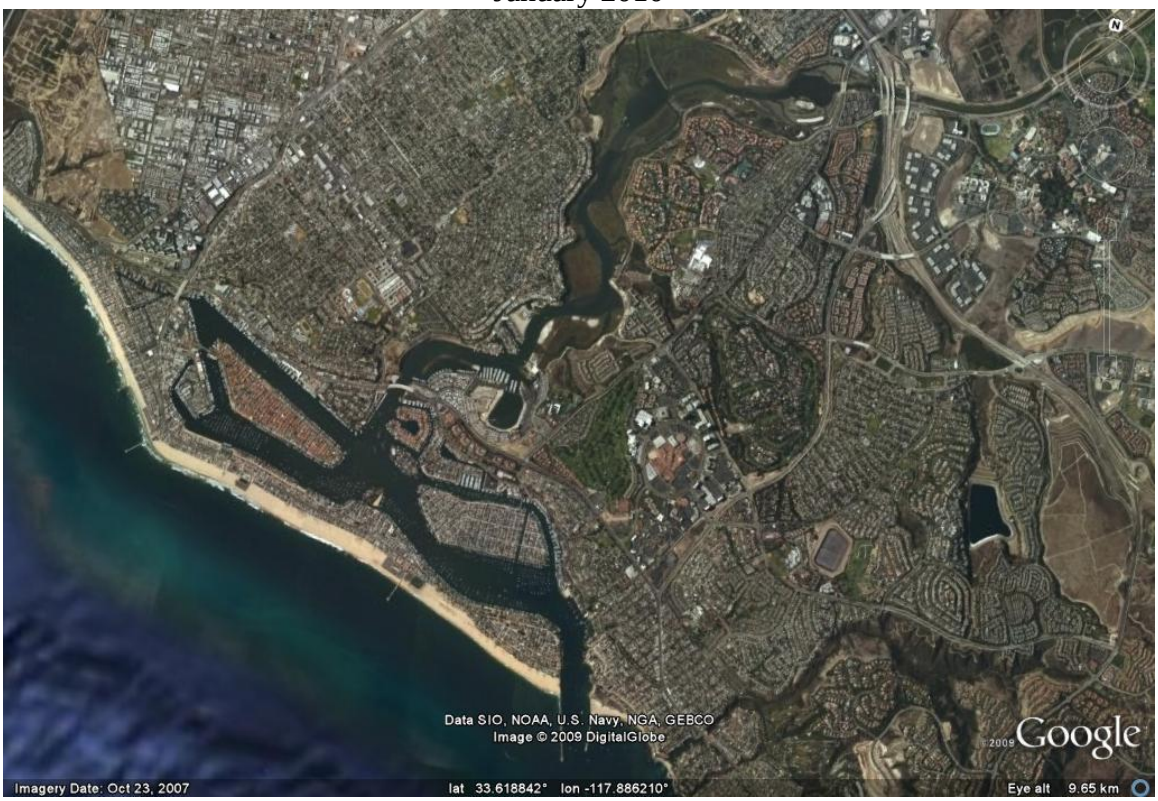
Newport Bay Stormdrain Metals Study

Final Report

January 2010



Prepared for the City of Newport Beach
by
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and
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Executive Summary

A Toxics TMDL for Newport Bay was promulgated in June 2002 by USEPA, and a Metals TMDL for Newport Bay is currently under development by Santa Ana Regional Board staff. Metals listed in the Toxics TMDL for the Lower Newport Bay include Cu, Pb and Zn (Cd, Cu, Pb, and Zn in Rhine Channel). The Toxics TMDL stated that the chemical concentrations [of toxics, including metals] in water, sediment or biota [may] cause adverse effects in aquatic life or aquatic-dependent species. The goal of this project was to document the concentration of metals, especially Copper, in stormdrain runoff to Lower Newport Bay and to estimate the load of metals to the bay from storrmdrains.

A total of two hundred and seventy (270) water samples were collected from twenty representative stormdrains during fourteen sampling events (8 dry weather and 6 wet weather) in Newport Bay from April 2007 to May 2009. The samples were analyzed at CRG Marine Laboratory for total and dissolved metals, dissolved organic carbon, hardness and total suspended solids. Temperature, pH, conductivity and salinity measurements along with observations on water odor and color were conducted in the field by Coastkeeper staff. The results were then compared to California Toxics Rule saltwater criteria to determine exceedences of standards for metals (Cu, Zn, Cd, Ni and other Title 22 metals).
Estimates of copper loads to the bay from stormdrains were also calculated for dry and wet weather. Dry weather flow rates were calculated from previous storm drain studies focusing on bacteria by the City of Newport Beach (2008) and Everest Environmental (2004). Wet weather loads are based on runoff volume calculations for rain events using standard methods.

Water column

The data shows that dissolved copper, zinc and nickel exceeded the CMC (acute) saltwater CTR criteria, and copper, zinc, cadmium and nickel exceeded the CCC

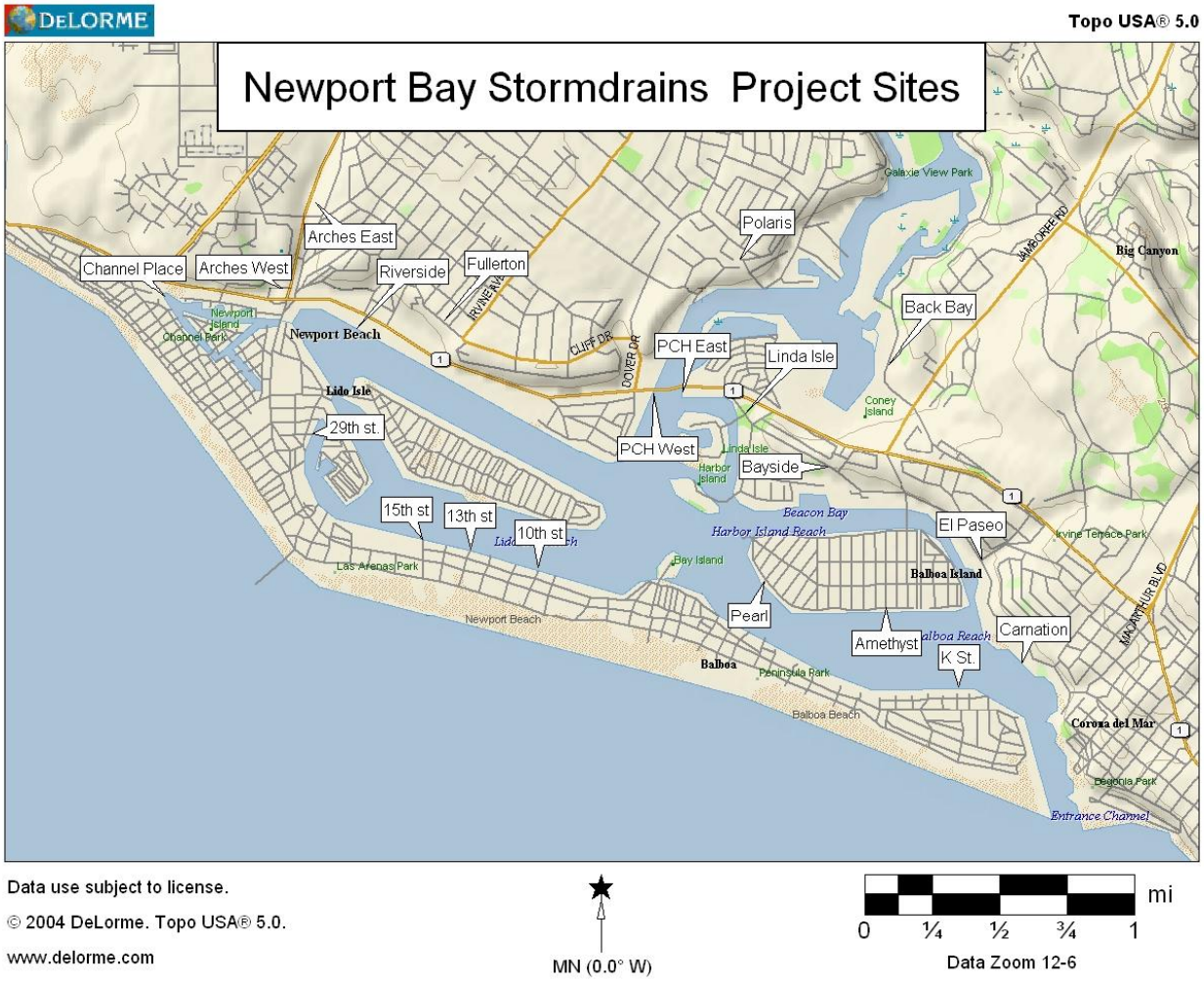
(chronic) saltwater CTR criteria for dissolved metals. Of these four metals, copper exceeded the most often followed by zinc, nickel, and cadmium. To break it down further, copper exceeded the CTR criteria at all 20 project stormdrains (66.5% acute and 75.6% chronic) and zinc exceeded at 15 (15.2% acute and 21.7% chronic) Nickel exceeded at 9 (0% acute and 15.6% chronic) and cadmium exceeded at only one drain, Carnation (0%acute and 6.9% chronic).

While the data shows that exceedances of CTR criteria in stormdrain runoff are common, the load of metals to the bay from stormdrains is relatively low. The six largest stormdrains account for approximately 98% of the dry weather flow and 85% of the dry weather copper load into the bay based on the flow data (El Paseo, Carnation, Polaris, PCH West, Arches West, Arches East). Loading calculations were done for all stormdrains draining directly to Newport Bay for wet and dry weather flow for 2007 through 2009; loads from stormdrains that were not sampled during this project were estimated. These calculations show that wet weather is when the majority of the loading occurs (92.1% of Cu load for 2007 and 97.2% of Cu load for 2008 was during wet weather). However, the overall estimated total load of Cu to the bay from stormdrains (90.1lb Cu for 2007and 252.54 lb for 2008) is low when compared to the metals inputs from the major tributaries (San Diego Creek and the Santa Ana Delhi Channel, 7020 lbs/yr Cu) and from copper bottom boat paints in Lower Newport Bay (50,114 lbs/yr Cu) as documented in the Toxics TMDL for San Diego Creek and Newport Bay. Later calculations show Cu loading from boats as approximately 59,000 lbs/yr (pers.comm. LM Candelaria).

In summary, stormdrains are a source of metals to the bay, and copper is the metal that most often exceedes Saltwater CTR Criteria in stormdrain runoff, followed by zinc, nickel, and cadmium. Exceedances of CRT saltwater criteria in stormdrain runoff are common, however the load of metals to the bay from stormdrains is low relative to other local sources.

Special thanks to the following individuals for their help in completing this project: Linda Candelaria PhD. of the Santa Ana Regional Water Quality Control Board. Rich Gossett of CRG Laboratory, Peter Pham of Orange County Coastkeeper and O.C.Coastkeeper interns Lamot Kateb, and Grace Wong. This project was funded by the State Water Resources Control Board and the City of Newport Beach.

Project Map



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Background

A Toxics TMDL for Newport Bay was promulgated in June 2002 by USEPA, and a Metals TMDL for Newport Bay is currently under development by Santa Ana Regional Water Board staff. According to the Newport Bay Toxics TMDL, metals shown to exceed the saltwater CTR criteria in Lower Newport Bay include copper (Cu), lead (Pb) and zinc (Zn) (cadmium (Cd), Cu, Pb, and Zn in Rhine Channel). Available data indicate that the pollutants addressed in these TMDLs were found in water column, bottom sediments, or fish tissue at potentially unsafe levels which exceed applicable water quality standards. (San Diego Creek and Newport Bay Toxics TMDL). Cu and other metals are known to be toxic to fish and other aquatic species.

Copper or other metals in the water may remain in the dissolved phase, adsorb to suspended particles and settle, form salt precipitates or be flushed out of the Bay. Benthic organisms that live in the sediment may ingest these metals, and filter feeders, such as mollusks, may accumulate metals from the water. In addition, sediments may be resuspended and release metals back into the water.

Sources of metals to Newport Bay include boat bottom paints (over 50,000 lbs/yr Cu), surface runoff from San Diego Creek, the Delhi Channel and Big Canyon Creek **(**7,020 lbs/yr Cu, 13,812 lbs/yr Pb, and 33,245 lbs/yr Zn), zinc from sacrificial anodes on boats (no current estimate), and storm drains (this study). With respect to Cu, boat bottom paints are the number one source of Cu to Newport Bay (Newport Bay Toxics TMDL).

One hundred and forty nine storm drains empty directly into Newport Bay and previous studies show high metal concentrations in the sediment around storm drains in the Rhine Channel section of the bay (Bay 2003, OCCK 2004). Copper, zinc and mercury (Hg) were also found to exceed ERM guidelines in some areas of Newport Bay, in particular the Turning Basin area and S.Lido channel (Lower

Newport Bay Copper/Metals Marina Study 2007). Metals such as copper and zinc are commonly found in roadways due to wear from car brake pads and tires and exhaust. Industrial areas are a source of metals from activities ranging from metal plating shops to auto repair, and residential areas are sources of metals from auto washing, roofing materials, and construction activities. While there are load estimates for boat hull paints (Cu) and major tributaries (metals), there were no current estimates of metal loads in storm drain runoff. Therefore, the goal of this project was to document the concentration of metals in stormdrain runoff to Lower Newport Bay, by sampling a portion of Bay storm drains, and estimating the load of metals to the bay from all storrmdrains.

Sampling Design

To achieve this goal we selected twenty representative stormdrains from the one hundred and forty nine stormdrains, identified in the City of Newport Beach Stormdrain map, that drain directly into Lower Newport Bay. The selected stormdrains represent large, medium and small stormdrains based on both drain size and dry weather runoff volume, and make up 13.4% of stormdrains draining to the bay. The six large stormdrains (48 to 78 inch) are; El Paseo, Carnation, Polaris, PCH West, Arches West and Arches East. All have year round flow and represent over 98% of the dry weather flow into the bay. The seven medium stormdrains (30 to 36 inch) are; Riverside St., Bayside, PCH East, Channel, Fullerton, K St., and Linda Isle, of these only Riverside has year round flow. The small stormdrains (18 to 24 inch) are; Backbay, Pearl, Amethyst, 29th, 15th, 13th, and 10th,all have intermittent dry weather flow. A list of Stormdrains is detailed in Table 1 and stormdrain flow rates in table 3.

Methodology

Sampling Events and Sites

For this study, twenty stormdrains that drain to Lower Newport Bay were sampled fourteen times from April 2007 through May 2009 (see map 1). Eight times in dry weather; April 19th , July 12th , and August 27th 2007, May 7th , July 3rd , August 28th ,

and December 12th 2008, May 8th 2009. And during six rain events; November 30th and December 12th 2007, January 4th and 21st and December 18th 2008, February 6th 2009.

Samples were collected from all project stormdrains that had flow during each sampling event resulting in 270 total samples collected. Samples could not be collected from all stormdrains during every sampling event. At many stormdrains, especially those with very small watersheds, runoff is highly variable and is only collectable when rain or irrigation is occurring so the number of samples collected during each event varied (Table 1). Additionally, tides played a big role in our ability to collect samples as many of the stormdrain outlets were submerged except during negative tides. Accordingly, both dry weather and storm event monitoring had to be done at extreme low tides. In wet weather, sampling involved scheduling at a low tide, then watching the weather for rain. In dry weather, drains were observed to determine when high flows occurred, then sampling was conducted in the early morning hours at low tide. Some drains had no flow during dry weather.

Sample Collection and Analyses

All water samples were collected directly into two 1l and one 500 ml acid-washed sample bottles (supplied by the contract lab) at the stormdrian outlet, if possible, or from a manhole closest to storm drain outlet. If direct collection was not possible due to low flows the samples were collected in a 1L whirlpak held by hand or a sample bottle with top cut off (with a acid washed stainless steel knife) mounted on a sampling pole. The samples collected from low flows were composites from the multiple grabs required to fill the sample bottles.

Table 1- Project Stormdrains and Number of Samples Collected.

Stormdrain	Total Samples Collected	Dry Weather	Wet Weather
Carnation	25	19	6
Arches East	25	14	11
El Paseo	16	10	6
Polaris	24	16	8
PCH West	23	17	6
Arches West	16	8	8
Riverside	20	12	8
Pearl	11	9	2
Bayside	2	0	2
BackBay	13	8	5
Linda Isle	8	5	3
PCH East	6	1	5
Fullerton	11	3	8
Channel	3	1	2
29th st.	15	11	4
15th st.	10	8	2
13th st.	7	4	3
10th st.	15	11	4
K st.	18	14	4
Amethyst	2	1	1
All Drains	270	169	101

Samples were put on ice immediately after collection and delivered to CRG Marine Laboratories within 24 hours. The water samples were analyzed for total and dissolved title 22 metals including copper, cadmium, nickel, zinc, chromium, lead, arsenic, and tin, using EPA method 1640m or 200.8m (depending on salinity) by ICPMS (Fe, Pd extraction), Dissolved Organic Carbon (DOC) using EPA method 415.1, Total Suspended Solids (TSS) using SM2540D, and Hardness by SM2340b. A subset of samples were analyzed for mercury using EPA method 245.7m. Field

measurements including temperature, pH, and conductivity using Oakton meters, and salinity measurements using a SeaTest specific gravity meter were taken at the sampling site when samples were collected.

Photographs were taken of each sample site when samples were collected to document conditions. No flow measurements were taken for this project. All flow data used was generated from previous studies or estimated from those studies.

Data Analysis Methods

Data analysis was done using two different methods. The first is a basic determination of whether the data for each site exceeds the criteria selected for comparison. For water the criteria selected are the California Toxics Rule (CTR) saltwater criteria for the Criterion Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC). The saltwater CTR criteria was used to determine exceedences as the storm drains empty directly into the receiving water (ie Lower Newport Bay). Site means were calculated for all, wet and dry data for each site. The second was to calculate the load of metals to the bay during wet and dry weather conditions. Loads for project storm drains were calculated by multiplying the volume of runoff and the concentration of metals in runoff as detailed in the following section. Loads for nonproject storm drains were then estimated based on results from project stormdrains.

Data Results

CTR Criteria Exceedence Discussion

As described above, an evaluation for exceedence of Dissolved Metals CTR criteria was conducted for all the metals (table 2). The objectives used for determining an exceedence are the CCC (chronic) and CMC (acute) for dissolved metals in saltwater. To aid in the identification of the exceedences found, table 6 below has been prepared detailing the number of exceedences at each stormdrain. For this narrative we will limit the discussion of the analysis to the broad trends found in the data.

Table 2 Water Quality Criteria

Dissolved Metals CTR Saltwater Criteria (µg/L)		
Element	**CMC**	**CCC**
As (Arsenic)	69	36
Cd (Cadmium)	42	9.3
Cr-tot (Chromium –Total)	1100	50
Cu (Copper)	4.8	3.1
Pb (Lead)	210	8.1
Hg (Mercury)	1.8	.94
Ag (Silver)	1.9	
Se (Selenium)	290	71
Zn (Zinc)	90	81
Ni (Nickel)	74	8.2

California Toxics Rule (CTR) criteria are the Criterion Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC). Wet weather flow volumes vary by amount of rainfall and are calculated for each individual event

Table 3 Dry Weather Flow Rates

Flow rates in gallons per day	
Carnation	225,000 gpd
Arches East	92,000 gpd
El Paseo	81,000 gpd
Polaris	32,000 gpd
PCH West	9,800 gpd
arches west (est)	7,500 gpd
Riverside (est)	3,266 gpd
All 129 others	43 gpd (each) 5, 977 gpd total
Total daily dry weather stormdrain runoff	456, 543 gpd

Water Column

The data shows that dissolved copper, zinc and nickel exceeded the CMC (acute) saltwater CTR criteria, and copper, zinc, cadmium and nickel exceeded the CCC (chronic) saltwater CTR criteria for dissolved metals. Of these four metals, copper exceeded the most often followed by zinc, nickel, and cadmium. To break it down further, copper exceeded the CTR criteria at all 20 project stormdrains (66.5% acute and 75.6% chronic) and zinc exceeded at 15 (15.2% acute and 21.7 %chronic) Nickel exceeded at nine(0.4% acute and 15.6% chronic) and Cadmium exceeded at only one drain, Carnation (0%acute and 6.9% chronic).
The CCC is used for long term exposure (chronic), while the CMC is intended as a short term maximum level (acute).

Dissolved Copper concentrations exceeded the CMC level in all stormdrains (66.5% of all samples), Zinc concentrations exceded the CMC at thirteen stormdrains (15.2% of all samples). No other metals exceeded the CMC.

Dissolved Concentrations.

Site means and standard deviations (all data), and wet and dry means were calculated for each site. For 08-09 data: Copper: All site means(5.2-54.5 ug/L) and all wet weather means (5.9-73 ug/L) exceeded the acute CTR saltwater criteria (CMC criteria). In dry weather, 12/20 site means exceeded the acute or chronic standard, and dry weather means ranged from 1.1ug/L (Amethyst) to 38.2 ug/L (Arches W).

Zinc: For all data, only 2 site means exceeded the acute criteria–Arches W (281ug/L) and Linda Isle (103ug/L), and 1 additional site mean exceeded the chronic criteria –Channel (81.8ug/L). In wet weather, 7 site means exceeded the acute or chronic criteria –Arches W (221ug/L), Arches E (123ug/L), Channel (144ug/L-1sample), 29th St. (118ug/L), Linda Isle (157ug/L), Fullerton (86ug/L), PCH W (87ug/L) and PCH E (86ug/L). In dry weather, only Arches W (356ug/L) exceeded the acute criteria, and dry weather means ranged from 4.3ug/L (Backbay) to 356ug/L (Arches W).

Nickel: There were no exceedences of the acute CTR criteria.

For all data, 5/20 site means exceeded the chronic criteria –Carnation (43ug/L), El Paseo (8.3ug/L), Backbay (11.2ug/L), Arches W (10.3ug/L) and Arches E (10ug/L). In wet weather, 4/20 site means exceeded the chronic criteria –Carnation (26ug/L), El Paseo (6.4ug/L), Backbay (12.2ug/L), and Arches W (14.6ug/L). The one wet sample at Channel also exceeded the chronic (13ug/L). In dry weather, 4/20 site means exceeded the chronic criteria - Carnation (51ug/L), El Paseo (10.8ug/L), Backbay (9.1ug/L), and Arches E (11.5ug/L).

Cadmium: Only 1 site mean exceeded the chronic criteria for all data and in dry weather –Carnation (10.6, 12.1 ug/L). There were no exceedences in wet weather.

Metals Loading Analysis

Loading calculations were done for all twenty project stormdrains for wet and dry weather flow for 2007 through 2009, and from these results the loads from non-project stormdrains were estimated.

Dry Weather Load Calculations. Dry weather load for eighteen of the twenty project stormdrains was calculated using flow data supplied from two previous studies, the first is the Newport Beach Stormdrain Diversion Study produced by Everest Environmental Consultants Inc. in 2004. This study focused on bacteria loading Newport Bay and measured dry weather flow at the five largest stormdrains, Carnation, El Paseo, PCH West, Polaris and Arches East. The second study was the Lower Newport Bay Flow and Water Quality study. This study measured bacteria concentrations and flow from ten small stormdrains in the Lower Bay and calculated an "average flow" for small stormdrains in Newport Bay. The average flow developed as part of this study was used for the thirteen smallest drains in the current study. Two stormdrains, Riverside and Arches West were not monitored as part of the Everest or Lower Newport Bay study and had flows that were different in volume from the eighteen drains that are represented by the two studies (5 large drains –Everest study, 13 small drains –Newport study). The flows for the two medium drains were estimated by project manager Ray Hiemstra by comparing the observed flow in each drain with larger drains that had larger flows but similar design. For instance, the Riverside stormdrain outlet is similar in design to the PCH West stormdrain but appeared to have about 1/3 of the flow. Using this method it was determined that the dry weather flow in the Riverside drain was one third the flow in the PCH West stormdrain and that the flow in the Arches West Storm drain is one quarter the flow in the Arches East storm drain.

The load for dry weather runoff was calculated directly from the flows detailed in the referenced studies and the estimated flows for the two medium storm drains. For loading estimates all non project stormdrains were considered to be small and the dry weather flow rate from the referenced study of small stormdrains was applied. The storm drain flow in gallons per day was converted to liters and then multiplied by the average dry weather metals concentration for each site from all dry weather monitoring events for the project to generate the load in milligrams which was then converted to pounds (Table 4).

The formula used for this calculation is **V x C= Load (ug/d) x mg/ug x lbs/mg**

where V is the volume of water from the stormdrain (L/d), C is the average measured concentration of a metal in stormdrain runoff (ug/L) and L is the Load of metals to the bay (ug/d).

As an example the Carnation street stormdrain has a daily flow of 225,000 gallons per day (851717.651 L/d) and a average dry weather Cu concentration(2007-2009) of 4 ug/l. Using this information the daily load is 851717.651 x 0.4 =3406868ug or 0.0075 lbs. Since the daily dry weather flows are considered to be constant, monthly or annual loads can be calculated. Tables for Copper, Zinc, Nickel and Cadmium dry and wet weather loads are included at end of this report.

Table 4 Annual Dry Weather Copper Load

Site	Flow (L/day)	Days/year	Avg Copper Concentration for 2007,2008,2009 (µg/L)	Annual Copper Load for Dry Weather (µg/year)	Annual Copper Load for Dry Weather (g/year)	Annual Copper Load for Dry Weather (lbs/year)
Carnation	851717.65	365.00	3.74	1162058011.49	1162.06	2.56
Arches East	113562.35	365.00	3.36	139148520.17	139.15	0.31
El Paseo	306618.36	365.00	8.36	935503332.75	935.50	2.06
Polaris	121133.18	365.00	9.54	421620981.19	421.62	0.93
PCH West	37097.04	365.00	3.61	48840286.91	48.84	0.11
Arches West	28390.59	365.00	39.63	410709900.62	410.71	0.91
Riverside	12365.68	365.00	11.63	52482657.88	52.48	0.12
Pearl	162.77	365.00	1.60	94821.78	0.09	0.00
Bayside	162.77	365.00	no data	no data		no data
Backbay	162.77	365.00	3.47	205863.08	0.21	0.00
Linda Isle	162.77	365.00	11.99	712589.27	0.71	0.00
PCH East	162.77	365.00	11.30	671357.24	0.67	0.00
Fullerton	162.77	365.00	6.37	378277.13	0.38	0.00
Channel	162.77	365.00	2.89	171701.10	0.17	0.00
29th	162.77	365.00	17.97	1067873.89	1.07	0.00
15th	162.77	365.00	2.69	159996.91	0.16	0.00
13th	162.77	365.00	5.83	346253.98	0.35	0.00
10th	162.77	365.00	2.65	157263.95	0.16	0.00
K	162.77	365.00	1.36	80681.69	0.08	0.00
Amethyst	162.77	365.00	1.07	63571.00	0.06	0.00
All other drains (129)	162.77	365.00	5.77	44222241.89	44.22	0.10
All Drains				3218696183.92	3218.70	7.10

Wet Weather Loads (Storm Events). Storm drain runoff was collected during several storm events, so wet (storm) loads could be calculated for the project storm drains that were sampled, and estimated for project storm drains not sampled and non-project storm drains. Metal loads were calculated for every storm event whether sampled or unsampled, then loads were totalled for all storm events. Metal concentrations were determined as indicated in the matrix below.

Storm event (sampled) ***Metal conc. (M) used***

--> project drains

--> sampled --measured M from site sample

--> unsampled --average M from storm samples at site same year

-->non-project drains --average M from storm samples at all small sites same year

Storm events (unsampled)

--> project drains --average M from storm samples at site same year

--> non-project drains --average M from storm samples at all small sites same year

Wet weather flow was estimated for each of the project stormdrains using a volume calculation combined with a infiltration coefficient of 0.5 (low density residential).The flow was based on the acreage of the stormdrain watershed (taken from the City of Newport Beach Stormdrain map, or measured and calculated from the stormdrain map) and rainfall as recorded at the John Wayne Airport rain gauge reported as Balboa Island station on Weather Undergorund. For the calculation the acre feet of water projected in the project watersheds was determined by multiplying the size of the watershed in acres by the fraction of a foot of rainfall for the storm (any continuous rain event regardless of length). The full volume in acre feet was then multiplied by an impervious coefficient of 0.5 for low density residential use (from the July 2008 Impervious Surface Coefficients Factsheet produced by the California Environmental Protection Agency Office of Environmental Health) to produce the estimated actual runoff. The low density coeffiecent was used to represent average for the entire project area, this coefficient can be adjusted for conditions in individual watersheds if desired.

To calculate loads, the estimated runoff in acre feet was then converted to liters and multiplied by the metals concentrations in (ug /L) documented for the storm event to produce the metals load in milligrams which was then converted to pounds. (Table 5 shows Wet Weather Copper loads for all drains.)

The formula used for this calculation is :

V (L/storm) x C (ug/L) = Load (ug/storm) x mg/ug x lbs/mg

where V is the volume of water from the stormdrain , C is the average measured concentration of metals in stormdrain runoff and L is the Load of metals to the bay per storm.

For project drains and storm events which did not have direct monitoring data the volume calculations were the same as for sampled drains, except the concentration used for each metal was the average concentration of that metal from all sampled storm events at that drain. The load estimates for both unmonitored storm events and monitored storm events were combined to produce estimates of annual wet weather loads for each metal. Dry and wet weather loads were combined to generate estimates of total annual loads. Tables for Copper, Zinc, Nickel and Cadmium dry and wet weather loads are included at end of this report.

Table 5 Wet Weather Copper load for 11/30/2007 storm event

*Highlighted sites used estimated concentrations as no sample data was available

Sites and Dates	Drainage Area (acres)	runoff coefficient	rainfall (feet)	liters conversion	Cu concentration (µg/L)	LOAD (µg)	LOAD (g)	LOAD (lb)
11/30/2007								
el paseo	523.74	0.50	0.08	1233481.83	9.20	225849911.27	225.85	0.50
backbay	94.09	0.50	0.08	1233481.83	9.45	41676537.46	41.68	0.09
polaris	384.22	0.50	0.08	1233481.83	15.00	270139181.57	270.14	0.60
riverside	114.85	0.50	0.08	1233481.83	45.85	246823605.82	246.82	0.54
arches east	146.01	0.50	0.08	1233481.83	23.70	162198674.21	162.20	0.36
arches west	146.47	0.50	0.08	1233481.83	29.10	199782766.89	199.78	0.44
pch west	280.81	0.50	0.08	1233481.83	25.71	338400502.45	338.40	0.75
pch east	10.17	0.50	0.08	1233481.83	31.50	15015778.72	15.02	0.03
channel	13.76	0.50	0.08	1233481.83	39.50	25476037.68	25.48	0.06
10th	28.42	0.50	0.08	1233481.83	38.70	51552697.14	51.55	0.11
15th	34.00	0.50	0.08	1233481.83	40.90	65180633.65	65.18	0.14
13th	14.10	0.50	0.08	1233481.83	38.70	25576813.15	25.58	0.06
29th	14.08	0.50	0.08	1233481.83	309.05	203961292.67	203.96	0.45
k	51.80	0.50	0.08	1233481.83	85.00	206378778.90	206.38	0.45
fullerton	47.76	0.50	0.08	1233481.83	38.35	85851134.66	85.85	0.19
amethyst	10.11	0.50	0.08	1233481.83	34.94	16557333.99	16.56	0.04
pearl	7.67	0.50	0.08	1233481.83	15.47	5561629.20	5.56	0.01
linda isle	33.09	0.50	0.08	1233481.83	14.20	22024267.06	22.02	0.05
bayside	7.50	0.50	0.08	1233481.83	15.20	5343443.29	5.34	0.01
carnation	630.00	0.50	0.08	1233481.83	15.22	449439827.26	449.44	0.99
All Other Storm Drains								19.79
						Total Load (lb) 11/30/07		**25.66**

The six largest stormdrains account for approximately 98% of the dry weather flow and 96% of the 2007 dry weather copper load, and 75.78% of the wet weather flow and 12.4% of the wet weather copper load for the 11/30/07 storm event into the bay based on the flow data previously mentioned. These calculations show that wet weather is when the majority of the loading occurs (for copper 92.1 % of the load for 2007 and 97.2% of the load for 2008 was during wet weather).

Overall, estimated metal loads from storm drains are low compared to other sources (boat bottom paints for Cu, and tributaries for all metals. The overall estimated total load of Cu to the bay from stormdrains (90.11 lb Cu for 2007and 252.19 lb for 2008) is low when compared to the copper inputs from San Diego Creek and Santa Ana Delhi (7020 lbs/yr Cu) or from boat bottom paints (50,114 lbs/yr Cu), as documented in the Toxics TMDL for San Diego Creek and Newport Bay. Later calculations show Cu loading from boats as approximately 59,000 lbs/yr (pers.comm. L.M. Candelaria).

For Zinc 92% of the load for 2007 and 97.3% of the load for 2008 was during wet weather. The overall estimated total load of Zinc to the bay from stormdrains is 207.31 lb for 2007 and 611.83 lb for 2008. For Nickel 46% of the load for 2007 and 69.8% of the load for 2008 was during wet weather. The overall estimated total load of Nickel to the bay from stormdrains is 53.24 lb for 2007and 121.76 lb for 2008. For Cadmium 34.5% of the load for 2007 and 65.9% of the load for 2008 was during wet weather. The overall estimated total load of Cadmium to the bay from stormdrains is 12.04 lb for 2007and 24.8 lb for 2008 majority from carnation.

Table 6 Total Dissolved Metal Loads in pounds to Newport Bay 2007 and 2008

	Wet 2007	Dry 2007	Total for 2007	Wet 2008	Dry 2008	Total for 2008
Cu	83.01	7.13	90.14	245.09	7.45	252.54
Zn	193.59	30.88	224.47	595.44	33.65	629.09
Ni	24.52	28.71	53.23	85.06	36.7	121.76
Cd	4.37	7.67	12.04	16.5	8.36	24.86

Summary of Individual Sites

Graphs for dissolved copper and other selected metals exceeding the dissolved CTR discussed above are presented in graph set 1. Cu exceeded the acute or chronic criteria in *all samples* at El Paseo, Polaris, Arches W, PCH E, Riverside, Fullerton, Linda Isle, Bayside (2), 13th Street and 29th Street. Cu and Zn concentrations both exceeded the acute CTR criteria at El Paseo, Arches W, Arches E, PCH W, PCH E, Riverside, Fullerton, Linda Isle, Bayside Dr, Channel, 29th St, 15th St. There were no acute exceedences for Ni or Cd. Ni and Cd both exceeded the chronic criteria at Carnation*, and Ni also exceeded the chronic criteria at El Paseo, Arches W, Arches E, PCH E, Backbay Dr, Linda Isle, Fullerton, Channel, 15th St. and 13th St. Dissolved Cu *mean* concentrations exceeded the CTR acute criteria at *all sites,* while dissolved Zn *mean* concentrations exceeded the acute criteria at 2 sites -Arches W and Linda Isle, and the chronic criteria at Channel Place. Cd *mean* concentrations exceeded the chronic criteria only at Carnation, while Ni *mean* concentrations exceeded at Carnation, El Paseo, Arches W, Arches E and Backbay. Mean dissolved concentrations for 2007 and 2008-09 data were highest at Arches W for Cu and Zn (41.9, 64.3ug/L and 281.4, 466ug/L), and at Carnation for Cd and Ni (10.6, 17ug/L and 42.9, 45.7ug/L), respectively.

Detailed Stormdrain Descriptions

Detailed descriptions of the project stormdrains, exceedances of saltwater CTR criteria and site means follow. Table 7 provides a summary of exceedances for all stormdrains and the map (Appendix A) shows the location of all project storrmdrains. Metals data was compared to the dissolved saltwater CTR criteria (CCC (Chronic) and CMC (Acute)) to determine numbers of exceedences. The drain descriptions are arranged according to location on the project map starting in the northeast and ending in the southeast.

Table 7 Stormdrain Description Summary

Stormdrain Location	Drain size	Watershed size (in acres)	Land Use	Flow Type	Metals Exceedances CCC	Metals Exceedances CMC
Arches East	**Swale**	**146.01**	Light Industrial/Residential	constant	Cu,Ni,Zn	Cu,Zn
Arches West	**48" RCP**	**146.47**	Light Industrial	constant	Cu,Ni,Zn	Cu,Zn
PCH Bridge West	**60" RCP**	**280.81**	Residential/Commercial	constant	Cu,Zn	Cu,Zn
Polaris	**72" RCP**	**384.22**	Residential	constant	Cu	Cu
El Paseo	**78" RCP**	**523.74**	Residential/High Density Commercial	constant	Cu,Ni,Zn	Cu,Zn
Carnation Street	**54" RCP**	**630**	Residential	constant	Cu,Cd,Ni,	Cu
Back Bay Drive	**18" RCP**	**94.09**	Commercial/Residential	intermetent	Cu,Ni	Cu
Riverside	**30" RCP**	**114.85**	Residential/commercial	constant	Cu,Zn	Cu,Zn
Bayside Drive	**33" RCP**	**7.5**	Residential	intermetent	Cu,Zn	Cu,Zn
PCH Bridge East	**30" RCP**	**10.17**	Commercial/Residential	intermetent	Cu,Ni,Zn	Cu,Zn
Channel Place	**30" RCP**	**13.76**	Residential/Commercial	intermetent	Cu,Ni,Zn	Cu,Zn
Amethyst	**24" RCP**	**10.11**	Residential	intermetent	Cu	Cu
Pearl	**21" RCP**	**7.67**	Residential	intermetent	Cu,Zn	Cu
Linda Isle	**33" RCP**	**33.09**	Commercial/Residential	intermetent	Cu,Ni,Zn	Cu,Zn
Fullerton	**30" RCP**	**47.76**	Residential	intermetent	Cu,Ni,Zn	Cu,Zn
29th Street	**18" RCP**	**14.08**	Residential/Commercial	intermetent	Cu,Zn	Cu,Zn
15th Street	**18" RCP**	**34**	Residential	intermetent	Cu,Ni,Zn	Cu,Zn
13th Street	**18" RCP**	**14.1**	Residential	intermetent	Cu,Zn	Cu,Zn
10th Street	**18" RCP**	**28.42**	Residential	intermetent	Cu	Cu
K Street	**36" RCP**	**51.8**	Residential	intermetent	Cu	Cu

Carnation St

The Carnation St. stormdrain drains 630 acres and is the largest stormdrain watershed in Newport Beach. It also has the highest dry weather flow of all stormdrains at 225,000 gpd and flows 24 hours a day. The watershed is primarily residential and includes spyglass hill and much of Corona Del Mar. It discharges to the ocean through a 54 inch concrete outlet in the bulkhead at a point near the intersection of Bayside Drive. and Bayside Place. Samples were collected at the outlet to the ocean. 23 samples were collected here. Exceedences of the CTR dissolved saltwater criteria (CMC% /CCC%) include Copper (30.4/56.52%) Cadmium (0/47.8%) and Nickel (0/100%).

Only Cu exceeded the CMC (acute) criteria (7/23-all wet). Six additional samples exceeded only the CCC (chronic) for Cu, and two additional metals exceeded only the chronic criteria: Cd (14/23), Ni (23/23). There were no exceedences for Zn at this site. *This is the only site that had high numbers of Ni and Cd exceedences of the chronic criteria and all samples exceeded the chronic for Ni. .*
Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (9.4,16.4ug/L), Cd (10.6,17ug/L), Ni (42.9, 45.7ug/L), Zn (29.9, 43.7ug/L). Note that at this site the dissolved Ni and Cd mean concentrations are both higher than the dissolved Cu mean concentration, and the Ni mean concentration is also higher than the Zn; this is surprising as Cd concentrations are usually below Cu concentrations, and Ni is usually lower than Zn and Cu concentrations. Ni and Cd concentrations were consistently high across multiple samples. The primary land use in this area is medium density residential, so there are no obvious potential sources of cadmium such as metal plating or battery production facilities.

El Paseo St

The El Paseo stormdrain drains 523.74 acres and is the second largest stormdrain watershed in the city. It has the third largest dry weather flow of all stormdrains at 81,000 gpd. It includes the Fashion Island area which consists of high density retail and office areas and hosts a large number of cars. The watershed also contains a significant amount of residential land use area. The design of this stormdrain features three separate branch drains converging just below the sample point and then draining to the ocean through a 78 inch outlet in the bulkhead adjacent to the Bahia Corinthian Yacht Club. Due to access issues we could only sample from one (the center branch) of the three branch stormdrains. Since the drainage areas of all three branches are all very similar in land use and development density, we consider the samples we collected to be representative of the watershed as a whole. The flow volume used in our calculations, was measured below the convergence and includes all flow (from Everest study). Sixteen samples were collected here. Exceedences of CTR dissolved saltwater criteria (CMC % /CCC %) include copper

(92/100%) nickel (0/46.15%) Zinc (15.38/15.38%). Only Cu and Zn exceeded the CMC (acute) criteria: Cu (12/13), Zn (2/13). *All samples exceeded the acute or chronic criteria for Cu.* The only sample for Cu that did not exceed the acute criteria exceeded the chronic criteria, Zn had no additional chronic only exceedences. Nickel exceeded only the CCC (chronic): Ni (6/13). Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (14.5, 23.1ug/L), Cd (0.9, 2.5ug/L), Ni (8.3, 13.8ug/L), Zn (36.1, 94.4ug/L).

Amethyst St.

The Amethyst St. stormdrain drains 10.11 acres and is located on Balboa Island, a high density residential area. The runoff in this area flows on the surface in street gutters until it enters a catch basin just before discharging to the ocean through a 24 inch concrete pipe. Samples were collected at the outlet. Flow from this stormdrain was rare even during rain events due to its small watershed and rapid draining. Two samples were collected here in 08-09 (1wet, 1dry); no samples were collected in 07 due to no runoff. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include Copper (50/50%). Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (18.01, 23.10ug/L), Cd (0.08, 0.08 ug/L), Ni (1.07, 1.28 ug/L), Zn (20.98, 34.92 ug/L).

Pearl St.

The Pearl St, stormdrain drains 7.67 acres and is located in Balboa Island, a high density residential area. The runoff in this area flows on the surface in street gutters until it enters a catch basin just before discharging to the ocean through a 24 inch concrete pipe. Samples were collected at the outlet. Eleven samples were collected here. Exceedences of CTR dissolved saltwater criteria (CMC% /CCC %) include Copper (20/20%) Zinc (0/10%). The salinity measurements for pearl street stormdrain samples showed substantial saltwater influence in all samples, it is likely that most of the water during dry weather and about half the water from wet weather

was from saltwater infiltration of the stormdrain from groundwater. Exceedences of Cu and Zn were in wet only –Cu 2 acute, Zn 1chronic. Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (6.3, 9.92ug/L), Cd (0.11, 0.11 ug/L), Ni (1.64, 2.16 ug/L), Zn (27.11, 56.71ug/L).

Bayside Dr.

The Bayside Stormdrain drains 7.5 acres consisting of primarily high density residential areas. This stormdrain is a overflow branch of an equally sized drain and runoff must top a small berm in the main drain line to flow down this pipe and discharge into the bay through a 33 inch concrete outlet in the rip rap along the shore. This only occurred during two wet weather events. Samples were collected at the outlet. Two samples were collected at this site Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include Copper (100/100%) Zinc (50/50%). The two wet samples exceeded the acute criteria for Cu, 1 exceeded the acute criteria for Zinc. Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (5.7, 7.7ug/L), Cd (ND, 0.20 ug/L), Ni (2.10, 2.70 ug/L), Zn (43.6, 61.3ug/L).

Backbay Drive

The Backbay Drive stormdrain drains 94.09 acres that includes residential areas and a resort hotel that has a large parking lot and many cars. Street flow, parking lot sheet flow and flow from a drain leading from the residential area of the watershed converge in a open channel parallel to Back Bay Drive before entering a underground pipe and discharging to the bay at Newport Dunes. Samples were collected at the end of the open channel just before it goes unergorund. Thirteen samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include Copper (66.6/75%), Nickel (0/75%). *All wet samples exceeded the acute or chronic criteria for Cu.* Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (5.15, 6.38ug/L), Cd (2.37, 3.10 ug/L), Ni (11.2, 11.38ug/L), Zn (14.53, 17.13 ug/L).

Linda Isle

The Linda Isle stormdrain drains 33.09 of residential and mixed retail areas including a nearby car dealership and gas station. The sample collection point is in the catch basin across the street from the entrance to Linda Isle where three drains converge before draining to the bay at Linda Isle through a 33 inch concrete outlet. On one occasion service bay cleaning activities were observed in the auto dealership and greasy water and strong fumes were found at the drain suggesting illegal dumping of cleaning water. The police were called and the fire department responded. Eight samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include Copper (87/100%) Nickel (0/25%) Zinc (37/50%). *All samples exceeded the acute or chronic criteria for Cu.* Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (25.48, 36.23ug/L), Cd (0.16, 0.19 ug/L), Ni (6.60, 7.40ug/L), Zn (102.93, 144.46ug/L).

PCH East

The PCH East stormdrain drains 10.17 acres of a retail use area including a large but lightly used parking lot and a hilly section of PCH. Samples were collected at a crack in the pipe a few feet above the outlet or at the 33 inch concrete outlet depending on flow rate. Six samples were collected here. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include Copper (83.3/100%) Nickel (0/16.66%) Zinc (33.33/50%). *All samples exceeded the acute criteria for Cu.* Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (34.18, 43.281ug/L), Cd (ND, 0.20 ug/L), Ni (5.48, 6.13ug/L), Zn (69.23, 95.28ug/L).

PCH West

PCH West is the fourth largest stormdrain and drains 280.81 acres of residential and mixed retail areas with a dry weather flow of 9,800 gpd that runs 24 hours a day. Samples were collected at the 60 inch concrete box outlet. Twenty three samples

were collected here. Exceedences of CTR dissolved saltwater criteria (CMC % /CCC %) include Copper (42.8/61.9%) Zinc (9.5/9.5%). Only Cu and Zn exceeded the CMC (acute) criteria Cu (9/21), Zn (2/21-wet only). No additional samples exceeded only the chronic criteria for Cu and Zn. There were no exceedences for Ni or Cd. Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (11.8, 20.5ug/L), Cd (0.28, 0.24ug/L), Ni (3.7, 4.5ug/L), Zn (31.8, 56.9 ug/L).

Polaris

The Polaris stormdrain drains 384.22 acres of mixed use retail and residential areas and is the third largest stormdrain draining to the bay with a flow of 32,000gpd that runs 24 hours a day. The Polaris drain daylights for ½ mile as a concrete trapezoidal channel before going underground at North Star Beach road and discharging to the bay through a 72 inch concrete pipe. Samples were collected in the channel just before it entered the underground pipe. Twenty four samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include Copper (90.5/90.5%). *All samples exceeded the acute or chronic criteria for Cu.* Only Cu exceeded the CMC (acute) criteria (19/21) and the CCC (chronic) criteria – the two samples for Cu that did not exceed the acute criteria exceeded the chronic criteria. Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (13.4, 16.9ug/L), Cd (ND), Ni (2.6, 2.8ug/L), Zn (24.1, 37.5ug/L).

Fullerton St.

The Fullerton St. stormdrain drains 47.76 acres of residential area. Samples were collected from the catch basin near the intersection of Fullerton Ave. and Cliff Dr. The outlet to the bay for this stormdrian is in the bulkhead of the Balboa Bay Club. Eleven samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper of (80/80%) zinc (20/20%), and Nickel, (0/10%). *All wet samples exceeded the acute criteria for Cu.* Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (30.19,43.28ug/L), Cd (0.30, 0.40ug/L), Ni (4.27, 5.33 ug/L), Zn (56.31, 114.19ug/L).

Riverside Dr.

The Riverside strormdrain drains 144.85 of residential acre. Samples were collected at the outlet located in the bulkhead next to Billy's at the Beach restaurant. The is one of the two stormdrains that we had no pervious flow information for so the daily flow of 3,266 gpd which occurs 24 hours a day and is the seventh largest dry weather flow into the bay was estimated based on the flow from PCH west which as a similar outlet configuration. Twenty samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper (89.5/100%) and zinc (5.2/10.52%) *All samples exceeded the acute or chronic criteria for Cu.* Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (31.64, 36.75ug/L), Cd (0.20, 0.19 ug/L), Ni (2.93, 3.22 ug/L) Zn (38.52, 47.40ug/L).

Arches East

The arches east drains 146.01 acres of retail, light industrial, and residential land uses This stormdrain has the fourth largest dry weather flow at 92,000 gpd and flows 24 hous a day. This stormdrain is unique in that it daylights for approximently 1/8th mile where it has been designed as a swale that provides some treatment for storm events. The low flow section of the swale is a concrete/rip-rap mix. Samples were collected at the end of the swale just before the stormdrain returns underground to discharge into the bay at bulkhead of Harbor Marina. Samples were not collected at the bulkhead due to the fact it is always tidally influenced. Twenty five samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper (42.8/61.9%) Zinc (33.3/33.3%), and Nickel (0/42.8%) Only Cu and Zn exceeded the CMC (acute) criteria Cu (10/21), Zn (7/21). One additional sample for Cu and Zn only exceeded the chronic criteria. Nickel exceeded only the CCC (chronic): Ni (6/18). Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (6.8, 19.1ug/L), Cd (0.4, 0.4ug/L), Ni (10, 10.5ug/L), Zn (44.4, 78.3ug/L).

Arches West

The arches west stormdrain drains 146.47 acres of primarily industrial land use areas along with some retail, and residential land use areas. This stormdrain merges with the Arches East stormdrain just before discharging into the bay through the bulkhead in Harbor Marina. Samples were collected from a manhole under the green Caltrans road sign on the ramp from Newport Blvd south to PCH. This stormdrain was expected to have high levels of metals due to the land uses in the watershed it drains but it was not considerably different from other large stormdrains in the number of exceedances found. Sixteen samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper (93/100%) nickel (0/46.6%) and zinc (66.66/73.33%). *All samples exceeded the acute or chronic criteria for Cu and most samples exceeded the acute criteria for Zn.* Most samples exceeded the CMC (acute) criteria for Cu (14/15), and Zn (10/15), especially in 08-09. The last Cu sample and one additional Zn sample exceeded only the chronic criteria. Nickel exceeded only the CCC (chronic) criteria (7/15), and there were no exceedences for Cd. Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (41.9, 64.3ug/L), Cd (1.7, 2.1ug/L), Ni (10.3, 11.3ug/L), Zn (281.4, 466ug/L). Of the large drains, Arches W had the highest mean concentrations for Cu and Zn, however, there was one outlier for Cu and Zn in the 08-09 data set, 92.2 and 1141ug/L both on Dec. 12, 08.

Channel Place

The Channel Place storrmdrain drains 34 acres of retail and residential land uses and a stretch of PCH. Samples were difficult to collect here due to the extremely low relief of the area and the low level of the stormdrain outlet (1.5 ft. below mean low tide). Three samples were collected here. One sample (November 30 2007) was collected from the manhole near the intersection of channel place and 44th st, the other two were collected from the stormdrain outlet. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper (66.6/66.6%) Nickel (0/33.3%) and Zinc (66.6/66.6%). Mean water concentrations for 08-09 (Dissolved,Total) were: Cu (54.5,147.85ug/L), Cd (0.20, 0.40 ug/L), Ni (7.23,10.17) Zn (81.75, 228.31ug/L).

The high dissolved/total ratios found at this site correspond with the relatively high (for this project) Total Suspended Solids concentration of 152 mg/l.

29th st.

The 29th street storm drain drains 14.08 of retail residential and industrial land uses. This area used to be one of the most industrial areas of Newport Beach and had metal plating facilities, along with machine shops and boatyards. Most of the industrial companies have left and many of the old industrial sites have converted to professional, retail, and residential uses. A boatyard is located adjacent to the sample site. The samples were collected at the catch basin at the end of 29th St. just before it empties into the Rhine Channel area of the bay. Previous studies have shown that the Rhine Channel sediments are heavily contaminated with metals, PCB's and pesticides. This stormdrain had the highest single sample copper concentration of the project; 309 ug/l on November 30 2007. Based on the salinity data all but one of the samples at this site were influenced by seawater. Fifteen samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper(100/100%) zinc (15.38/15.38%). All samples exceeded the dissolved acute CTR criteria for Cu, and Zn . Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (28.82,37.80ug/L), Cd (0.18, 0.16 ug/L), Ni (1.85, 2.03 ug/L), Zn (70.31, 81.19ug/L).

15th st

The 15th street stormdrain drains 34 acres of residential use area on the Balboa Peninsula. Samples were collected from the stormdrain outlet unless it was submerged during a rain event in which case samples were taken from the catch basin near the intersection of Bay ave. and 15th st. Based on the salinity data all dry weather samples at this site were influenced by seawater. Ten samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper (22.2/22.2%) nickel (0/11.11%) zinc (11.1/11.11%). . Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (7.68,52.32ug/L), Cd

(0.07, 0.27 ug/L), Ni (1.19,4.08) Zn (27.08,131.9ug/L). One sample at this site had the highest Total Suspended Solids concentrations of the project at 496.7 mg/l and three of the five total samples that were over 100mg/l.

13th st

The 13th street stormdrain drains 14.1 acres of residential use area on the Balboa Peninsula. Samples were collected from the stormdrain outlet unless it was submerged during a rain event in which case samples were taken from the catch basin near the intersection of Bay ave. and 13th st. Based on the salinity data three of the five dry weather samples at this site were influenced by seawater. Seven samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include acres copper (85.7/100%) zinc (14.29/14.29%), nickel (0/14.29%). *All samples exceeded the acute or chronic criteria for Cu*. Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (28.2,46.67ug/L), Cd (0.10, 0.13 ug/L), Ni (2.73, 3.38 ug/L), Zn (31.48, 61.71ug/L).

10th st

The 10th St. stormdrain drains 28.42 acres of residential use area on the Balboa Peninsula. Samples were collected from the stormdrain outlet unless it was submerged during a rain event in which case samples were taken from the catch basin near the intersection of Bay ave. and 10th St. Based on the salinity data all except three of the four wet weather samples at this site were influenced by seawater. Fifteen samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper (33.3/41.66%) *All wet samples exceeded the acute criteria for Cu.* . Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (16.06,29.54ug/L), Cd (0.08, 0.12 ug/L), Ni (1.80, 2.72 ug/L), Zn (17.74, 49.33 ug/L).

K St.

The K street stormdrain drains 51.8 acres of residential use area on the Balboa Peninsula. Samples were collected from the stormdrain outlet unless it was

submerged during a rain event in which case samples were taken from the catch basin near the intersection of Bay Ave. and 13th St. Based on the salinity data all but two samples at this site were influenced by seawater. Eighteen samples were collected at this site. Exceedences of CTR dissolved saltwater criteria (CMC % CCC %) include copper (26.66/26.66%). *All wet samples exceeded the acute criteria for Cu.* . Mean water concentrations for 08-09 (Dissolved/Total) were: Cu (6.49,23.32ug/L), Cd (0.05, 0.11 ug/L), Ni (0.76, 2.18 ug/L), Zn (8.91, 32.82 ug/L).

Conclusions

1 While exceedences of the dissolved metals CTR saltwater criteria are common in the runoff from stormdrains draining into Newport Bay, *the overall load of metals to the bay from stormdrains is small when compared to loads from boat bottom paint (Cu) or tributaries (San Diego Creek and Santa Ana Delhi).*

2 The overall estimated load of dissolved metals to the bay from stormdrains are; Copper: 90.14 for 2007 and 252.54 lb for 2008, Zinc: 224.47lb for 2007 and 629.09 lb for 2008, Nickel: 53.23 lb for 2007 and 121.76 lb for 2008, and Cadmium: 12.04 lb for 2007 and 24.86 lb for 2008 majority from carnation. Loads were higher in 2008 compared to 2007, likely because 2008 was a wetter winter compared to 2007.

3 The highest loads of Cu were at El Paseo, Carnation, Polaris, PCH W and Arches W; Zn at ArchesW, El Paseo and Carnation; and Ni and Cd at Carnation* and El Paseo. Mean dissolved concentrations for 07 and 08-09 data were highest at Arches W for Cu and Zn (41.9, 64.3ug/L and 281.4, 466ug/L), and at Carnation for Cd and Ni (10.6, 17ug/L and 42.9, 45.7ug/L)

4 Dissolved copper, zinc, cadmium, nickel, and zinc concentrations exceeded the CMC (acute) and/or CCC (chronic) CTR Saltwater criteria for dissolved metals. Copper exceeded the CTR criteria at all 20 project stormdrains (66.5% acute and 32% chronic), Zinc exceeded at 15 (15.2% acute and 21.7% chronic), Nickel

exceeded at 9 (0.4% acute and 15.6% chronic) and cadmium exceeded at only one drain, Carnation (0%acute and 6.9% chronic). Only Cu and Zn exceeded the CMC.

5 Carnation drain was the only site that had exceedences of Cadmium, and Nickel and Cadmium loads were highest here. This is a common combination of metals for use in batteries but since the drainage is a residential area a source for these metals remains unknown.

Table 8 Exceedences of CTR (Dissolved)

Sample Site	Carnation [CCC/CMC]	El Paseo [CCC/CMC]	Backbay [CCC/CMC]	Polaris [CCC/CMC]	Riverside [CCC/CMC]	Arches E [CCC/CMC]	PCH West [CCC/CMC]
Copper (Cu)	13/23;7/23	13/13;12/13	8/12;8/12	19/21;18/21	19/19;15/19	11/21;10/21	13/21;9/21
Zinc (Zn)		2/13;2/13			2/19;1/19	7/21;7/21	2/21;2/21
Nickel (Ni)	23/23;0/23	6/13, 0/13	9/12,0/12			9/21,0/21	
Cadmium (Cd)	14/23;0/23						
Sample Site	PCH East [CCC/CMC]	Channel Place [CCC/CMC]	10th Street [CCC/CMC]	15th Street [CCC/CMC]	29th street[CCC/CMC]	K Street [CCC/CMC]	Fullerton [CCC/CMC]
Copper (Cu)	6/6;5/6	2/3;2/3	5/12;4/12	2/9;2/9	13/13;13/13	3/15;3/15	8/10;8/10
Zinc (Zn)	3/6;2/6	2/3;2/3		1/9;1/9	2/13;2/13		2/10,2/10
Nickel (Ni)	2/6,0/6	1/3;0/3		1/9,0/9			1/10;0/10
Cadmium (Cd)							
Sample Site	Pearl [CCC/CMC]	Linda Isle [CCC/CMC]	13th Street[CCC/CMC]	Arches West [CCC/CMC]	Bayside [CCC/CMC]	Amthyst [CCC/CMC]	
Copper (Cu)	2/10;2/10	8/8;6/8	6/7;6/7	15/15;14/15	2/2;2/2	1/2;1/2	
Zinc (Zn)	1/10;0/10	3/8;3/8	1/7;1/7	11/15;10/15	1/2;1/2		
Nickel (Ni)		2/8,0/8		7/15,0/15			
Cadmium (Cd)							

Total Load Data
Total Load - Copper

Sites	Wet Load Cu (lbs) 2007	Dry Load Cu (lbs) 2007	Total Load Cu (lbs) 2007	Wet Load Cu (lbs) 2008	Dry Load Cu (lbs) 2008	Total Load Cu (lbs) 2008	Wet Load Cu (lbs) Jan-May 2009
El Paseo	1.93	2.96	4.888	15.44	1.49	16.935	2.90
Backbay	0.29	0.00	0.289	0.81	0.00	0.807	0.17
Polaris	2.52	1.12	3.636	9.56	1.18	10.744	3.02
Riverside	1.68	0.07	1.751	5.87	0.16	6.031	2.23
Arches East	1.27	0.34	1.615	3.62	0.37	3.991	0.78
Arches West	2.09	0.79	2.882	8.48	0.86	9.339	1.52
PCH West	2.36	0.09	2.448	10.00	0.16	10.160	1.63
PCH East	0.10	0.00	0.104	0.63	0.00	0.629	0.11
Channel Pl	0.22	0.00	0.221	2.02	0.00	2.015	0.24
10th	0.42	0.00	0.419	1.61	0.00	1.607	0.31
13th	0.30	0.00	0.304	1.78	0.00	1.781	0.16
15th	0.43	0.00	0.430	1.40	0.00	1.398	0.23
29th	1.55	0.00	1.549	1.00	0.00	1.002	0.10
K	1.58	0.00	1.575	1.61	0.00	1.610	0.41
Fullerton	0.76	0.00	0.765	2.67	0.00	2.668	1.19
Amethyst	0.13	0.00	0.133	0.51	0.00	0.506	0.10
Pearl	0.04	0.00	0.044	0.17	0.00	0.168	0.03
Linda Isle	0.20	0.00	0.195	1.45	0.00	1.451	2.06
Bayside	0.04	no data	0.041	0.08	no data	0.078	0.04
Carnation	1.86	1.76	3.620	11.35	3.23	14.584	4.44
All Others	63.23	0.00	63.229	165.04	0.00	165.042	32.45
Total	83.01	7.13	90.136	245.09	7.45	252.545	54.13

Total Load - Zinc

Sites	Wet Load Zn (lbs) 2007	Dry Load Zn (lbs) 2007	Total Load Zn (lbs) 2007	Wet Load Zn (lbs) 2008	Dry Load Zn (lbs) 2008	Total Load Zn (lbs) 2008	Wet Load Zn (lbs) Jan-May 2009
el paseo	12.14	11.55	23.687	52.83	2.49	55.315	5.47
backbay	0.97	0.00	0.966	3.19	0.00	3.194	0.43
polaris	8.43	3.31	11.737	31.16	2.19	33.345	4.97
riverside	3.30	0.06	3.357	9.32	0.18	9.502	2.54
arches east	7.45	1.48	8.928	14.39	2.11	16.498	3.78
arches west	13.83	1.34	15.171	49.09	9.99	59.082	6.25
pch west	6.10	0.23	6.330	37.66	0.23	37.894	4.85
pch east	0.47	0.00	0.474	1.34	0.00	1.336	0.22
channel	0.56	0.00	0.558	0.49	0.00	0.491	0.11
10th	0.54	0.00	0.540	1.10	0.00	1.098	0.21
15th	0.91	0.00	0.912	2.29	0.00	2.288	0.16
13th	1.60	0.00	1.597	2.27	0.00	2.275	0.74
29th	2.61	0.01	2.620	3.04	0.01	3.049	0.24
k	1.23	0.00	1.233	1.13	0.00	1.126	0.45
fullerton	1.01	0.00	1.010	6.16	0.00	6.156	3.21
amethyst	0.13	0.00	0.133	0.50	0.00	0.503	0.07
pearl	0.18	0.00	0.179	0.92	0.00	0.921	0.06
linda isle	1.03	0.00	1.029	5.25	0.01	5.255	4.09
bayside	0.28	no data	0.278	0.89	no data	0.892	0.09
carnation	9.99	12.90	22.892	37.81	16.44	54.251	7.94
All other drains	120.84	0.00	120.843	334.61	0.00	334.615	58.26
Total for all drains	193.59	30.88	224.475	595.44	33.65	629.086	104.13

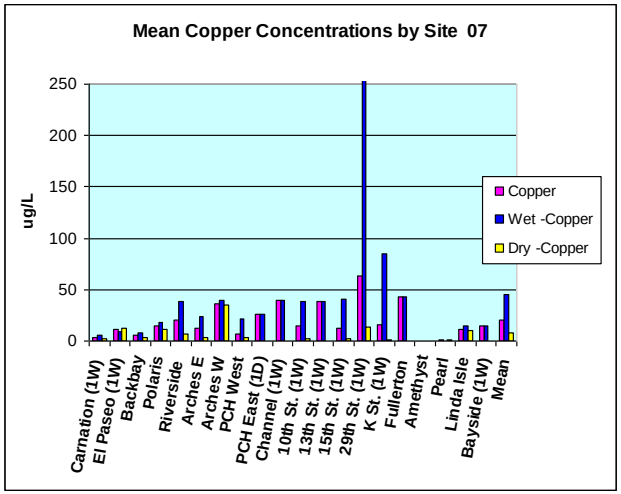
Total Load - Nickel

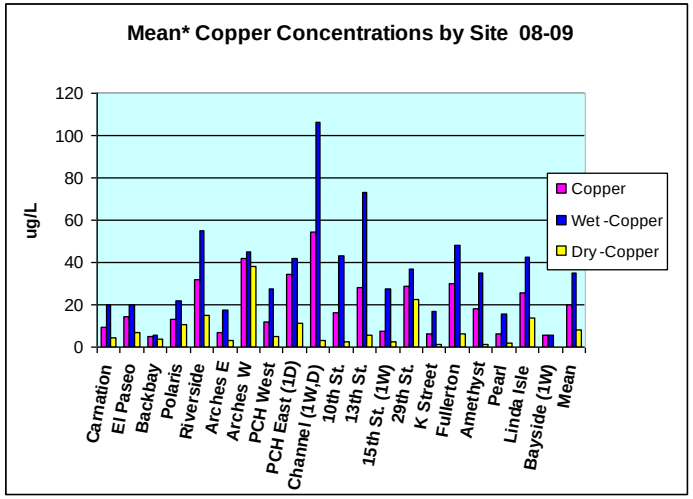
	Wet Load Ni (lbs) 2007	Dry Load Ni (lbs) 2007	Total Load Ni (lbs) 2007	Wet Load Ni (lbs) 2008	Dry Load Ni (lbs) 2008	Total Load Ni (lbs) 2008	Wet Load Ni (lbs) Jan-May 2009
el paseo	0.38	1.92	2.295	8.97	1.92	10.888	0.74
backbay	0.25	0.00	0.255	1.44	0.00	1.438	0.37
polaris	0.41	0.29	0.699	1.28	0.24	1.524	0.34
riverside	0.20	0.02	0.223	0.71	0.02	0.734	0.16
arches east	0.37	0.60	0.975	1.46	0.94	2.401	0.17
arches west	0.85	0.10	0.954	2.04	0.11	2.146	0.51
pch west	0.53	0.09	0.617	2.02	0.10	2.118	0.23
pch east	0.02	no data	0.017	0.10	0.00	0.099	0.02
channel	0.02	no data	0.017	0.24	0.00	0.236	0.03
10th	0.04	0.00	0.039	0.15	0.00	0.153	0.03
15th	0.05	0.00	0.048	0.15	0.00	0.149	0.01
13th	0.09	0.00	0.087	0.14	0.00	0.142	0.04
29th	0.03	0.00	0.028	0.08	0.00	0.079	0.01
k	0.06	0.00	0.060	0.11	0.00	0.111	0.03
fullerton	0.06	0.00	0.060	0.43	0.00	0.434	0.27
amethyst	0.01	0.00	0.006	0.02	0.00	0.022	0.00
pearl	0.00	0.00	0.005	0.01	0.00	0.010	0.00
linda isle	0.03	0.00	0.030	0.27	0.00	0.271	0.16
bayside	0.01	no data	0.005	0.01	no data	0.013	0.00
carnation	14.11	25.69	39.803	32.07	33.37	65.444	1.75
All aothers	7.01	0.00	7.005	33.35	0.00	33.354	7.26
Total	24.52	28.71	53.229	85.06	36.70	121.765	12.12

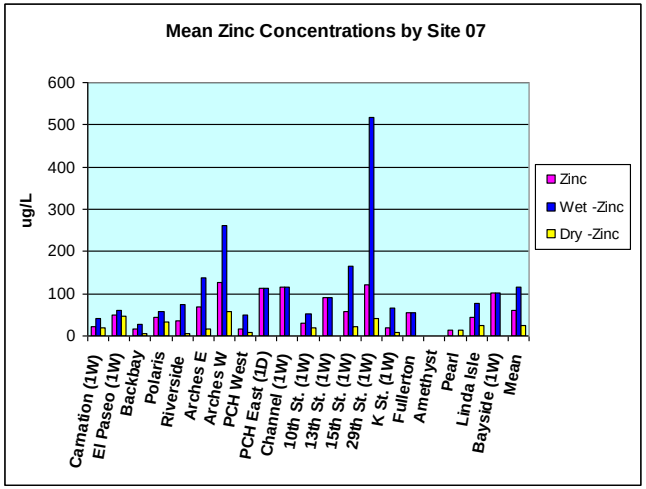
Total Load - Cadmium

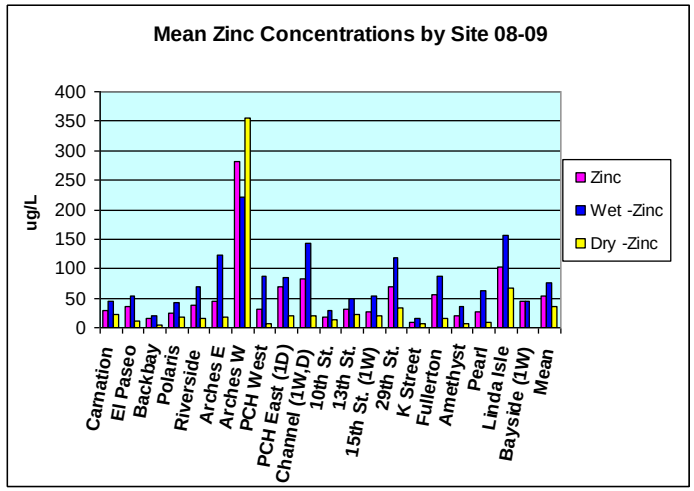
	Wet Load Cd (lbs) 2007	Dry Load Cd (lbs) 2007	Total Load Cd (lbs) 2007	Wet Load Cd (lbs) 2008	Dry Load Cd (lbs) 2008	Total Load Cd (lbs) 2008	Wet Load Cd (lbs) Jan-May 2009
el paseo	8.35E-03	4.80E-01	0.488	6.67E-01	3.10E-01	0.977	3.94E-02
backbay	6.10E-02	0.00E+00	0.061	5.40E-01	0.00E+00	0.540	5.23E-02
polaris	0.00E+00	1.20E-01	0.120	0.00E+00	5.00E-02	0.050	0.00E+00
riverside	0.00E+00	2.00E-02	0.020	3.23E-02	0.00E+00	0.032	5.47E-03
arches east	1.10E-02	1.40E-01	0.151	6.53E-02	5.00E-02	0.115	0.00E+00
arches west	1.05E-01	5.00E-02	0.155	2.95E-01	2.00E-02	0.315	6.65E-02
pch west	1.16E-03	4.00E-02	0.041	3.76E-02	1.00E-02	0.048	0.00E+00
pch east	0.00E+00	0.00E+00	0.000	0.00E+00	0.00E+00	0.000	0.00E+00
channel	4.30E-05	0.00E+00	0.000	3.53E-03	0.00E+00	0.004	3.67E-04
10th	2.67E-05	0.00E+00	0.000	1.65E-03	0.00E+00	0.002	3.29E-04
15th	0.00E+00	0.00E+00	0.000	0.00E+00	0.00E+00	0.000	1.26E-04
13th	0.00E+00	0.00E+00	0.000	0.00E+00	0.00E+00	0.000	0.00E+00
29th	3.53E-03	0.00E+00	0.004	4.12E-03	0.00E+00	0.004	7.91E-04
k	3.24E-05	0.00E+00	0.000	1.49E-03	0.00E+00	0.001	6.00E-04
fullerton	0.00E+00	0.00E+00	0.000	1.22E-02	0.00E+00	0.012	3.02E-02
amethyst	3.81E-04	0.00E+00	0.000	1.45E-03	0.00E+00	0.001	2.86E-04
pearl	2.86E-04	0.00E+00	0.000	2.10E-03	0.00E+00	0.002	0.00E+00
linda isle	7.24E-05	0.00E+00	0.000	5.26E-04	0.00E+00	0.001	2.33E-01
bayside	0.00E+00	no data	0.000	0.00E+00	no data	0.000	9.07E-05
carnation	3.48E+00	6.82E+00	10.300	8.40E+00	7.92E+00	16.324	4.93E-01
All Other Drains	7.03E-01	0.00E+00	0.703	6.39E+00	0.00E+00	6.388	6.10E-01
Total	4.37E+00	7.67E+00	12.043	1.65E+01	8.36E+00	24.815	1.53E+00

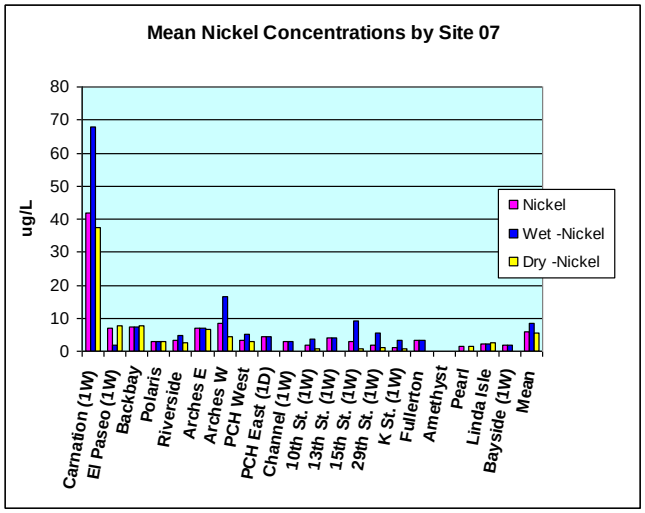
Graph Set 1 Mean Dissolved Metals Concentrations

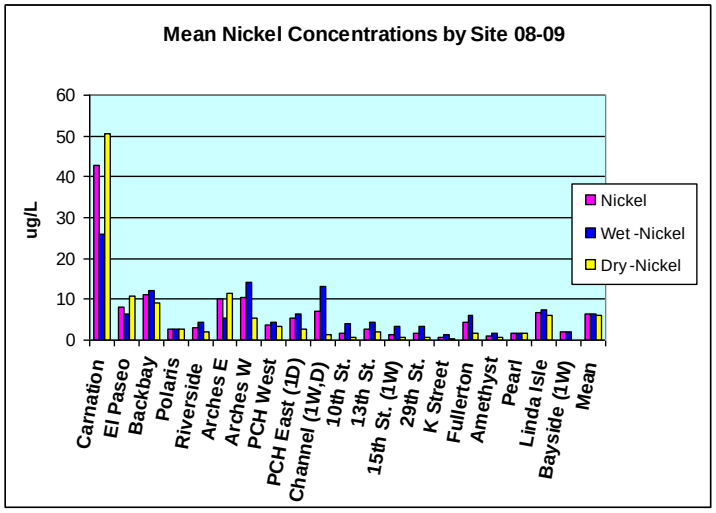


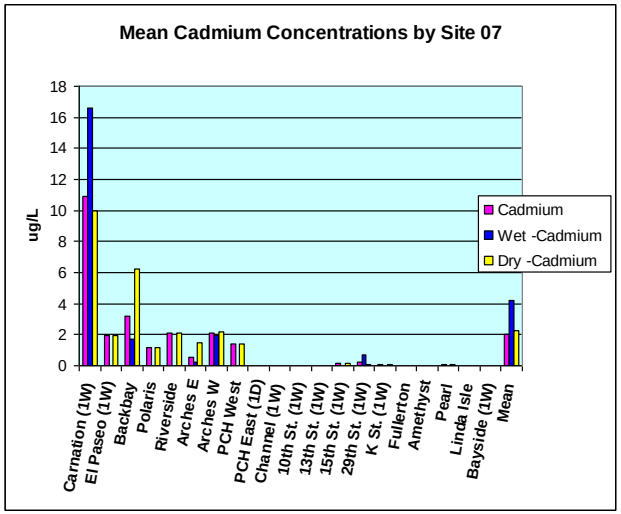


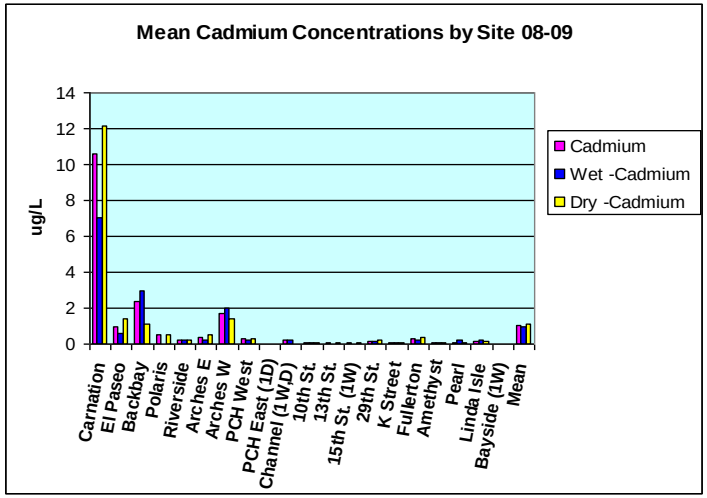




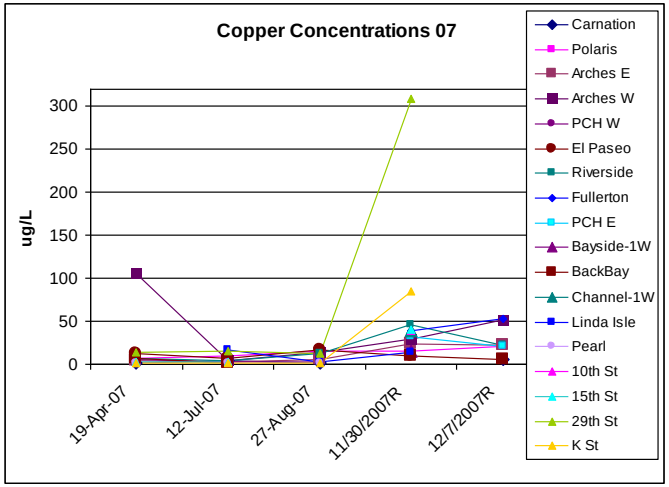

Mean Nickel Concentrations by Site 07
ug/L
0
10
20
30
40
50
60
70
80
Nickel
Wet -Nickel
Dry -Nickel
Carnation (1W)
El Paseo (1W)
Backbay
Polaris
Riverside
Arches E
Arches W
PCH West
PCH East (1D)
Channel (1W)
10th St. (1W)
13th St. (1W)
15th St. (1W)
29th St. (1W)
K St. (1W)
Fullerton
Amethyst
Pearl
Linda Isle
Bayside (1W)
Mean

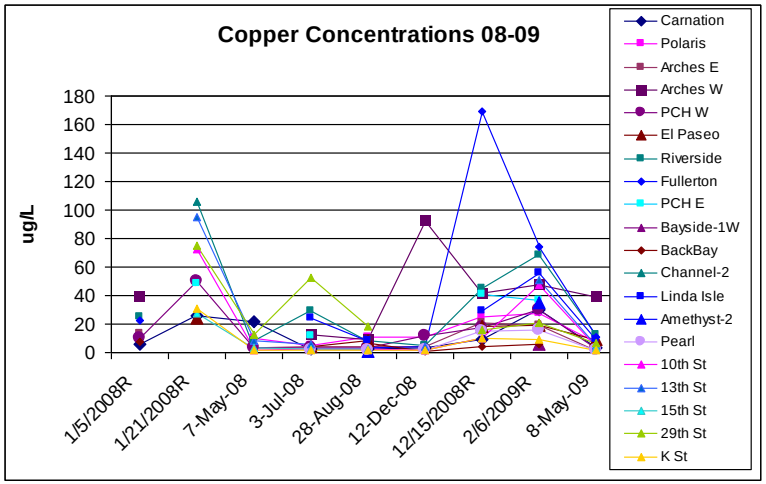

Mean Nickel Concentrations by Site 08-09
ug/L
0
10
20
30
40
50
60
Nickel
Wet -Nickel
Dry -Nickel
Carnation
El Paseo
Backbay
Polaris
Riverside
Arches E
Arches W
PCH West
PCH East (1D)
Channel (1W,D)
10th St.
13th St.
15th St. (1W)
29th St.
K Street
Fullerton
Amethyst
Pearl
Linda Isle
Bayside (1W)
Mean

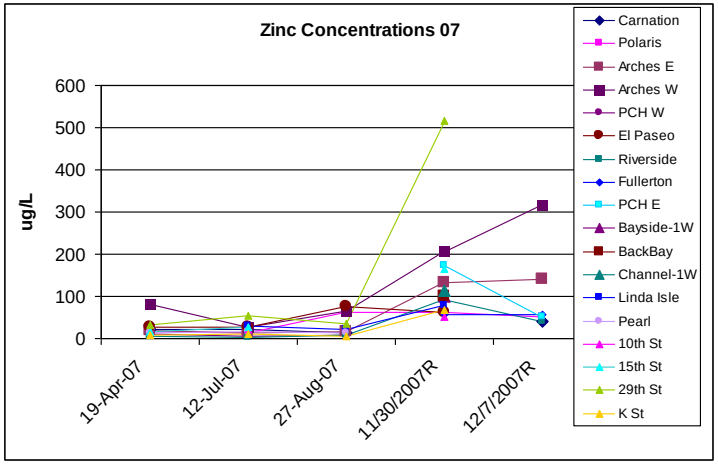

Mean Cadmium Concentrations by Site 07
ug/L
0
2
4
6
8
10
12
14
16
18
Cadmium
Wet -Cadmium
Dry -Cadmium
Carnation (1W)
El Paseo (1W)
Backbay
Polaris
Riverside
Arches E
Arches W
PCH West
PCH East (1D)
Channel (1W)
10th St. (1W)
13th St. (1W)
15th St. (1W)
29th St. (1W)
K St. (1W)
Fullerton
Amethyst
Pearl
Linda Isle
Bayside (1W)
Mean

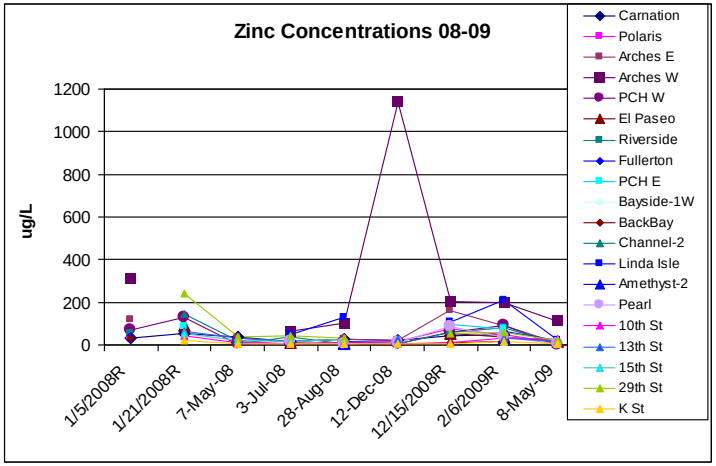

Mean Cadmium Concentrations by Site 08-09
ug/L
0
2
4
6
8
10
12
14
Cadmium
Wet -Cadmium
Dry -Cadmium
Carnation
El Paseo
Backbay
Polaris
Riverside
Arches E
Arches W
PCH West
PCH East (1D)
Channel (1W,D)
10th St.
13th St.
15th St. (1W)
29th St.
K Street
Fullerton
Amethyst
Pearl
Linda Isle
Bayside (1W)
Mean

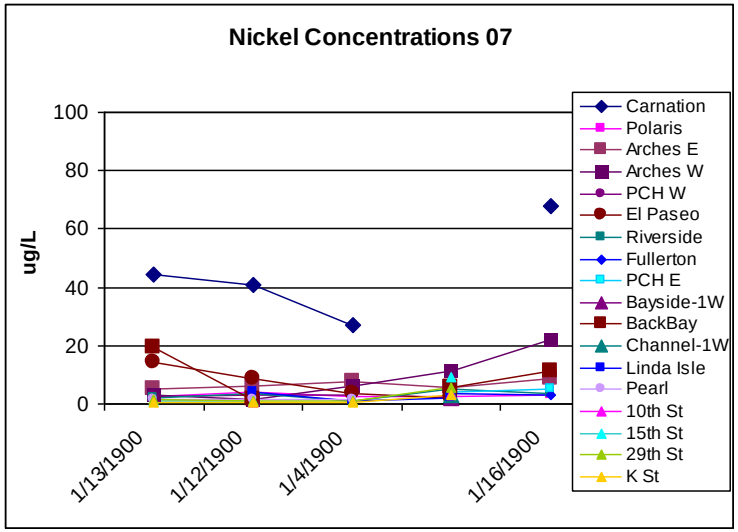
Graph Set 2
Daily Metals Concentrations Graphs

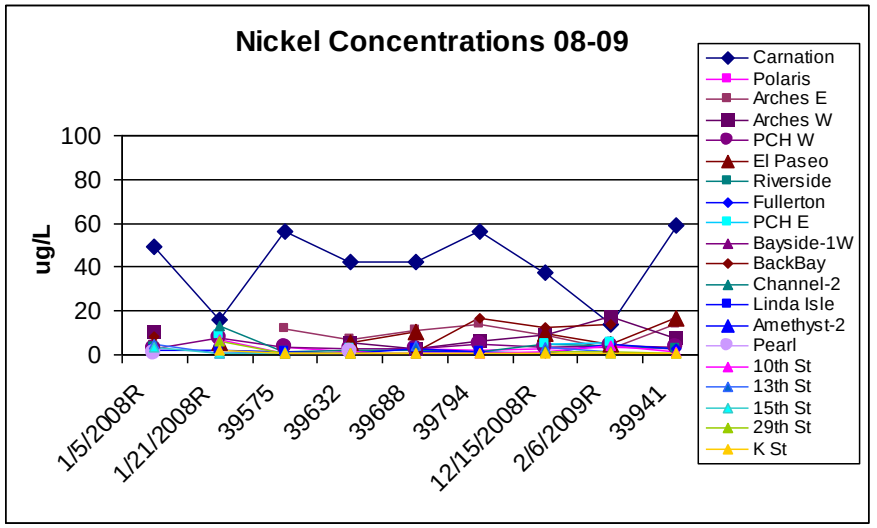


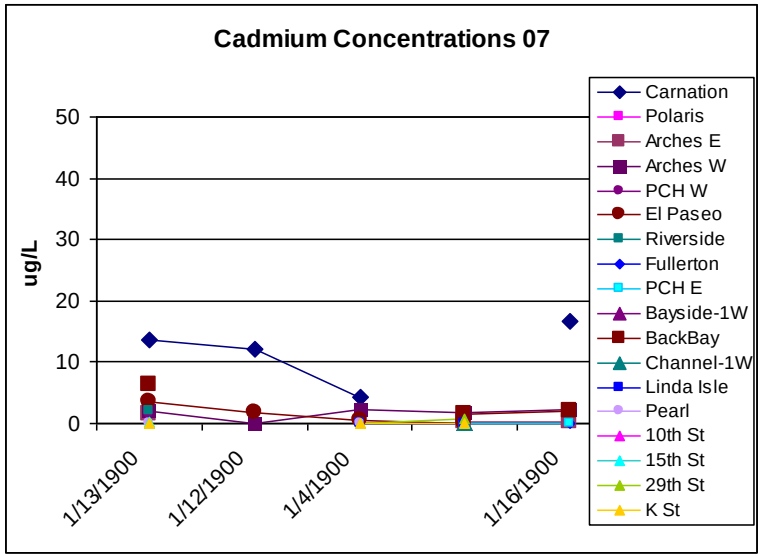


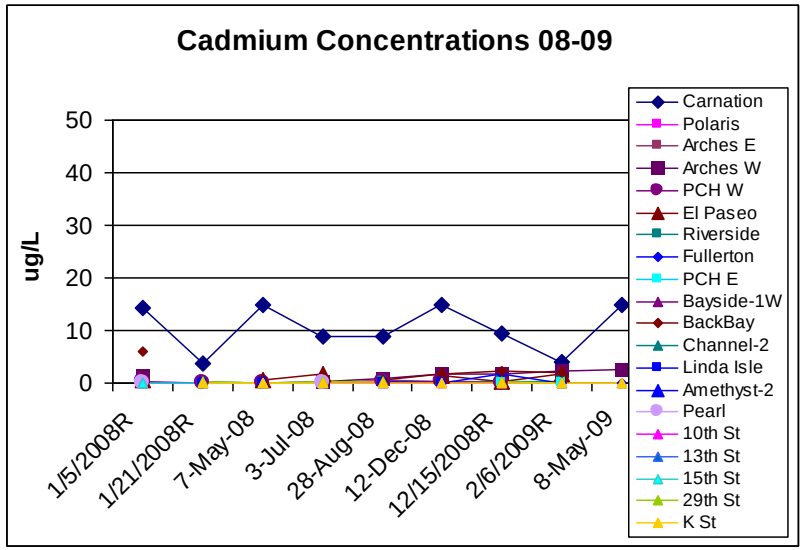




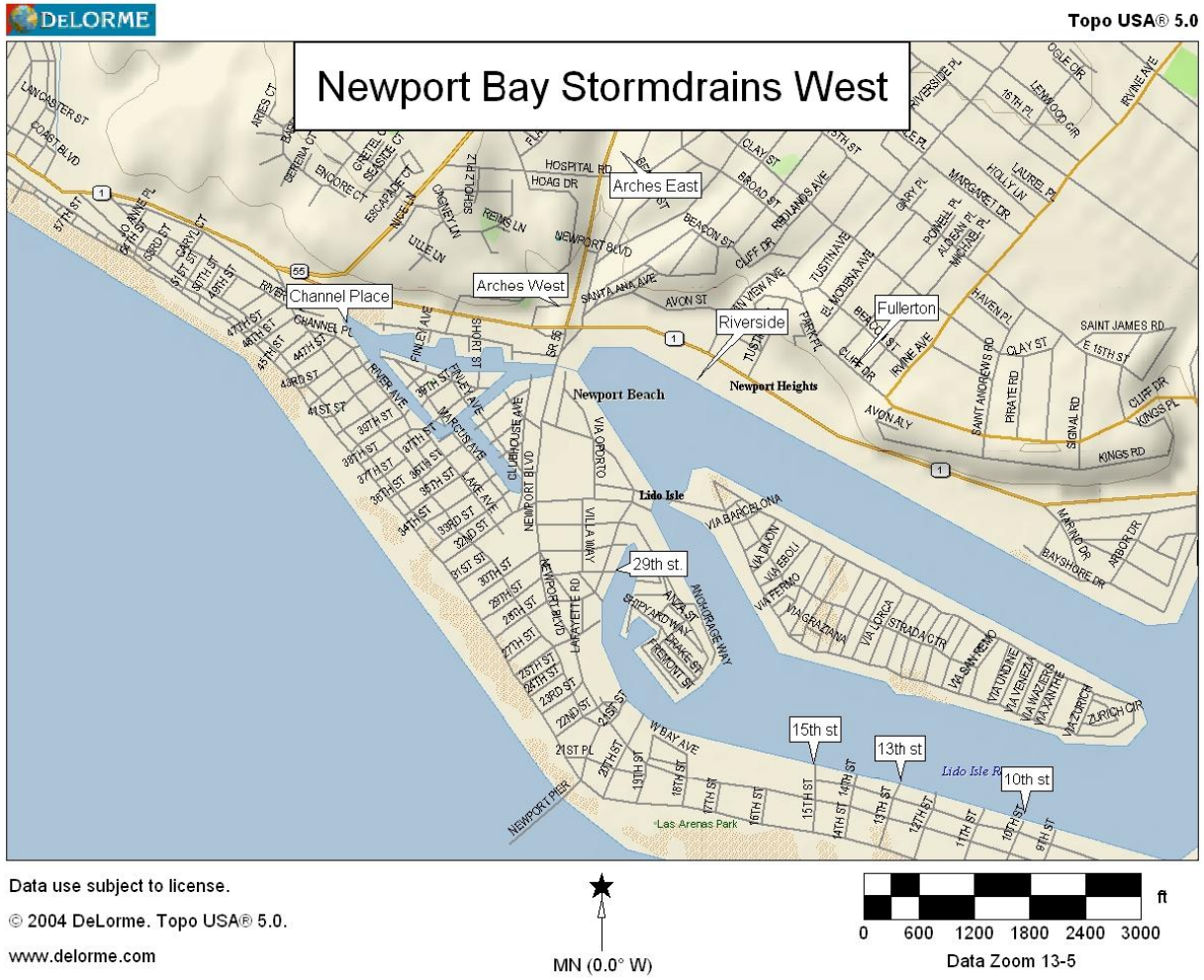

Nickel Concentrations 07
ug/L
100
80
60
40
20
0
1/13/1900
1/12/1900
1/4/1900
1/16/1900
Carnation
Polaris
Arches E
Arches W
PCH W
El Paseo
Riverside
Fullerton
PCH E
Bayside-1W
BackBay
Channel-1W
Linda Isle
Pearl
10th St
15th St
29th St
K St

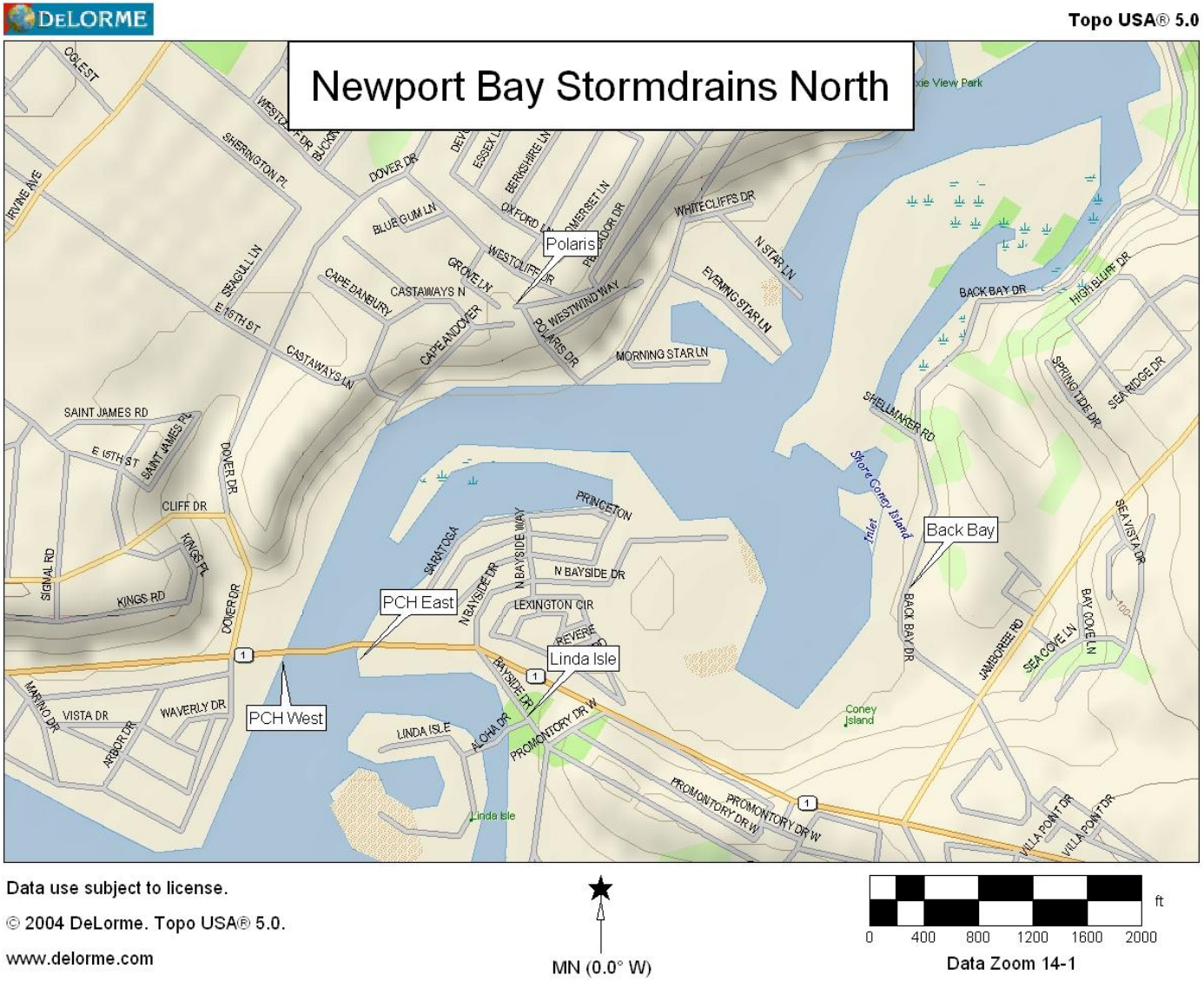

Nickel Concentrations 08-09
ug/L
100
80
60
40
20
0
1/5/2008R
1/21/2008R
39575
39632
39688
39794
12/15/2008R
2/6/2009R
39941
Carnation
Polaris
Arches E
Arches W
PCH W
El Paseo
Riverside
Fullerton
PCH E
Bayside-1W
BackBay
Channel-2
Linda Isle
Amethyst-2
Pearl
10th St
13th St
15th St
29th St
K St


Cadmium Concentrations 07
ug/L
50
40
30
20
10
0
1/13/1900
1/12/1900
1/4/1900
1/16/1900
Carnation
Polaris
Arches E
Arches W
PCH W
El Paseo
Riverside
Fullerton
PCH E
Bayside-1W
BackBay
Channel-1W
Linda Isle
Pearl
10th St
15th St
29th St
K St


Cadmium Concentrations 08-09
ug/L
50
40
30
20
10
0
1/5/2008R
1/21/2008R
7-May-08
3-Jul-08
28-Aug-08
12-Dec-08
12/15/2008R
2/6/2009R
8-May-09
Carnation
Polaris
Arches E
Arches W
PCH W
El Paseo
Riverside
Fullerton
PCH E
Bayside-1W
BackBay
Channel-2
Linda Isle
Amethyst-2
Pearl
10th St
13th St
15th St
29th St
K St

Detailed Project Maps




DeLORME
Topo USA® 5.0
Newport Bay Stormdrains North
Polaris
PCH East
PCH West
Linda Isle
Back Bay
Data use subject to license.
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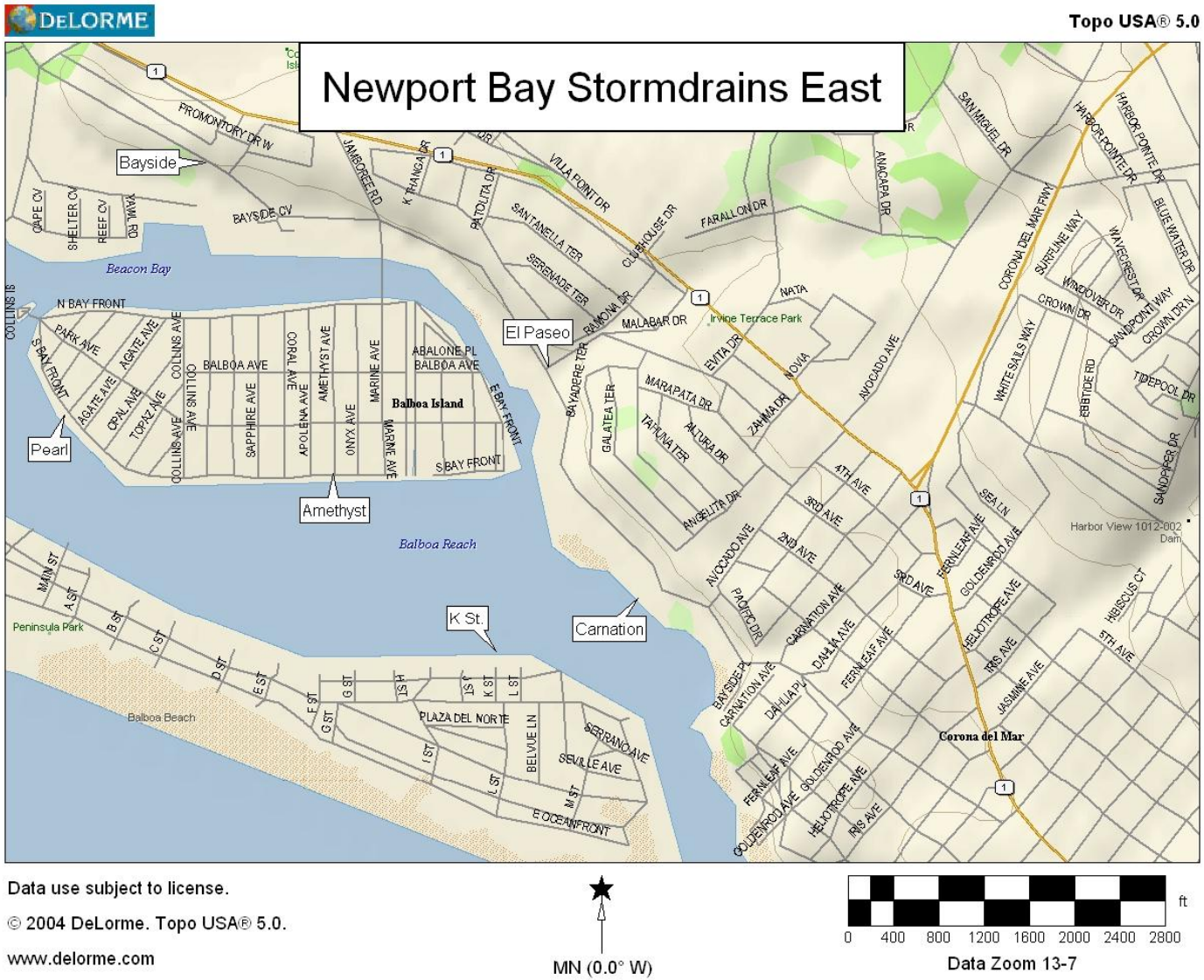
www.delorme.com
MN (0.0° W)
0 400 800 1200 1600 2000 ft
Data Zoom 14-1


DELORME
Topo USA® 5.0
Newport Bay Stormdrains East
Bayside
Beacon Bay
El Paseo
Balboa Island
Pearl
Amethyst
Balboa Reach
K St.
Carnation
Peninsula Park
Balboa Beach
Irvine Terrace Park
Harbor View 1012-002 Dam
Corona del Mar
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www.delorme.com
MN (0.0° W)
0 400 800 1200 1600 2000 2400 2800 ft
Data Zoom 13-7

Stormdrain Project Site Photos

Carnation

El Paseo

Amethyst

Pearl

Bayside

Linda Isle

Back Bay

PCH East

PCH West

Polaris

Fullerton

Riverside

Arches East

Arches West

29th St.

Channel

15th St.

13th St.

10th St.

K St.