 02/19/2006). This result was of great enough magnitude to cause the mean EMC loads to exceed the mean WQO loads. The fecal coliform mean EMC load exceeded the mean WQO load by three orders of magnitude, and the diazinon mean EMC load exceeded the mean WQO by a slight margin

The mean modeled loads calculated in GIS for the Tijuana River Watershed indicate that almost every constituent load based on measured constituent concentrations is higher than might be expected given the Tijuana River Watershed's land use distribution. The numerous constituents on the 303(d) list for the Tijuana Valley Sub-watershed appears to confirm this broad pollutant loading problem. The fecal coliform load is a thousand times greater than the load estimated from land use. The total suspended solids load is more than a hundred times greater than what might be predicted from land use concentrations in the National Storm water Quality Database.

Two stream bioassessment monitoring sites were sampled in the Tijuana River WMA. One site in Campo Creek was sampled in October and May and one site in the Tijuana River at Dairy Mart Road was sampled in May 2006 only. The Index of Biotic Integrity rating for the Campo Creek site was Poor for both surveys, and there were several organisms collected that were otherwise found only at reference sites, and specific conductance was relatively low. The Tijuana River site was rated Poor, but based on an assessment of individual metrics and observations made in the field, the investigators in this study feel that this rating is much higher than indicated by the actual benthic community quality.

The 2005 Ambient Bay and Lagoon Monitoring assessment for the Tijuana River Estuary analyzed sediment chemistry, toxicity, and benthic community structure. The results of the 2005 ABLM program for chemistry assessment indicated that seven metals common to all embayments were also found in the Tijuana River Estuary sediments. Concentrations were low and none exceeded their respective ERL and ERM sediment quality values. In addition, PAHs were not found in the Estuary above the detection limit. However, 4,4'-DDE was detected in the Estuary at a concentration below the ERL sediment quality value. The mean ERM-Q value for the Estuary was 0.09 and below the threshold of 0.10. Test organisms did not display a toxic response to the Estuary sediment collected. Correlated with the SEM:AVS Ratio, it was determined that bioavailable metals found in the Tijuana River Estuary sediment were not toxic to the amphipod *E. estuarius*. The infaunal community was dominated by a gammarid amphipod and a common polychaete worm. For the 2005 ABLM sampling, the Tijuana River Estuary scored good for toxicology, fair for biology and good for chemistry.

The water quality priority ratings agreed with the WMA assessment findings for the Tijuana Valley sub-watershed but since this sub-watershed is only 7% of the entire Tijuana River WMA, it suggests that the high priorities and COCs may be more localized to the area near the MLS. The overall Tijuana River WMA did not have any high priority (A) ratings. The highest rated constituents were heavy metals, sediments, pesticides, bacteria, benthic alteration, and toxicity which were all assigned a B priority rating. All other categories received either a C or D priority rating.

The information provided from the triad matrix results used in conjunction with the water quality priority ratings can assist the jurisdictions in making informed decisions in developing their WURMP programs. The two reports also allow for an evaluation of where data gaps exist and where efforts should be targeted.

Utilizing the BLTEA rating methods for future data evaluations would also allow for long-term BMP effectiveness assessment. Incorporation of additional useable data from other third party sources such as the San Diego Coastkeeper, other non-profit organizations, and other POTWs would also help to increase the confidence of the water quality priority ratings and overall WMA assessments.

Several considerations should be made with respect to the findings provided in this watershed management area assessment. The recommendations for this watershed are to continue monitoring to gather long-term trend information, identify where data gaps exist that do not allow for informed decision making, and consider where watershed resources may be more effectively targeted to reduce constituents of concern and impacts to the physical stream habitats. Long term effectiveness assessment ratings should be continued on an annual basis. Storm water managers should be aware that several changes to the water quality priority ratings may be expected based on the additional parameters added in the proposed 2006 303(d) list. The draft monitoring order (R9-2006-0011) calls for two temporary watershed assessment stations for this watershed. These two stations should be placed with respect to addressing the spatial distribution of heavy metals, dissolved minerals, sediments, pesticides, and bacteria. Future monitoring stations associated with the outfall monitoring and source identification studies should be located with respect to assessing the spatial distribution of constituents of concern and with respect to watershed priority activities. As watershed activities are developed based on the high water quality priority ratings, watershed monitoring stations may need to be located strategically to be able to effectively measure the pollutant load changes (either additions or reductions) with respect to location and sensitivity. In this manner, BMP strategies and decisions can be made to adjust and fine tune future BMP implementation in order to reach the desired load reductions necessary to meet the water quality objectives throughout the watershed and protect the beneficial uses.