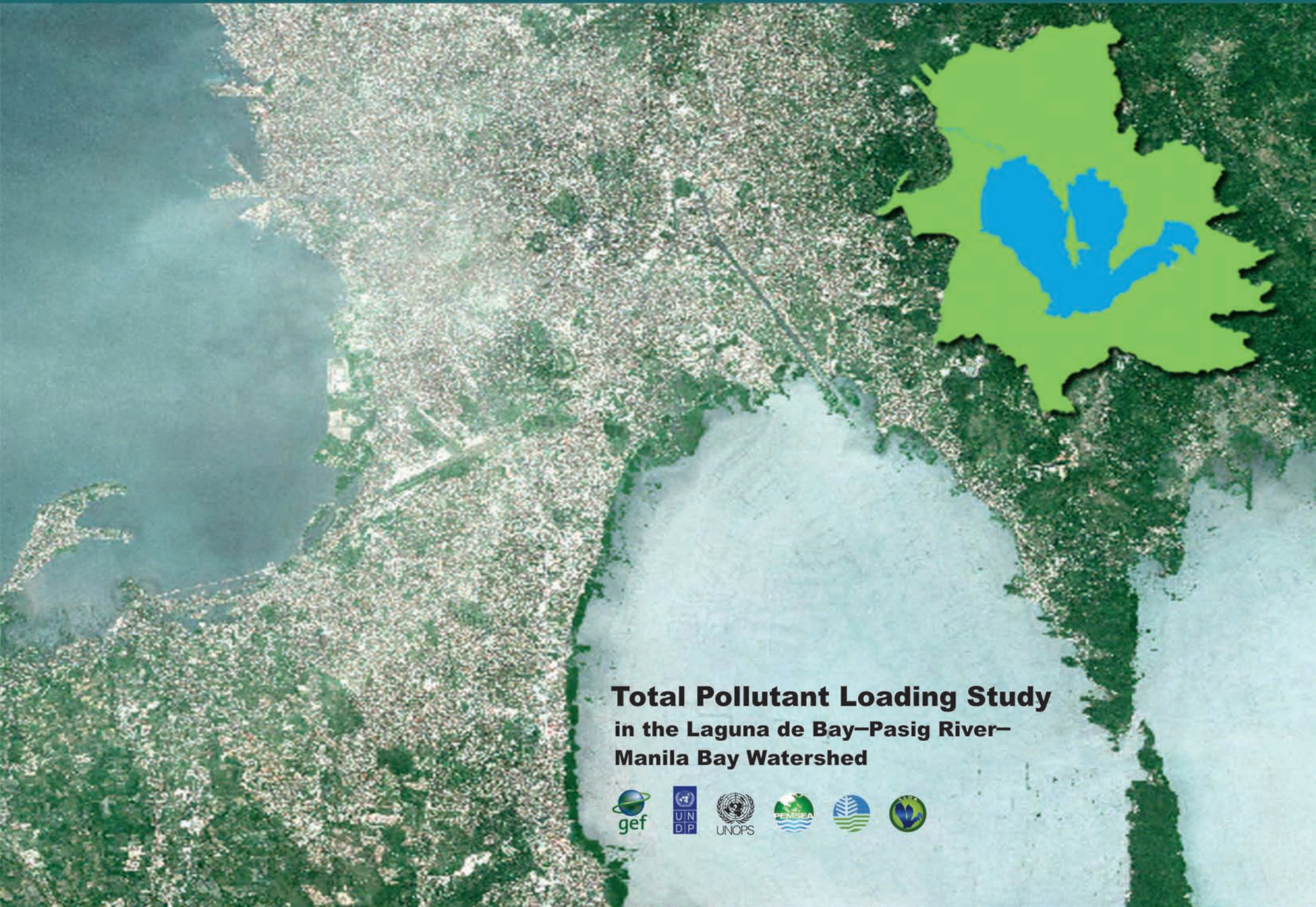

Total Pollutant Loading Study

in the Laguna de Bay–Pasig River–Manila Bay Watershed

Total Pollutant Loading Study in the Laguna de Bay–Pasig River– Manila Bay Watershed

Loading of 58 Sub-basins: Biochemical Oxygen Demand,
Total Nitrogen and Total Phosphorous Loading
for 2008, 2010, 2015 and 2020

Total Pollutant Loading Study in the Laguna de Bay–Pasig River–Manila Bay Watershed

June 2013

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- Ms. Gina Lopez, Pasig River Rehabilitation Commission.

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Abstract

The Biochemical Oxygen Demand (BOD), total nitrogen (total N) and total phosphorous (total P) loads entering Manila Bay were estimated using the unit load approach. The Waste Load Model of the Laguna Lake Development Authority – Decision Support System (LLDA-DSS) was used to compute the total pollutant loading for 2008, 2010, 2015 and 2020.

Fifty-eight sub-basins were identified within the watersheds of Pasig River and Laguna de Bay and other smaller basins in Metro Manila, Bulacan and Cavite that directly drain into Manila Bay. The annual BOD generation from the 58 sub-basins was estimated at 232,764 MT/yr for 2008; 242,781 MT/yr for 2010; 270,182 MT/yr for 2015; and 302,531 MT/yr for 2020. These were computed at point sources, without considering any natural purification of surface waters. The annual total phosphorous generation was estimated at 17,619 MT/yr for 2008; 18,412 MT/yr for 2010; 20,580 MT/yr for 2015; and 23,138 MT/yr for 2020. Lastly, the annual total nitrogen generation was estimated at 79,621 MT/yr for 2008; 83,568 MT/yr for 2010; 93,738 MT/yr for 2015; and 105,770 MT/yr for 2020. Domestic sources of BOD and other chemicals contributed the highest pollution loads, followed by industrial and commercial sources, agricultural sources and inputs from forest land cover.

1 Introduction

1.1 Rationale

In support of the Supreme Court *mandamus* to fully implement the Operational Plan for the Manila Bay Coastal Strategy of the Department of Environment and Natural Resources (DENR) for the immediate rehabilitation, restoration and conservation of Manila Bay, a study on the total pollutant loading in the Laguna de Bay–Pasig River–Manila Bay watershed was conducted. The study aims to draft a pollution reduction strategy by identifying key sources of pollutants in Manila Bay. The watershed is deemed to contribute the largest proportion of pollutants entering Manila Bay and, therefore, reduction in pollution loads from these areas will directly affect the overall water quality in Manila Bay.

The Waste Load Model (WLM) of the Laguna Lake Development Authority – Decision Support System (LLDA-DSS) was used to estimate pollution loads in the Laguna de Bay–Pasig River–Manila Bay watershed. It measures the amount of substances produced by human activities (i.e., domestic, agricultural and industrial) and the amount of substances that end up in the coast or lake after passing through treatment facilities, sewer systems or natural processes in surface waters. The model was used because monitoring all point and non-point sources of pollution loads would be extremely difficult. Using the WLM, key sources of pollution loads are estimated or calculated from the mass balances. Water quality modeling allows a first pass estimate of pollution loads. It also provides a platform for computing pollution loads at different time slices and/or for different scenarios.

1.2 Coverage

A total of 58 sub-basins have been identified in this study. Thirty-seven sub-basins are within the Pasig River and Manila Bay watershed and 24 sub-basins are within the Laguna de Bay watershed (**Figure 1** and **Annex A**).

1.3 Objective

The main objective of the model run is to determine the BOD, total phosphorous and total nitrogen loadings of the identified 58 sub-basins in the Laguna de Bay–Pasig River–Manila Bay watershed from major point sources (i.e., industry, domestic, agriculture and forest) for 2008, 2010, 2015 and 2020.

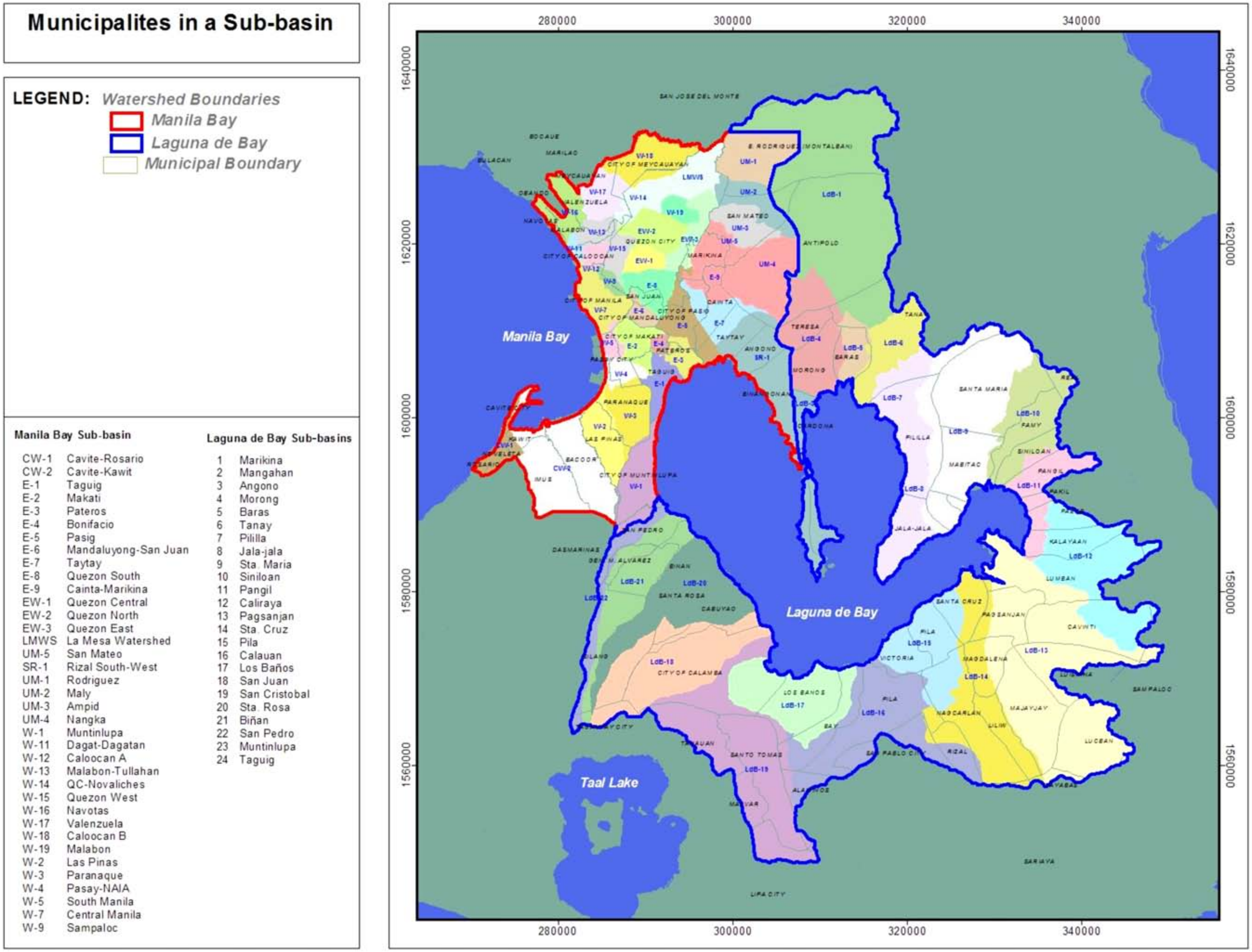


Figure 1. Map Showing Geographic Coverage of the Study.

2

Data Sets and Assumptions

General Assumptions

The total pollution loading was computed onsite without considering the natural purification in river systems as well as in drains from households without septic tanks going through the river systems.

Specifically, the following assumptions were used in computing the BOD, total N and total P loading in the identified sub-basins:

1. Delineation of 58 Sub-basins

The delineation of the 37 sub-basins within the Pasig River and Manila Bay watershed come from a compilation of previous sub-basin delineations (MWSS and MWCI, 2010, 2011a and 2011b). Boundaries were determined based on topographic controls as well as existing sewerage configuration. On the other hand, the delineation of the 24 sub-basins within the Laguna de Bay watershed was based on topographic analysis conducted by LLDA. The Manggahan, Muntinlupa and Taguig sub-basins were included in the Pasig River–Manila Bay watershed, although parts of these sub-basins may still be draining into Laguna de Bay. Moreover, these sub-basins should be re-mapped based on recent sewerage projects by the Manila Water Company Inc. (MWCI) and Maynilad Water Services Inc. (MWSI) as these will affect the current sewerage network.

2. Emission Factors

2.1 Concentration in Industrial Wastewater Discharge

Emission factors of each parameter were adapted from previous literature used by LLDA and some were updated to fit local conditions whenever applicable. For the BOD concentration of industrial wastewater discharge, the model used actual industry discharge per category of the industry registered within the Laguna de Bay region in 2008. For nitrate, ammonium and phosphorous, figures used in the report came from Orbeta and Indab (1993) (**Table 1**). The model used the 2008 data on industrial wastewater discharge for estimating the pollutant loadings for 2010, 2015 and 2020.

Table 1. Concentration in Industrial Wastewater Discharge.

	Concentrations in Industrial Wastewater (g/m^3)			
	NH_4	NO_3	TP	BOD_5
Food Manufacturing	50	0	12	1,003
Pulp and Paper Manufacturing	6	0	1	57
Dye/Textile/Garments	5	50	6	47
Piggeries/Poultry/Livestock	138	0	10	750
Slaughterhouse/Hatchery	198	0	20	667
Beverages	22	0	10	40
Semicon	0	0	0	19
Metal	0	15	1	8
Agricultural	214	0	29	5
Chemicals/Pharmaceuticals	30	2	2	22
Minerals/Non-metals	15	0	23	5
Laundry	19	0	11	30
Wood	23	0	62	74
Rubber/Leather	123	0	7	728
Plastic/Film/Foam	24	0	1	142
Gasoline Station	0	0	0	109
Industrial Estate/Dumpsite	0	38	1	49
Housing/Recreation	0	0	0	137
Powerplant	0	30	1	3
Transportation	0	0	0	276

Source: Orbeta & Indab, 1993.

2.2 Population Equivalent and Septic Tank Efficiency

A per capita load was used to estimate the total BOD, total N and total P loading per sub-basin. The waste load production per capita or population equivalent was subdivided into grey water discharge (domestic wastewater from washing and bathing) and black water or waste loads from toilets. In particular, 10 g/BOD/capita/day from greywater discharge and 20 g/BOD/capita/day from blackwater was used. A 10 percent reduction in blackwater BOD was used as efficiency removal of septic tanks. The 10 percent septic tank efficiency was adopted from Japan International Corporation Agency-Environmental Management Bureau (JICA-EMB) report on Marilao–Meycauayan–Obando River. No natural purification from local drains was considered. For domestic wasteload per inhabitant of nitrogen and phosphorus, the calculation used the LLDA emission factors which were adapted from the results of study of Orbeta and Indab (1993) (**Table 2**).

Table 2. Population Equivalent and Septic Tank Efficiency.

G/c/d	BOD	NH_4	NO_3	TP
Grey	10	1	1	1.5
Toilet	20	7	0	0.8

Source: Orbeta & Indab, 1993.

2.3. Land Cover

The forest cover estimate of Laguna de Bay watershed was based on a land use identification/validation study of a 2003 satellite image map. Land cover data for the 37 sub-basins were provided by the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA & MBEMP, 2007). Land cover classification in the model was divided into forest and agriculture. Agricultural lands were then classified into arable, plantation and grassland (**Annex B**). The land cover data was used in estimating the agricultural and forest cover loading. For the leaching of land cover per category, the results of the study of Managilod (1996) was used (**Table 3**). No natural purification from river systems and local drains were considered. The loadings computed were all onsite sources loadings.

Table 3. Leaching per Land Cover Classification.

Kg/ha/yr	BOD	NH_4	NO_3	P
Arable Land	75	25	10	9
Plantation	25	1	2	2
Forest	50	0	3	0.5
Grass land	25	1	2	2

Source: Manaligod, 1993.

3. Population Projection and Population Density

Total population for each sub-basin for 2008, 2010, 2015 and 2020 were projected using the latest National Statistics Office (NSO) data for city/municipality population and the calculated average growth rate for 2000 to 2007. The number of inhabitants per sub-basin was estimated using overlays of municipal and sub-basin boundaries in the ARCVIEW GIS-system. Assuming a uniform population distribution, the population distribution of each city/municipality in a sub-basin was calculated (**Figures 2**, **3**, **4** and **5** and **Annex C**).

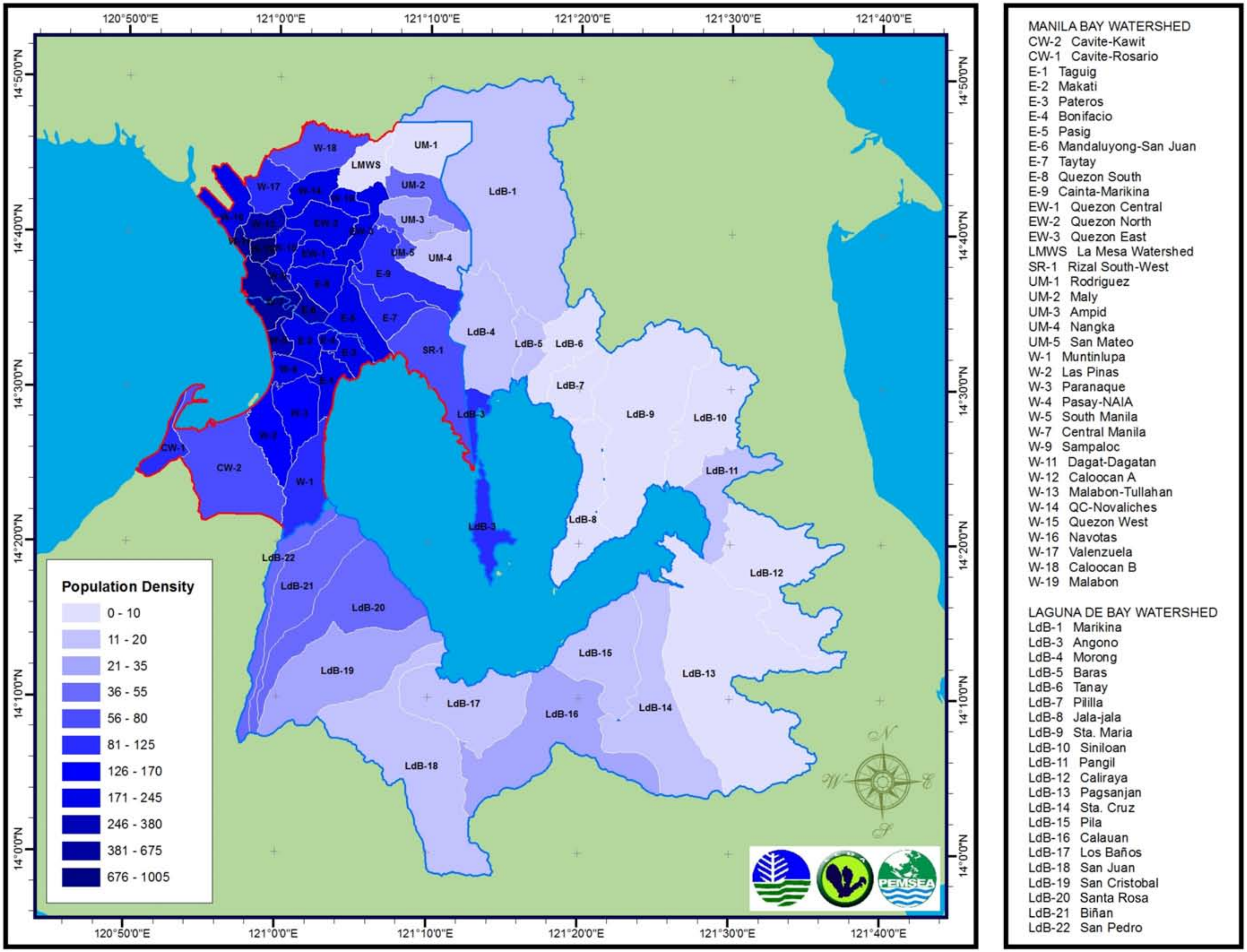


Figure 2. Population Density Map for 2008.

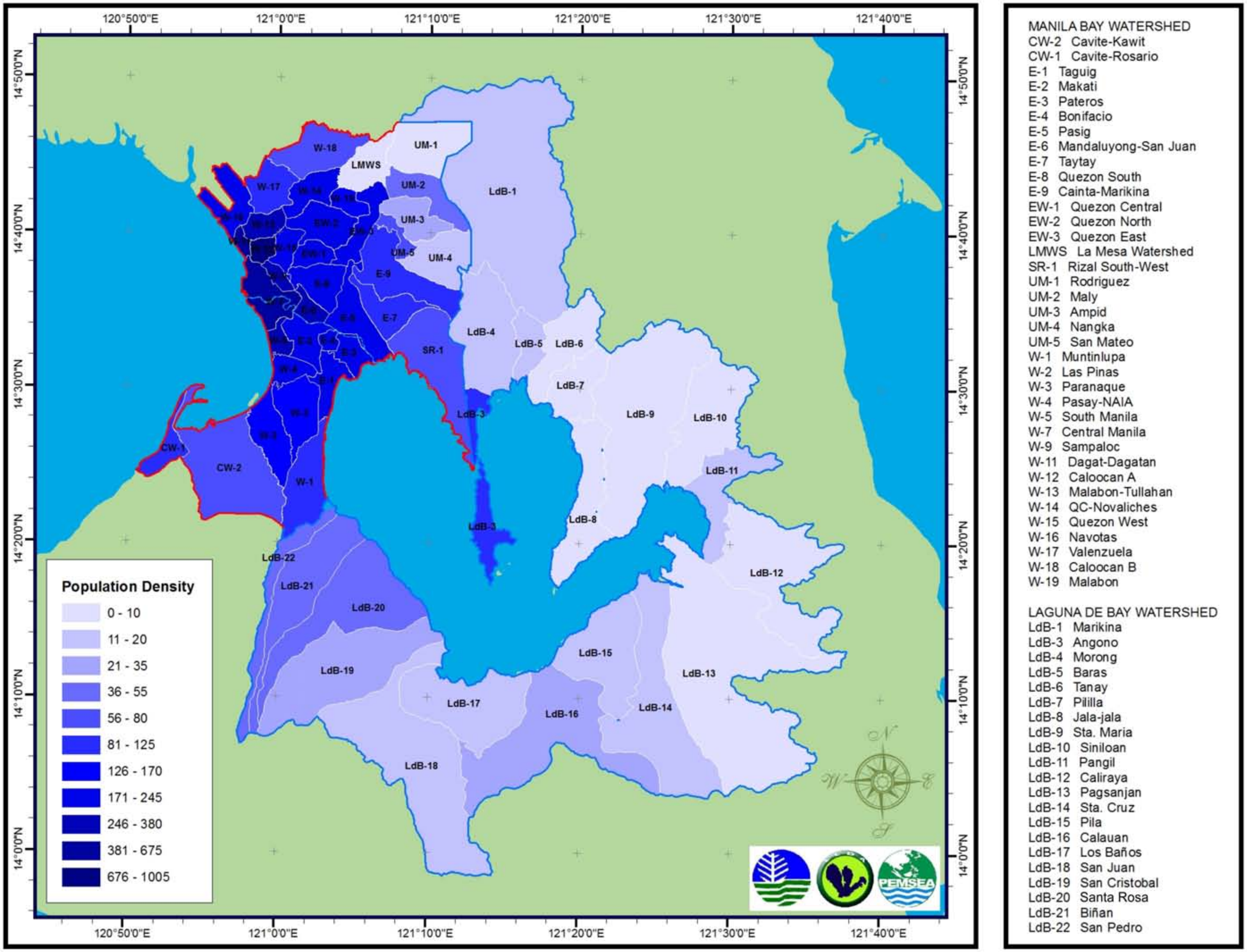


Figure 3. Population Density Map for 2010.

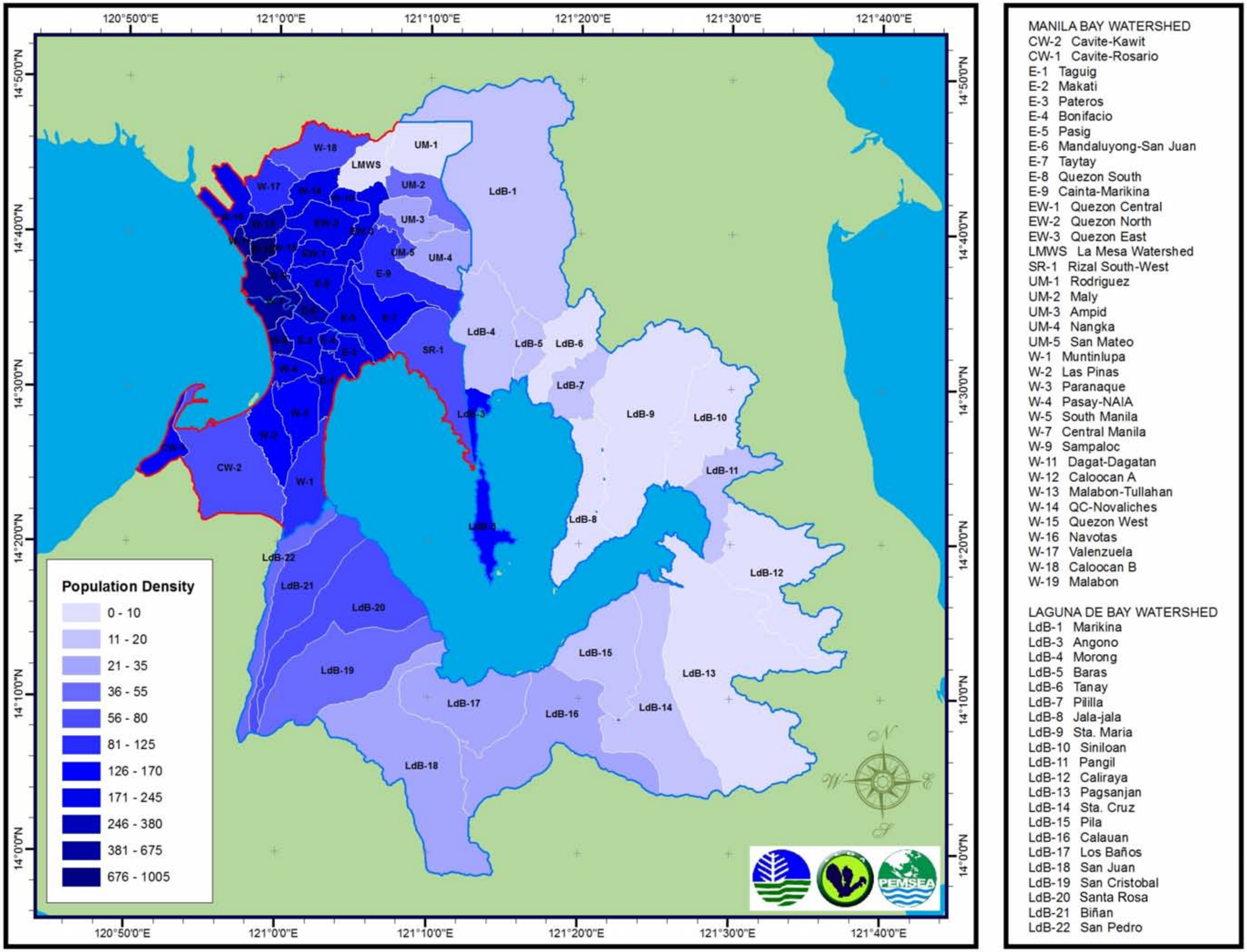


Figure 4. Population Density Map for 2015.

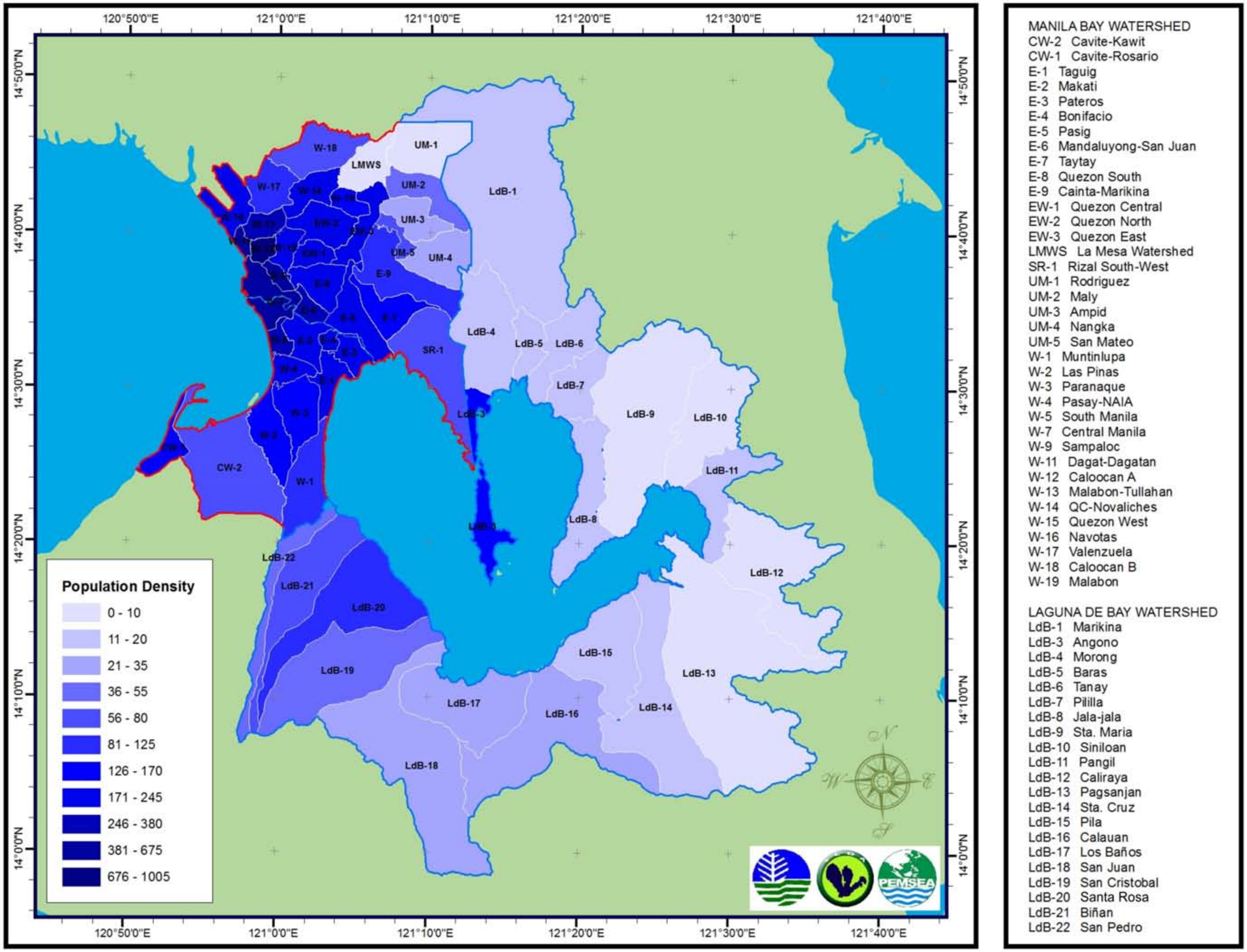


Figure 5. Population Density Map for 2020.

Discharge of domestic wastewater in Laguna de Bay region was based on the Department of Health Annual Report (1998) which includes a percentage of inhabitants per municipality with septic tanks. On the other hand, the NSO survey (2000) on population with and without septic tanks was used in measuring the discharge of domestic wastewater in Manila Bay sub-basins.

The rate of the population with septic tank used was the average rate of population per municipality inside the sub-basin with sewer. Not all municipalities inside the sub-basins from Manila Bay have available data on the population (inside municipality) that has sewer/septic tank for 2008, 2010, 2015 and 2020. (**Annexes D**, **E**, **F** and **G**).

4. Industrial Wastewater Discharge

For the Laguna de Bay watershed, 3,916 firms monitored in 2008 were included, consisting of the industries' location, industrial category, discharge rate and wastewater quality data. On the other hand, a list of industries and corresponding wastewater discharge in the Manila Bay watershed were not complete. Some available industry data with wastewater discharge based on self monitoring reports (SMR) are from San Juan City and Cavite City. An accounting of the number of industries operating along the Pasig River System (Manila, Makati and San Juan), Parañaque River System, Zapote River System, Meycauayan–Marilao–Obando (MMO) River System and Manila Bay come from the River Basin Central Office (RBCO) database as well as from JICA-EMB reports on the MMO.

Estimates for industry discharge in the Manila Bay sub-basins were extrapolated from the industry data from Laguna de Bay sub-basins. For the Manila Bay sub-basins, the industry discharge of the adjacent sub-basin or the nearest municipality within the Laguna de Bay Region which have similar industrial characteristics was used. The number of industry considered was based on the area of municipality inside the Manila Bay sub-basins. The type/category and/or number of industry operating in the municipality was also considered. If there are available data on industries per category but no monitoring data for discharge in Manila Bay and Pasig River watersheds, the available discharge data with the same category of industries operating within the Laguna de Bay Region was used.

3

Results

The BOD discharges from various land-based sources were assumed to converge in the waters of the sub-basins. At the lower reaches of the sub-basins (particularly the rivers), the BOD, total nitrogen and total phosphorus mass loading were estimated as the product of their respective resulting emission factors and their corresponding emission variable per pollution sources per sub-basin, as presented in the following equation:

Load (BOD, TN and TP)	= factor	* variable
domestic	: pop. eq.	* inhabitants
industry	: concentration	* discharge
agriculture	: kg/ha	* crop area
forest	: kg/ha	* forest area

The Laguna de Bay–Pasig River–Manila Bay watershed was divided into 58 sub-basins to have a detailed information on the extent of pollution loads from each sub-basin and to easily identify which sub-basin needs immediate improvement in wastewater management.

The annual BOD generation from the 58 sub-basins at point source without considering any natural purification of surface waters was estimated at 232,764 MT/yr for 2008; 242,781 MT/yr for 2010; 270,182 MT/yr for 2015; and 302,531 MT/yr for 2020.

The annual total phosphorous generation was estimated at 17,619 MT/yr for 2008; 18,412 MT/yr for 2010; 20,580 MT/yr for 2015; and 23,138 MT/yr for 2020.

Lastly, the annual total nitrogen generation was estimated at 79,621 MT/yr for 2008; 83,568 MT/yr for 2010; 93,738 MT/yr for 2015; and 105,770 MT/yr for 2020. In 2008, domestic effluents from residential areas contributed the highest, followed by the effluents from the industrial, agricultural and forest land cover sources (**Figures 6**, **7** and **8**). These figures also accounted for an annual increase of loading of about 5,814 MT/yr for BOD, 460 MT/yr for total phosphorus and 2,179 MT/yr for total nitrogen from 2008 to 2020.

The total annual loading per sub-basin is summarized in **Tables 4**, **6** and **8** and in **Figures 9** to **20** where total annual pollutant loading from major sources (i.e., industry, domestic, agriculture and forest) of BOD, total nitrogen and total phosphorus loading for 2008, 2010, 2015 and 2020 are provided. The results are also presented on a loading per area in terms of pollution loading distribution (**Tables 5**, **7** and **9**).

The results of the loading per area identified the sub-basins with the most number of pollutant loadings for the identified years (i.e., 2008, 2010, 2015 and 2020). Six sub-basins with high BOD loading by area ranging from 4 to 13 MT/yr/ha come from the following sub-basins: Caloocan (W-12), Dagat-Dagatan (W-11), Central Manila (W-7), Mandaluyong–San Juan (E-6), Sampaloc (W-9) and Malabon–Tullahan (W-13) sub-basins.

Sub-basins that were estimated to contribute the highest total nitrogen loading by area are the following: Caloocan (W-12), Dagat-Dagatan (W-11), Central Manila (W-7), Mandaluyong–San Juan (E-6), Sampaloc (W-9) and Malabon–Tullahan (W-13) sub-basins, which range from 1.17 MT/yr/ha to 4.79 MT/yr/ha.

Sub-basins that were estimated to contribute the highest total phosphorus loading by area are: Caloocan (W-12), Dagat-Dagatan (W-11), Central Manila (W-7), Mandaluyong–San Juan (E-6), Sampaloc (W-9) and Malabon–Tullahan (W-13) sub-basins, which range from 0.28 MT/yr/ha to 1.06 MT/yr/ha. All these sub-basins are located at the North-West region of the Manila Bay watershed.

The variations in the amount of pollution loading from different sub-basins can be attributed to many factors, such as area, population, the number of industry discharging into the river system, treatment facilities and natural purification of the river system. It is also noticeable from the results that total pollution loading is directly proportional to the population density. The pollution loading trend in population density per area of every sub-basins shows an increasing number of pollution loading from South-East going to North-West sub-basins. The observation in the trends in population density per area is the same with all the pollution loading per area results as shown in **Figures 9 to 20**.

Figure 6. BOD Loading of 58 Sub-basins (232,764 MT/yr) for 2008.

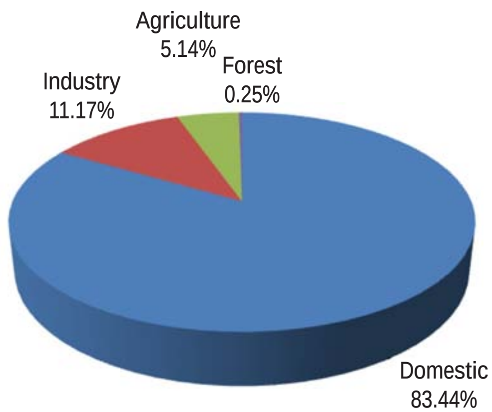


Figure 7. Total Phosphorus Loading of 58 Sub-basins (17,619 MT/yr) for 2008.

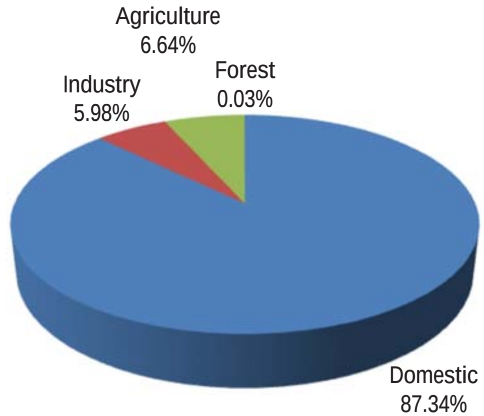


Figure 8. Total Nitrogen Loading of 58 Sub-basins (79,621 MT/yr) for 2008.

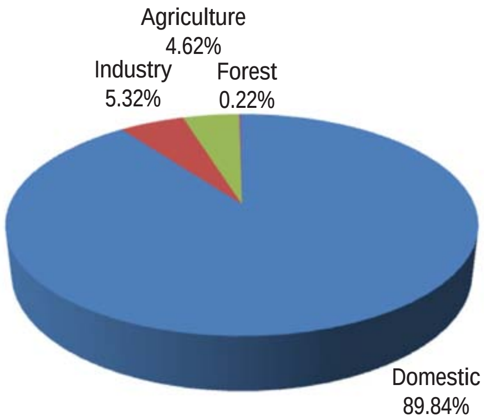


Table 4. Total BOD Loading for 2008, 2010, 2015 and 2020.

SB Name	BOD (MT/Year)			
	2008	2010	2015	2020
CW-1	2,766	2,896	3,268	3,719
CW-2	9,813	10,541	12,682	15,374
E-1	4,125	4,394	5,162	6,088
E-2	5,647	5,975	6,901	7,999
E-3	3,297	3,487	4,023	4,661
E-4	1,315	1,389	1,596	1,840
E-5	6,941	7,319	8,377	9,467
E-6	3,830	3,895	4,064	4,245
E-7	4,457	4,707	5,411	6,242
E-8	6,056	6,300	6,970	7,591
E-9	6,971	7,244	7,997	8,720
EW-1	2,713	2,859	3,265	3,593
EW-2	6,013	6,349	7,279	8,210
EW-3	4,828	5,066	5,726	6,343
LMWS	7	7	7	7
UM-5	700	749	891	921
SR-1	5,285	5,658	6,716	7,981
UM-1	473	561	867	1,349
UM-2	1,360	1,464	1,769	2,157
UM-3	970	1,051	1,289	1,583
UM-4	1,058	1,131	1,342	1,601
W-1	6,361	6,645	7,421	8,298
W-11	3,968	4,109	4,489	4,913
W-12	8,446	8,815	9,820	10,808
W-13	5,488	5,684	6,215	6,667
W-14	5,512	5,781	6,523	7,233
W-15	3,806	3,973	4,434	4,824
W-16	6,079	6,228	6,620	7,043
W-17	3,687	3,824	4,200	4,480
W-18	4,571	4,754	5,261	5,698
W-19	1,999	2,107	2,406	2,751
W-2	6,583	6,782	7,313	7,893
W-3	6,387	6,690	7,527	8,487
W-4	3,578	3,718	4,098	4,529
W-5	2,596	2,691	2,948	3,236
W-7	18,270	18,505	18,421	19,619
W-9	2,749	2,824	3,030	3,119
LdB-1	7,575	7,650	7,846	8,050
LdB-3	5,682	5,721	5,821	5,922
LdB-4	2,460	2,478	2,524	2,571
LdB-5	540	558	610	672
LdB-6	976	1,002	1,087	1,152
LdB-7	679	703	773	854
LdB-8	1,061	1,098	1,201	1,322
LdB-9	1,424	1,454	1,534	1,626
LdB-10	944	972	1,047	1,133
LdB-11	851	872	926	985
LdB-12	813	823	851	879
LdB-13	2,623	2,672	2,802	2,943
LdB-14	2,802	2,874	3,065	3,277
LdB-15	1,653	1,696	1,809	1,934
LdB-16	4,146	4,293	4,689	5,131
LdB-17	2,722	2,842	3,174	3,559
LdB-18	5,405	5,698	6,534	7,542
LdB-19	5,953	6,402	7,547	9,390
LdB-20	7,692	8,391	10,588	13,652
LdB-21	5,810	6,155	7,135	8,316
LdB-22	2,249	2,253	2,291	2,329
Total	232,764	242,781	270,182	302,531

Table 5. BOD Loading per area for 2008, 2010, 2015 and 2020.

SB Name	BOD Ha08	BOD Ha10	BOD Ha15	BOD Ha20
CW-1	1.66	1.73	1.96	2.23
CW-2	0.89	0.96	1.15	1.40
E-1	2.23	2.37	2.79	3.29
E-2	2.68	2.84	3.28	3.80
E-3	2.36	2.49	2.88	3.33
E-4	2.71	2.86	3.29	3.79
E-5	2.03	2.14	2.45	2.77
E-6	4.00	4.07	4.25	4.44
E-7	1.55	1.64	1.89	2.17
E-8	2.40	2.50	2.76	3.01
E-9	1.25	1.30	1.44	1.57
EW-1	2.19	2.31	2.63	2.90
EW-2	2.01	2.13	2.44	2.75
EW-3	2.07	2.17	2.46	2.72
LMWS	0.00	0.00	0.00	0.00
UM-5	0.77	0.82	0.98	1.01
SR-1	0.71	0.76	0.91	1.08
UM-1	0.09	0.11	0.17	0.27
UM-2	0.44	0.47	0.57	0.70
UM-3	0.36	0.39	0.48	0.58
UM-4	0.27	0.29	0.34	0.41
W-1	1.39	1.46	1.63	1.82
W-11	8.25	8.55	9.34	10.22
W-12	10.65	11.12	12.38	13.63
W-13	4.04	4.18	4.58	4.91
W-14	2.51	2.63	2.97	3.29
W-15	2.91	3.04	3.39	3.69
W-16	2.27	2.32	2.47	2.62
W-17	1.38	1.44	1.58	1.68
W-18	1.06	1.10	1.22	1.32
W-19	1.87	1.97	2.25	2.57
W-2	1.97	2.03	2.19	2.36
W-3	1.81	1.90	2.14	2.41
W-4	2.69	2.80	3.08	3.41
W-5	2.98	3.09	3.38	3.71
W-7	5.89	5.96	6.02	6.32
W-9	4.22	4.34	4.66	4.79
LdB-1	0.23	0.23	0.24	0.24
LdB-3	1.46	1.47	1.49	1.52
LdB-4	0.27	0.27	0.28	0.28
LdB-5	0.24	0.25	0.27	0.30
LdB-6	0.18	0.19	0.20	0.21
LdB-7	0.16	0.17	0.19	0.21
LdB-8	0.15	0.15	0.16	0.18
LdB-9	0.07	0.07	0.07	0.08
LdB-10	0.10	0.10	0.11	0.12
LdB-11	0.15	0.16	0.17	0.18
LdB-12	0.06	0.06	0.06	0.07
LdB-13	0.08	0.08	0.09	0.09
LdB-14	0.19	0.19	0.21	0.22
LdB-15	0.18	0.19	0.20	0.21
LdB-16	0.25	0.26	0.29	0.31
LdB-17	0.26	0.28	0.31	0.35
LdB-18	0.26	0.28	0.32	0.37
LdB-19	0.42	0.46	0.54	0.67
LdB-20	0.64	0.70	0.88	1.13
LdB-21	0.68	0.72	0.83	0.97
LdB-22	0.60	0.60	0.61	0.62

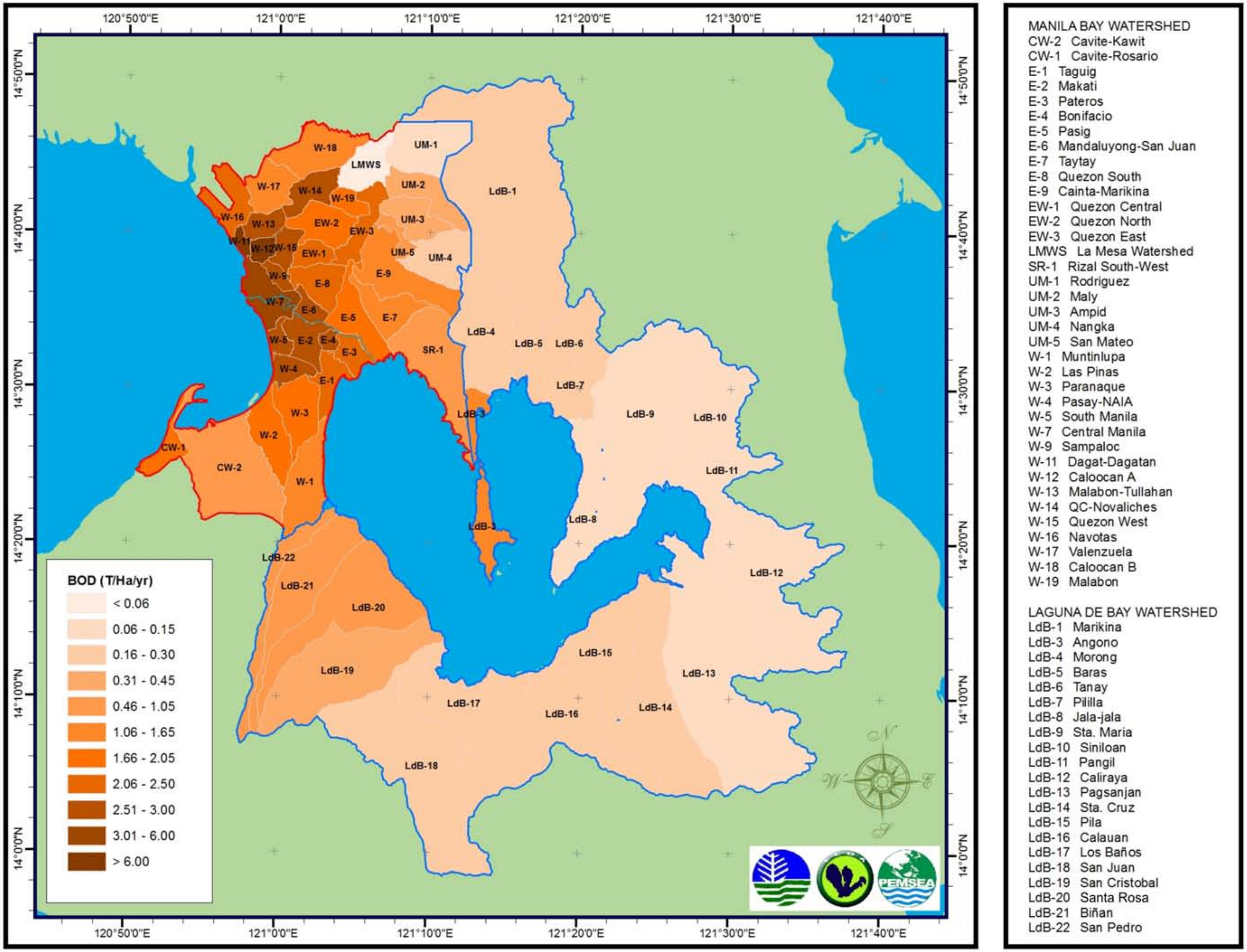


Figure 9. Map of BOD Loading per Area in 58 Sub-basins for 2008.

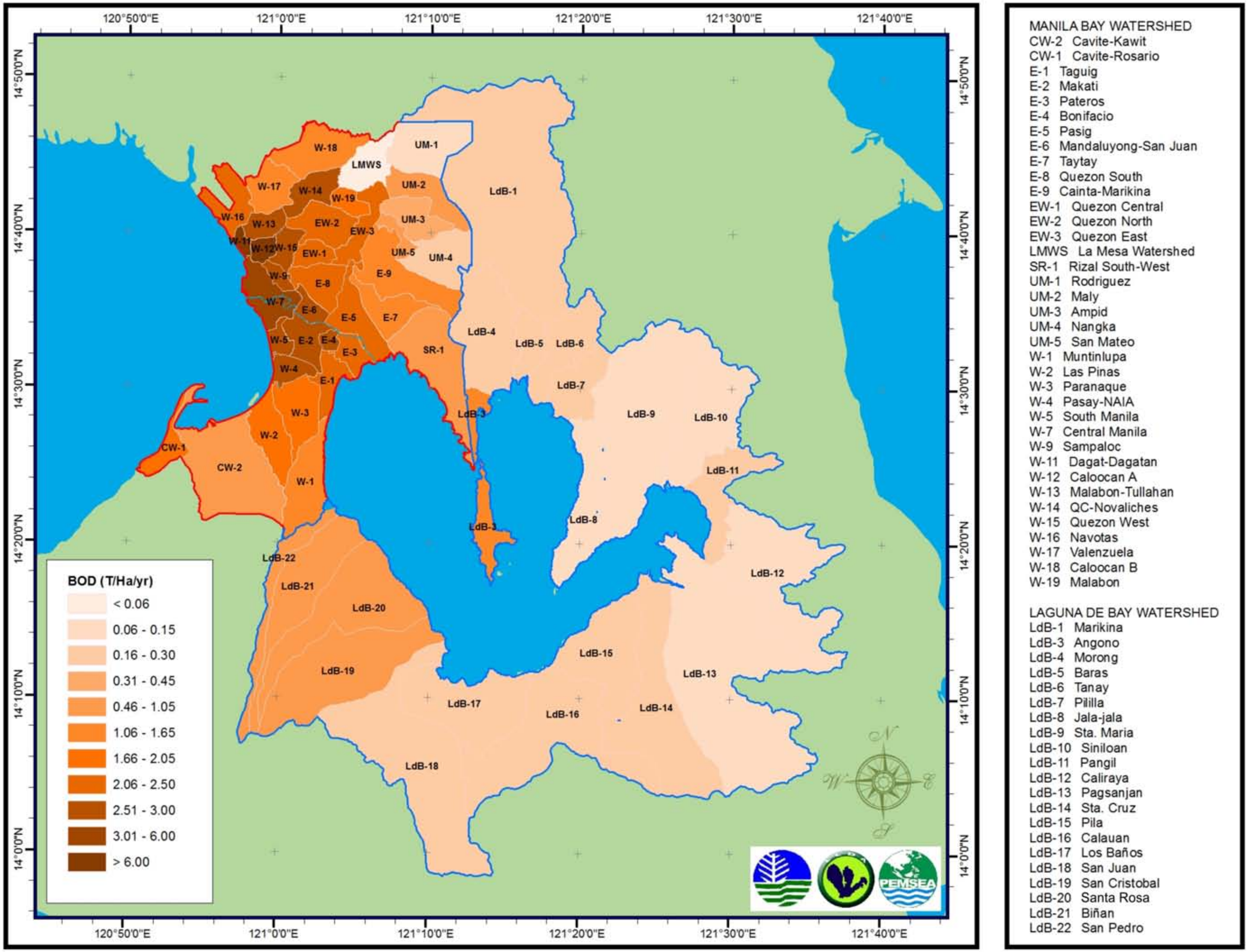


Figure 10. Map of BOD Loading per Area in 58 Sub-basins for 2010.

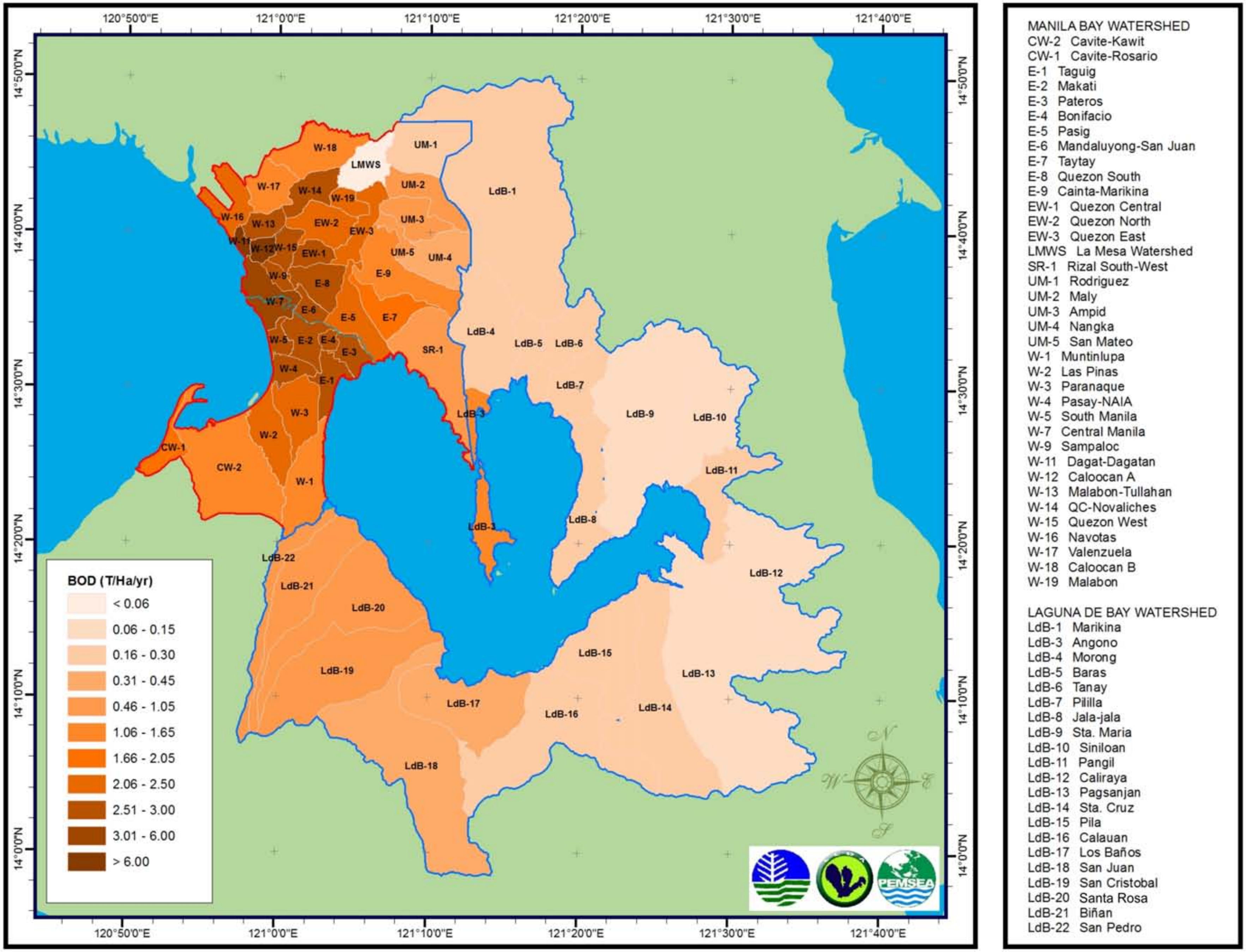


Figure 11. Map of BOD Loading per Area in 58 Sub-basins for 2015.

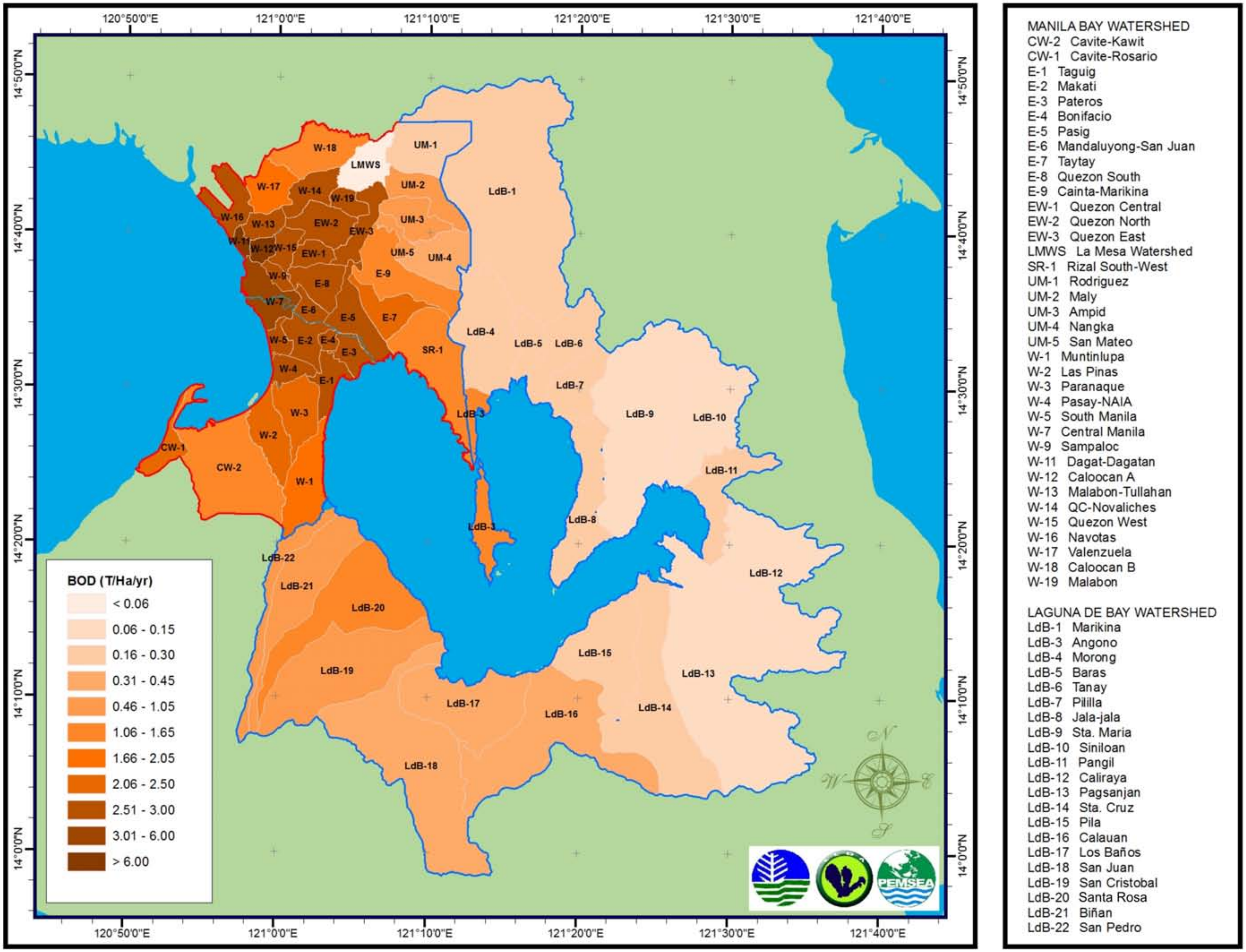


Figure 12. Map of BOD Loading per Area in 58 Sub-basins for 2020.

Table 6. Total Phosphorous Loading for 2008, 2010, 2015 and 2020.

SB Name	Total P (MT/year)			
	2008	2010	2015	2020
CW-1	187	197	227	262
CW-2	715	772	941	1154
E-1	348	369	430	503
E-2	377	403	476	563
E-3	254	269	311	362
E-4	93	99	115	135
E-5	531	561	644	731
E-6	266	272	285	299
E-7	309	329	385	451
E-8	435	454	507	556
E-9	526	548	607	664
EW-1	207	219	251	277
EW-2	471	498	571	645
EW-3	368	387	439	488
LMWS	1	1	1	1
UM-5	55	58	70	72
SR-1	405	435	518	618
UM-1	36	43	68	106
UM-2	104	113	137	167
UM-3	74	81	99	123
UM-4	73	79	95	116
W-1	487	510	571	641
W-11	310	321	351	384
W-12	657	686	766	844
W-13	418	434	476	512
W-14	416	437	496	552
W-15	284	298	334	365
W-16	468	479	510	544
W-17	271	282	311	344

SB Name	Total P (MT/year)			
	2008	2010	2015	2020
W-18	325	340	380	414
W-19	153	162	185	213
W-2	478	494	536	582
W-3	483	507	573	649
W-4	270	281	311	345
W-5	200	208	228	251
W-7	1359	1377	1371	1465
W-9	207	213	229	236
LdB-1	662	668	684	700
LdB-3	457	460	468	476
LdB-4	204	206	209	213
LdB-5	36	37	41	46
LdB-6	61	63	70	75
LdB-7	52	54	59	66
LdB-8	88	91	99	109
LdB-9	104	106	113	120
LdB-10	60	62	68	75
LdB-11	64	65	69	74
LdB-12	56	57	59	61
LdB-13	185	189	199	210
LdB-14	193	199	214	231
LdB-15	181	186	200	215
LdB-16	321	333	364	398
LdB-17	204	213	240	270
LdB-18	438	461	526	606
LdB-19	448	483	573	718
LdB-20	583	638	811	1051
LdB-21	430	457	534	627
LdB-22	170	170	173	176
Total	17619	18,411	20,580	23,138

Table 7. Total Phosphorous Loading per Area for 2008, 2010, 2015 and 2020.

SB Name	TP Ha08	TP Ha10	TPHa15	TP Ha20
CW-1	0.11	0.12	0.14	0.16
CW-2	0.06	0.07	0.09	0.10
E-1	0.19	0.20	0.23	0.27
E-2	0.18	0.19	0.23	0.27
E-3	0.18	0.19	0.22	0.26
E-4	0.19	0.20	0.24	0.28
E-5	0.16	0.16	0.19	0.21
E-6	0.28	0.28	0.30	0.31
E-7	0.11	0.11	0.13	0.16
E-8	0.17	0.18	0.20	0.22
E-9	0.09	0.10	0.11	0.12
EW-1	0.17	0.18	0.20	0.22
EW-2	0.16	0.17	0.19	0.22
EW-3	0.16	0.17	0.19	0.21
LMWS	0.00	0.00	0.00	0.00
UM-5	0.06	0.06	0.08	0.08
SR-1	0.05	0.06	0.07	0.08
UM-1	0.01	0.01	0.01	0.02
UM-2	0.03	0.04	0.04	0.05
UM-3	0.03	0.03	0.04	0.05
UM-4	0.02	0.02	0.02	0.03
W-1	0.11	0.11	0.13	0.14
W-11	0.64	0.67	0.73	0.80
W-12	0.83	0.87	0.97	1.06
W-13	0.31	0.32	0.35	0.38
W-14	0.19	0.20	0.23	0.25
W-15	0.22	0.23	0.26	0.28
W-16	0.17	0.18	0.19	0.20
W-17	0.10	0.11	0.12	0.13
W-18	0.08	0.08	0.09	0.10

SB Name	TP Ha08	TP Ha10	TP Ha15	TP Ha20
W-19	0.14	0.15	0.17	0.20
W-2	0.14	0.15	0.16	0.17
W-3	0.14	0.14	0.16	0.18
W-4	0.20	0.21	0.23	0.26
W-5	0.23	0.24	0.26	0.29
W-7	0.44	0.44	0.44	0.47
W-9	0.32	0.33	0.35	0.36
LdB-1	0.02	0.02	0.02	0.02
LdB-3	0.12	0.12	0.12	0.12
LdB-4	0.02	0.02	0.02	0.02
LdB-5	0.02	0.02	0.02	0.02
LdB-6	0.01	0.01	0.01	0.01
LdB-7	0.01	0.01	0.01	0.02
LdB-8	0.01	0.01	0.01	0.01
LdB-9	0.01	0.01	0.01	0.01
LdB-10	0.01	0.01	0.01	0.01
LdB-11	0.01	0.01	0.01	0.01
LdB-12	0.00	0.00	0.00	0.00
LdB-13	0.01	0.01	0.01	0.01
LdB-14	0.01	0.01	0.01	0.02
LdB-15	0.02	0.02	0.02	0.02
LdB-16	0.02	0.02	0.02	0.02
LdB-17	0.02	0.02	0.02	0.03
LdB-18	0.02	0.02	0.03	0.03
LdB-19	0.03	0.03	0.04	0.05
LdB-20	0.05	0.05	0.07	0.09
LdB-21	0.05	0.05	0.06	0.07
LdB-22	0.05	0.05	0.05	0.05

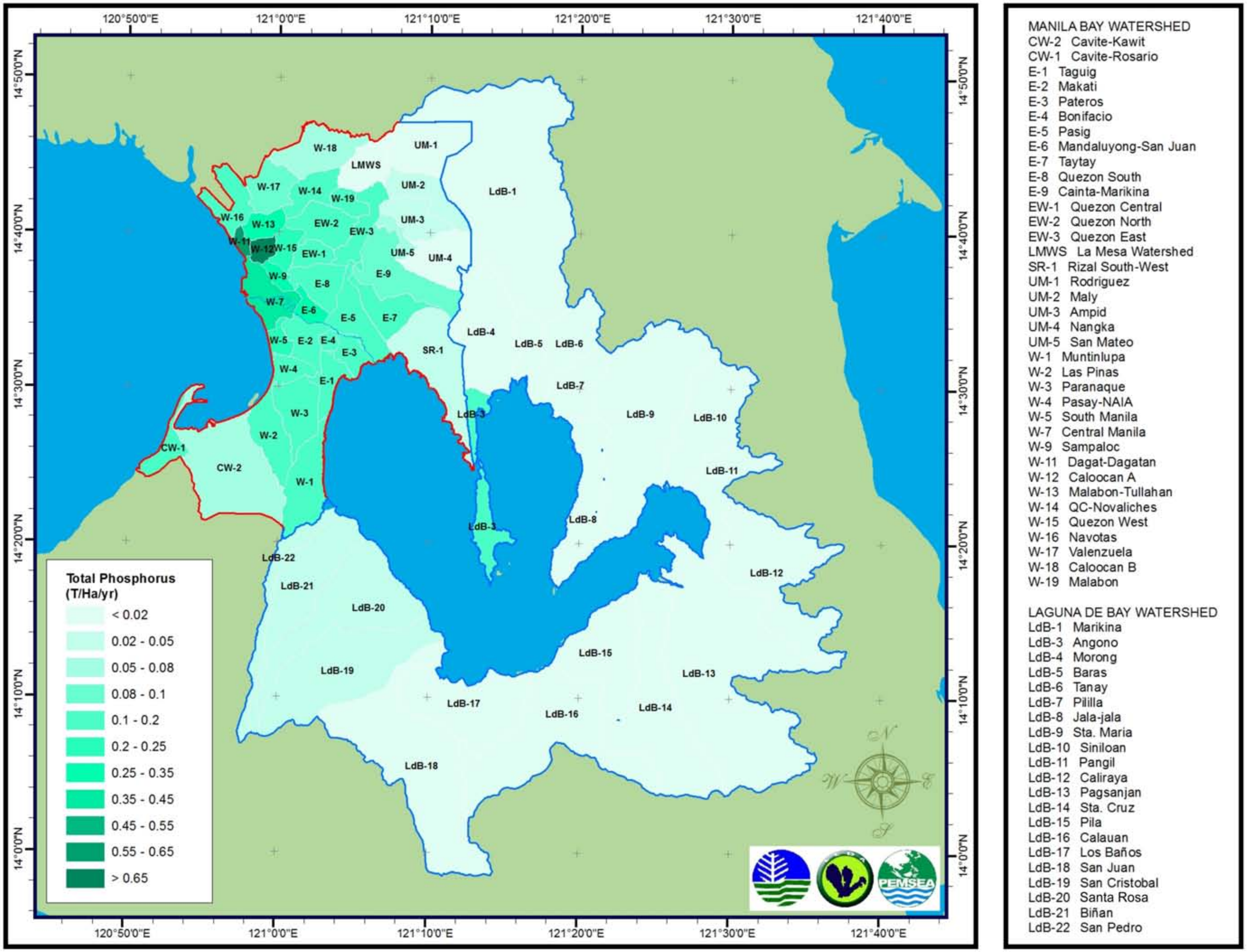


Figure 13. Map of Total Phosphorus Loading per Area in 58 Sub-basins for 2008.

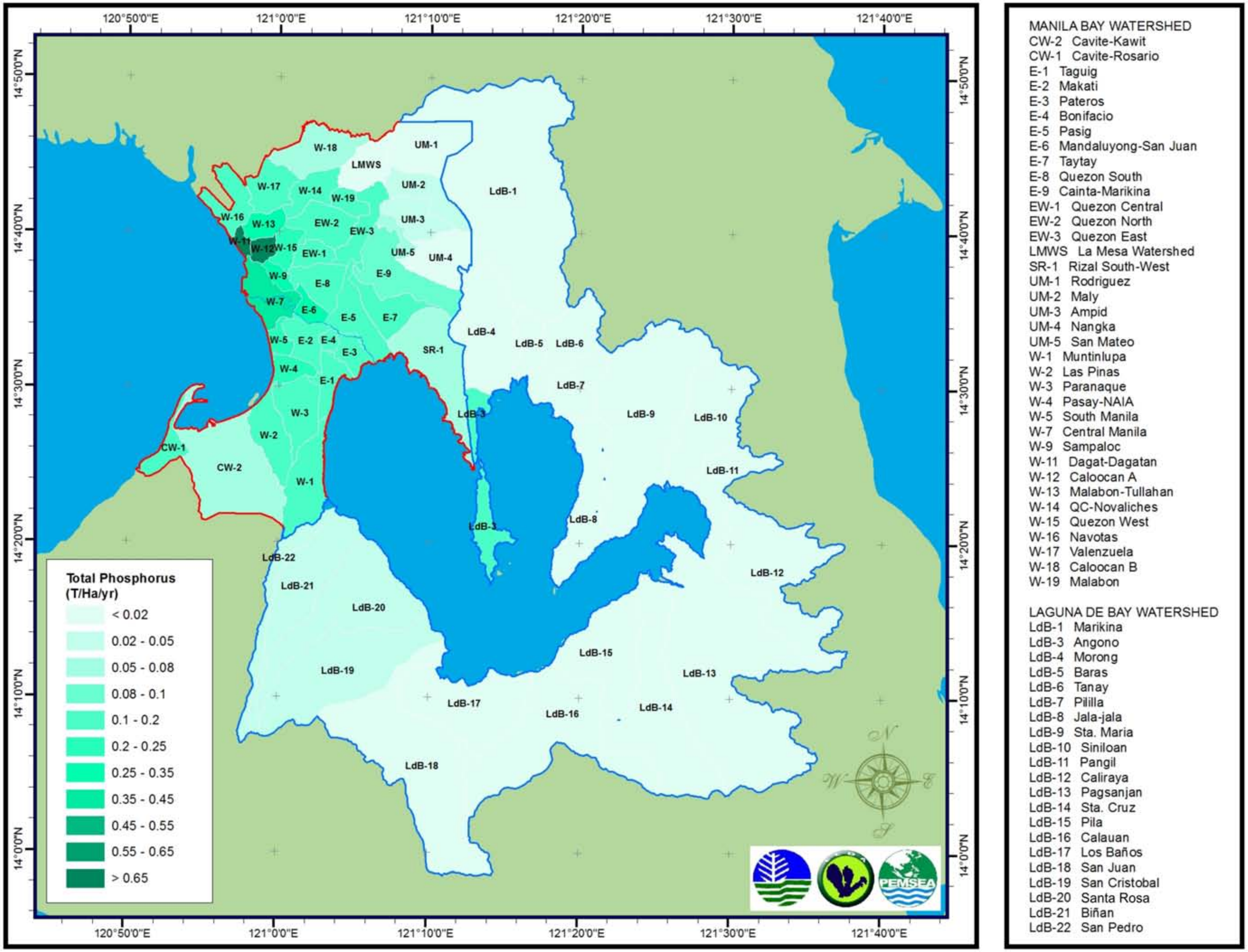


Figure 14. Map of Total Phosphorus Loading per Area in 58 Sub-basins for 2010.

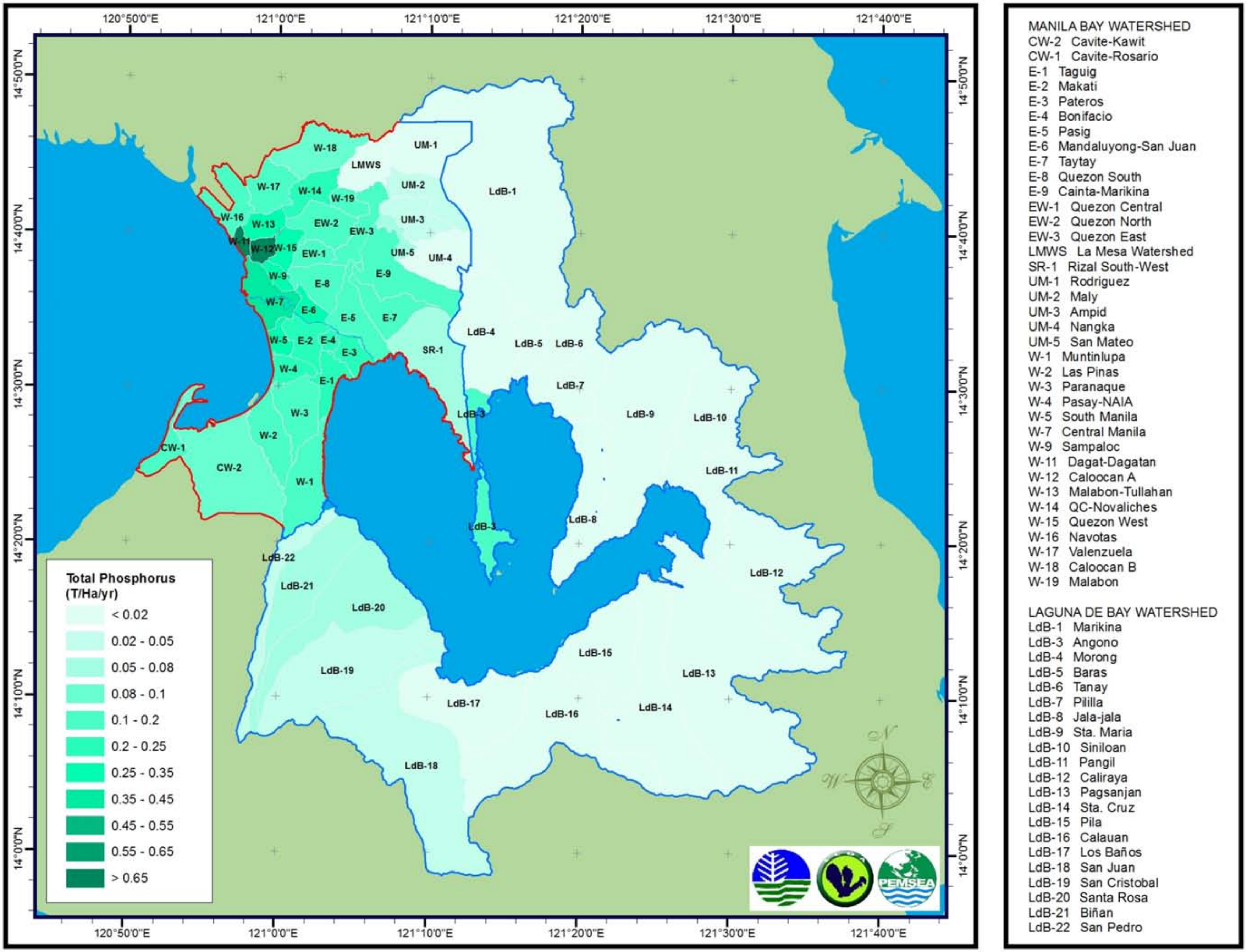


Figure 15. Map of Total Phosphorus Loading per Area in 58 Sub-basins for 2015.

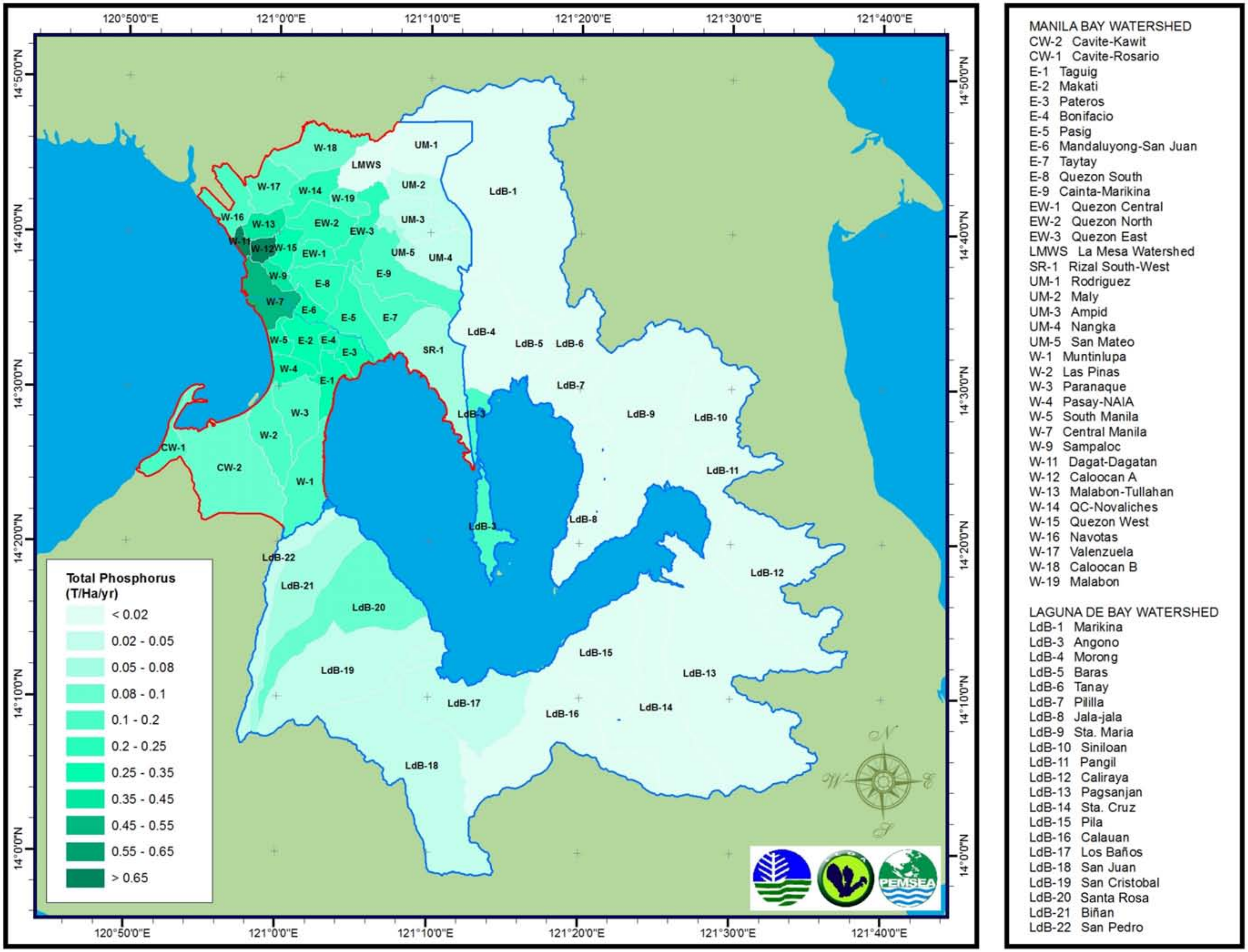


Figure 16. Map of Total Phosphorus Loading per Area in 58 Sub-basins for 2020.

Table 8. Total Nitrogen Loading for 2008, 2010, 2015 and 2020.

SB Name	Total Nitrogen (MT/year)			
	2008	2010	2015	2020
CW-1	953	1001	1138	1305
CW-2	3,416	3684	4469	5456
E-1	1,447	1546	1828	2167
E-2	1,707	1826	2161	2559
E-3	1,092	1160	1353	1582
E-4	427	454	529	618
E-5	2,385	2523	2909	3307
E-6	1,122	1146	1207	1273
E-7	1,410	1502	1760	2065
E-8	1,979	2068	2311	2538
E-9	2,393	2493	2769	3033
EW-1	927	980	1126	1244
EW-2	2,158	2279	2614	2949
EW-3	1,671	1758	2000	2225
LMWS	2	2	2	2
UM-5	253	271	323	334
SR-1	1,920	2058	2448	2914
UM-1	168	200	310	484
UM-2	477	515	626	768
UM-3	344	374	461	568
UM-4	375	402	480	575
W-1	2,180	2284	2568	2890
W-11	1,365	1418	1562	1723
W-12	2,948	3081	3442	3797
W-13	1,855	1925	2116	2279
W-14	1,841	1938	2206	2462
W-15	1,227	1287	1454	1595
W-16	2,168	2223	2366	2521
W-17	1,177	1226	1362	1463
W-18	1,399	1465	1648	1807
W-19	681	720	827	951
W-2	2,127	2199	2392	2604
W-3	2,106	2217	2521	2871
W-4	1,190	1241	1380	1536
W-5	907	941	1034	1138
W-7	5,964	6050	6019	6453
W-9	936	963	1037	1070
LdB-1	2,650	2678	2750	2826
LdB-3	2,138	2153	2191	2231
LdB-4	868	875	893	911
LdB-5	168	176	196	220
LdB-6	322	332	365	390
LdB-7	234	243	270	302
LdB-8	371	385	425	471
LdB-9	473	485	517	552
LdB-10	309	320	349	383
LdB-11	312	320	341	364
LdB-12	275	279	290	301
LdB-13	892	912	963	1018
LdB-14	975	1003	1078	1161
LdB-15	567	582	624	671
LdB-16	1,543	1600	1756	1929
LdB-17	973	1020	1150	1301
LdB-18	2,094	2208	2536	2931
LdB-19	2,157	2333	2782	3503
LdB-20	2,841	3114	3975	5175
LdB-21	2,210	2345	2729	3192
LdB-22	551	785	799	814
Total	79,621	83,568	93,738	105,770

Table 9. Total Nitrogen Loading per Area for 2008, 2010, 2015 and 2020.

SB Name	TN Ha08	TN Ha10	TN Ha15	TN Ha20
CW-1	0.57	0.60	0.68	0.78
CW-2	0.31	0.33	0.41	0.50
E-1	0.78	0.83	0.99	1.17
E-2	0.81	0.87	1.03	1.22
E-3	0.78	0.83	0.97	1.13
E-4	0.88	0.94	1.09	1.27
E-5	0.70	0.74	0.85	0.97
E-6	1.17	1.20	1.26	1.33
E-7	0.49	0.52	0.61	0.72
E-8	0.78	0.82	0.92	1.01
E-9	0.43	0.45	0.50	0.55
EW-1	0.75	0.79	0.91	1.00
EW-2	0.72	0.76	0.88	0.99
EW-3	0.72	0.75	0.86	0.95
LMWS	0.00	0.00	0.00	0.00
UM-5	0.28	0.30	0.35	0.37
SR-1	0.26	0.28	0.33	0.39
UM-1	0.03	0.04	0.06	0.10
UM-2	0.15	0.17	0.20	0.25
UM-3	0.13	0.14	0.17	0.21
UM-4	0.10	0.10	0.12	0.15
W-1	0.48	0.50	0.56	0.63
W-11	2.84	2.95	3.25	3.58
W-12	3.72	3.89	4.34	4.79
W-13	1.37	1.42	1.56	1.68
W-14	0.84	0.88	1.00	1.12
W-15	0.94	0.98	1.11	1.22
W-16	0.81	0.83	0.88	0.94
W-17	0.44	0.46	0.51	0.55
W-18	0.32	0.34	0.38	0.42
W-19	0.64	0.67	0.77	0.89
W-2	0.64	0.66	0.72	0.78
W-3	0.60	0.63	0.72	0.82
W-4	0.90	0.93	1.04	1.16
W-5	1.04	1.08	1.19	1.31
W-7	1.92	1.95	2.01	2.08
W-9	1.44	1.48	1.59	1.64
LdB-1	0.08	0.08	0.08	0.09
LdB-3	0.55	0.55	0.56	0.57
LdB-4	0.10	0.10	0.10	0.10
LdB-5	0.07	0.08	0.09	0.10
LdB-6	0.06	0.06	0.07	0.07
LdB-7	0.06	0.06	0.07	0.07
LdB-8	0.05	0.05	0.06	0.06
LdB-9	0.02	0.02	0.03	0.03
LdB-10	0.03	0.03	0.04	0.04
LdB-11	0.06	0.06	0.06	0.07
LdB-12	0.02	0.02	0.02	0.02
LdB-13	0.03	0.03	0.03	0.03
LdB-14	0.07	0.07	0.07	0.08
LdB-15	0.06	0.06	0.07	0.07
LdB-16	0.09	0.10	0.11	0.12
LdB-17	0.09	0.10	0.11	0.13
LdB-18	0.10	0.11	0.12	0.14
LdB-19	0.15	0.17	0.20	0.25
LdB-20	0.24	0.26	0.33	0.43
LdB-21	0.26	0.27	0.32	0.37
LdB-22	0.15	0.21	0.21	0.22

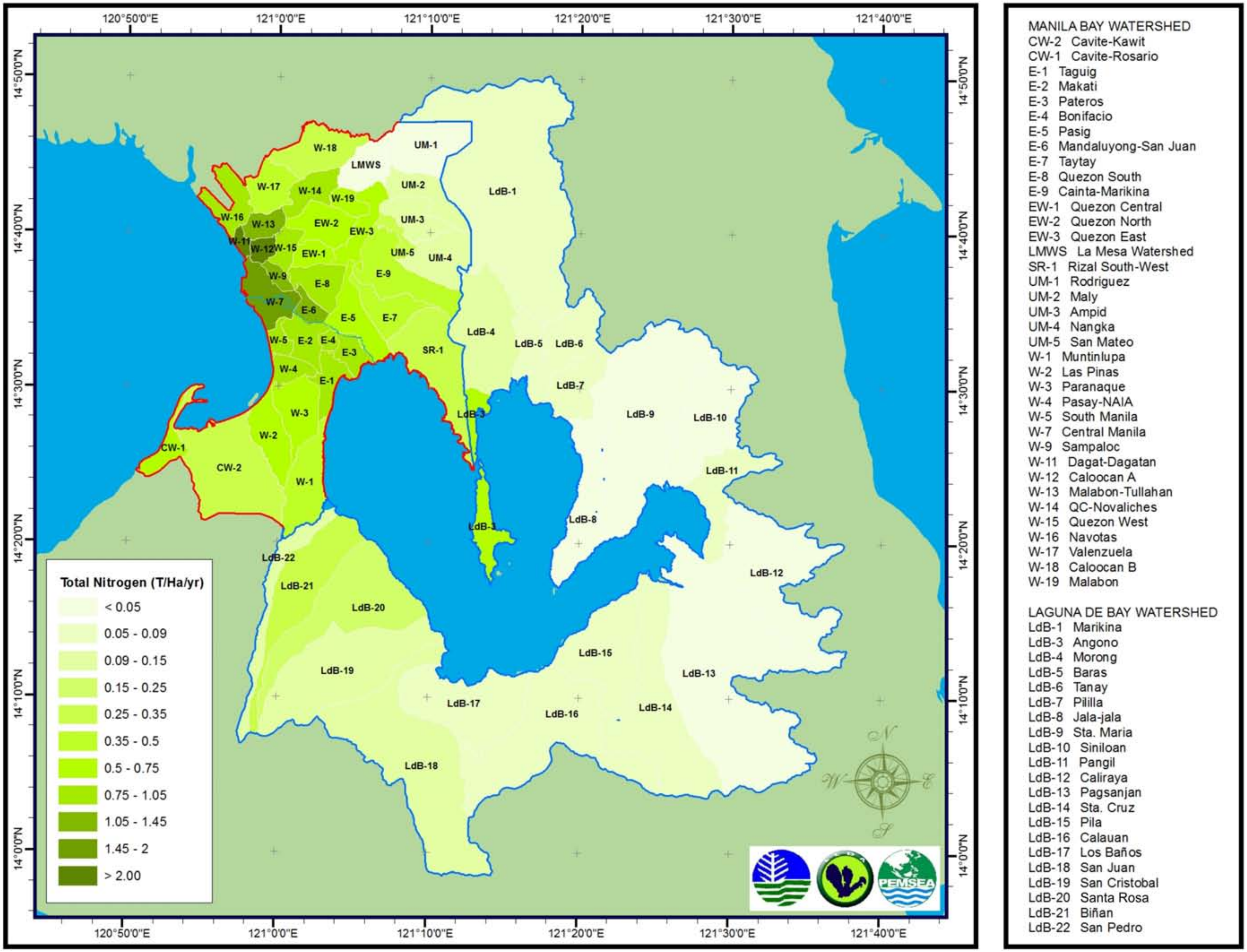
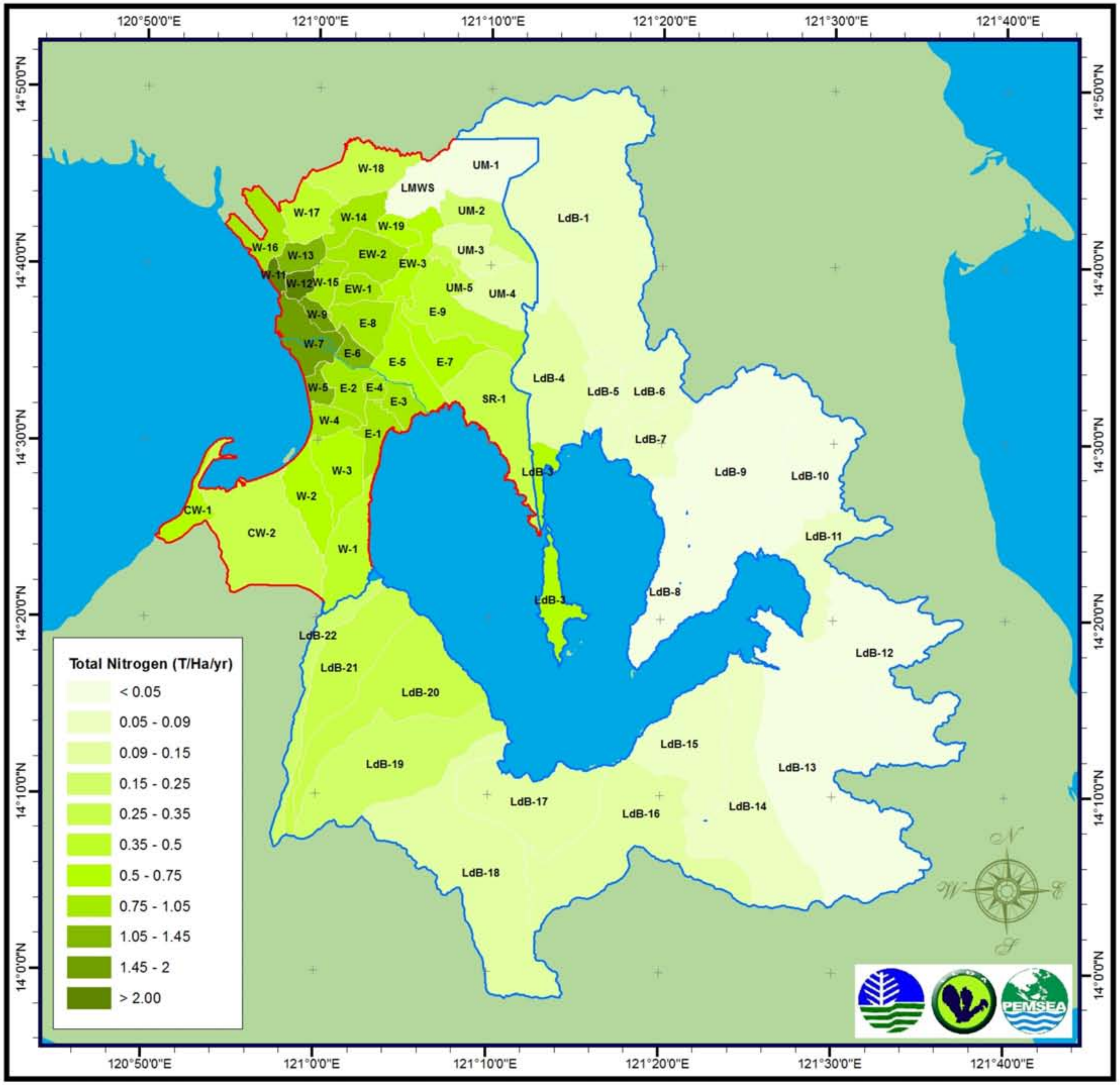


Figure 17. Map of Total Nitrogen Loading per Area in 58 Sub-basins for 2008.



MANILA BAY WATERSHED
CW-2 Cavite-Kawit
CW-1 Cavite-Rosario
E-1 Taguig
E-2 Makati
E-3 Pateros
E-4 Bonifacio
E-5 Pasig
E-6 Mandaluyong-San Juan
E-7 Taytay
E-8 Quezon South
E-9 Cainta-Marikina
EW-1 Quezon Central
EW-2 Quezon North
EW-3 Quezon East
LMWS La Mesa Watershed
SR-1 Rizal South-West
UM-1 Rodriguez
UM-2 Maly
UM-3 Ampid
UM-4 Nangka
UM-5 San Mateo
W-1 Muntinlupa
W-2 Las Pinas
W-3 Paranaque
W-4 Pasay-NAIA
W-5 South Manila
W-7 Central Manila
W-9 Sampaloc
W-11 Dagat-Dagatan
W-12 Caloocan A
W-13 Malabon-Tullahan
W-14 QC-Novaliches
W-15 Quezon West
W-16 Navotas
W-17 Valenzuela
W-18 Caloocan B
W-19 Malabon

LAGUNA DE BAY WATERSHED
LdB-1 Marikina
LdB-3 Angono
LdB-4 Morong
LdB-5 Baras
LdB-6 Tanay
LdB-7 Pililla
LdB-8 Jala-jala
LdB-9 Sta. Maria
LdB-10 Siniloan
LdB-11 Pangil
LdB-12 Caliraya
LdB-13 Pagsanjan
LdB-14 Sta. Cruz
LdB-15 Pila
LdB-16 Calauan
LdB-17 Los Baños
LdB-18 San Juan
LdB-19 San Cristobal
LdB-20 Santa Rosa
LdB-21 Biñan
LdB-22 San Pedro

Figure 18. Map of Total Nitrogen Loading per Area in 58 Sub-basins for 2010.

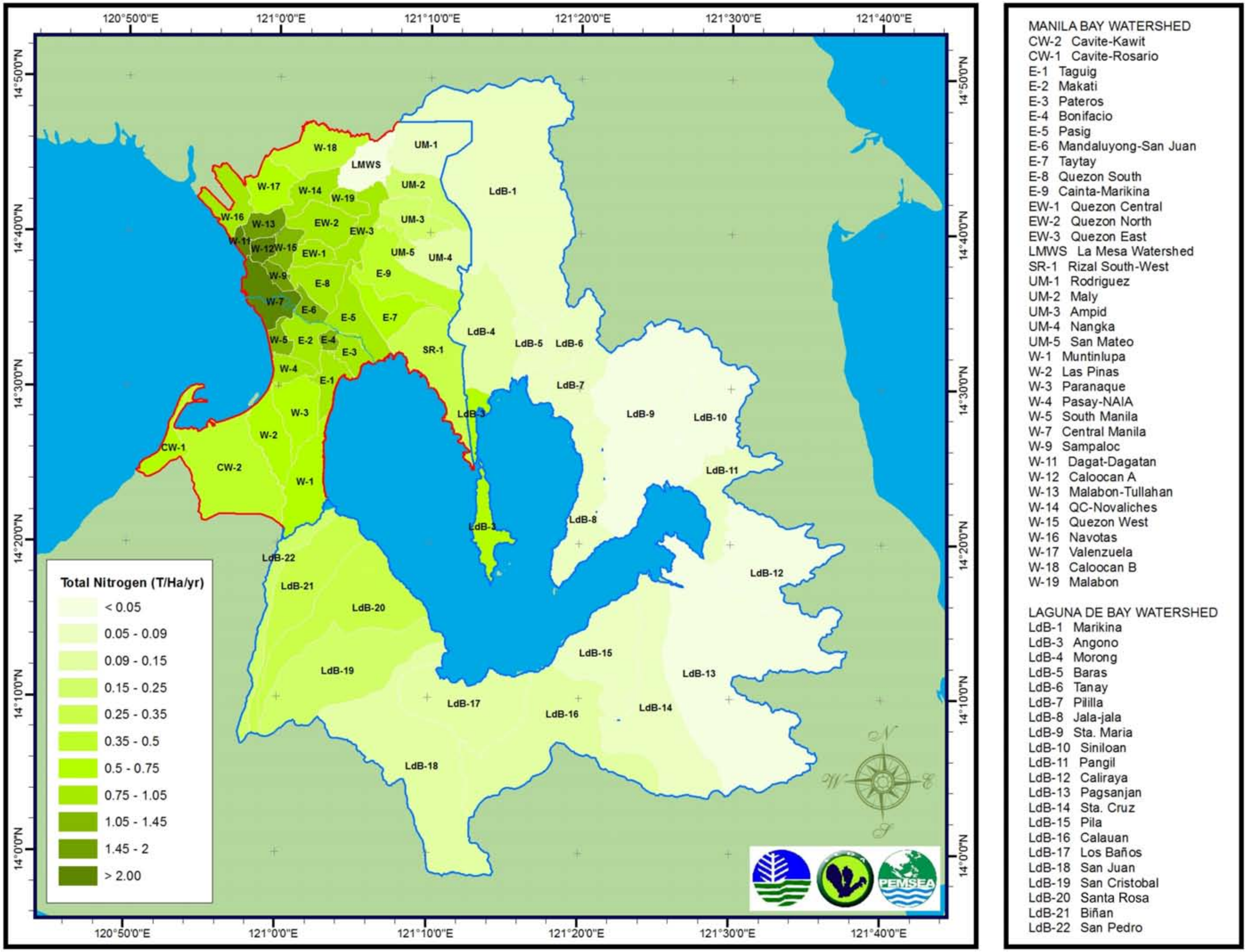
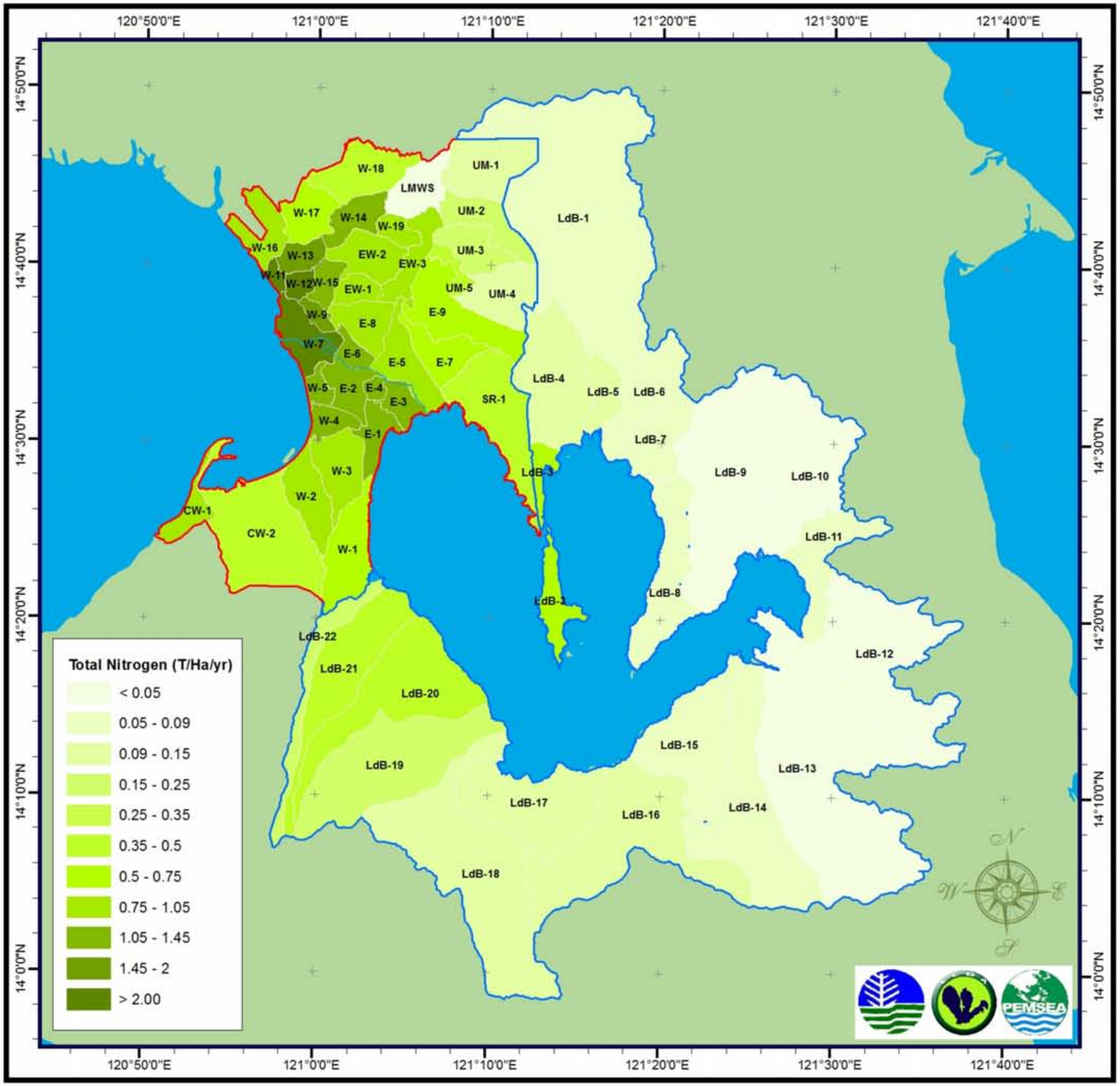


Figure 19. Map of Total Nitrogen Loading per Area in 58 Sub-basins for 2015.



MANILA BAY WATERSHED
CW-2 Cavite-Kawit
CW-1 Cavite-Rosario
E-1 Taguig
E-2 Makati
E-3 Pateros
E-4 Bonifacio
E-5 Pasig
E-6 Mandaluyong-San Juan
E-7 Taytay
E-8 Quezon South
E-9 Cainta-Marikina
EW-1 Quezon Central
EW-2 Quezon North
EW-3 Quezon East
LMWS La Mesa Watershed
SR-1 Rizal South-West
UM-1 Rodriguez
UM-2 Maly
UM-3 Ampid
UM-4 Nangka
UM-5 San Mateo
W-1 Muntinlupa
W-2 Las Pinas
W-3 Paranaque
W-4 Pasay-NAIA
W-5 South Manila
W-7 Central Manila
W-9 Sampaloc
W-11 Dagat-Dagatan
W-12 Caloocan A
W-13 Malabon-Tullahan
W-14 QC-Novaliches
W-15 Quezon West
W-16 Navotas
W-17 Valenzuela
W-18 Caloocan B
W-19 Malabon

LAGUNA DE BAY WATERSHED
LdB-1 Marikina
LdB-3 Angono
LdB-4 Morong
LdB-5 Baras
LdB-6 Tanay
LdB-7 Pililla
LdB-8 Jala-jala
LdB-9 Sta. Maria
LdB-10 Siniloan
LdB-11 Pangil
LdB-12 Caliraya
LdB-13 Pagsanjan
LdB-14 Sta. Cruz
LdB-15 Pila
LdB-16 Calauan
LdB-17 Los Baños
LdB-18 San Juan
LdB-19 San Cristobal
LdB-20 Santa Rosa
LdB-21 Biñan
LdB-22 San Pedro

Figure 20. Map of Total Nitrogen Loading per Area in 58 Sub-basins for 2020.

4

Recommendations

1. Pollution reduction strategies must focus on the domestic sources of pollutants followed by industrial and other sources.

2. The allowable load of every sub-basin must be identified in order to estimate the target reduction load of a particular sub-basin.

3. For reduction setting/determination, sub-basins need to be schematized with a Sewage Treatment Plant (STP) to account for the effects of treatment plants on the waste loads to the Manila Bay.

4. Natural purification of river system should also be considered to clarify the amount of loading coming from Laguna de Bay to Pasig River before it drains into Manila Bay.

5. A standard criteria should be set for the subdivision of major sub-basins into smaller sub-basins.

6. In the absence of data on industrial monitoring of discharge, mere estimate of universe and/or classification of industries operating within the municipality covered by Manila Bay sub-basin must be provided.

7. Latest maps or more recent land use classification and accounting must be developed for more accurate computation of agricultural and other forms of land use loadings.

8. A water quality model for Manila Bay should be set up in support of the results of the waste load model for the development of pollution reduction strategies like the water quality scenarios in relation to the proposed location and capacity of treatment facilities.

5

Next Steps

1. Estimate allocation of allowable pollutant discharge loadings, based on the results;

2. Include existing and planned sewage treatment plants (STPs) in the schematization for routing domestic loads;

3. Run model scenarios to consider various intervention measures (i.e., impacts of STPs, sewerage, best management practices for agriculture and industry sources, etc.);

4. Develop water quality models for Manila Bay and Pasig River; and

5. Develop models for other major rivers (Marilao–Meycauayan–Obando River, Navotas–Malabon–Tullahan,Tenejeros River, Pampanga River) draining into Manila Bay.

6

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Annex A. Area and name of 58 Sub-basins.

Code	MMSB_HAS	Name
CW-1	1670.53	Cavite-Rosario
CW-2	11008.99	Cavite-Kawit
E-1	1851.90	Taguig
E-2	2105.59	Makati
E-3	1397.74	Pateros
E-4	485.36	Bonifacio
E-5	3417.63	Pasig
E-6	956.28	Mandaluyong-San Juan
E-7	2870.46	Taytay
E-8	2523.27	Quezon South
E-9	5558.84	Cainta-Marikina
EW-1	1239.40	Quezon Central
EW-2	2985.00	Quezon North
EW-3	2330.60	Quezon East
LA MESA	2792.97	
UM-5	912.82	San Mateo
SR-1	7401.14	Rizal South-West
UM-1	5036.33	Rodriguez
UM-2	3102.79	Maly
UM-3	2711.26	Ampid
UM-4	3904.05	Nangka
W-1	4564.81	Muntinlupa
W-11	480.84	Dagat-Dagatan
W-12	792.93	Caloocan A
W-13	1358.14	Malabon-Tullahan
W-14	2199.37	QC-Novaliches
W-15	1307.22	Quezon West
W-16	2683.85	Navotas
W-17	2663.03	Valenzuela
W-18	4313.01	Caloocan B

Code	MMSB_HAS	Name
W-19	1069.85	Malabon
W-2	3342.25	Las Pinas
W-3	3522.30	Paranaque
W-4	1328.48	Pasay-NAIA
W-5	871.52	South Manila
W-7	3103.30	Central Manila
W-9	650.75	Sampaloc
Ldb-1	33228.34	Marikina
Ldb-3	3903.46	Angono
Ldb-4	9036.57	Morong
Ldb-5	2270.63	Baras
Ldb-6	5415.06	Tanay
Ldb-7	4118.75	Pililla
Ldb-8	7313.43	Jala jala
Ldb-9	20531.67	Sta. Maria
Ldb-10	9345.05	Siniloan
Ldb-11	5585.66	Pangil
Ldb-12	13521.86	Caliraya
Ldb-13	31899.03	Pagsanjan
Ldb-14	14858.14	Sta. Cruz
Ldb-15	9055.20	Pila
Ldb-16	16331.16	Calauan
Ldb-17	10283.21	Los Baños
Ldb-18	20426.27	San Juan
Ldb-19	14066.00	San Cristobal
Ldb-20	12030.38	Sta. Rosa
Ldb-21	8603.22	Biñan
Ldb-22	3744.09	San Pedro

Annex B. Land Cover Classification Data (ha).

Manila Bay Sub-basins

SB Name	Sb_crop	Sb_builtup	Sb_forest	Sb_grass
CW-1	332.41	862.37		
CW-2	2,756.77	12,116.99		
E-1		0.0041199		
E-2				
E-3				
E-4				
E-5				
E-6		1.48		16.44931
E-7				
E-8				
E-9				
EW-1				
EW-2				
EW-3				
LA MESA	0.08	0.01	0.07	0.052999
NO NAME				
SR-1				
UM-1	0.04	0.01	0.03053837	0.024388
UM-2				
UM-3				
UM-4				

SB Name	Sb_crop	Sb_builtup	Sb_forest	Sb_grass
W-1	0.38	1.88		
W-11				
W-12				
W-13				
W-14	5.28	0.82	4.17	3.333803
W-15				
W-16	0.21	0.03	0.16	0.131152
W-17	148.06	23.07	117.01	93.44115
W-18	1,356.08	211.31	1,071.69	855.8357
W-19				
W-2	1.03	9.07	0.19	
W-3		80.41		
W-4		7.27		
W-5		0.08		
W-7		0.00156		0.000174
W-9				

LLDA Land Cover Classification				
	Forest	Plantation	Grassland	Arable
Angono	169.869	12.69	488	5,898
Baras		5.561	828	1,306
Biñan		1,030.787	580	4,478
Calauan	185.934	7,018.132	3,616	4,272
Caliraya	651.335	4,317.328	5,186	896
Jala-Jala		590.919	1,861	4,559
Los Baños	1,391.601	2,413.106	2,498	3,201
Marikina	7,166.767		12,486	26,684
Morong		292.887	1,225	7,449
Pagsanjan	654.947	16,829.876	9,512	3,267
Pangil	1,517.306	927.923	1,706	822
Pila		2,227.531	2,396	4,166
Pililla		608.266	1,256	2,131
San Cristobal		3,362.572	1,859	7,100
San Juan	362.731	4,721.409	2,576	9,449
San Pedro		613.634	259	2,379
Siniloan	2,309.212	1,067.108	2,730	1,098
Sta. Cruz	844.621	5,623.601	5,661	2,207
Sta. Maria	2,144.173	6,295.552	8,104	3,794
Sta. Rosa		1,426.565	1,431	6,282
Tanay	1,7443.895	859.899	2,403	1,902

Annex C. Summary of Growth Rate per Municipality in 58 Sub-basins from 2000 to 2007.

City/Municipality	GR (%) 00-07	M SBASIN
Cavite City	0.71	CW-1
General Trias	10.24	CW-1
Imus	3.63	CW-1
Kawit	2.75	CW-1
Noveleta	2.89	CW-1
Rosario	3.45	CW-1
Bacoor	5.19	CW-2
Cavite City	0.71	CW-2
City of Las Piñas	1.65	CW-2
General Trias	10.24	CW-2
Imus	3.63	CW-2
Kawit	2.75	CW-2
City of Muntinlupa	2.48	E-1
City of Parañaque	2.88	E-1
Pasay City	1.77	E-1
Taguig City	3.82	E-1
City of Makati	3.41	E-2
City of Mandaluyong	1.29	E-2
City of Manila	0.68	E-2
City of Pasig	3.04	E-2
Pasay City	1.77	E-2
Taguig City	3.82	E-2
City of Makati	3.41	E-3
City of Pasig	3.04	E-3
Pateros	1.05	E-3
Taguig City	3.82	E-3
Taytay	3.95	E-3
City of Makati	3.41	E-4
City of Pasig	3.04	E-4
Pateros	1.05	E-4

City/Municipality	GR (%) 00-07	M SBASIN
Taguig City	3.82	E-4
Cainta	3.19	E-5
City of Makati	3.41	E-5
City of Mandaluyong	1.29	E-5
City of Marikina	1.14	E-5
City of Pasig	3.04	E-5
Quezon City	2.92	E-5
Taguig City	3.82	E-5
Taytay	3.95	E-5
City of Makati	3.41	E-6
City of Mandaluyong	1.29	E-6
City of Manila	0.68	E-6
City of Pasig	3.04	E-6
City of San Juan	0.87	E-6
Cainta	3.19	E-7
City of Antipolo	4.18	E-7
City of Pasig	3.04	E-7
Taytay	3.95	E-7
City of Mandaluyong	1.29	E-8
City of Marikina	1.14	E-8
City of Pasig	3.04	E-8
City of San Juan	0.87	E-8
Quezon City	2.92	E-8
Cainta	3.19	E-9
City of Antipolo	4.18	E-9
City of Marikina	1.14	E-9
City of Pasig	3.04	E-9
Quezon City	2.92	E-9
San Mateo	4.36	E-9

City/Municipality	GR (%) 00-07	M SBASIN
City of San Jose Del Monte	1.17	UM-1
Quezon City	2.92	UM-1
Rodriguez (Montalban)	9.58	UM-1
City of Antipolo	4.18	UM-2
Quezon City	2.92	UM-2
Rodriguez (Montalban)	9.58	UM-2
San Mateo	4.36	UM-2
City of Antipolo	4.18	UM-3
Quezon City	2.92	UM-3
San Mateo	4.36	UM-3
City of Antipolo	4.18	UM-4
San Mateo	4.36	UM-4
Bacoor	5.19	W-1
City of Las Piñas	1.65	W-1
City of Muntinlupa	2.48	W-1
City of Parañaque	2.88	W-1
San Pedro	2.75	W-1
Taguig City	3.82	W-1
Caloocan City	2.33	W-11
City of Malabon	0.98	W-11
City of Navotas	0.87	W-11
Caloocan City	2.33	W-12
City of Manila	0.68	W-12
Quezon City	2.92	W-12
Caloocan City	2.33	W-13
City of Malabon	0.98	W-13
City of Valenzuela	2.21	W-13
Quezon City	2.92	W-13
Caloocan City	2.33	W-14
City of Meycauayan	2.61	W-14
City of Valenzuela	2.21	W-14
Quezon City	2.92	W-14
Caloocan City	2.33	W-15
City of Manila	0.68	W-15
Quezon City	2.92	W-15
City of Malabon	0.98	W-16
City of Meycauayan	2.61	W-16
City of Navotas	0.87	W-16
City of Valenzuela	2.21	W-16
Obando	0.85	W-16
City of Meycauayan	2.61	W-17
City of Meycauayan	2.61	W-17
City of Valenzuela	2.21	W-17
Quezon City	2.92	W-17
City of Meycauayan	2.61	W-18
City of Meycauayan	2.61	W-18
City of San Jose Del Monte	1.17	W-18
City of Valenzuela	2.21	W-18
Quezon City	2.92	W-18
Quezon City	2.92	W-19
Bacoor	5.19	W-2
City of Las Piñas	1.65	W-2
City of Muntinlupa	2.48	W-2
City of Parañaque	2.88	W-2

City/Municipality	GR (%) 00-07	M SBASIN
Quezon City	2.92	EW-1
Caloocan City	2.33	EW-2
Quezon City	2.92	EW-2
City of Marikina	1.14	EW-3
Quezon City	2.92	EW-3
San Mateo	4.36	EW-3
City of Meycauayan	2.61	LA MESA
City of San Jose Del Monte	1.17	LA MESA
Quezon City	2.92	LA MESA
Rodriguez (Montalban)	9.58	LA MESA
City of Antipolo	4.18	NO NAME
City of Marikina	1.14	NO NAME
Quezon City	2.92	NO NAME
San Mateo	4.36	NO NAME
Angono	3.7	SR-1
Binangonan	3.38	SR-1
Cardona	1.97	SR-1
City of Antipolo	4.18	SR-1
Morong	2.42	SR-1
Taytay	3.95	SR-1
Teresa	5.69	SR-1

City/Municipality	GR (%) 00-07	M SBASIN
City of Las Piñas	1.65	W-3
City of Muntinlupa	2.48	W-3
City of Parañaque	2.88	W-3
Pasay City	1.77	W-3
Taguig City	3.82	W-3
City of Makati	3.41	W-4
City of Parañaque	2.88	W-4
Pasay City	1.77	W-4
Taguig City	3.82	W-4
City of Makati	3.41	W-5
City of Manila	0.68	W-5
City of Parañaque	2.88	W-5
Pasay City	1.77	W-5
Caloocan City	2.33	W-7
City of Makati	3.41	W-7
City of Mandaluyong	1.29	W-7
City of Manila	0.68	W-7
City of San Juan	0.87	W-7
Quezon City	2.92	W-7
City of Manila	0.68	W-9
Quezon City	2.92	W-9

Annex D. Summary of Inhabitants in 58 Sub-basins With and Without Sanitary Toilets (2008).

SBASIN	Total 2008	w/ Septic	w/o Septic
CW-1	213,842	189,892	23,950
CW-2	817,373	750,349	67,025
E-1	335,425	307,473	27,952
E-2	452,297	433,075	19,223
E-3	282,948	277,289	5,659
E-4	114,078	108,755	5,324
E-5	607,616	566,819	40,797
E-6	254,354	241,127	13,226
E-7	361,207	332,311	28,897
E-8	515,269	484,353	30,916
E-9	613,330	564,264	49,066
EW-1	241,323	236,496	4,826
EW-2	560,237	546,231	14,006
EW-3	428,483	397,061	31,422
LA MESA WATERSHED	959	921	38
NO NAME	66,426	61,112	5,314
SR-1	491,304	442,174	49,130
UM-1	44,153	42,682	1,472
UM-2	123,569	115,537	8,032

SBASIN	Total 2008	w/ Septic	w/o Septic
UM-3	89,275	82,728	6,547
UM-4	82,792	74,513	8,279
W-1	549,010	505,089	43,921
W-11	318,070	257,636	60,433
W-12	783,092	767,430	15,662
W-13	481,409	471,781	9,628
W-14	469,986	454,711	15,275
W-15	285,322	274,860	10,462
W-16	572,268	527,631	44,637
W-17	288,123	278,038	10,084
W-18	329,154	317,304	11,850
W-19	177,689	174,135	3,554
W-2	545,135	512,427	32,708
W-3	532,103	500,177	31,926
W-4	303,264	285,069	18,196
W-5	242,852	235,566	7,286
W-7	1,485,562	1,423,663	61,898
W-9	247,263	237,372	9,891

LLDA	Total 2008	w/ Septic	w/o Septic
Marikina	479,683	431,715	47,968
Angono	490,142	367,606	122,535
Morong	155,737	116,803	38,934
Baras	25,671	19,253	6,418
Tanay	45,141	33,856	11,285
Pililla	35,631	26,723	8,908
Jala jala	52,831	39,623	13,208
Sta. Maria	66,322	46,425	19,897
Siniloan	52,748	36,924	15,825
Pangil	64,519	45,164	19,356
Caliraya	46,791	32,753	14,037
Pagsanjan	154,965	108,476	46,490
Sta. Cruz	189,087	132,361	56,726
Pila	140,162	98,113	42,049
Calauan	335,522	234,865	100,657
Los Baños	198,212	138,749	59,464
San Juan	389,800	272,860	116,940
San Cristobal	422,546	295,782	126,764
Sta. Rosa	565,835	396,085	169,751
Biñan	450,666	315,466	135,200
San Pedro	175,078	148,816	26,262

Annex E. Summary of Inhabitants in 58 Sub-basins With and Without Sanitary Toilets (2010).

SB Name	Total 2010	w/ Septic	w/o Septic
CW-1	226,472	201,107	25,365
CW-2	888,097	815,273	72,824
E-1	361,539	331,411	30,128
E-2	484,227	463,648	20,580
E-3	301,432	295,403	6,029
E-4	121,265	115,606	5,659
E-5	644,503	601,229	43,274
E-6	260,669	247,114	13,555
E-7	385,529	354,687	30,842
E-8	539,029	506,688	32,342
E-9	639,910	588,717	51,193
EW-1	255,623	250,510	5,112
EW-2	593,017	578,191	14,825
EW-3	451,725	418,598	33,126
LA MESA WATERSHED	1,000	960	40
NO NAME	71,282	65,580	5,703
SR-1	527,465	474,718	52,746
UM-1	52,766	51,007	1,759
UM-2	133,661	124,973	8,688

SB Name	Total 2010	w/ Septic	w/o Septic
UM-3	97,208	90,080	7,129
UM-4	89,866	80,879	8,987
W-1	576,612	530,483	46,129
W-11	331,618	268,611	63,007
W-12	819,207	802,823	16,384
W-13	500,605	490,593	10,012
W-14	496,227	480,100	16,127
W-15	301,597	290,539	11,059
W-16	586,702	540,939	45,763
W-17	301,595	291,039	10,556
W-18	347,098	334,602	12,496
W-19	188,217	184,453	3,764
W-2	564,475	530,607	33,869
W-3	561,623	527,925	33,697
W-4	316,841	297,830	19,010
W-5	252,093	244,530	7,563
W-7	1,508,531	1,445,676	62,855
W-9	254,665	244,478	10,187

LLDA	Total 2010	w/ Septic	w/o Septic
Marikina	487,024	438,322	48,702
Angono	493,899	370,424	123,475
Morong	157,456	118,092	39,364
Baras	27,447	20,586	6,862
Tanay	47,586	35,690	11,897
Pililla	37,994	28,496	9,499
Jala jala	56,352	42,264	14,088
Sta. Maria	69,139	48,397	20,742
Siniloan	55,365	38,756	16,610
Pangil	66,481	46,537	19,944
Caliraya	47,787	33,451	14,336
Pagsanjan	159,648	111,753	47,894
Sta. Cruz	195,944	137,161	58,783
Pila	145,354	101,748	43,606
Calauan	349,545	244,681	104,863
Los Baños	209,689	146,782	62,907
San Juan	417,807	292,465	125,342
San Cristobal	465,405	325,783	139,621
Sta. Rosa	632,612	442,829	189,784
Biñan	483,572	338,500	145,072
San Pedro	176,505	150,029	26,476

Annex F. Summary of Inhabitants in 58 Sub-basins With and Without Sanitary Toilets (2015).

SB Name	Total 2015	w/ Septic	w/o Septic
CW-1	262,458	233,063	29,395
CW-2	1,095,834	1,005,976	89,858
E-1	436,069	399,730	36,339
E-2	574,299	549,891	24,408
E-3	353,679	346,606	7,074
E-4	141,421	134,821	6,600
E-5	747,212	697,042	50,170
E-6	277,163	262,751	14,412
E-7	453,847	417,540	36,308
E-8	604,131	567,883	36,248
E-9	713,008	655,967	57,041
EW-1	295,196	289,292	5,904
EW-2	683,630	666,539	17,091
EW-3	515,816	477,989	37,826
LA MESA	1,005	965	45
NO NAME	85,110	78,301	6,809
SR-1	630,011	567,010	63,001
UM-1	82,565	79,813	2,752
UM-2	163,329	152,713	10,616

SB Name	Total 2015	w/ Septic	w/o Septic
UM-3	120,265	111,445	8,819
UM-4	110,310	99,279	11,031
W-1	651,881	599,731	52,150
W-11	368,222	298,260	69,962
W-12	917,181	898,837	18,344
W-13	552,403	541,355	11,048
W-14	568,498	550,021	18,476
W-15	346,530	333,824	12,706
W-16	624,750	576,019	48,730
W-17	338,136	326,301	11,835
W-18	396,392	382,122	14,270
W-19	217,350	213,003	4,347
W-2	616,008	579,047	36,960
W-3	642,941	604,364	38,576
W-4	353,842	332,611	21,231
W-5	277,110	268,797	8,313
W-7	1,568,039	1,502,704	65,335
W-9	274,703	263,715	10,988

LLDA	Total 2015	w/ Septic	w/o Septic
Marikina	505,966	455,369	50,597
Angono	503,427	377,570	125,857
Morong	161,849	121,387	40,462
Baras	32,450	24,338	8,113
Tanay	54,297	40,723	13,574
Pililla	44,627	33,470	11,157
Jala jala	66,228	49,671	16,557
Sta. Maria	76,835	53,785	23,051
Siniloan	62,561	43,793	18,768
Pangil	71,662	50,163	21,499
Caliraya	50,375	35,262	15,112
Pagsanjan	172,072	120,450	51,622
Sta. Cruz	214,281	149,997	64,284
Pila	159,245	111,472	47,774
Calauan	387,392	271,174	116,218
Los Baños	241,477	169,034	72,443
San Juan	497,667	348,367	149,300
San Cristobal	574,839	402,388	172,452
Sta. Rosa	842,573	589,801	252,772
Biñan	577,279	404,095	173,184
San Pedro	180,123	153,105	27,018

Annex G. Summary of Inhabitants in 58 Sub-basins With and Without Sanitary Toilets (2020).

SB Name	Total 2020	w/ Septic	w/o Septic
W-1	737,036	678,073	58,963
W-11	409,100	331,371	77,729
W-12	1,013,466	993,197	20,269
W-13	596,412	584,484	11,928
W-14	637,655	616,932	20,724
W-15	384,501	370,403	14,098
W-16	665,808	613,875	51,933
W-17	365,410	352,620	12,789
W-18	438,985	423,182	15,803
W-19	250,991	245,971	5,020
W-2	672,453	632,106	40,347
W-3	736,275	692,099	44,177
W-4	395,728	371,985	23,744
W-5	305,166	296,011	9,155
W-7	1,616,965	1,549,592	67,374
W-9	283,423	272,086	11,337

SB Name	Total 2020	w/ Septic	w/o Septic
W-1	737,036	678,073	58,963
W-11	409,100	331,371	77,729
W-12	1,013,466	993,197	20,269
W-13	596,412	584,484	11,928
W-14	637,655	616,932	20,724
W-15	384,501	370,403	14,098
W-16	665,808	613,875	51,933
W-17	365,410	352,620	12,789
W-18	438,985	423,182	15,803
W-19	250,991	245,971	5,020
W-2	672,453	632,106	40,347
W-3	736,275	692,099	44,177
W-4	395,728	371,985	23,744
W-5	305,166	296,011	9,155
W-7	1,616,965	1,549,592	67,374
W-9	283,423	272,086	11,337

LLDA	Total 2020	w/ Septic	w/o Septic
Angono	513,152	384,864	128,288
Morong	166,385	124,789	41,596
Baras	38,374	28,781	9,594
Tanay	61,961	46,470	7,526
Pililla	52,443	39,333	13,111
Jala jala	77,855	58,391	19,464
Sta. Maria	85,576	59,903	25,673
Siniloan	70,809	49,566	21,243
Pangil	77,267	54,087	23,180
Caliraya	53,107	37,175	15,932
Pagsanjan	185,602	129,921	55,681
Sta. Cruz	234,472	164,131	70,342
Pila	174,550	122,185	52,365
Calauan	429,617	300,732	128,885
Los Baños	278,257	194,780	83,477
San Juan	594,030	415,821	178,209
San Cristobal	750,959	525,672	225,288
Sta. Rosa	1,135,428	794,800	340,629
Biñan	690,085	483,060	207,026
San Pedro	183,816	156,244	27,572