REPUBLIC OF THE PHILIPPINES

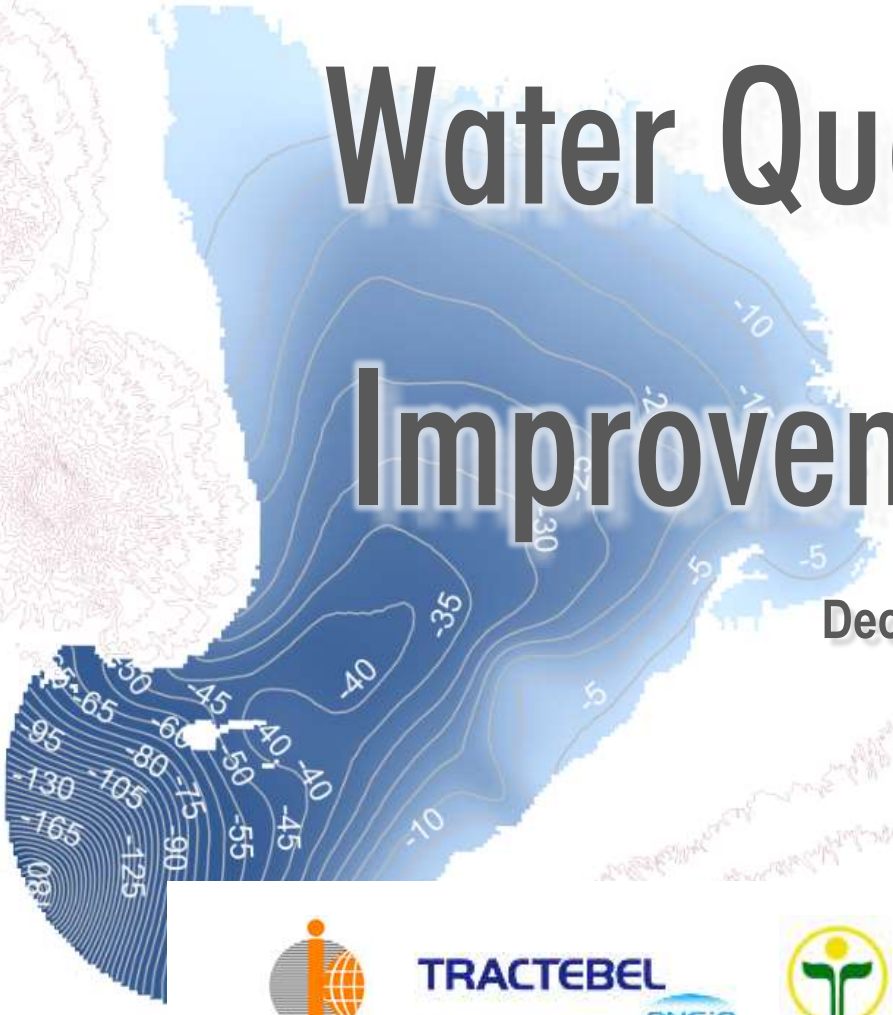
NATIONAL ECONOMIC AND DEVELOPMENT AUTHORITY

Manila Bay Sustainable Development Master Plan

SITUATION ANALYSIS REPORT

Water Quality Improvement

December 2018



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Manila Bay Sustainable Development Master Plan

Situation Analysis Report | Focal Theme Reports

Water Quality Improvement

December 2018

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Acronyms and Abbreviations

CHED	Commission on Higher Education
BCDA	Bases Conversion & Development Corporation
BFAR	Bureau of Fishery and Aquatic Resources
CSW	Completed Staff Work
CWA	Clean Water Act
DA	Department of Agriculture
DENR	Department of Environment and Natural Resources
DepEd	Department of Education
DILG	Department of Interior and Local Government
DOH	Department of Health
DOST	Department of Science and Technology
DOTC	Department of Transport and Communications
DPWH	Department of Public Works and Highways
DRR	Dutch Risk Reduction
DTI-BOI	Department of Trade and Industry - Board of Investments
ECC	Environmental Compliance Certificate
EIS	Environmental Impact Statement
EO	Executive Order
GOCC	Government Owned or Controlled Corporations
HLURB	Housing and Land Use Regulatory Board
IA	Implementing Agreement
IEE	Initial Environmental Examination
ICC	Investment Coordination Committee
IRR	Implementing Rules and Regulations
JV	Joint Venture
LGU	Local Government Unit
LLDA	Laguna Lake Development Authority
MBCO	Manila Bay Coordinating Office
MBEMP	Manila Bay Environmental Management Project
MBSDMP	Manila Bay Sustainable Development Master Plan
MMDA	Metro Manila Development Authority
MWWS	Metropolitan Waterworks and Sewerage System
NB	NEDA Board
NEDA	National Economic Development Authority
NGA	National Government Agency
NHA	National Housing Authority
NPC	National Power Corporation
NRDC	National Resources Defense Council
NWRB	National Water Resources Board
PAMB	Protected Area Management Board
PAPs	programs, activities, projects
PCG	Philippine Coast Guard
PER	Project Evaluation Report
PIA	Philippine Information Agency
PPA	Philippine Ports Authority
PPP	Public Private Partnership
PRA	Philippine Reclamation Authority
PEZA	Philippine Economic Zone Authority
PHIVIDEC	Philippine Veterans Investment Development Corporation
PNP	Philippine National Police
PPA	Philippine Port Authority
PRRC	Pasig River Rehabilitation Commission
PSA	Philippine Statistics Authority
PWSSMP	Philippine Water Supply and Sanitation Project
RA	Reclamation Agreement
RBCO	River Basin Control Office
RDC	Regional Development Council
RIZLAQUE	Rizal-Laguna-Aurora, Quezon
SMBA	Subic Bay Metropolitan Authority
WD	Water District
WQMA	Water Quality Management Area

Preface

The Manila Bay Sustainable Development Master Plan (MBSDMP) is to be a comprehensive and sustainable master plan for Manila Bay and the immediate coastal zone together with its larger catchment area – the Manila Bay basin.

Consistent with the Philippine Development Plan (PDP) and contributes in achieving AmBisyon 2040, the master plan is to be instrumental in linking economic planning and development projects to environmental and resource management goals for Manila Bay and addressing social and ecological issues (such as poverty alleviation, food security, public health and biodiversity) through the rehabilitation and sustainable development of marine and coastal resources with appropriate financing/funding.

While the traditional plans for Coastal Management and Development assume public financing, the MBSDMP approach aims to make use of solicited private sector investments to achieve strategic management and development goals for five (5) focal themes, namely:

- inclusive growth,
- ecosystem protection,
- climate change adaptation and disaster risk reduction,
- water quality improvement, and
- upgrading informal settlements.

In preparing the Situation Analysis Report, five (5) Focal Theme Reports are prepared accordingly in preparation for the next step – the Strategy Building Phase.

The Situation Analysis Report consist of:

- Executive Summary of the 5 Focal Themes,
- Manila Bay Area 2018 | A Situational Atlas, and
- Five (5) Focal Theme Reports, namely:
    - Inclusive Growth
    - Ecosystem Protection,
    - Climate change adaptation and disaster risk reduction,
    - Water quality improvement, and
    - Upgrading informal settlements.

This is the **Focal Theme Report for Water Quality Improvement**.

1 Introduction

This focal theme report is the first version dated September 2018 outlining the stage for Water Quality Improvement. This first version will be identifying and inventorying in nature. The focal theme report will be updated with new information and additional insights and will be made more specific and focused in two iterations in March 2019 and September 2019.

1.1 Concept and Importance

In general, water quality refers to the condition of the water, including its chemical, physical, biological, and radiological characteristics. It is a measure of the condition of the water relative to the requirements of one or more biotic species and/or to any human need or its suitability for a particular purpose.

The Clean Water Act of the Philippines (RA 9275) defines water quality as the characteristics of water which defines its use in terms of physical, chemical, biological, bacteriological or radiological characteristics by which the acceptability of water is evaluated.

Thus, the desired water quality of a particular water body will be those characteristics which are needed to sustain its beneficial use/s. For example, the characteristics of waters to be used for drinking water purposes are more stringent than those for recreational use.

Water quality improvement means reducing or preventing the contamination of a particular water body such as a river, a stream, a lake, or the sea using a watershed (ridge to reef) approach. It starts with an investigation of the sources of pollution/contamination to then identifying the measures, including policies, programs, and projects, necessary to prevent or, at the very least, reduce those pollutants/contaminants. It can involve measures to prevent solid waste from getting dumped into the water, to mobilizing stakeholders for clean up drives. It also includes setting effluent standards for any discharges into a particular classification of a water body. The standards identify the different parameters and the acceptable (numerical) discharge limits for different criteria pollutants, such as Biochemical Oxygen Demand (BOD, Dissolved oxygen, nutrients, etc.) per water body classification. It should also include investing in and properly operating and maintaining wastewater treatment infrastructures in order to ensure the long-term protection of water quality.

1.2 Relevance of Water Quality Improvement for Manila Bay

Over the years, the water quality of Manila Bay has continuously deteriorated due to increasing discharges from untreated domestic and industrial sources, as well as urban and agricultural runoffs. Sea-based activities such as aquaculture and waste dumping from passenger ships and cargo vessels also contribute to the increasing pollutant load of the Bay.

Organic pollution generated from the entire Manila Bay Area was estimated in this study at 1,170 tons of BOD/day and 89 tons of total phosphorus/day for 2018. While Metro Manila contributes about 40% of this pollution load, major infrastructures on sewerage and sanitation are operating with more capacities being constructed by the two private sector concessionaires of the Metropolitan Waterworks and Sewerage System (MWSS) to treat sewage and septage prior to discharge to creeks and rivers. The challenge remains for the 60% pollution load coming from outside the jurisdiction of MWSS where investments on wastewater collection and treatment are still sorely lacking.

Recent EMB monitoring data from the major river basins showed that nutrients such as ammonia and phosphate concentrations have exceeded the prescribed water quality guidelines. This is mainly attributed to increased agricultural activities and inadequate sewage treatment.

Wastewater from industrial sources contains higher concentrations of organics and will occasionally contain heavy metals and priority organics. Contributions from these sources are not yet fully established as the EMB continues to conduct monitoring and surveillance of establishments. The latest PEMSEA report in 2013 for the Laguna Lake-Pasig River-Manila Bay watershed estimated about 11% of the BOD are attributable to industrial sources.

Pollution brought about by inadequate solid waste management is another serious threat to the water quality of the Bay. Illegally thrown solid wastes not only pollute the waters but usually also clog rivers and drainage canals resulting in flooding especially during heavy rains. Dumping of sludge, wastes, and other contaminated materials into the ocean as well as coastal reclamation contributes to the devastation of the Bay and its environment.

Manila Bay (L) on a clear day, photo by JM Lim, July 2018 and (R) with solid wastes along coastal area after heavy rains, photo from J. Manabat, ABS-CBN, August 2018

The Mandamus Order of the Supreme Court was precisely issued to address the continuing degradation of the water quality of the Bay and reduce its adverse impacts on fishery, health, recreation and the health of the ecosystem. Poor water quality poses a risk to the health of people. It also adversely affects the health of the ecosystem. To quote:

> *"defendant-government agencies to clean up, rehabilitate, and preserve Manila Bay, and restore and maintain its waters to SB level (Class B sea waters per Water Classification Tables under DENR Administrative Order No. 34 [1990]) to make them fit for swimming, skin-diving, and other forms of contact recreation."*

It is worth noting that the Supreme Court decision mandated that the Manila Bay be improved to a Class SB water body category. In 2010, the EMB in compliance to the Supreme Court decision, the entire Manila Bay was classified as Class SB water. Its most beneficial uses are now Recreational Water Class 1 (areas regularly used by the public for bathing swimming, skin diving, etc.) and Fishery Water class 3 (spawning areas for Chanos chanos or "Bangus" and similar species. This means that the water quality criteria for Manila Bay are now more stringent to enable it to sustain its beneficial uses. Water quality improvement is thus key to the sustainable development of Manila Bay.

For any development plan to be approved, it must consider its impact on the water quality of the Bay and must ensure that its implementation will not further compromise the ongoing efforts on water quality rehabilitation and whenever possible include features that will help make the Bay achieve the water quality suitable to its intended beneficial uses.

2 Relevant Policies, Laws and Plans

To embed the focal theme in the policy arenas on various levels the connection of Water Quality is discussed with the most applicable UN Sustainable Development Goals (SDGs) and the related Philippine Development Plan Goals (PDP Goals) and outcomes. The current legal and policy framework relevant to the Water Quality theme is also discussed.

2.1 National and Subnational Laws, Policies and Plans

The **Philippine Clean Water Act of 2004 (Republic Act 9275)** is the primary law relevant to Water Quality Improvement. It aims to protect the country's water bodies from pollution from land-based sources (industries and commercial establishments, agriculture and community/household activities). It provides for a comprehensive and integrated strategy to prevent and minimize pollution through a multi- sectoral and participatory approach involving all the stakeholders. Management of water quality will either be based on watershed, river basin or water resources region. Water quality management areas with similar hydrological, hydrogeological, meteorological or geographic conditions which affect the reaction and diffusion of pollutants in water bodies are to be designated by the DENR in coordination with the National Water Resources Board (NWRB). All owners or operators of facilities that discharge wastewater are required to get a permit to discharge from either the DENR or the Laguna Lake Development Authority.

The Department of Public Works and Highways (DPWH), in coordination with local government units is mandated to prepare a national program on sewage and septage management not later than 12 months from effectivity of this Act. A priority list is likewise to be prepared which will be the basis for the allotment of funds on an annual basis by the national government for the construction and rehabilitation of required facilities. On the other hand, LGUs are to provide the land including road right of the way for the construction of sewage and/or septage treatment facilities and raise funds for the operations and maintenance of said facilities.

The Department of Health (DOH) was tasked to formulate guidelines and standards for the collection, treatment and disposal of sewage as well as the guidelines for the establishment and operation of centralized sewage treatment system. The MWSS and other agencies mandated to provide water supply and sewerage facilities are required to connect to existing sewage lines, subject to the payment of sewerage service charges/fees within five years following effectivity of this Act. All sources of sewage and septage are required to comply with the law.

The NSSMP and the cost-sharing policy was supposed to be supported by an information, communication and education (IEC) program which was to be rolled out to all the provinces so that the LGUs will know about it. This has only been done to a limited extent. Together with other difficulties encountered, up to now, only 1 city has been able to access the Fund. The Road Map has also hardly been implemented.

The law also provides that anyone discharging wastewater into a water body will have to pay a wastewater charge. This economic instrument based on the polluters pay principle which will be developed in consultation with all concerned stakeholders is expected to encourage investments in cleaner production and pollution control technologies to reduce the amount of pollutants generated and discharged. Effluent trading per management area will also be allowed.

RA 9003 of the Ecological Solid Waste Management Act established the National Solid Waste Management Board, chaired by the DENR. Among the major mandates of the Board are:

- Prepare the National Solid Waste Management Framework;
- Approve local solid waste management plans in accordance with its rules and regulations;
- Review and monitor the implementation of local solid waste management plans;
- Adopt a program to provide technical and other capability building assistance and support to local government units in the development and implementation of source reduction programs;
- Develop and implement a program to assist local government units in the identification of markets for materials that are diverted from disposal facilities through re-use, recycling, and composting, and other environment-friendly methods;
- Develop a mechanism for the imposition of sanctions for the violation of environmental rules and regulations;
- Manage the Solid Waste Management Fund;
- Develop and prescribe procedures for the issuance of appropriate permits and clearances;
- Review the incentives scheme for effective solid waste management; and

- Formulate the necessary education promotion and information campaign strategies;

In addition to chairing the Board, the DENR was mandated to also prepare an Annual National Solid Waste Management Status Report; Prepare and distribute information, education and communication materials; Establish methods and other parameters for the measurement of waste reduction, collection and disposal; Provide technical and other capability building assistance and support to the LGUs in the development and implementation of local solid waste management plans and programs; Recommend policies to eliminate barriers to waste reduction programs; Exercise visitorial and enforcement powers to ensure strict compliance and establish a National Ecology Center.

Section 6 highlighted that LGUs shall be primarily responsible for the implementation and enforcement of the provisions of this Act within their respective jurisdictions. Segregation and collection of solid waste shall be conducted at the barangay level specifically for biodegradable, compostable and reusable wastes: Provided, That the collection of non-recyclable materials and special wastes shall be the responsibility of the municipality or city.

The Law required all open dumpsites to be closed and transformed into controlled dumpsites within 3 years of the effectivity of the law and for all controlled dumpsites to be closed and transformed into sanitary landfills within 5 years of the effectivity of the law. It also prohibited open burning of wastes. RA 9003 also set a target of 25% diversion of waste materials from disposal sites with this target to be increased every 3 years thereafter.

In addition to the Clean Water Act and the Ecological Solid Waste Management Act, the following national laws and Implementing Rules and Regulations in Table 1 are also relevant to this theme.

Table 1: National and subnational policies and programs relevant to DRR and CCA.

Law (Republic Act, Presidential Decree, etc.)	Relevant rules and regulations (Agency, Year Issued)
Clean Water Act 2004 (RA 9275)	▪ DENR AO (DAO) 2005-10 – Implementing Rules and Regulations of RA 9275 ▪ EMB Memorandum Circular 012, series of 2012 – Methods of Analysis for Water and Wastewater ▪ DAO 2016-08, Water Quality Guidelines and General Effluent Standards of 2016
Water Code of the Philippines (PD 1067)	▪ IRR adopted at the 119th meeting of the National Water Resources Council on June 11, 1979 ▪ Revised IRR adopted at the 29th meeting of the National Water Resources Board on March 21, 2005
National Water Crisis Act 1995 (RA 8041)	▪ EO 374 (October 15,1996) creating the Presidential Task Force on Water Resources Development and Management
Code of Sanitation (PD 856)	▪ Implementing Rules and Regulations (IRR) of PD 856
Oil Pollution Compensation Act 2007 (RA 9483)	
Philippine Coast Guard Law 2009 (RA 9993)	▪ IRR approved by DOTC on April 8, 2011
Ecological Solid Waste Management Act 2001 (RA 9003)	▪ IRR of RA 9003 ▪ NSWMC Resolution No 6 (Dec 2005) , Guidelines on Categorized Final Disposal Facilities ▪ DAO 2006-10, Guidelines on Categorized Final Disposal Facilities (Sanitary Landfills)
	▪ EO 510 (OP, 2006) creating the River Bain Control Office ▪ EO 816 (OP, 2009) RBCO as lead agency for river basin management in the country ▪ EO 533 Adopting ICM (OP, 2006)

2.2 Relevant International Agreements and Conventions

The International Convention for the Prevention of Pollution from Ships otherwise known as MARPOL is the international convention most relevant to the theme of water quality improvement. It includes regulations aimed at preventing and minimizing, both accidental and operational, pollution from ships with six Technical Annexes. To wit:

- Annex I – Regulations for the Prevention of Pollution by Oil
- Annex II – Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk
- Annex III – Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form
- Annex IV – Prevention of Pollution by Sewage from Ships
- Annex V – Prevention of Pollution by Garbage from Ships
- Annex VI – Prevention of Air Pollution from Ships

All these technical annexes are relevant to the theme on water quality improvement, since all these possible sources of pollution can degrade the water quality of the Bay.

2.3 National, regional and local (Manila Bay) development goals, plans and policies

In accordance with the Clean Water Act, the National Sewage and Septage Management Plan (NSSMP) was developed and formally adopted. In addition to the NSSMP, a National Sustainable Sanitation Road Map was likewise prepared. There is an ongoing effort led by NEDA to formulate the Philippine Master Plan for Water Supply and Sanitation where, among other things, the National Sustainable Sanitation Road Map will be integrated with the National Road Map for Water Supply. This is expected to be finished and formally adopted by the NEDA by the end of 2018.

In line with the NSSMP, a policy was adopted by the NEDA Board on the cost sharing of investments for sewage and septage projects of LGUs. Initially, the grant of 40% of the investment cost was to be provided only to Highly Urbanized Cities (HUCs) outside of Metro Manila (since MM is already covered by the 2 concessionaires of the MWSS) investing in sewerage systems. To fund this, an allocation of PhP2B was included in the budget of DPWH and included in the General Appropriations Act (GAA) from 2015 up to the present. The policy was revised in 2017 to increase the grant to 50% grant for investments not just for sewerage but also for septage treatment systems and expanding eligible LGUs from just HUCs to include all cities and 1st class municipalities.

2.4 Current institutional and legal (and policy) framework including inventory of actors and stakeholders

A number of government agencies have different roles and responsibilities in improving water quality. These include the Environmental Management Bureau (EMB) of the DENR, the Laguna Lake Development Authority (LLDA), the Metropolitan Waterworks and Sewerage System (MWSS), the Local Water Utilities Administration (LWUA), the Philippine Coast Guard (PCG), the Philippine National Police Maritime Police (PNP) and the LGUs.

The **Environmental Management Bureau (EMB)** has the mandate to set effluent standards as well as water quality guidelines based on the classification of the water body. It also issues permit to discharge for all institutional, commercial, industrial establishments nationwide except for those within the jurisdiction of the Laguna Lake Development Authority and requires all permittees to submit quarterly self-monitoring reports (SMRs). EMB also monitors permittees from time to time. Those found in violation are issued Notices of Violation (NOV) and if no appropriate remedial actions are taken, then the EMB files a case against the erring company/agency with the Pollution Adjudication Board (PAB). EMB also regularly monitors the water quality of different rivers, lakes, beaches and seas in the country.

The **Pollution Adjudication Board (PAB)** is a quasi-judicial body under the office of the DENR Secretary, Chaired by the DENR Secretary, it is composed of two (2) Undersecretaries designated by the Secretary, the Director of the Environmental Management, and three (3) others (usually one representative each from the business sector, NGOs and the academe) designated by the Secretary as members. It took over the functions of the National Pollution Control Commission in adjudicating all pollution cases. It imposes penalties as appropriate including possible closure of the operations of violators and the payment of damages.

The **Laguna Lake Development Authority (LLDA)** has the mandate to manage the development within the Laguna de Bay. Similar to EMB, they issue discharge permits, monitor compliance, issues notices of violations and if needed, files pollution cases against the erring company/institution with the PAB. They also regularly monitor the water quality of the lake. Lake waters flow through the Pasig River system and eventually end up in Manila Bay. On the other hand, when lake waters are low and there is high tide, water from Manila Bay flow back into the lake. To control the degradation of the lake, LLDA also controls the number of fish cages and fish pens within the lake and has set a maximum of 10% of the Lake (9,200 hectares) as the maximum carrying capacity of the lake for aquaculture.

The **Metropolitan Waterworks and Sewerage System (MWSS)** by its mandate constructs, maintains and operates domestic/municipal water supply and sewerage projects in Metro Manila and contiguous areas. It has since privatized its operations to two concessionaires, namely Manila Water Company Inc. and Maynilad Water Services Inc. who continue to expand access to safe water and also to sewerage and septage treatment. They also monitor the quality of the waters which they will be tapped for water supply purposes and also report on the water quality of their effluents.

The **Local Waterworks and Utilities Administration (LWUA)** serves as a specialized lending institution for the promotion, development and financing of local utilities (specifically organized as Water Districts). It also builds capacity of WDs for water supply and sanitation and monitors sewage/septage treatment of WDs.

All water service providers (WSPs) are mandated by the Clean Water Act to provide sanitation services to their customers. If the Local Government Unit (LGU) is the one providing the water supply services, then it also has the mandate to provide sanitation services.

Section 16 on General Welfare of the Local Government Code (LGC) of the Philippines (RA 7160) provides that every **Local Government Unit (LGU)** shall exercise the powers expressly granted, those necessarily implied therefrom, as well as powers necessary, appropriate, or incidental for its efficient and effective governance, and those which are essential to the promotion of the general welfare. Within their respective territorial jurisdictions, local government units shall ensure and support, among other things….. promote health and safety, enhance the right of the people to a balanced ecology…

Under Section 17 on Basic Services and Facilities, among those which Barangays are supposed to provide are services and facilities related to general hygiene and sanitation, beautification, and solid waste collection. For a Municipality, it includes (vi) Solid waste disposal system or environmental management system and services or facilities related to general hygiene and sanitation; (viii) Infrastructure facilities intended primarily to service the needs of the residents of the municipality and which are funded out of municipal funds including but not limited to…….,drainage and sewerage, …For a Province, it includes (iii) pursuant to national policies and subject to supervision, control and review of the DENR, enforcement of.. pollution control law,….. and other laws on the protection of the environment; (vii) Infrastructure facilities intended to service the needs of the residence of the province and which are funded out of provincial funds including, but not limited to, drainage and sewerage..; and For a City, All the services and facilities of the municipality and province, and in addition some others.

Clearly therefore, LGUs have roles and responsibilities relevant to keeping the water quality of water bodies within their jurisdictions “clean”. Only a handful of LGUs in the country have invested in wastewater treatment and much less, actually regulate and monitor the discharges of commercial, industrial and institutional establishments within their area. Hardly any LGU actively monitors the water quality of the waters in their jurisdiction. Most simply rely on the DENR/EMB and LLDA. Solid waste management though is fully within the mandate of the LGUs as provided by both the LGC and RA 9003. They are supposed to implement the Ecological Solid Waste Management ACT (RA 9003) and thus ensure waste segregation at source, establish Materials Recovery Facilities (MRF) to facilitate recycling and reuse, compost biodegradable waste, collect the residual waste materials, dispose them properly in sanitary landfills and close open dumpsites.

The **Department of Agriculture (DA)** also has a role to play in the water quality improvement of the Bay area since discharges from poultry and livestock as well as agricultural run-offs which can be very rich in nutrients end up in Manila Bay.

The **Philippine Coast Guard (PCG)** is tasked primarily with enforcing laws within Philippine waters, conducting maritime security operations, safeguarding life and property at sea, and protecting marine environment and resources. Together with the PNP Maritime Enforcement Unit, they enforce the MARPOL and other laws that affect the Philippine waters including pollution, be it solid or liquid from ships and boats that ply across the Manila Bay.

As far as stakeholders are concerned, directly impacted by deteriorating water quality are the fisherfolks who depend on the Bay for their livelihood. Affected too are those involved in the tourism industry along the Manila Bay. The pollution of the waters discourage tourists from patronizing to their resorts/hotels and bathing in the sea, or even just being in the area if the waters are smelly or full of floating solid waste. Also affected are the communities who live directly along the shorelines of the Bay who face the risk of getting sick due to their exposure to the polluted waters, especially the children who still swim in Manila Bay even if it is already prohibited in some areas.

3 Objectives and Criteria

3.1 Overview of targets and indicators

3.1.1 Mandamus Order

The objective of the Supreme Court Mandamus Order is to have "Manila Bay cleaned, rehabilitated and preserved, and its waters restored and maintained at Class SB level". The Operational Plan for the Manila Bay Coastal Strategy provides the Manila Bay stakeholders a blueprint on what needs to be done now to achieve a shared vision of the future. The latest operational plan of Manila Bay (2017-2022) identified 5 outcome statements with each outcome having several output indicators.

Most relevant to the theme on WQI are Outcome 1 on liquid waste discharges and Outcome 2 on solid waste ending up in the Bay. Table 2 below presents the targets and indicator of the MBCS in relation on the mandamus targets on liquid and solid waste management.

Table 2: Targets and indicators related to Water Quality Improvement and based on OPMBCS (from the Operational Plan of the Manila Bay Coastal Strategy 2017-2022).

Targets	Indicators
Outcome 1 Liquid waste discharging into Manila Bay in compliance with effluent (GES) and/or ambient water quality within the water quality guidelines	▪ % reduction of liquid waste loading to Manila Bay from point sources (BOD, COD and fecal coliform) ▪ % reduction of nutrient loading to Manila Bay from non-point (agricultural) sources
Output 1.1 Industrial and commercial including institutional (e.g. healthcare facilities) establishments discharging waste water into the Manila Bay in compliance with the general effluent standards determined	▪ Pollution from point sources determined by 2018 ▪ Nutrient load from agricultural sources determined by 2019 ▪ 40,000 commercial, industrial and institutional establishments compliant by 2022 (20,000 EMB, 20,000 LLDA) ▪ 100% of establishments surveyed and mapped and volume of pollution load of establishments with or without discharge permits determined by 2018 ▪ # of establishments regularly monitored
Output 1.2 Water-served population connected to sewerage and sanitation services	▪ 100% of water-served population connected to sewerage and sanitation services - Maynilad 47% sewerage 80% sanitation - Manila Water 43% sewerage 100% sanitation - LWUA 15% sewerage 15% sanitation
Output 1.3 Monitoring and Compliance to General Effluent Standards Enforced	▪ Surveyed wet establishments are monitored compliant with General Effluent Standards 90% of Notices of Violations are issued on time ▪ All NOVs issued with Technical Conferences/ ADR ▪ % of compliance to notices/elevation to PAB
Output 1.4 Policy on pollution prevention and control issued	▪ Policy, guidelines MC or DAO on waste minimization (recycling/reuse) developed and issued by 2020 and compliance monitored thereat ▪ Mathematical model developed by 2018
Output 1.5 Marine environmental protected laws, rules and regulations enforced (PD 979, RA 9993 and other laws/regulations addressing marine pollution within Manila Bay)	▪ 100% compliance to maritime laws, rules and regulations by 2022 ▪ All vessels entering Manila Bay monitored ▪ All land-based facilities inspected ▪ Seaborne patrol operations regularly conducted ▪ All violators apprehended
Output 1.6 Operations of Shore Reception Facilities (SRF) for ships wastes	▪ 100% of vessels docked in MBR subject to waste collection and proper waste disposal ensured ▪ 100% of vessels entering MBR monitored ▪ Volume of liquid waste from commercial vessels collected and recorded ▪ Shore Reception Facility (SRF) constructed/ installed in every port
Output 1.7 PNP Maritime Operations fully enforced	▪ Number of seaborn patrols conducted ▪ Number of violators apprehended ▪ 100% apprehension with appropriate legal actions taken

Targets	Indicators
Output 1.8 Pollution load from livestock and Poultry reduced	▪ Volume of pollution loading from poultry, livestock and others within MBR determined by 2019 ▪ Inventory of livestock/poultry and others completed by 2018 ▪ 90% of inventoried poultry livestock and others without treatment/pollution prevention facilities installed by 2022
Output 1.9 Nutrient Load from crop lands within the Manila Bay region determined	▪ Volume of nutrient loading from croplands within MBR determined by 2018 ▪ # of sampling stations monitored within compliance with water quality guidelines ▪ Isotope studies in MBR completed by 2019
Output 1.10 Volume of nutrient loading from aquaculture farms in the Manila Bay region maintained within water quality criteria	▪ Nutrient loading from aquaculture determined by 2019 ▪ Inventory of aquaculture (public and private) including hatcheries conducted by 2018 ▪ Aquaculture practices of inventoried farms monitored ▪ Nutrient levels, including heavy metals and pathologic bacteria, as well as other pollutant indicators in accordance with Section 7.1 of DAO 2016-08 regularly monitored ▪ Technical studies conducted and policy issued to ensure that volume of nutrient loading is maintained
Output 1.11 Water Ways maintained and freed from obstructions	▪ Number of identified sites for dredging, desilting, declogging established ▪ 80% of identified sites programmed for dredging/desilting ▪ 100% of programmed sites dredge/desilted and waste materials properly disposed of ▪ 100% of declogging activities conducted vis a vis targets
Output 1.12 Water Bodies Monitored and Water Quality Parameters Assessed in compliance with the water quality guidelines (DAO 2016-08)	▪ # of water bodies monitored and water quality parameters assessed: - 19 bathing beaches - 9 bay wide stations - 21 river systems monitored (NCR-3, R3-14, R4A-4) - Laguna Lake
Output 1.13 Principal rivers draining into Manila Bay designated as WQMA with Governing Board created	▪ 66 principal rivers draining into Manila Bay region designated as WQMA with Governing Boards established by 2022 ▪ All WQMA areas with Master Plans addressing storm waters, municipal, agricultural run-off prepared and approved
Output 1.14 Water Bodies/Estero within the Manila Bay Region Adopted	▪ 60 water bodies/esteros within MBR adopted - NCR-20, R3-20, R4A-20
Outcome 2 Solid waste ending up in Manila Bay reduced	▪ Solid waste ending up in Manila Bay reduced by ___% in 2022
Output 2.1 Republic Act No. 9003 enforced	▪ 70% of LGUs complied with Ra 9003 by 2020 and 100% by 2022 ▪ 70% of barangays with established waste collection, segregation at source by 2020 and 100% by 2022 ▪ Ordinance regulated junkshops and ambulant waste collectors draft and endorsed to respective Sanggunians by 2018 ▪ Annual awards/incentives provided to LGUs with best practices (ECA, SLMAR, SLGL) ▪ 100% non-compliant LGUs subjected to legal action ▪ % diversion target of MBR
Output 2.2 SWM Plans prepared and approved	▪ 100% of LGUs with approved plans by 2019
Output 2.3 Materials Recovery Facility/System and other resource recovery facilities established and sustained	▪ 100% of barangays served by MRF/MRS established and sustained by 2019 ▪ 10 Resource Recovery facilities established ▪ NCR 4- R3-3, R4-3
Output 2.4 Residual wastes managed	▪ 70% of residual waste disposed to accredited final disposal facilities, resource recovery facilities, or alternative technologies

Targets	Indicators
Output 2.5 Open and controlled dumpsites in the Manila Bay Region closed and rehabilitated	▪ All open dumpsites closed and rehabilitated by 2022 ▪ 75 LGUs provided with financial assistance to close and rehabilitate open and controlled dumpsites (R4A- 50, R3-25)
Output 2.6 Solid wastes from waterways, pumping stations and vessels regularly removed and disposed of in accordance with current rules and regulations	▪ Volume of solid waste regularly collected from pumping stations recorded (CY2018 for the establishment of the baseline re reduction ending up in Manila Bay) ▪ Regular clean-up of waterways, esteros and pumping stations conducted ▪ Volume of solid waste collected during clean ups ▪ All collected waste disposed properly ▪ All solid wastes from vessels entering Manila Bay are collected and disposed properly: ▪ # of commercial vessels entering Manila Bay ▪ Constructed/installed Shore Reception Facilities for SW in every port ▪ Volume of collected recyclable waste from vessels entering the MBR
Output 2.7 Institutional set-up for solid waste management within LGUs established/ strengthened	▪ 90% of LGUs (160) with regular offices/units handling waste management or with institutional set up for SWM
Output 2.8 Policies to address issues on SWM formulated and issued	▪ Policy drafted and recommended to the appropriate body in response to issues/ concerns: ▪ Dredging guidelines not covered by ECC ▪ Disposal of dredged materials and materials collected during clean-ups ▪ Number of SWM policies drafted and recommended for approval ▪ Number of approved SWM policies disseminated
Output 2.9 Marine Environmental Protection Laws, Rules and regulations compliance enforced	▪ All vessels entering Manila Bay and all land-based facilities inspected ▪ Seaborn patrol operations to monitor compliance with 969, RA10654 and RA 9003 and other laws designed to prevent marine pollution regularly conducted ▪ All violators apprehended and legal actions carried out.
Output 2.10 Healthcare wastes properly managed	▪ Volume of healthcare waste managed ▪ Number of hospitals and LGUs compliant with the healthcare waste management policy issued by DOH

3.1.2 Philippine Development Plan (PDP) 2017-2022

The most relevant Chapter of the PDP 2017-2022 to the theme on Water Quality are Chapter 19 on Accelerating Infrastructure Development which includes water and sanitation and Chapter 20 which focuses on Ensuring Ecological Integrity, Clean and Healthy Environment. Table 3 below presents the targets and indicators relevant to this theme.

Table 3: Philippine Development Plan targets and indicators related to Water Quality Improvement

Chapter #	Title	Outcome	Indicator/s	Responsible Agency
19	Accelerating Infrastructure Development	Gaps in basic infrastructure for human capital development reduced	Proportion of HHs with access to basic sanitation to total number of HHs increased (%, cumulative)	DOH, DILG, LGUs
			Water and sanitation (WatSan) facility to pupil ratio improved: ▪ Primary (K to 6) ▪ Junior High School ▪ Senior High School	DepEd
			Volume of desludged and/or treated septage in WDs increased (m^3)	LWUA, WDs

Chapter #	Title	Outcome	Indicator/s	Responsible Agency
			Proportion of barangays with access to Material Recovery Facilities (MRFs) to total no. of barangays (%, cumulative)	DENR-NSWMC/EMB
			Proportion of barangays with access to Sanitary Land Fills (SLFs) to total number of barangays (%, cumulative)	DENR-NSWMC/EMB
20	Ensuring Ecological Integrity, Clean and Healthy Environment	Environmental quality improved	Percentage of priority water bodies within water quality guidelines increased (e.g. BOD, DO, pH, temperature, P, N, fecal coliform): - Public water supply - Food production - Recreational	DENR
			Percentage of highly urbanized and other major urban centers within ambient air quality guideline value (i.e., PM_{10} and PM2.5) increased	DENR
			Solid waste diversion rate increased (%,cumulative)	DENR

Table 4: Provincial Physical Framework and Development Plans (PPFDP) of Bulacan and Bataan

Province	Goal	Objectives, PPAs	Targets
Bulacan	Preserve, Protect and Rehabilitate the Environment	▪ Provincial SLF ▪ Sewage treatment plant for MMO river system ▪ Septage management program ▪ River protection and rehabilitation ▪ Angat river system rehabilitation ▪ MMO river system rehabilitation ▪ Operation of Wastewater treatment laboratory ▪ Waterways protection and rehabilitation	▪ All barangays with operational and functional MRFs. ▪ 100% of establishments along MMO river system inspected and monitored. ▪ 90% reduction of waste dumping along MMO ▪ 75% of households practice 3Rs.
Bataan	Conduct environmental awareness campaign and information dissemination/IEC Coastal Clean-up activities Rehabilitation and River clean-ups	▪ Reactivate Solid Waste Management (SWW) Board; ▪ Construct proper waste management facilities in the LGUs; ▪ Construction of wastewater treatment facilities for industrial and commercial establishments and residential communities; ▪ Increase river bank protection and stabilization;	▪ Biogas Digester technology transfer for piggery operators ▪ Establishment of Sanitary Landfill/MRF Facility ▪ Establishment of Wastewater Treatment Facility ▪ Purchase of Water Quality Testing Instruments

3.1.3 Sustainable Development Goals (SDG) 2030

For Water Quality Improvement, the most relevant SDG goals are Goal 6 on Clean Water and Sanitation and Goal 14 on Life Below Water. The subset of the goals, targets and indicators found to be most relevant and applicable to this theme of the MBSDMP are shown in Table 4 below:

Table 5: SDGs, targets, and indicators related to DRR and CCA (from 2030 Agenda for Sustainable Development).

Goal	Targets	Indicators
Goal 6 Ensure availability and sustainable management of water and sanitation for all	**Target 6.2** By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	**Indicator 6.2.1** Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water
	Target 6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	**Indicator 6.3.1** Proportion of wastewater safely treated **Indicator 11.b.2** Proportion of bodies of water with good ambient water quality
Goal 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development	**Target 14.1** By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from, land-based activities, including marine debris and nutrient pollution	**Indicator 14.1.1** Index of coastal eutrophication and floating plastic debris density
	Target 14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels	**Indicator 14.3.1** Average marine acidity (pH) measured at agreed suite of representative sampling stations
	Target 14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want"	**Indicator 14.1.1** Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United Nation Convention on the Law of the Sea, for the conservation and sustainable use of the oceans and their resources

Goal 6 on Water and Sanitation is very relevant to this WQI theme since about 80% of the water which people consume end up as wastewater, including sewage and septage. Unless this wastewater is treated, they will pollute the waters and thus substantially contribute to the degradation of the Bay's water quality.

Sanitation is not just about providing people with toilets. More importantly, it includes the treatment of what goes into the toilets and the septic tanks or the sewer lines. Unlike the MDG when sanitation was merely defined as having basic toilets and septic tanks, in the SDG, this definition has now been expanded to now be "improved sanitation" meaning the sewage or septage is treated, either on-site or off-site.

It is precisely due to the fact that there is very limited sewage and septage treatment capacity in Metro Manila, Region 3 and Region 4A that domestic wastewater substantially contributes to the pollution of the waters within the Manila Bay area. No wonder no less than the President himself recently referred to Manila Bay a "cesspool".

3.2 Proposed short-list of targets and indicators

An analysis of the above-mentioned indicators of the OPMBCS show that quite a number of them are actually input indicators which will be useful to measure progress towards achieving the objective of water quality improvement of the Manila Bay. Among others, this includes:

- Output 1.9 Nutrient Load from crop lands within the Manila Bay region determined
- Output 1.14 on Water Bodies/Estero within the Manila Bay Region Adopted
- Output 2.2 Solid Waste Management Plans (SWMPs) prepared and approved
- Output 2.7 Institutional set-up for solid waste management within LGUs established/ strengthened.

This is not to say that the above-mentioned outputs in the OPMBCS are not important and will not be monitored. As earlier mentioned, they refer to steps or actions that are needed to be able to achieve the desired outputs and outcomes. However, in order to actually achieve the objective of water quality improvement, it is initially

recommended that focus be on the following more strategic indicators which adequately reflect the various aspects of water quality improvement:

Table 6: Focus of Water Quality on more strategic indicators

Focus	Indicator
Improved and sustainable Manila Bay water quality suitable for its intended beneficial use	▪ Percentage of water bodies that meet the water guideline values ▪ Reduction of pollution load from baseline ▪ % of solid waste that is properly managed

3.2.1 Role and function of indicators in analysis and planning process

If water quality improvement is to be achieved so that the sustainable development can be attained, it is important that all water bodies that drain into the Manila Bay actually meet the water quality required for their specific classification. In addition, of course the Bay itself must meet the water quality criteria for a class SC coastal marine water body. If they do not, then the source of the pollution must be identified and appropriate actions should be planned for and implemented.

It is critical that pollution loads going into all these concerned water bodies are either avoided or substantially reduced. This means that 100% of households must be served by either a sewerage or a septage treatment facility and that effluents from point sources such as institutional buildings, commercial and industrial establishments (including piggeries, poultries and other livestock farms) meet the appropriate effluent standards. It also means that nutrient loading from agricultural run-offs are substantially reduced. Equally important is to prevent or reduce the pollution loading from ships/boats that ply the Bay involving those regulated by MARPOL, namely oil, noxious liquid substances in bulk, harmful substances carried by sea in packaged form, sewage, garbage and even air pollution.

If ecological solid waste management as prescribed by Republic Act (RA) 9003 is properly and strictly implemented, then solid waste will no longer or will hardly contribute any pollution load to the Bay. Thus, it is important to monitor the percentage of solid waste that is collected and properly disposed of in sanitary landfills. What should be collected is just the residual waste which should be a small percentage of the total waste generated since biodegradable waste materials are supposed to be composted while recyclable and reusable waste materials must be recycled or reused accordingly. If ecological solid waste management is effective then waterways must be free from obstruction and drainage canals/ waterways are no longer clogged. If the number or percentage of waterways and drainage canals that are obstructed and clogged by solid waste remains high then it simply indicates that solid waste continue to be indiscriminately thrown in the streets and any water body.

The number of open dumpsites is also an important indicator since the leachate from open dumpsites eventually find their way and pollute either the groundwater or any nearby surface water. RA 9003 required that all open dumpsites must be converted to controlled dumpsites within 3 years of the effectivity of the law and that all controlled dumpsites must be closed within 5 years of the effectivity of the law. The law took effect in 2005, so these deadlines have long passed. There should be no open dumpsites operating now. In its place should be properly operated and maintained sanitary landfills with sufficient provision for leachate collection and treatment, as well as soil cover to prevent the waste materials from being blown away by the wind.

4 Problem Analysis (Base Case)

4.1 Description of present situation

4.1.1 Water Quality

4.1.1.1 Water Quality Monitoring Strategy

Water quality monitoring (WQM) for inland waters is primarily conducted by the regional offices of the Department of Environment and Natural Resources – Environmental Management Bureau (DENR-EMB). Other agencies conducting independent monitoring include the Department of Agriculture – Bureau of Soil and Water Management (DA-BSWM), Laguna Lake Development Authority (LLDA), and the Pasig River Rehabilitation Commission (PRRC). Additional monitoring is done once a particular watershed, river basin or water resource region, has been designated as a Water Quality Management Area (WQMA) by the DENR and National Water Resources Board (NWRB).

With the present monitoring strategy, there is an intensive monitoring of rivers and tributaries within the Manila Bay Area including Pasig River and Laguna Lake. BOD, nutrients and other physical parameters of major river basins have been established with most historical data collected since the Mandamus was issued in 2009. However, there is limited information on the water quality particularly on the organic and nutrient loadings of the coastal waters of the bay itself. Even if the pollution from agricultural run-offs and discharges from livestock are part of the Mandamus Order, baseline surveys on these are yet to be done and are part of the OPMBCS 2017-2022. Except for the regular monitoring of bathing beaches along the coast of Bataan and Cavite, there is limited information on how the Bay is assimilating the increasing organic and nutrient discharges coming from the different sub-basins of the Manila Bay Area.

The present coverage of WQM done by these agencies within the Manila Bay Area (MBA) is presented in Table 7 below.

Table 7: Agencies involved in Water Quality Monitoring within the Manila Bay Region.

Agency	Coverage Area	Coverage Period	Frequency
DENR-Environmental Management Bureau (EMB) Regional Offices	16 major river systems within the MBA	2011-2015 (from MBEA)	Quarterly
	14 river outfalls within the MBA	2011-present (from MBDS**)	Quarterly
DA-Bureau of Soil and Water Management (BSWM)	Pampanga, Bataan, Cavite and Pasig River Basins	2012-2014 (from MBEA)	Quarterly
Laguna Lake Development Authority (LLDA)	Laguna de Bay	1973-present	Monthly
Pasig River Rehabilitation Commission (PRRC)	Pasig River Unified Monitoring Stations (PRUMS) composed of 14 sites from Pasig River headwater up to the mouth of Manila Bay	2009-present	Monthly

Source: Manila Bayanihan Database System

4.1.1.2 Water Quality Monitoring Results: Physical Parameters

The trend of total suspended solids (TSS) in most inland waters is generally increasing indicating the impact of siltation from agricultural activities, urban runoff and various land development projects and deforestation particularly in the upstream basins. The current water quality guideline for TSS is 80 mg/l for Class C and 50 mg/l for Class B.

Major River Systems. The results of the monitoring of the physical parameters for 2011, 2014 and 2017 in the 16 major rivers in Manila Bay Area are compiled in the Manila Bay Atlas. The following observations are presented below:

- The TSS levels of most rivers in NCR increased from 2011 to 2014 but decreased by 2017 and all stations are within the water quality criteria for Class C.
- Compared to 2011, the monitoring of TSS in 2017 showed lower values with range of 20-40 mg/L. Based from the 2017 data, the pH and TSS of all Region III rivers are within the standards for Class B and C.

- For Region IV-A, TSS concentration of all the stations decreased from 2011 to 2014 but increased in 2017. TSS values are within the Class B and C water standards except for Ylang-Ylang River.

Pasig River. In general, the TSS of the stations along Pasig River decreased from 2010 to 2016 except in Buayang Bato, Guadalupe Nuevo, Guadalupe Viejo and Havana Bridge where the TSS increased. In 2010, 4 stations failed to meet the standards for Class C and 9 stations did not meet the standards for Class SB. Meanwhile in 2016, all the stations met the TSS limit for Class C and SB except for stations in Buayang Bato, Guadalupe Nuevo, Guadalupe Viejo and Havana bridge that exceeded the TSS limit for Class SB. With these values, there might be a need to correlate the amount of silts deposited along the rivers as these sediments are regularly flushed out into Manila Bay especially during heavy rains when stream flow velocity and scouring of bottom sediments are high.

Laguna Lake. In 2009 and 2013, all the stations have pH level of greater than 8. By 2016, pH in east bay and central bay decreased to 6 while the remaining stations remained greater than 8. The pH range of the tributary rivers of Laguna lake was measured to be 7 to 8. Total suspended solids are not being monitored in the lake. Mention what it should be based on WQG.

Sub-watershed. All the watersheds have measured TSS of <0.1 mg/L, way below the limit for Class A water.

Coastal/Bathing Beaches. In 2017, all the stations in Region 3 and Region 4A have total suspended solids greater than the standard limit for Class SB. It was also observed that there was a high increase in the TSS level in most of the stations from 2014 to 2017. All the stations in NCR were consistently meeting the TSS limit since 2011.

River Outfall. Only the stations in the Obando River and Talisay River have TSS level above the standard limit for Class C. Most of the stations have measured TSS that decreased from 2014 to 2017.

Marine Water. There is an increase of pH level in the monitoring stations in Manila Bay. In 2009, the pH range is 7 to 8, while in 2017, the pH range is 7 to 9.

4.1.1.3 Water Quality Monitoring Results: Organic Contaminants

Sewage produced by the increasing population in the region are not accommodated by the existing sewerage systems. Most still rely on septic tanks which only removes 10 to 30% of the BOD, especially since most are not properly managed. With this, untreated (direct discharge) and partially treated sewage (effluents of septic tanks) are received by drainage, creeks, major rivers and including Laguna Lake. Increased sewage disposal in water bodies are correlated with the BOD and dissolved oxygen (DO) of the receiving bodies of water.

Most of the monitoring results from Pasig River and other major basins confirm the impact of untreated sewage to the quality of the river waters. For Laguna Lake, however, the reported BOD from 2008 to 2016 remain low and most dissolved oxygen readings are high still meeting the water quality criteria for Class C water despite the increasing urban development and inadequate wastewater infrastructure within the Laguna Lake sub basin.

Major River Systems

- From 2011 to 2017, the DO concentrations in the rivers in NCR and Region 4-A decreased while the rivers in Region 3 have increased DO. Rivers in the NCR already have zero DO by 2014 while the rivers in Regions 3 and Region 4-A met the minimum limit of DO for Class C.
- In 2017, all the rivers in NCR and Region 4-A have measured BOD5 values of greater than the limit for Class C that is 7 mg/L. Only Talisay and Angat Rivers in Region 3 complied with the Class C limit. All the rivers have increased BOD from 2011 to 2017.
- All river stations in Metro Manila has oil and grease concentration above the 2 mg/l, majority registering values greater than 5 mg/l.

Pasig River

- The Pasig River has an average DO concentration of 2-3 mg/L in 2016, below the minimum for Class C. The stations in Sevilla and Havana bridge have constant DO concentrations of below 1 mg/L from 2009 to 2016.
- Four stations (Buayang Bato, Guadalupe Nuevo, Guadalupe Viejo and Havana Bridge) have BOD5 of greater than 100 mg/L. Almost all the stations have BOD5 that increased from 2009 to 2016. Only the Manila Bay station has BOD5 of 5 mg/L.

- Oil and Grease in the river increased from 2010 to 2016. All the stations did not meet the criteria for Class C. Havana bridge station has the highest concentration of O&G.

Laguna Lake

- All the stations are constantly meeting the minimum DO concentration of 5 mg/L for the past years.
- The 2016 monitoring of Laguna lake revealed that the measured BOD5 of all the stations is below the Class C limit of 7 mg/L. Range of the BOD5 is 1-3 mg/L.
- Only the Central bay station has O&G of greater than 2 mg/L, the limit for Class C. All the remaining stations have <2 mg/L O&G concentration.
- Only 11 of the 21 major tributary rivers of the Laguna lake have DO of greater than 5 mg/L.

Coastal/Bathing Beaches

- All the stations in NCR have dissolved oxygen below the limit in 2017 and were observed to have low dissolved oxygen since 2011.
- Stations in Region 3 and Region 4A have DO levels of 6-7 mg/L from 2011 to 2017.

Marine Water

- The DO concentrations of all the stations increased from 2009 to 2017. There's a decreasing trend on the DO concentration in each station from top to bottom. Only four stations conformed with the minimum DO concentration of 5 mg/L from top to bottom.

4.1.1.4 Water Quality Monitoring Results: Nutrients

Within the region, nutrients may come from sewage, industrial wastewater, aquaculture, and agricultural runoff particularly from fertilizers. The current General Effluent Standards now imposes limits on nutrients for discharges and trade effluents. This stricter requirement on discharges was influenced by the increasing nutrients such as phosphate and ammonia monitored by EMB in rivers increasing threats to aquatic life.

Major River Systems

- The rivers in Region 3 and Region 4-A have nitrate concentration of below 1 mg/L since 2011. The nitrates in the rivers in NCR increased from 2011 to 2014 but decreased by 2017, meeting the standard limit of 7 mg//L.
- Only Talisay, Angat and Pampanga River have measured phosphate that is below the limit of 0.5 mg/L in 2017. It was observed that the rivers in Metro Manila have high concentration of phosphates that is greater than 10 mg/L in 2014 but decreased to 2 mg/L by 2017 Nitrates in Region 4-A also increased in 2017.
- Ammonia levels in Region 3 rivers are way above the 0.05 mg/l limit with most stations reporting more than 20 mg/l. There is a need to verify if the values reported are consistent with the units of the standard presented in mg/l NH3-N. In Region 4-A, ammonia in Ylang-Ylang and Canas River is below the 0.05 mg/L limit.

Pasig River

- In 2016, the average nitrate concentration in Pasig River is 4.96 mg/L and the highest was measured at Havana bridge. Five stations failed to meet the 7 mg/L standard for nitrate. Nitrate concentration decreased from 2009 to 2014 then increase from 2014 to 2016.
- Phosphates in the monitoring stations are above the standard limit of 0.5 mg/L except in Manila Bay station. In 2016, highest phosphate was measured at the Guadalupe Nuevo station. The phosphate concentrations in all the stations constantly increased from 2009 to 2016.
- All the stations failed to confer with the ammonia limit of 0.05 mg/L. There are four stations that have ammonia concentration of greater than 4 mg/L.

Laguna Lake

- Nitrate concentration in the stations were all below the limit. However, it was observed that the nitrate concentration increased from 2009 to 2016. All the tributary rivers of Laguna lake also have nitrate concentration of below 7 mg/L.
- All the stations also complied with the standard for phosphate. The same was true with almost half of the tributary rivers to Laguna Lake.

Coastal/Bathing Beaches

- Only the stations in NCR have available data on nutrients. Measured nitrate in NCR stations are below the standard limit for Class SB. This is also true for the measured phosphate concentrations in the stations.

River Outfall

- In 2017, only the San Antonio de Abad station exceeded the nitrate limit for Class C.
- Phosphate level in the stations were mostly decreasing however, all the stations in NCR and in Imus and Ylang-ylang River have high phosphate concentrations. Only stations in Pampanga and Talisay River complied with the phosphate standard.

Marine Water

- In 2014, the measured phosphate concentration in all the stations are above the limit of 0.5 mg/L. Average phosphate concentration in the Manila bay is 1.3 mg/L.

4.1.1.5 Water Quality Monitoring Results: Heavy Metals

Heavy metals monitored from rivers may indicate discharges from industrial activities. The EMB monitoring showed increasing concentrations of cadmium, chromium and lead in some stations along Pasig River.

Pasig River

- Results of 2009 monitoring showed that all the stations have below detection limit for cadmium. However, by 2014, the cadmium concentration increased and exceeded the limit.
- Chromium concentration measured in all stations is above the detection limit of 0.01 mg/L.
- Lead concentration in the stations decreased from 2009 to 2014. However, in 2014, only 2 stations (Sevilla bride and Lambingan bridge) have lead concentration below the detection limit.
- There was a high increase of mercury in all monitoring stations from 2009 to 2014. In 2009, the mercury concentration measured was below 0.0003 mg/L. But in 2014, the mercury increased up to 0.05 mg/L.

4.1.1.6 Water Quality Monitoring Results: Pathogens

Presence of high number of coliforms was observed in almost all the river stations of EMB including those monitored by LLDA with values exceeding the water quality criteria. This indicates the contamination of most inland waters with coliform posing health risks to surrounding communities especially during flood events where sewage-contaminated river water overflows to streets.

Pasig River

- All the stations exceeded the Class C (former criterion from DAO 34) for total coliform. The highest value was monitored in Guadalupe Nuevo station in Makati City along Pasig River.
- All stations also exceeded the fecal coliform for Class C and SB. Highest fecal coliform was measured in Guadalupe Viejo station.

Laguna Lake

- All the stations have fecal coliform that is below the 200 MPN/100 mL limit of Class C. It was observed that the measured fecal coliform decreased from 2009 to 2016.
- All tributary rivers draining to Laguna Lake exceeded the WQS for total and fecal coliform with Tunasan River registering the highest fecal coliform reading.

Sub-watershed

- All the watersheds exceeded the limit for total and fecal coliform. It was observed that there was a large increase in the fecal coliform reading of the watersheds from 2011 to 2014. This may be due to the disposal of sewage and wastewater from agro-industrial within the watersheds.

Bathing Beaches

- All the coastal beach monitoring stations contain high level of fecal and total coliform exceeding the standard limit. The stations in NCR were observed to have the highest measured coliforms. This indicates that the bathing beaches are not safe for human contact.

4.1.2 Water Supply

4.1.2.1 Water Supply for National Capital Region

Water supply by itself belongs to inclusive growth since most of those who do not have access access to water are the poor segments of society. Its relevance to the theme of Water Quality Improvement is because of the fact that about 80% of the water that people consume end up as wastewater, part of which is sewage. If the wastewater is not treated, then providing more water means there will also be more pollution.

Within the Manila Bay area, the areas served by the two concessionaires of MWSS have increased access to water from 40% to 90% of about 15 Million people in Metro Manila including parts of Rizal and Cavite provinces. Service provision outside the areas covered by the 2 concessionaires are served by any of the following: Water Districts, LGU-run water systems, Rural and Barangay Waterworks and Sanitation Associations (RWSA and BWSA) and Water Cooperatives.

Table 5: Areas and Population served by a Water Service Provider (WSP).

AREA	Population Served
NCR	15,690,265
Region 2	18,555
Region 3	1,147,341
Region 4A	727,930
TOTAL	17,584,091

With an estimated total population served in the Manila Bay Areas of 17,584,091 and applying a per capita demand of 100 liters per day, the computed domestic water demand is about 642 million cubic meter (MCM) per year. If 80% will become wastewater, that's 513.5 million cubic meters (MCM) per year of wastewater that needs to be treated.

4.1.3 Sanitation

4.1.3.1 Sanitation in NCR

In the NCR, septage management services or sanitation services is assumed to be available to 100% of the current service connections of the two concessionaires. Per the concession agreement, the concessionaires are also required to continuously build their capacities in terms of septage or sludge collection and treatment based on the programming of the desludging activity of the scheduled customers per each year. Ideally, 20% of the total projected service connections should be scheduled or programmed in a year. However, only 30% to 40% of the scheduled customers are served, the rest are unserved or have opted to sign a waiver. The waiver basically says that the customer is relinquishing his claim on the desludging service that he paid for and releases the concessionaire from the responsibility of providing the service.

4.1.3.2 Sanitation in Manila Bay Areas Outside NCR (Regions 2, 3 and 4A)

There are several operational septage management services in the provinces of Laguna, Bataan, Pampanga and Bulacan. These are listed in Table 6 below. The rest of the Manila Bay areas are assumed to be serviced by private desludging companies who may or may not be legally and environmentally compliant in their operations.

4.1.3.3 Extent of open defecation

From the total Bay Area population of 30,753,511, about 1.03% or 316,761 still have no toilets and presumably practice open defecation.

4.1.3.4 Number of unsanitary toilets

From the total Bay Area population of 30,753,511, about 1.79% or 550,488 are still using unsanitary toilets.

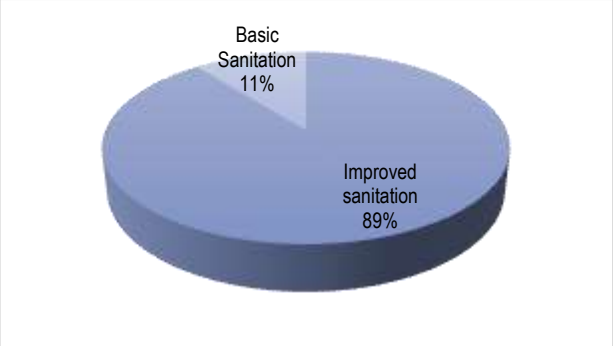


Figure 1. Percentage of improved sanitation vis a vis basic sanitation.

4.1.3.5 Septic Tank Access

Majority (80%) of the households in the Manila Bay Area have sanitation facilities that have septic tanks to collect and pre-treat their toilet wastewater (black water). However, most of the septic tanks installed have poor designs and are not regularly being desludged, resulting in low treatment efficiencies or no treatment at all. The effluent of these septic tanks is discharged either directly into the drainage system, which will eventually flow into the bodies of water, or in the sewer lines which will be conveyed to a treatment plant for further treatment. For households that do not have septic tanks, their toilet wastewater is either discharged directly to the drainage or to the sewer lines.

4.1.3.6 Sewerage Coverage

On the other hand, wastewater from other household activities (greywater) either flows directly to the drainage system or to the sewer lines. From the sewer lines, the wastewater is supposed to flow to the treatment plant prior to disposal.

In Metro Manila, there are established sewerage areas operated by the two water concessionaires of MWSS. Maynilad Water Services Inc. provides sewerage services to its customers in West Manila while Manila Water Company Inc. provides the services for East Manila. At present, only 7.1% of the population in the Manila Bay Area have sewer connections. These areas are in Metro Manila and some municipalities in Cavite and Rizal.

Maynilad has 30 Sewage Treatment Plants (STPs) with a combined treatment capacity of 542 MLD while Manila Water has 41 STPs with a total capacity of 312 MLD. The location and capacities of the STPs owned and operated by Maynilad and Manila Water are shown in the Annex. With the existing facilities of Maynilad and Manila Water, only about 27% of the wastewater generated within the Manila Bay Area is being treated.

Other than the sewerage services, Maynilad and Manila Water also offers sanitation services, such as desludging of septic tanks and treatment of collected septage, to its customers who are not connected to the sewer system. Outside Metro Manila, there are also some water districts that provide septic tank desludging services to its customers. Other provinces that have septage management are Nueva Ecija, Bulacan and Laguna. The collected septage are transported to their Septage Treatment Plants (SpTP) for proper treatment prior to disposal. In addition, there are some private sector desludgers. But where they bring what they desludge and whether this is treated is unknown. The table in the Annex details the septage management in Manila Bay Area.

4.1.4 Wastewater from Economic Activities

Wastewater from economic activities includes commercial/institutional wastewater and industrial wastewater. Most of commercial or institutional establishments generate wastewater that have the same quality as domestic wastewater. They are either discharged to the sewer lines or they have septic tanks to collect their wastewater. Some establishments that generate large volume of wastewater such as schools, hotels or malls, have their own wastewater treatment plant to treat their wastewater prior to discharge to the drainage or to bodies of water. Since the Mandamus Order, DENR now strictly requires this of all commercial, industrial and institutional establishments. Table 8 below shows a list of identified operating manufacturing economic zones within the Manila Bay Area and indicates those that have a Centralized Wastewater Treatment Facility.

Table 9: List of operating manufacturing economic zones within the Manila Bay Area

REGION	PROVINCE	ECONOMIC ZONE	NO. OF LOCATORS
NCR	Muntinlupa	Amkor Technology SEZ	
	Pasig	Asahi SEZ	

REGION	PROVINCE	ECONOMIC ZONE	NO. OF LOCATORS
	Taguig City	Food Terminal Incorporated SEZ	
	Pasay City	MacroAsia Ecozone	
	Manila	Manila Harbour Centre	
	Caloocan City	Victoria Wave SEZ	
3	Bataan	Hermosa Ecozone Industrial Park*	11
		Plastic Processing Center SEZ	
	Bulacan	Sta. Maria Industrial Park	
	Pampanga	Angeles Industrial Park	
		Alveria Industrial Park	
		Clark Special Economic Zone	9
		Clark TI Special Economic Zone	
		Pampanga Economic Zone	
		TECO Economic Zone*	8
	Tarlac	Central Technopark	1
		Luisita Technopark	
4A	Batangas	AG&P Special Economic Zone	
		Cocochem Agro-Industrial Park	
		First Philippine Industrial Park*	129
		First Philippine Industrial Park II	
		Keppel Philippines Marine SEZ	
		Light Industry & Science Park III	64
		Light Industry & Science Park IV	
		Lima Technology Center	101
		First Industrial Township – SEZ	
		Tabangao Special Economic Zone	
	Cavite	Cavite Economic Zone*	406
		Cavite Economic Zone II*	
		Cavite Technopark-Special Economic Zone	13
		Daiichi Industrial Park*	17
		EMI Special Economic Zone	1
		First Cavite Industrial Estate	126
		Gateway Business Park*	27
		Golden Mile Business Park	30
		Golden Gate Business Park-Cavite Export Processing Zone	5
		People's Technology Complex	37

REGION	PROVINCE	ECONOMIC ZONE	NO. OF LOCATORS
		Suntrust Ecotown Tanza	18
	Laguna	Calamba Premiere International Park	114
		Carmelray Industrial Park I*	51
		Carmelray Industrial Park II*	96
		Carmelray International Business Park	2
		Filinvest Technology Park Calamba	
		Greenfield Automotive Park	
		Laguna International Industrial Park*	
		Laguna Technopark SEZ*	314
		Laguna Technopark Annex*	
		Light Industry & Science Park I*	80
		Light Industry & Science Park II*	
		SMPIC Special Economic Zone	
		Toyota Sta. Rosa (Laguna) SEZ	
		YTMI Realty Special Economic Zone	

*with Centralized Wastewater Treatment Facility
Source: Philippine Economic Zone Authority, 2018

Compared to commercial/institutional wastewater, industrial wastewater is more toxic and may be considered as hazardous. The volume and characteristics of the industrial wastewater depends on the production process and production rate. Wastewater produced by industries is not limited to process wastewater; industries also produce domestic wastewater from employees. Industries are required to have their own wastewater treatment plants. However, there are still some industries and commercial/institutional establishments that discharge their wastewater directly to the drainage system without any treatment.

Unfortunately, at present, data on the wastewater generated and discharged (in terms of quality and volume) by these point sources remain with the regional offices of the EMB and are not collated and analyzed in the central office. It is thus difficult to have an overview of the extent of the pollution loading coming from all these point sources within the Manila Bay area. This remains a gap which should be addressed.

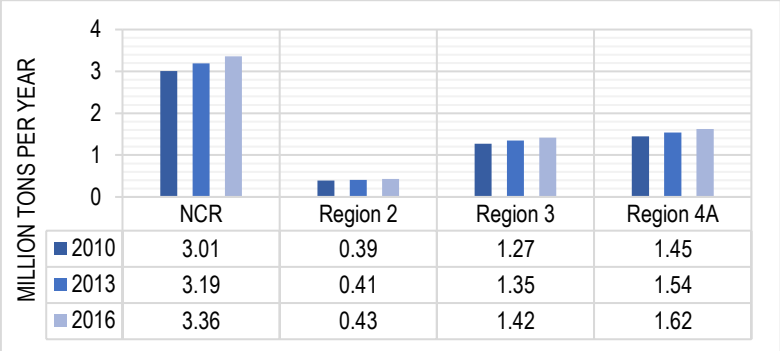
4.1.5 Solid Wastes

Pollution brought about by inadequate solid waste management (SWM) is a major contributor to the water quality of the creeks, estero, rivers and the Manila Bay. Domestic, commercial, and industrial activities generate solid wastes (i.e., garbage) that enter the Bay directly or via river and drainage systems. Solid wastes can impair ecosystems and habitats, deteriorate aesthetics, and pose public health risks . They also aggravate the flooding problem since they clog the pumping stations rendering them inoperable.

Amount and Composition. Crucial in effective SWM is waste characterization, which is conducted to identify the materials that comprise the municipal solid waste (MSW) stream within the jurisdiction of a local government unit (LGU).

Comparative information on the MSW generation in the whole of NCR, Region 3 (Central Luzon), and Region 4A (CALABARZON) are presented in the figure below. The 2010 are based from the National Solid Waste Management

Strategy for 2012-2016, citing the National Solid Waste Management Commission (2009) as the primary data source. On the other hand, the 2013 and 2016 data are taken from the NSWMC Online Database, last updated on June 14, 2018.



	NCR	Region 2	Region 3	Region 4A
2010	3.01	0.39	1.27	1.45
2013	3.19	0.41	1.35	1.54
2016	3.36	0.43	1.42	1.62

Figure 2: Annual Solid Waste Generation in Four Regions (2010, 2013, 2016)

The figure below illustrates the typical composition of MSW generated in the Philippines.

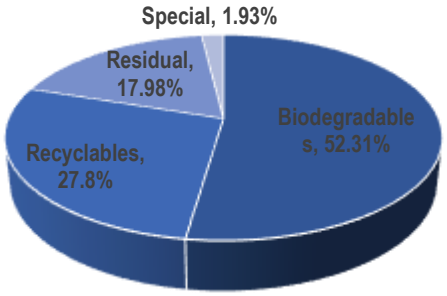


Figure 3: Typical Composition of MSW in the Philippines (2008-2013)

As presented, about half (52.31%) of MSW generated in the country is considered biodegradable – with kitchen/food waste comprising the 86% and yard/garden waste, 14%. Additionally, more than a quarter (27.78%) of MSW is recyclable – with plastic packaging accounting for 38%; paper and cardboard for 31%; and metals, glass, textile, leather, and rubber account for the remaining 31%. Fundamentally, these two waste fractions, collectively accounting for 80% of total MSW generated, can be diverted, leaving only the residuals (17.98%) and special wastes (1.93%) for appropriate treatment and final disposal.

Local Solid Waste Management Plan

Under the RA 9003, every city/municipal LGU, through its Local SWM Board, is mandated to develop and oversee the implementation of the Local SWM Plan, which shall ensure the long-term management of solid waste and integrate the various SWM plans and strategies of the barangays in its area of jurisdiction. As of 2018, 162 (or 83%) of the 195 LGUs identified to comprise the MBA have duly submitted a 10-year Local SWM Plan to the NSWMC. However, only 76 (or 47%) of the submitted plans have secured official approval, and 11 (or 7%) of the submissions may already be considered obsolete (i.e., submitted before 2008) as of this writing.

Materials Recovery Facility

The establishment of a Materials Recovery Facility (MRF) in every barangay or cluster of barangays is mandated under the RA 9003 to receive, sort, process and store compostable and recyclable materials in an efficient and environmentally sound manner, thereby reducing the amount of MSW for final disposal. A total of 1,663 MRFs, serving a total of 948 barangays, currently operate within the Manila Bay Area as of 2018.

Additionally, a number of waste-to-energy facilities operating within the MBA also contribute to the diversion of mostly biodegradable wastes, such as rice husks and hulls and other agricultural by-products, as well as selected wastes from sanitary landfill facilities (SLFs).

Table 10. Operating waste-to-energy facilities within the Manila Bay Area (2018)

REGION	PROVINCE	LOCATION	OPERATOR	WASTE PROCESSED
NCR	Metro Manila	Muntinlupa City	Restored Energy Development Corp.	Rice husk
		Quezon City	Pangea Green Energy Philippines Inc.	Payatas SLF waste
3	Bataan	Samal	Bataan 2020 Inc.	Rice hull
	Bulacan	Bocaue	Hypergreen Energy Corp.	Rice husk
	Nueva Ecija	San Jose City	V. S. Gripal Power Corp.	Rice husk
			San Jose City I Power Corp.	Rice husk
		Talavera	Green Innovations for Tomorrow Corp.	Rice husk
	Pampanga	Mabalacat	Green Atom Renewable Energy Corp.	Rice husk
	Tarlac	Tarlac City	Asian Carbon Neutral Power Corp.	Agricultural biowaste
4A	Rizal	Rodriguez	Green Alternative Technology Specialist, Inc.	Rodriguez SLF waste
			Montalban Methane Power Corp.	Rodriguez SLF waste

Solid Wastes Disposal Facility

Any practice or disposal involving the use of open dumpsites is prohibited under the RA 9003. Conversion of open dumpsites into controlled disposal facilities was allowed only until 2006 as a temporary and remedial measure. Nevertheless, all over the country, many open and controlled disposal facilities remain to be in operation at present. As of 2018, there are 52 open dumpsites and 16 controlled disposal facilities still operating within the MBA alone. Majority (37) of the existing open dumpsites are located in Region 3, largely in the provinces of Nueva Ecija and Pampanga, while the remaining 15 are found in Region 4A, mostly in the provinces of Laguna and Cavite, where most of the controlled disposal facilities also operate. Conversely, there are no recorded open dumpsites and controlled disposal facilities currently in operation in NCR (Metro Manila).

The legally mandated method of final disposal is sanitary landfilling. A sanitary landfill facility (SLF) pertains to a waste disposal site designed, constructed, operated, and maintained in a manner that exerts engineering control over significant potential environmental impacts that may arise from its development and operation.[1] The minimum requirements for the establishment of an SLF are as follows: landfill liner system; leachate collection and treatment; gas control recovery system; groundwater monitoring wells; application of daily cover during operations and final cap over the completely filled landfill; and closure and post-closure maintenance procedure.

As of 2018, there are 15 SLFs currently in operation within the MBA, with nine located in Region 4A, five in Region 3, and the remaining one in NCR.

The list of the existing disposal facilities within MBA is shown below:

Table 11. List of the operational SLFs in the Manila Bay Area (2018)

REGION	PROVINCE	LOCATION	OPERATOR	CATEGORY	DISPOSAL CAPACITY, tonnes/day
NCR	Metro Manila	Navotas City (Brgy. Tanza)	Phil Ecology Systems Corp.	-	1,799
3	Bataan	Abucay (Brgy. Capitangan)	---	-	<15
		Limay (Brgy. St Francis I)	---	-	<15

[1] National Solid Waste Management Status Report, 2008-2014

REGION	PROVINCE	LOCATION	OPERATOR	CATEGORY	DISPOSAL CAPACITY, tonnes/day
3	Bulacan	Norzagaray (Brgy. San Mateo)	Wacuman Inc.	4	2,000
	Nueva Ecija	Santa Rosa (Brgy. Mapalad)	-	-	<15
	Tarlac	Capas (Brgy. Cut-Cut II)	Metro Clark Waste Management Corp.	-	3,000
4A	Cavite	Imus City (Brgy. Pasong Buaya I)	Coldwell Environmental Care Corp.	2	70
	Laguna	City of San Pedro (Brgy. San Antonio)	Pilotage Trading and Construction Corp.	3	200
		Kalayaan (Brgy. Longos)	-	1	3.36
		Paete (Brgy. Ermita)	-	-	-
		San Pablo City (Brgy. Sto. Niño)	-	3	80
	Quezon	Sampaloc (Brgy. Bilucao)	-	1	1.85
	Rizal	Morong (Brgy. San Guillermo)	Basic Environmental Systems & technologies	-	-
		Rodriguez (Brgy. San Isidro)	International Solid Waste Integrated Management Specialist, Inc. (ISWIMS)	-	-
		San Mateo (Brgy. Pintong Bukawe)	New San Mateo Sanitary Landfill/Waste Management Project	4	2,000

REFERENCES: NSWMC Online Database (Last updated on June 14, 2018); DENR-EMB CALABARZON List of Existing Disposal Facilities as of August 7, 2018; Operators' official websites

4.1.6 Toxic Waste

Special wastes in RA 9003 include toxic and hazardous wastes generated by households and commercial establishments such as paints, thinners, household batteries, lead-acid batteries, consumer electronics such as cell phones, television etc. Bulky wastes such as electronic and electrical appliances are also included under the special wastes category. As mentioned, special waste accounts for about 1.93% of the generated municipal solid waste in

the Philippines and typically consists of healthcare waste, waste electrical and electronic equipment (WEEE) and other hazardous materials.

Republic Act No. 6969 (Toxic Substances and Hazardous and Nuclear Waste Act of 1990) calls for the regulation of and restriction on the importation, manufacture, processing, sale, distribution, use and disposal of chemical substances and mixtures that pose risk and/or injury to health and to the natural environment. Only EMB-registered haulers and TSD facilities are allowed to haul out, treat and dispose the special wastes generated. As of 2015, there are 137 accredited haulers and 90 registered TSD facilities within the MBA.

In terms of the management of health care waste in the Philippines, the Department of Health initiated the revision of the existing Hospital Waste Management Manual by the Environmental and Occupational Health Office (EHS-DOH, 2007). The current (Third Edition) Health Care Waste Management Manual released in 2013 aims to promote the use of appropriate technologies and to efficiently communicate the risks associated with health care waste and is intended for the workers within the health care facilities, LGUs and private service providers who are involved in the generation, handling, storage, treatment, and disposal of health care waste. Individuals responsible for managing the health care waste stream are the major target groups of the Manual. According to the DOH official webpage, there are limited numbers of health care waste treatment facilities in the country, most of which are located in NCR and Region IVA.

4.1.7 Forest Ecosytem

The Forest ecosystem will be discussed in detail in the Ecosystem Protection theme. It is relevant to the Water Quality Improvement theme in terms of the extent of the sedimentation of the Bay resulting from the denudation and degradation of the watersheds and from inappropriate cultivation practices in the uplands as well as land development in the lowlands. Sedimentation affects water quality since it increases the total suspended solids in the waters affecting turbidity.

5 System Analysis: Mechanisms driving performance

Below Is a typical diagram illustrating the causes and consequences of Poor Water Quality, including soft factors such as the tendency of politicians to not relocate informal settlers as that may result in loosing votes in the next election. In these diagrams, you also see the connection of the theme to other focal themes; e.g. inclusive growth.

Figure 2: Causes and Consequences of Poor Water Quality.

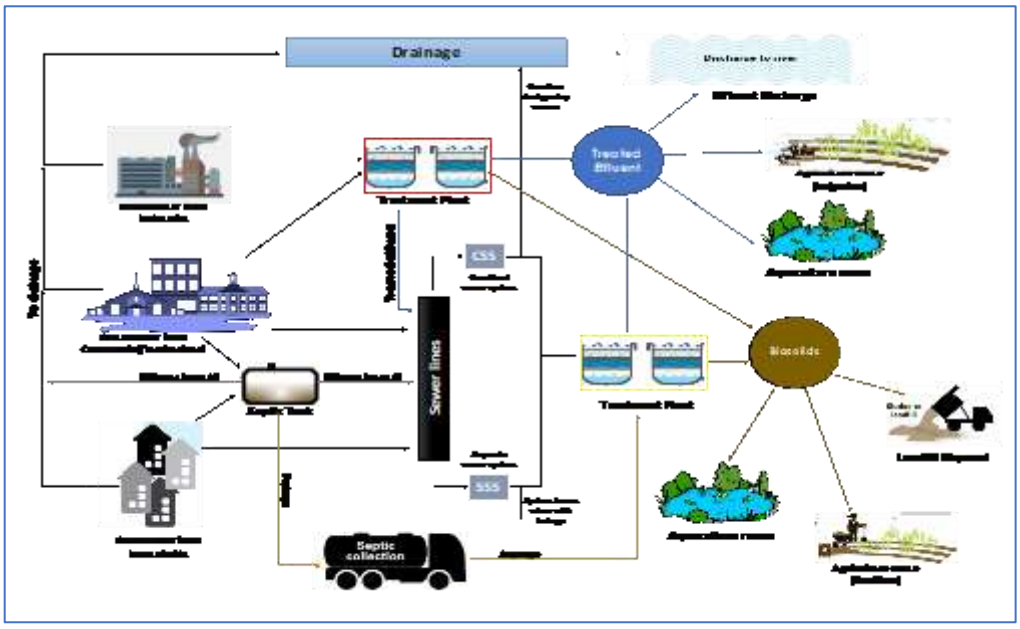


Figure 3: Wastewater Management Map of Manila Bay Region.

6 Scenarios – Forecasting and Management of Uncertainty

[Expected plausible future values for the External Factors considered most influential for system performance, according to the focal theme. Scenarios can be derived from relevant policy context such as the Philippine Development Plan. Explicit mention of time horizons per external factor: The time horizon(s) for the study – 2022, 2030, 2040 and outlook 2100.]

6.1 Projections of Wastewater from Domestic Sources

The volume of domestic wastewater generated within the Manila Bay Area was estimated and projected until 2050. It is assumed that 80% of the water consumed per capita was converted to wastewater. It is also assumed that the population living in urban areas has a unit consumption rate of 160 lpcd while 80 lpcd for those living in rural areas. It was estimated that 3.1 Million cubic meter of wastewater is being generated per day in the MBA in 2018 wherein almost 42% is from Metro Manila.

Presented in the following table is the projected daily domestic wastewater generation per province in Manila Bay Area.

Table 12: Projected Daily Domestic Wastewater Generation within the Manila Bay Region.

Region	Province	Wastewater Generation m^3/day				
		2018	2022	2030	2040	2050
NCR	Metro Manila	1,303,031	1,398,934	1,617,116	1,949,075	2,364,057
Region 2 and 3	Nueva Vizcaya	1,820	1,922	2,145	2,460	2,822
	Bataan	65,434	70,995	83,574	102,477	125,656
	Pampanga	226,856	247,427	294,474	366,395	456,372
	Bulacan	302,375	334,678	410,006	528,438	681,079
	Nueva Ecija	159,190	170,361	195,110	231,161	273,875
	Tarlac	70,726	75,422	85,769	100,722	118,281
Region 4A	Cavite	340,164	395,806	535,881	782,622	1,142,971
	Rizal	299,042	343,158	451,874	637,413	899,134
	Laguna	276,150	309,484	388,708	516,839	687,206
	Batangas	65,766	72,028	86,399	108,459	136,151
	Quezon	4,760	5,048	5,678	6,576	7,617
TOTAL		3,115,319	3,425,267	4,156,738	5,332,641	6,895,224

The volume of wastewater generated depends on the population living in the area, activities and the characteristics of the location (urban or rural). People in urban areas generally consume more water because they have more accessible water supply than those living in rural areas. In general, as incomes increase, consumption goes up and so does waste generation.

6.2 Projections of Solid Waste Generation

The subsequent table presents the estimated total MSW generation in the MBA comprising of 195 city and municipal LGUs within 13 provinces. It was estimated that in 2018, 20,586 tonnes per day of solid wastes are being generated within MBA and was projected to increase to 28,818 tonnes per day by 2050.

Table 13: Projected Total MSW Generation in the Manila Bay Region (By Province).

Region	Province	Projected MSW Generation (tons/day)				
		2015	2018	2022	2030	2040
NCR	Metro Manila	8,054	8,489	9,113	10,534	12,701
Region 2	Nueva Vizcaya	10	10	11	12	14
Region 3	Bataan	356	378	410	483	592
	Pampanga	1,427	1,523	1,663	1,981	2,470
	Bulacan	1,842	1,988	2,201	2,696	3,475
	Nueva Ecija	1,085	1,142	1,222	1,400	1,658
	Tarlac	486	510	543	618	726
Region 4A	Cavite	2,194	2,458	2,860	3,872	5,654
	Rizal	1,567	1,738	1,994	2,626	3,704
	Laguna	1,757	1,914	2,145	2,694	3,581
	Batangas	472	505	554	664	834
	Quezon	30	31	33	37	43
TOTAL	12	19,279	20,686	22,748	27,616	35,451

NOTE: Projections were generated using latest available (2015) baseline information from NSWMC (per capita waste generation) and PSA (average annual population growth rate).

Out of the solid wastes generated, it was projected that about 80% of the solid wastes generated in 2018 to 2022 can be recovered and will increase to 90% by 2030 to 2040. Such wastes that can be recovered are biodegradable and recyclable wastes.

Wastes can also be diverted to reduce or eliminate the amount of solids wastes from the waste disposal facilities. Diversion activities include the processing, composting, recovery and recycling of collected materials from the MSW stream. Based on the report in Philippine Development Plan for 2017 to 2022, the waste diversion rate (or the percentage of MSW diverted out of the total generation) for the baseline year of 2015 is at 48% for LGUs in Metro Manila and 46% in LGUs outside of Metro Manila. The rate is expected to increase to 80% by year 2022 and be sustained until 2050. It can be noted that the target diversion rate is almost equivalent to the percentage of MSW with potential for recovery.

The projected amount of solid wastes (i.e. residual and special wastes) that are to be disposed in shown in the table below. The figures are derived from the total MSW generation estimates and the combined share of residual and special materials (i.e., 19.91%) in the overall MSW composition in the Philippines.

Table 14. Projected Total MSW for Disposal in the Manila Bay Area (By Province)

Region	Province	Projected MSW Generation (tons/day)					
		2015	2018	2022	2030	2040	2050
NCR	Metro Manila	1,604	1,676	1,769	1,955	2,187	9, 723
Region 3	Aurora	8	9	9	10	11	49
	Bataan	71	75	80	90	102	462
	Bulacan	367	395	428	495	578	2,657
	Nueva Ecija	223	232	245	272	306	1,366
	Pampanga	284	295	316	357	407	1,841
	Tarlac	1,303	1,380	1,465	1,634	1,845	748
	Zambales	14	14	15	17	19	85

Region	Province	Projected MSW Generation (tons/day)					
		2015	2018	2022	2030	2040	2050
Region 4A	Batangas	94	96	104	120	139	640
	Cavite	437	469	517	615	737	3,454
	Laguna	350	371	403	468	550	2, 537
	Quezon	6	6	7	7	8	37
	Rizal	312	338	372	440	525	2,448
TOTAL		5,073	5,354	5,729	6,479	7,415	26,046

NOTE: The figures are derived from the total MSW generation estimates and the combined share of residual and special materials (i.e., 19.91%) in the overall MSW composition in the Philippines.

6.3 Projections of Pollution Loadings

Mass pollution load in terms of Biological Oxygen Demand (BOD) and Total Phosphorus (TP) from major wastewater discharges in the Manila Bay were estimated. The major sources considered were from domestic, agricultural and industrial sources. Total BOD and Phosphorus pollution loads generated and discharged from these sources were computed per province within the Manila Bay Area and projected for 2022, 2030, 2040 and 2050.

Domestic Pollution Load. The total pollution load generated from domestic wastewater was computed based on the population. The waste load production per capita used was 10 g-BOD/capita/day for grey water and 20 g-BOD/capita/day for black water. For total phosphorus, waste production rate used was 1.5 g TP/capita/day for grey water and 0.8 g TP/capita/day for blackwater. The total BOD and TP load generated can be reduced by treating the wastewater prior to disposal.

For the population that is covered by a sewerage system, a reduction of 95% is assumed. Maynilad and Manila Water offer sewerage treatment services to its water customers. The population with sewer connections are projected based on the target percent sewer coverage of the two water concessionaires in their service areas, as shown in the table below. By 2037, 100% sewer coverage is targeted by both sewerage service providers.

Table 15. Target Percent Sewer Coverage of Maynilad and Manila Water.

Service Provider	Service Areas	Target percent coverage			
		2021	2026	2031	2036
Maynilad Water Service Inc.	West Zone of Metro Manila, Province of Cavite	47%	68%	87%	100%
Manila Water Services Inc.	East Zone of Metro Manila, Province of Rizal	39%	65%	90%	99%

For population that is served by septic tanks as pre-treatment of wastewater prior to discharge, a BOD reduction of 30% was estimated if the septic tanks are covered by septage desludging and treatment while 10% reduction if not. The percentage of population per province that have septic tanks range from a low of 57% in Quezon to a high of 97% in Mandaluyong City. It is projected that every year, the population with septic tank increases by 1% until all reaches 100% by 2040.

For the water customers of Maynilad and Manila Water that do not have sewer connections, sanitation services are being offered such as desludging of septic tanks and treatment of the collected septage. Some provinces such as Nueva Ecija, Bulacan and Laguna also implements septage management in some of their areas. The septage management from these provinces are operated by the water districts. It is estimated that by 2022, 80% of the population of the provinces with septage management will have their septic tanks desludged while for 2030 until 2050, it is assumed to be 100%. Regular desludging of septic tanks increases the capacity of the septic tanks to decrease the BOD content of the wastewater.

In 2018, it was estimated that the annual BOD and TP load discharged from domestic wastewater is 371,935 MT/year and 30,100 MT/year, respectively, With the existing sewage treatment facilities in MBA, about 13% of the BOD load and 8% of the TP load generated were reduced in 2018.Total BOD load discharged in 2022, 2040 and 2050 are estimated to be 352, 262 MT/year, 409,693 MT/yr and 499,786 MT/yr, respectively, while for TP load are 27,257 MT/yr, 30,038 MT/yr and 34,272 MT/yr, respectively. And with the plans of increasing the sewerage connections and septic tanks within MBA, the BOD and TP load can be reduced by 35% in 2050.

Metro Manila was observed to be the highest contributor on the total BOD and TP load discharged. However, there will be a high decrease of BOD and TP load from Metro Manila starting 2030 because of the 100% sewer coverage target of Maynilad and Manila Water. The figure below shows the relation of the BOD pollution load and the number of sewer connections in Metro Manila. The higher the number of sewer connections, the greater the reduction of the BOD generated thus, the BOD discharged decreases.

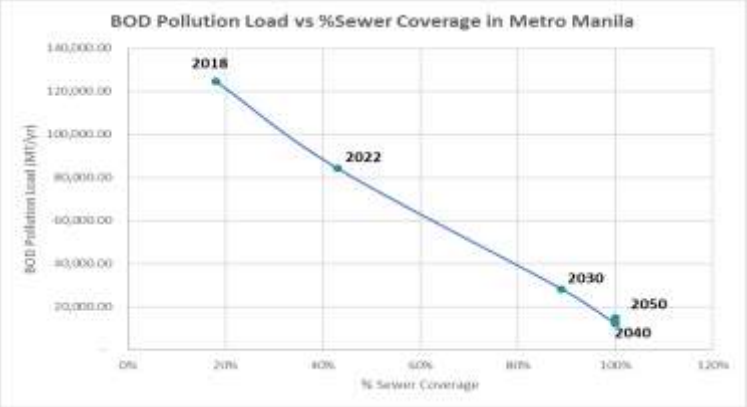


Figure 6: Relation of BOD Pollution Load vs Sewer Coverage in MM.

7 Summarizing and Concluding Problem Statement for Water Quality Improvement

Figure 7 illustrates a typcial illustration of the environmental and anthropogenic drivers of water quality in the MBA. The key drivers of water quality condition in the MBA particularly the bay waters include climate change, population and economic development activities. Climate change especially the increase in rainfall will trigger accelerated soil erosion and landslides that usually generates large amount of sediment materials that are deposited into rivers, lakes, coastal and marine areas with deleterious impacts on critical ecosystems. Increase in temperature enhances the sea surface temperature that contributes to coral bleaching and depletion of DO in water. Increase in temperature and changes in rainfall could also alter the water balance in a basin and could also induce degradation of physical and biological properties of water.

Population growth is closely related to increasing economic activities that is usually associated with increasing demand for water, generation of wastewater and solid wastes that degrade water quality in rivers, lakes and the bay. This is either attenuated or amplified by existing policies governing the use of land and other natural resources. Enforcement of related environmental laws and regulations pave the way for the the better control of development activties in the direction of minimizing adverse impacts on water and ecosystems. In reality this is however not the case as the existence of what many consider good laws in the country are so poorly enforced to the detriment of not only water quality but moreso of the pursuit of broader development goals.

In the MBSDMP, the improvement of enabling environment for a more wilfull enforcement of laws and regulations by the LGUs and more robust interagency collaboration should be a prominent strategy. Specifically, enforcement of laws and regualtions governing the use of land and water, waste management and diligent and comprehensive assessment of environmental impacts of any and all development projects should be given utmost considerations. Likewise addressing the dearth of fresh and dynamic datasets and information systems on water resources and ecosystems should gain serious attention as an enabling strategy for better policies and management decisions.

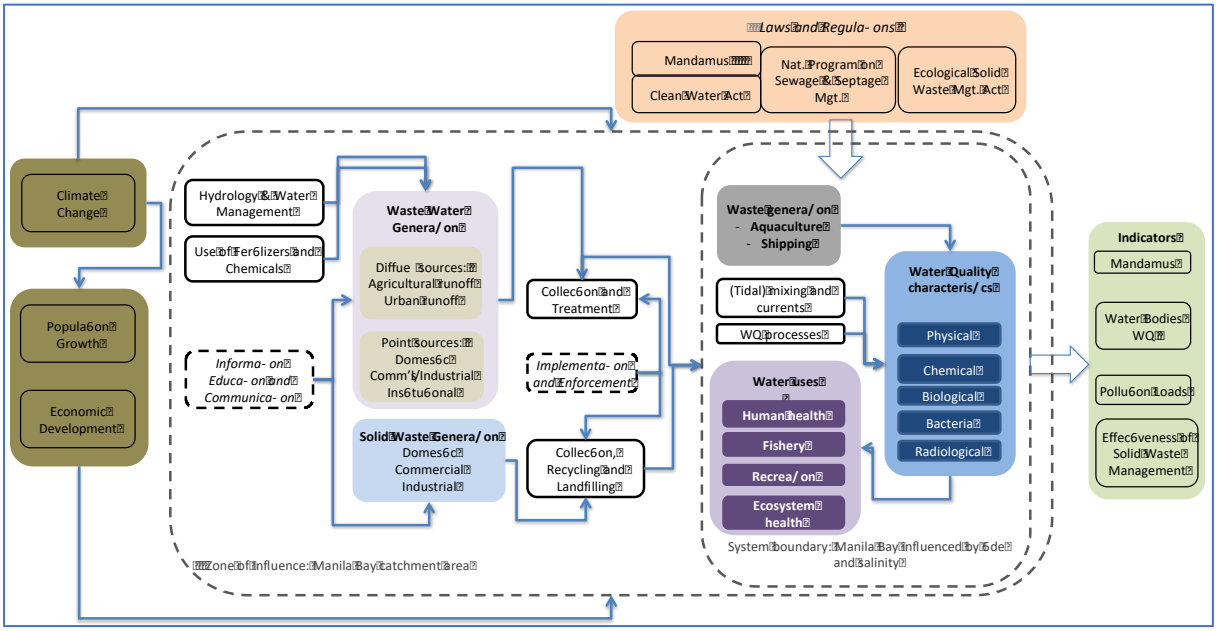


Figure 7. Typical diagram of drivers of water quality in MBA.

7.1 Relationships to Other Focal Themes

7.1.1 Linkage to Inclusive Growth

The Bay is a multiple use water body used for navigation, recreation and fisheries. Many fishing communities who live along the shorelines of the Bay are among those who live below the poverty line. A substantial number are also informal settlers. They largely depend on the productivity of the bay for their livelihood and for their own nutrition. This can be through artisanal fishing or through aquaculture like the culture of mussels.

The pollution of the Bay has led to the reduction in the productivity of the Bay. The catch per level of effort has been declining meaning less income for the fisherfolks. This reduces their capability to have food on the table, send their children to school, have access to healthcare and other social services and generally improve the quality of their lives. At the same time. communities living along the shores of Manila Bay, many of whom are informal settlers are at risk to health problems due to polluted bay waters. These issues are central to the theme of Inclusive Growth.

7.1.2 Linkage to Upgrading Informal Settlements

Informal settlers are usually the ones who have no access to sewer connections, to sewage and septage treatment facilities or to regular solid waste collection. They thus defecate openly or wrap their feces in paper or plastic and throw them into the nearest water body to where they live, be it a river or the bay itself. They also throw their solid waste anywhere, be it the streets, any drainage canal or any water body – most of which end up in Manila Bay. Informal settlements thus contribute much to the degradation of the water quality of the Manila Bay area. Upgrading these informal settlements is part of the strategies for water quality improvement.

7.1.3 Linkage to Ecosystem Protection

The degraded water quality of the Bay is not just due to water pollution from both point and non-point sources. It is also due to activities undertaken in the uplands (the watersheds). This is precisely the reason why the Philippines has adopted the integrated water resource management (IWRM) as the overall framework for managing its water resources. It is acknowledged that what happens on the ridge affect the lowlands and finally, the seas. Thus the continuing deforestation of the watersheds of the Manila Bay area and the resulting increased levels of soil erosion end up as more siltation of the bay, adversely affecting water quality.

Agricultural inputs such as chemical fertilizers and pesticides are washed away by the rains and contribute to increased nutrient levels of the Bay. In addition, the lack of soil conservation measures in agroforestry and agriculture also lead to increased soil erosion. Improperly managed livestock waste also contribute to water pollution. The resulting poor water quality also adversely affects the health of the ecosystem. All these highlight the need for an ecosystem-based approach to protecting the water quality of Manila Bay.

References

Department of Environmental and Natural Resources (DENR) – Manila Bay Coordinating Office (MBCO)

Department of Environmental and Natural Resources (DENR) – Laguna Lake Development Authority (LLDA)

Manila Bay Area Environmental Atlas

Manila Bayanihan Database System

National Water Resources Board (NWRB)