Draft - Technical Memorandum

PLOAD Model for Marina del Rey Harbor

Preliminary Results

Prepared for

USEPA, Region 9

San Francisco, CA

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Introduction

This technical memorandum provides the methodology and results of the preliminary modeling of water quality in the watershed that drains into the Marina del Rey (MDR) Harbor.

The preliminary modeling of stormwater runoff quality and load to the harbor was performed with the PLOAD model. The PLOAD model is a GIS-based pollutant loading model that estimates non-point sources of pollution on an average annual or seasonal basis for user-specified pollutants. The PLOAD model is part of the BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) environment as released in version 3.

The constituents of concern for the MDR TMDL are:

- TSS (Total Suspended Solids)
- Total Copper
- Dissolved Copper
- Total Lead
- Dissolved Lead
- Total Zinc
- Dissolved Zinc
- PCB
- DDE
- Dieldrin
- Chlordane
- Dissolved Organic Carbon

Data Summary

Watershed Boundaries

The MDR watershed boundary was extracted from a GIS file received from the Los Angeles County Department of Public Works (LADPW) in 1999 for the Santa Monica Bay area. Figure 1 shows the boundary of the watershed. The GIS file included four sub-watersheds. For the purpose of this study, the sub-watershed that surface drains to MDR Harbor was further divided into two areas; Area 1A for the back harbor area (Basins D, E and F) and Area 1B for the rest of the harbor (all other basins). The five sub-watersheds were designated as follows: Area 1A, Area 1B, Area 2, Area 3, and Area 4. Only Areas 1A, 3, and 4 drain into the back harbor of the MDR Harbor. The boundaries of the watershed or the sub-watersheds have not been verified with field inspections.

These boundaries were overlaid onto storm drain maps provided by LADPW (LADPW, data provided May 20, 2002). The storm drains fall within the sub-watershed boundaries. Figure 2 shows the watershed, sub-watersheds, and the storm drains.

Land Use

Land use data was provided by LADPW on May 20, 2002 by Mr. T.J. Kim. Table 1 summarizes the land use types and areas in the five sub-areas of the Marina del Rey Harbor watershed.

TABLE 1. MARINA DEL REY HARBOR WATERSHED LAND USE SUMMARY

Land Use Type	MDR Watershed Area (ac)				
	Area 1A	Area 1B	Area 2	Area 3	Area 4
Education			3		67
General Office	2	17			
HDSFR			65	38	304
Institutional	1	9			
Light Industrial				2	86
Marina Facilities	65	106			
MFR	32	128	201	14	50
Military Installations		1			
Mixed Residential			1	13	18
Mixed Urban					3
Open Space/Recreation	19	65	2		3
Other Commercial	16	3	9		2
Receiving Waters	44	151	13		8
Retail/Commercial	32	30	21		94
Transportation	4				2
Under Construction		2	11	4	6
Urban Vacant	2	4			29
Vacant		53			
Total	217	569	327	70	671

Replace with Figure 1

Figure 1. Marina del Rey Harbor Study Location and Sub-Watershed Areas

Replace with Figure 2

Figure 2. LADPW Storm Drains in Marina del Rey Harbor Sub-Watershed Areas.

Event Mean Concentration

The event mean concentrations (EMCs) provide average concentrations to be expected for each pollutant in stormwater runoff in milligrams per liter (mg/l). Data available on the LADPW's web site was used to obtain the EMC values. The LADPW's web site provided EMC values estimated from storm data from 1994 to 2000 for 8 land uses. Table 2 summarizes the available EMCs from LADPW.

TABLE 2. EVENT MEAN CONCENTRATIONS BY LAND USE TYPE (FROM LADPW DATABASE)

Constituent	Unit	HDSFR	Light Industrial	Vacant	Retail/ Commercial	Multi-Family Residential	Trans-portation	Education	Mixed Residential
TSS	mg/l	104.65	229.37	164.68	67.40	46.35	75.35	103.02	69.06
Total Copper	µg/l	15.30	31.04	9.12	34.77	12.23	51.86	21.49	17.33
Dissolved Copper	µg/l	8.44	20.22	n/m	14.60	6.75	32.68	12.80	11.52
Total Lead	µg/l	9.59	14.87	n/m	11.53	5.13	9.08	4.53	8.70
Dissolved Lead	µg/l	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
Total Zinc	µg/l	80.35	565.60	38.81	238.53	134.88	279.45	123.69	184.85
Dissolved Zinc	µg/l	39.11	460.19	n/m	164.12	75.36	203.89	65.97	125.83
PCB	µg/l	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
DDE	µg/l	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
Dieldrin	LADPW did not collect data for this constituent.								
Chlordane	µg/l	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
DOC	LADPW did not collect data for this constituent.								

Notes:

HDSFR – High Density Single Family Residential

DOC – Dissolved Organic Carbon

n/m – not meaningful; not enough data above detection limit

For the purpose of this evaluation and due to the lack of better data, for the constituents that have an "n/m" for concentration, an EMC value of zero was assumed in most cases. Most of the constituents that have a value of "n/m" in Table 2, are pesticides and could be considered historical pollutants. Therefore, detection of these historical pollutants in stormwater would not be expected at this time.

Some metals also have "n/m" values in Table 2. It is likely that very low to below detection limit concentrations of dissolved metals could be encountered in the field since metals have a tendency to adhere to other particles, especially fine sediments. Dissolved lead has an "n/m" value across all land uses, and dissolved zinc and dissolved copper have values of "n/m" for the vacant land use. EMC values of zero were used for these dissolved constituents in the analysis. Total lead also has a value of "n/m". However, because lead is

normally not considered a historical pollutant and other metals, such as zinc and copper, which often occur together, have been measured, an analysis value of zero was considered inappropriate. Therefore, 50 percent of the detection limit of 5 µg/L (2.5 µg/L) was used for the total lead concentration in runoff from vacant land.

Since the LADPW data has a limited number of land use categories as compared to those found in the study area, EMC values for other land use categories were inferred from the LADPW data. Also, other EMC data was not located for Dieldrin and DOC, thus a zero value was assumed for these two constituents. Table 3 summarizes the EMC values used in the PLOAD model.

Rainfall

Rainfall data was provided by LADPW for the gage at LAX airport. The data included daily rainfall measured in inches from January 1, 1947 to October 29, 2000. The data was analyzed based on the rain year (October 1 to September 30) from 1948 to 2000. Table 4 summarizes the analysis of the data. For the purposes of modeling, the mean annual rainfall was used as a representative of a typical year. The 10^{th} and 90^{th} percentiles were used as representative of a typical dry year and a typical wet year, respectively.

TABLE 3. EVENT MEAN CONCENTRATIONS USED IN THE PLOAD MODEL FOR MARINA DEL RAY
All Units in mg/L

Land Use Category	TSS	Source	Total Copper	Source	Dissolved Copper	Source	Total Lead	Source	Dissolved Lead	Source	Total Zinc	Source
Education	103	a.	0.0215	a.	0.0128	a.	0.0045	a.	0	g.	0.1237	a.
General Office	148.4	b.	0.0329	b.	0.0174	b.	0.0132	b.	0	g.	0.4021	b.
HDSFR	104.7	a.	0.0153	a.	0.0084	a.	0.0096	a.	0	g.	0.0804	a.
Institutional	103	c.	0.0215	c.	0.0128	c.	0.0045	c.	0	g.	0.1237	c.
Light Industrial	229.4	a.	0.031	a.	0.0202	a.	0.0149	a.	0	g.	0.5656	a.
Marina Facilities	67.4	d.	0.0348	d.	0.0146	d.	0.0115	d.	0	g.	0.2385	d.
Military Installations	229.4	e.	0.031	e.	0.0202	e.	0.0149	e.	0	g.	0.5656	e.
Mixed Residential	69.1	a.	0.0173	a.	0.0115	a.	0.0087	a.	0	g.	0.1849	a.
Mixed Urban	148.4	b.	0.0329	b.	0.0174	b.	0.0132	b.	0	g.	0.4021	b.
Multiple Family Residential	46.4	a.	0.0122	a.	0.0068	a.	0.0051	a.	0	g.	0.1349	a.
Open Space/ Recreation	164.7	f.	0.0091	f.	0	f.	0.0096	f.	0	g.	0.0388	f.
Other Commercial	67.4	d.	0.0348	d.	0.0146	d.	0.0115	d.	0	g.	0.2385	d.
Receiving Waters	0		0		0		0		0		0	
Retail/ Commercial	67.4	a.	0.0348	a.	0.0146	a.	0.0115	a.	0	g.	0.2385	a.
Transportation	75.4	a.	0.0519	a.	0.0327	a.	0.0091	a.	0	g.	0.2795	a.
Under Construction	164.7	f.	0.0091	f.	0	f.	0.0096	f.	0	g.	0.0388	f.
Urban Vacant	164.7	f.	0.0091	f.	0	f.	0.0025	f.	0	g.	0.0388	f.
Vacant	164.7	a.	0.0091	a.	0	a.	0.0025	h.	0	g.	0.0388	a.

Land Use Category	Dissolved Zinc	Source	PCB	Source	DDE	Source	Dieldrin	Source	Chlora-dane	Source	DOC	Source
Education	0.066	a.	0	g.	0	g.	0	g.	0	g.	0	g.
General Office	0.3122	b.	0	g.	0	g.	0	g.	0	g.	0	g.
HDSFR	0.0391	a.	0	g.	0	g.	0	g.	0	g.	0	g.
Institutional	0.066	c.	0	g.	0	g.	0	g.	0	g.	0	g.
Light Industrial	0.4602	a.	0	g.	0	g.	0	g.	0	g.	0	g.
Marina Facilities	0.1641	d.	0	g.	0	g.	0	g.	0	g.	0	g.
Military Installations	0.4602	e.	0	g.	0	g.	0	g.	0	g.	0	g.
Mixed Residential	0.1258	a.	0	g.	0	g.	0	g.	0	g.	0	g.
Mixed Urban	0.3122	b.	0	g.	0	g.	0	g.	0	g.	0	g.
Multiple Family Residential	0.0754	a.	0	g.	0	g.	0	g.	0	g.	0	g.
Open Space/ Recreation	0	g.	0	g.	0	g.	0	g.	0	g.	0	g.
Other Commercial	0.1641	d.	0	g.	0	g.	0	g.	0	g.	0	g.
Receiving Waters	0		0		0		0		0		0	
Retail/ Commercial	0.1641	a.	0	g.	0	g.	0	g.	0	g.	0	g.
Transportation	0.2039	a.	0	g.	0	g.	0	g.	0	g.	0	g.
Under Construction	0	g.	0	g.	0	g.	0	g.	0	g.	0	g.
Urban Vacant	0	g.	0	g.	0	g.	0	g.	0	g.	0	g.
Vacant	0	g.	0	g.	0	g.	0	g.	0	g.	0	g.

a – LADPW
b - Assumed to be the average of Light Industrial and Retail/Commercial land uses.
c - Assumed to be the equivalent of Education land use.
d - Assumed to be the equivalent of Retail/Commercial land uses.
e - Assumed to be the equivalent of Light Industrial land use.
f - Assumed to be the equivalent of Vacant land use.
g - Listed as n/m in data, assumed to equal 0.0000
h -Total Lead EMC for Vacant land use is assumed to be half of the detection limit.

TABLE 4. ANNUAL RAINFALL ANALYSIS SUMMARY – LAX AIRPORT GAGE.

Analysis	Result (in/year)
Mean	11.94
Median	9.92
Maximum	30.79
Minimum	4.64
Standard Deviation	6.27
10th percentile	5.57
90th percentile	20.77

Factors

Two factors are necessary for the calculation of pollutant loads: impervious factor and ratio of storms producing runoff. Table 5 summarizes the imperious factors for the different land use categories. These factors were provided by LADPW from their Hydrology Manual. Not all land use categories used in this study had a direct correlation to land use categories found in the Hydrology Manual. Necessary factors were inferred from the available data.

TABLE 5. SUMMARY OF IMPERVIOUS FACTORS.

Land Use Category	Percent Impervious	Code [(1)]
Education	82%	1262-1266
General Office	91%	1241,1211-1213
High Density Single Family Residential	42%	1111
Institutional	91%	1246
Light Industrial	91%	1311
Marina Facilities	91%	1500
Military Installations	91%	1271
Mixed Residential	59%	1140
Mixed Urban	91%	1131
Multiple Family Residential	86%	1124
Open Space/Recreation	10%	1820
Other Commercial	96%	1221 - 1223
Receiving Waters	0%	N/A
Retail/Commercial	97%	1224
Transportation	91%	1411-4200

TABLE 5. SUMMARY OF IMPERVIOUS FACTORS.

Land Use Category	Percent Impervious	Code (1)
Under Construction	15%	1700
Urban Vacant	2%	1900
Vacant	2%	3300

Note:

(1) Codes are based on Hydrology Manual codes. Highest value used if range of codes given.

N/A Not Applicable. Water body.

Since appropriate stream flow data was not available at the time of analysis, the ratio of storm producing runoff factor was left at the default value of 0.9. This default value was developed by Thomas R. Schueler and is documented in "Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs" (Schueler, July 1987). This document is the source of the simple method upon which the PLOAD model is based. Schueler's findings were that over 50% of the storms analyzed were less than 0.2 inches. Thus, "The rainfall from minor storms may be entirely stored in surface depressions and eventually lost by evaporation or infiltration. As a result, no runoff is produced."

Point Sources and BMP Facilities

At the time of this analysis, point sources or best management practice (BMP) facilities were not identified.

Results

Table 6 summarizes the results of the PLOAD model analysis. The annual loads expressed in Table 6 represent the predicted amount of pollutants that are associated with runoff. They do not represent a receiving water concentration. The PLOAD modeling does not take into account the dynamic processes within the receiving water.

TABLE 6. SUMMARY OF PLOAD MODEL RESULTS FOR MARINA DEL REY HARBOR WATERSHED

(pounds per year)

Sub-Watershed	Total Suspended Solids	Total Copper	Dissolved Copper	Total Lead	Dissolved Lead	Total Zinc	Dissolved Zinc
Average Rain Year							
Area 1A	21,933.14	9.9	4.4	3.3	0.0	71.3	47.9
Area 1B	45,074.10	15.5	7.0	5.5	0.0	125.0	81.8
Area 2	31,953.86	8.5	4.4	3.5	0.0	77.0	44.6
Area 3	7,787.82	1.4	0.8	0.7	0.0	12.5	7.6
Area 4	111,741.62	23.0	12.4	9.7	0.0	218.2	153.7
Dry Rain Year							
Area 1A	10,231.79	4.6	2.0	1.5	0.0	33.2	22.4
Area 1B	21,027.03	7.2	3.3	2.6	0.0	58.3	38.1
Area 2	14,906.45	4.0	2.0	1.7	0.0	35.9	20.8
Area 3	3,633.01	0.7	0.4	0.3	0.0	5.8	3.6
Area 4	52,127.37	10.7	5.8	4.5	0.0	101.8	71.7
Wet Rain Year							
Area 1A	38,153.38	17.3	7.6	5.8	0.0	124.0	83.4
Area 1B	78,407.79	26.9	12.2	9.6	0.0	217.5	142.2
Area 2	55,584.73	14.7	7.6	6.2	0.0	133.9	77.5
Area 3	13,547.15	2.4	1.4	1.3	0.0	21.7	13.3
Area 4	194378.01	39.9	21.5	16.9	0.0	379.6	267.4

Conclusions

This analysis is based on the following assumptions:

- Event mean concentrations listed as "n/m" in the LADPW data are assumed to be zero for this analysis with the exception of total lead, which is assumed to be half the detection limit.
- Where explicit correlation between EMC categories and land use categories could not be made, equivalent EMCs were developed.
- Impervious values for categories not explicitly listed in the LADPW Hydrology Manual were inferred from other categories.
- The ratio of storms producing runoff was left as the default value of 0.9 (90 percent)

This preliminary analysis indicates that highest annual loads are from Area 1B and Area 4. This is not surprising given the size of each area (Area 1B – 569 ac and Area 4 – 671 ac) as compared to Area 1A (217 ac), Area 2 (327 ac), and Area 3 (70 ac). However, Area 4 loading exceeds Area 1B loading for several pollutants. This is due, in part, to the large amount of receiving waters (185 ac) in Area 1B. Area 4 only has 8 acres. More importantly, Areas 1B and 4 combined contribute over 60 percent of the total load for any of the pollutants modeled. In the back harbor area, Area 4 contributes over 70 percent of most pollutants mostly due to its size. As the evidence indicates, any significant management measures should be centered on Area 4 for back harbor issues.

This analysis is very coarse because of the lack of available data and the number of assumptions that had to be made. Because this is a small watershed, small errors in watershed and sub-watersheds boundaries can cause significant differences in the generated loads. Also, the lack of site specific data for the pesticides and dissolved organic carbon makes analysis for these constituents inconclusive. In addition, the limited number of land use categories for site specific EMC values added another unknown variable because inferred values had to be used which may or may not be applicable to local conditions. Lack of flow data at the time of analysis forced the use of the default value for the ratio of storms producing runoff.

To better refine the analysis these tasks are recommended:

- Verify drainage patterns and storm drain locations to better define watershed and sub-watersheds.
- Evaluate EMC values to see if additional, local MDR stormwater chemistry data would be needed for more accurate predictions of load.
- Collect/evaluate data for pesticides and DOC.
- Evaluate MDR rainfall vs. runoff data to define the ratio of storms producing runoff factor.
- Obtain BMP and point source data throughout the watershed.