# Part II Water Supply

## Chapter 2. Master Plan

## 13. Environmental Protection Considerations

### 13.1 Main Facilities and Locations

Table 12.1 presents the main facilities and their locations.

### 13.2 Existing Situation

#### 13.2.1 Resettlement

The existence or absence of residential houses in the project sites of the following facilities are presented as follows.

(1) Source Facilities

There are few residences in the general area of the source facilities.

(2) Conveyance Facilities

There are clusters of few residences near the project site.

(3) Treatment plant

- La Mesa III : There are no houses at the proposed treatment plant site.
- Pantay : No houses exist at the proposed treatment plant site.
- Dasmarinas : The proposed treatment plant site is in a farm with no houses.

(4) Reservoir and Pump station

- La Mesa No. 2: There are no houses at the proposed reservoir site.
- Bagbag : There are no houses at the proposed reservoir site.

Table 13.1 Main Facilities

| Name | Location | Remark |
|---|---|---|
| Source Facilities | | |
| Laiban Dam | Kaliwa River, approximately 3 km upstream of Daraitan | Including intake facilities |
| Conveyance Facilities | | |
| Pump Station | Imus, near the junction of irrigation channel and Molino National Road | CWSP. From channel of NIA |
| Treatment Plants | | |
| La Mesa III | In the same place of La Mesa TP. | |
| Pantay | Approximately 1 km west of Mount Tanauan. | |
| Dasmarinas | Imus, along Molino Road and at the southern side of San Miguel Subd. | CWSP |
| Reservoirs and Pump Stations | | |
| La Mesa No. 2 Reservoir | In Novaliches Reservoir | |
| Bagbag Reservoir | In the same place of existing Bagbag reservoir. | |
| Cogeo Reservoir | West of Cogeo Village and approximately 400 m from Marcos Highway. | |
| Antipolo Reservoir | In Rexson Farms along Sumulong Highway | |
| Pump Station No. 1 | Along Sumulong Highway and approximately 400 m south of Marcos Highway. | For pumping up to Antipolo reservoir |
| Pressure Control Station | | |
| Mayamot | Along Marcos Highway and at the southern side of Redemptoinist Seminary | |

- Cogeo : No houses exist at the proposed reservoir site.
- Antipolo : The site is a pasture with an amusement park beside it.
- Pump Sta. No. 1: No houses exist at the proposed pump station site.

(5) Pressure Control Station

The proposed pressure control station site is have many houses and development in the general area is on-going.

### 13.2.2 Economic Activities

At present, no significant economics activities exist in the project sites of the following proposed facilities.

(1) Source Facilities

The site of the proposed facilities is a natural forest with no commercial activities at present.

(2) Conveyance Facilities

The conveyance facilities will traverse open fields with no commercial crops nor commercial enterprises.

(3) Treatment Plants

The proposed Pantay treatment plant site is located in an area with only weeds and a few trees growing. No commercial crops exist. The proposed Dasmarinas treatment plant site is located in an area presently used as pasture.

(4) Reservoirs and Pump Stations

The Cogeo reservoir site is in natural forest with no on-going commercial activities. The proposed Antipolo reservoir site is being used as pasture with a portion being used as an amusement park. Only weeds grow at the Pump Station No. 1 site. No commercial crops exist.

### 13.2.3 Transportation and Daily life

Most of the roads are paved and can accommodate large sized trucks moving in both directions, except along roads at the vicinity of the source facilities.

Vehicular traffic is usually heavy. Many people living in the suburbs but working in the city commute to and from work by cars, buses, jeepneys and tricycles.

The district where Pantay Treatment Plant is planned has a dump site and traffic is heavy due to dump trucks.

### 13.2.4 Interruption to the Community

This item is not relevant to the existing situation except to say that the current communities appear to be stable and to enjoy a reasonably peaceful life.

### 13.2.5 Cultural Assets and Archeology

There are many churches in the whole area but none exist on or beside the sites of the proposed facilities. Neither are there archeological remains at the proposed sites.

### 13.2.6 Water and Common Rights

In Kaliwa River, it is assumed that any problem on customary rights on fishing and irrigation has already been solved around 10 years ago when Laiban dam construction was started.

In Laguna De Bay, the withdrawal of water for drinking water supply may possibly affect the fish farming in the area but problems related to this are assumed to be already solved before the start of the construction of the NIA intake facilities for irrigation.

### 13.2.7 Sanitation and Health

In common with areas outside of the NCR and with squatter areas, no sewerage systems exist in any of the areas surrounding the sites of the proposed facilities.

Unlike in suburban and squatter areas, the sanitary condition in urban areas is relatively good. Most houses have septic tanks and the use of flush toilets is wide spread. Based on 1993 figures, diarrheal diseases, attributable to poor sanitation and undesirable health behavior, is only the

second-largest cause of morbidity (at 919 per 100,000 population) in the NCR. Also, no large incidence of water borne diseases is reported in recent years.

### 13.2.8 Waste

In urban areas, formal collection and disposal is being carried out on wastes which are mostly generated from households. Roads are kept comparatively clean by street sweepers. Garbage, however, can still be seen scattered in rivers, channels and open areas.

Outside urban areas, no frequent waste collection appears to be carried out. Garbage can be seen almost anywhere.

### 13.2.9 Dangers

The dangers faced in the local communities are the same as those in any other urban or suburban areas. These dangers include gun-related crimes because firearms can still be readily obtained and kept. Also included are traffic accidents caused by the heavy traffic volume.

Squatter areas are dangerous especially during the night, but these areas can be easily identified and avoided and, generally, the possibility of meeting danger in any area is of the same level as in any ordinary activity.

### 13.2.10 Topography and Geology

Project sites have different topography. Described below are the topography of the following proposed facilities:

(1) Source Facilities

The elevation of the bottom of the river is approximately 210 - 220 m, and both banks have sharp ravine where rocks are exposed.

(2) Conveyance Facilities

The project site is along Molino National Road, has an elevation slightly above 40 m, and has a gentle slope. This site is located near the concrete-lined channel of the NIA irrigation system in

Cavite. The site is grass covered but the soil and rock below are not known at present. Few houses exist near the site.

(3) Treatment Plants

The Pantay Treatment Plant site has an elevation of about 130 m, has a gentle slope and with few trees. The type of rock and soil cover are not known at present. This site has no houses around it.

The Dasmarinas project site is located along the Molino National Road, has an elevation slightly above 60 m, and is gently sloping and is covered with grass. The type of rock and soil below, however, is still unknown. The site is presently fenced and used as farm.

(4) Reservoirs and Pump Stations

The La Mesa Reservoir No. 2 site is located at the Novaliches Reservoir with an elevation a little above 60 m. The Novaliches reservoir is full of water during rainy days but during the dry season its water level drops such that the bottom of the reservoir becomes exposed. The bottom of the reservoir is covered with mud but can be expected to provide strong foundation based on estimates of exposed ground around it.

The site of the proposed Bagbag reservoir extension is at the open space located beside the exiting reservoir. The reservoir site is fenced and almost the entire enclosed area is covered with weeds.

The proposed Cogeo reservoir and pump station site has an elevation of from 100 to 150 m and is covered with natural forest. The type of rock and soil cover are not known at present but strong foundation can be expected considering that a quarry can be found near the site.

The proposed Antipolo reservoir site is located along the Sumulong Highway and is near the Marcos Highway crossing in Antipolo. The site has an elevation slightly higher than 230 m and has a gentle slope. The type of rock and soil cover at the site are not known at present.

The Pump Station No. 1 site has an elevation a little above 120 m and a gentle slope. The site is in an open field presently used as pasture. The type of rock and soil cover are not known at present.

(5) Pressure Control Station

The proposed pressure control station site along the Marcos Highway has an elevation a little higher than 70 m. By observation of the exposed ground around it, the site can be expected to have a strong foundation. Semi-permanent houses exist in this project site.

### 13.2.11 Soil Erosion

Soil erosion is not known to be a problem in any of the proposed site areas.

### 13.2.12 Ground water

Shallow and deep groundwater, separated by impermeable stratum, exist in Metro Manila. The lower ground water is the one generally used. The shallow groundwater, which is usually drawn using manual pumps, has insufficient quantity and has a high possibility of being polluted by percolating waste water from toilet septic tanks.

### 13.2.13 Lakes, Marshes and Rivers

Presented below are the locations, in relation to bodies of water, of the project sites of the following proposed facilities.

(1) Conveyance Facilities

The project site is located beside a river where the water flows 1.3 km North to the Molino Dam, then overflows to the Zapote River and finally drains to Manila Bay.

(2) Treatment plant

The Pantay treatment plant site is located near the beginning of a creek which is a tributary of the Morong River. The Morong River drains its water to Laguna de Bay.

The Dasmarinas treatment plant site is located beside a creek which drains to the Molino Dam reservoir located 3.5 km north. Water overflowing the Molino Dam flows to the Zapote River then to Manila Bay.

(3) Reservoirs and Pump Stations

The La Mesa Reservoir No. 2 site is located inside the Novaliches Reservoir which is an artificial lake exclusively used by MWSS to temporarily save water coming mainly from the Angat Dam through the Ipo Dam. From the Novaliches Reservoir, water is transmitted to the Balara Treatment Plant.

The Cogeo Reservoir and pump station site is located near a creek from where water drains to the Nanka River, then to the Marikina River, then to the Pasig River and, finally, to Manila Bay.

The Pump Station No. 1 project site is located near a creek from where water also finds its way to Manila Bay through the Nanka River, the Marikina River and the Pasig River.

(4) Pressure Control Station

The Mayamot Pressure Control Station site is located near a creek which is also a tributary of the Nanka River, hence, water from the creek also reaches Manila Bay through the Nanka, Marikina and Pasig Rivers.

### 13.2.14 Coastline and Sea

The coastline and sea are not relevant because their distance from the proposed sites, except for pipelines, is significant.

### 13.2.15 Flora and Fauna

No rare or endangered species of flora or fauna are present in the affected areas as far as can be determined. Observed in the proposed sites are trees and weeds of little use and a few cattle.

### 13.2.16 Weather

The study area climate is characterized by two distinct seasons. The dry season from about November to April which coincides with the north-east monsoon, and the wet season from about May to October which coincides with the south-west monsoon. The average month temperature is about 27 degrees Celsius. January is the coldest month with an average temperature of 25.2 degrees Celsius, while May is the warmest at 29.0 degrees Celsius.

### 13.2.17 View

(1) Source facilities

The view at the proposed dam site is comprised of the river with flowing clean water, the sharp river banks with exposed rocks here and there, and the mountain slope upstream covered with green vegetation retaining its natural and human activity-free appearance.

(2) Conveyance facilities

The view at the irrigation channel towards the rear of the project site is a grass and weed covered ground which gently slopes upward.

(3) Treatment Plant

The Pantay project site is located on a plateau and the panoramic view from it is comparatively good.

Mountains can be viewed towards its northern, eastern and western sides. Visible towards the southern side is the spread of low lying rice fields with weeds and trees.

The view at the proposed Dasmarinas treatment plant site is limited because the site, presently used as farm, is level with the road and is surrounded by high concrete fence. Visible inside the fenced area is a rolling ground covered with green grass and weeds.

(4) Reservoirs and Pump Stations

The view at the site of the proposed La Mesa Reservoir No. 2 changes with the season. During rainy season, what can be seen is a beautiful lake full of water. During dry season , what can be viewed is a less beautiful lake with parts of the muddy bottom exposed.

The Cogeo Reservoir and pump station site can hardly be seen . Visibility is limited by the forest around the area.

The Antipolo Reservoir site, located in a farm with an amusement park, is clearly visible from below at the intersection of the roads along the southern and eastern sides.

(5) Pressure control facilities

The proposed Mayamot pressure control station site is located in a relatively developed area. Visible in front of the site are small wooden houses alongside the road.

### 13.2.18 Air Pollution

Air pollution caused by exhaust fumes is not significant at the proposed project sites unlike at the center of Metro Manila where vehicular traffic is heavy. The not-so-serious air pollution at the sites of the proposed facilities near the Molino National Highway is caused by dust from the unpaved highway and the vehicles going to and coming from the nearby on-going housing projects .

### 13.2.19 Water Pollution

At present, the rivers near the proposed treatment and reservoir project sites are already polluted due to the dumping of garbage and waste water from adjacent residential areas. The water upstream of the Molino Dam is already light brown in color due to heavy inflow of silt into the river. The sparse vegetation and the rapid development in the area possibly contributed to the problem.

### 13.2.20 Soil Pollution

The extent of soil pollution in the relevant areas is difficult to assess but can be assumed to be due to such things as sewage and discarded sump oil etc. .

### 13.2.21 Noise and Vibration

Noise and vibration in the project areas are principally due to vehicular traffic. This is true along the Marcos Highway where the sites for the proposed Antipolo Reservoir and the Mayamot Pressure Control Station are located. Vehicular noise and vibration are also noticeable along the Molino National Highway where conveyance, treatment and storage facilities will be located. An exception is the Laiban Dam area where no road and, hence, no vehicular noise and vibration problem exist at present.

### 13.2.22 Ground Subsidence

Ground subsidence is not a problem at any of the site areas.

### 13.2.23 Noxious Odors

The only noxious odors are those caused by rotting refuse, sewage-polluted ditches and exhaust fumes, and these are mainly limited in areas where there are clusters of houses.

## 13.3 Construction Phase

### 13.3.1 Resettlement

(1) Source Facilities

There are about 10 small wooden houses and a store selling soft drinks alongside the river just downstream of the dam site. These are possibly owned by people cutting down trees and bamboo on the mountain. During construction, these structures will have to be relocated since the area will be used as the plant site or the material storage yard.

(2) Conveyance Facilities

Approximately 0.8 hectares will be needed for the construction of the conveyance facilities, and although the site selection has some flexibility, one or two houses may still have to be relocated.

(3) Treatment Plants

No resettlement will be necessary during the construction of all the treatment facilities. The La Mesa TP No. 3 is located in an open area owned by MWSS, the Pantay treatment plant site is also in an area without any houses. The Dasmarinas treatment plant will be constructed on a farm lot, also without an existing house.

(4) Reservoirs and Pump Stations

The construction of the La Mesa Reservoir No. 2 and the new Bagbag Reservoir will not involve any relocation of houses. These facilities will be installed in open areas inside MWSS property.

On the other hand, the construction of the Cogeo storage and pumping facilities will necessitate the relocation of a few houses. Although the project site is located in an uninhabited forest, the required access road will traverse residential areas with the number of houses to be affected depending on the final plan.

In Antipolo, no resettlement problems are expected during the construction of the proposed Antipolo Reservoir and Pump Station No. 1, however, part of the existing amusement park and fence on the farm lot at the reservoir site may be affected.

(5) Pressure Control Station

During the construction of the pressure control station and its access road, the number of houses that will be resettled will be about ten or more depending on the final site selected and acquired. Site selection is not very flexible and whatever the final site position will be, house relocation will be necessary. Many houses of simple design and of semi-permanent materials exist along the road near the project site.

### 13.3.2 Economic Activities

(1) Source Facilities

A field investigation indicated that forest products related commercial activities are taking place in the general area of the site of the proposed source facilities. Large trucks have been seen hauling bamboo cut down from the mountains. The activities at the vicinity of the source facilities, however, appear to be small-scale ones since the mountains in the area have steep slopes where cutting of bamboo is difficult.

Research on these activities is still suggested before planning and construction.

(2) Conveyance Facilities

The grassy field near the project site is possibly grazed by cattle, however, this field is relatively small so that whatever loss of income the construction of the facilities will cost will not be significant.

(3) Treatment Plant

The effect on income during the construction in the Pantay treatment plant site is expected to be relatively small. The site is not being cultivated, only weeds and a few trees can be found. A few cattle graze in it from time to time.

The Dasmarinas treatment facilities will need a large area. However, the proposed site can be accommodated on a farm, ideally of single-ownership, hence, negotiation for the site acquisition may be relatively easy.

(4) Reservoirs and Pump Stations

The construction at the Cogeo project site will require some felling of trees and the resettlement of some houses to give way for the access road. Since the area is not being cultivated, the effect on income will be negligible.

The Antipolo Reservoir project site is in a farm lot partly occupied by an amusement park. During construction, the amusement facilities may be affected and a traffic problem may be caused by construction vehicles along roads leading to the park. With careful planning, the inconvenience caused by the construction activities may be minimized.

The Pump Station No. 1 site in Antipolo is covered only with grass which is grazed by cattle from time to time, hence, the effect on income during the construction phase is expected to be small.

(5) Pressure Control Station

Some houses and small stores will have to be relocated during the construction of the pressure control facilities and the necessary access road. If a resettlement area can be readied near the project area, the relocation will be relatively easy and the effect on income will not be very significant.

### 13.3.3 Transportation and Daily Life

(1) Source, Conveyance, Treatment, Storage, Pumping, and Pressure Control Facilities

The roads are generally well-equipped, however, the construction materials and equipment will be hauled to the project site usually by bigger but slow-moving trucks, hence, disruption to the local traffic due to construction vehicles is expected.

By careful scheduling of hauling activities and fielding of workers at strategic places for traffic control, the effect on traffic can be minimized. Construction truck movement may be arranged to avoid the morning and evening rush hour traffic. Workers can be assigned not only at the entrance and exit of the construction site but also at nearby traffic jam prone street intersections to help in traffic management.

(2) Pipe Line

The pipe line construction is the main cause of traffic jams and interruptions of the daily life of nearby population. Although the pipes along the main roads are generally laid on the shoulders or sidewalks to avoid roadway pavement breaking and disruption of traffic, there are still cases wherein pipes have to be laid along the roadway itself to avoid obstructions such as electric posts, drainage lines, telephone and other underground utility lines. In these cases, the roadway may be reduced to accommodate only one-way traffic or no traffic at all.

Measures can be taken to minimize the problem. The affected roads may be temporarily closed to one-way or two-way traffic and the vehicular flow diverted to existing side streets or temporary detours. Workers may be fielded to control traffic and signboards erected to provide necessary information to local population and motorists. As much as possible, excavations should be done during night time and immediately covered so as to minimize disruption to day time traffic.

### 13.3.4 Interruption to the Community

Certain unwelcome effects are often associated with construction sites and these can be broadly divided into those caused by the implementation of the project itself and those caused by the work force.

(1) Project Related

Under the first category are disturbances caused by construction traffic, principally noise, dust, vibrations and impediment of traffic flow. There are similar potential problems due to the work carried out on the site itself.

The activity which will cause the greatest disturbance to local communities will be trenching/pipe laying operations. Noise, dust, and obstruction of roadways will be inevitable, and particularly noticeable where the pipeline route passes through.

Countermeasures to be considered should include giving ample warning to each community, detailed planning to minimize the time for trenching, pipe laying, and backfilling. Sprinkling of water may be done in those areas where dust becomes a problem. Walls may be set up as noise dampers especially at the sites of the Cogeo and Antipolo Reservoirs and the Mayamot Pressure Control Station.

(2) Work Force Related

The second category of unwelcome effects, those caused by the work force, embraces increased crime, drunkenness, violence, etc. Countermeasures should include the establishment of a code of conduct for the work force and provision for its enforcement, plus identifying areas for limited or prohibited access.

Positive effects on the local communities are increased trade and the potential opportunity of employment.

### 13.3.5 Cultural Assets and Archeology

A survey of the project sites and the surrounding areas showed no evidence of any significant shrines, churches. No archeological remains are known to exist in the proposed site area.

### 13.3.6 Water and Common Rights

Small scale fishing appears to be taking place in Kaliwa River where Laiban Dam will be constructed and this may be the only common right that may be affected in this area during the construction phase. Fishing may be affected by the concerning works which will increase the disturbed soil being washed by rainfall into the river and also increase the alkalinity of water. However, if this problem should really happen, it will only be for a relatively short time, hence, this problem is expected to be not a serious one.

The construction of proposed facilities in the Antipolo area will cause muddy water in the nearby creeks and the polluted water will find its way to Laguna de Bay where many fish farms exist. The construction caused pollution, however, is insignificant compared to the muddying due to natural causes of the perennially yellow-brown lake water.

### 13.3.7 Sanitation and Health

Effects related to sanitation and health will be primarily caused by the presence of a large number of workers at the construction sites. An adequate number of properly designed and constructed latrines must be provided to ensure that a health hazard is not created that could lead to the spread of water borne diseases. Similarly, adequate living accommodation must be provided if the construction workers are to live on site. Overcrowding in sub-standard make-shift buildings will rapidly create unsanitary conditions.

### 13.3.8 Waste

Construction sites will generate a certain amount of solid waste. Initially it consists of the vegetation that must be cleared from the site areas and this should be stacked in designated locations.

The second source of waste comprises the packaging, crates, wrappings associated with the plant and equipment delivered to the site. Discarded building materials, broken items from construction plant and equipment, old tires, etc. make up the remainder.

To avoid unsightly appearances and to minimize wind blown debris such as sacks, plastic sheeting, paper, etc. from polluting the neighborhood, it will be necessary to provide well designed and located pits. With careful planning the solid waste generated during the

construction phase should not cause any undue harm to the environment. It will be essential however to plan for the ultimate disposal of such materials.

### 13.3.9 Dangers

Dangers are ever present on construction sites, but provided strict attention is paid to establish safe working practices, the risk will be kept to a minimum. Cave-ins during excavation pose a particular threat but no very deep structures are involved in this project. To help reduce the risks, pipe trenches should be kept open for the shortest possible time.

Some dangers will be present from the storage of fuels and lubricants for the construction plant and equipment. Adherence to fire regulations and provision of correct fire fighting equipment will reduce the problem to acceptable levels.

### 13.3.10 Topography and Geology

None of the structures at any of the construction sites are large enough to cause significant changes in the topography. The geology of the areas will be completely unaffected.

### 13.3.11 Soil Erosion

During the construction phase there is some potential for soil wash-off to occur but, generally, this cannot be classified as soil erosion as the quantity of soil involved will be minimal.

### 13.3.12 Ground Water

Some water will be obtained in the vicinity of the main construction sites from ground and/or surface waters for concrete production, etc. The quantities will be relatively small and should have no noticeable effect on the environment.

### 13.3.13 Lake, Marshes and Rivers

The Pantay treatment plant and the Cogeo reservoir will be constructed near tributary streams which are expected to receive rainfall washed soil from the construction sites. If detailed investigation will show that this muddy water will be significantly large compared to the natural caused muddy runoff from adjacent areas, regulating ponds to control the runoff may be constructed as a countermeasure.

Muddy runoff from the Dasmarinas treatment plant construction site may not significantly change the present state of the Molino Dam water located downstream of the site. Even during fine weather, the irrigation water at the Molino Dam is yellow-brown in color.

The La Mesa Reservoir No. 2, which will be constructed at the Novaliches reservoir, may not significantly cause any muddy water during the construction phase. The excavation works likely be done during dry months when the water at the construction site is at its lowest level. Also, the Novaliches reservoir is exclusively used by MWSS, therefore, no other users will be affected if ever there will be a problem.

### 13.3.14 Coastline and Sea

None of the construction sites are near the coast and none of the construction activities will have any secondary effects that could have an impact on coastline or sea.

### 13.3.15 Flora and Fauna

As far as can be ascertained, there are no rare or endangered species of plants or animals inside or at the vicinity of the construction sites. However, site clearance and construction of the intake, treatment and storage facilities will certainly eradicate and permanently exclude any larger forms of plant or animal life within their confines.

The noise and disturbance caused by the presence of the work force, plant and equipment may frighten nearby animals. However, there are no large scale livestock industries are to be found close to any of the construction sites and therefore no significant impact is expected from this effect.

Some animal life may be attracted to the construction sites, notably scavengers such as rats and crows. The unwelcome increase in these populations can be restricted by ensuring they are denied access to food waste from site canteens, etc.

### 13.3.16 Weather

The proposed project is too small to have any effect on the weather. Only very large projects such as irrigation schemes or the creation of a vast reservoir will have any weather related effect during the construction phase.

### 13.3.17 View

Generally, the structures to be constructed at the projects sites are relatively small compared to the surrounding areas. No major institutions, residential or recreational areas will have their view impaired by the proposed structures some of which will be partly or completely hidden by trees in adjacent areas.

### 13.3.18 Air Pollution

Potential sources of air pollution during construction are the exhaust gasses from site vehicles, plant, generators, etc., wind blown dust and smoke from the burning of rubbish, and measures can be taken to minimize or eliminate the problems they will have on the environment. Exhaust fumes should be rapidly dispersed. Dust, normally caused by vehicle movements on unmade site roads and from exposed spoil heaps under windy conditions, should be damp down using equipment which should be made available in areas where this problem is foreseen. Smoke from rubbish burning should be an intermittent and short lived event.

### 13.3.19 Water Pollution

The potential for polluting nearby surface or groundwater is one of the main environmental threats posed by the construction activities. This could occur in a number of different ways. Site clearance and excavation plant will disturb the ground and may lead to soil being washed into nearby watercourses. Where necessary, ponds should be constructed to prevent significant pollution from this source.

Trenching work for the laying of the transmission mains could pollute nearby ditches, etc. and care must be taken not to block such drainage channels with spoil heaps. Large spoil heaps on the main construction sites must be carefully located to minimize the risk of rainfall washing soil into nearby watercourses.

None of the construction activities themselves will cause pollution of the groundwater in the area. However, fuel and oil storage tanks for construction vehicles, generators etc. should be located in impermeable ponds to prevent contamination from spillage or leaks. Similarly, vehicle repair and servicing facilities should be equipped with properly designed surface drainage to prevent hydrocarbons being washed into nearby waters. Collection of wastewater from these

areas to a central point and treatment via a simple API separator before disposal should reduce such problems to an acceptable level.

### 13.3.20 Soil Pollution

The only potential sources of soil pollution during the construction phase of the project will be sewage from the construction work force and spillage of fuel and oil. Provided the preventive measures detailed above are carried out, no significant problems should occur.

### 13.3.21 Noise and Vibration

Noise will be unavoidable from vehicles and construction plant at the project sites. This problem will be generally more noticeable from pipelaying activities. Measures have to be taken to minimize the problem especially at the Bagbag Reservoir, Antipolo Reservoir and Mayamot pressure control station sites which are fairly close to residential areas. Careful planning should also result in shortening the duration of noise disturbance to a number of institutions which will inevitably be found along pipeline routes. Effective silencers should also be provided to all engines to minimize their noise output regardless of their location

The severity of vibrations caused by the operation of heavy plants and vehicles will depend on the ground conditions. If pilings are required, the method should be carefully selected such that the effect of vibration to the population near the construction sites be kept to acceptable levels..

### 13.3.22 Ground Subsidence

Ground subsidence, generally caused by excessive groundwater abstraction, will not likely to take place at the project sites since construction related groundwater abstraction will not be very significant.

### 13.3.23 Noxious Odors

Noxious odor problems during the construction phase will be caused possibly by exhaust fumes, burning plastics and rubbers etc. and rotting wastes, but preventive measures can be taken to avoid their occurrence. The exhaust fumes will be rapidly dispersed and will likely never reach concentration levels to cause a nuisance. The type of rubbish that may be burned can be

controlled and thereby prevent problems from that source. Rotting waste can also be avoided by ensuring that such materials is collected and removed from site to a designated disposal pit.

## 13.4 Operation Phase

### 13.4.1 Resettlement

The operation of the treatment plant and pump station will not require any further resettlement of people.

### 13.4.2 Economic Activities

There should be no effect on economic activities when the treatment plants and pump stations are in operation, though it may be argued that the increased provision of water could indirectly enhance economic growth in the supply area.

### 13.4.3 Transportation and Daily Life

Some traffic will be generated by the existence of the treatment plants and pump stations, mainly due to vehicles for maintenance and delivery of chemicals. It will however be minimal and should not affect the movement of local vehicles.

In the future, pipeline maintenance may cause temporary traffic problems, if and when it becomes necessary to excavate roadways to locate and repair leaks.

### 13.4.4 Interruption to the Community

No interruption to the community will result from the operation of the intake, treatment, storage and pumping facilities.

### 13.4.5 Cultural Assets and Archeology

There will be no effect on cultural assets or archeology.

### 13.4.6 Common Rights

No common rights will be infringed when the treatment plant and pump stations are in operation.

### 13.4.7 Sanitation and Health

No direct sanitation or health risks will be associated with the components of the project when they are in use. Indirectly, sanitation and health may suffer as a consequence of providing significantly greater quantities of water to the distribution areas considering that, with the exception of a relatively small area of the NCR, there are no existing sewerage systems. The increase in the supply of potable water will lead to an equivalent increase in waste production which, with no acceptable means of disposal, will inevitably lead to greater pollution of the surface and groundwater in certain areas and possibly an increase in water borne diseases.

### 13.4.8 Waste

The only waste generated in any significant quantity in the operation phase will be sludge from the treatment process. The end result of the sludge treatment will be a solid sludge cake which will periodically be dug out of the drying beds for disposal off-site. The final disposal of this sludge presents significant problem because it has no commercial value and, in general, cannot be used as fill material as it has poor load bearing properties.

Solid waste in the form of empty chemical sacks may require disposal, though these may be recycled. This is not considered to be a significant problem provided it is recognized and accommodated long before the plants are put into operation.

### 13.4.9 Dangers

The transportation and storage of chlorine at the treatment plant will constitute the main danger. The transportation danger can be reduced by selecting a delivery route which avoids main population centers. By careful design of the chlorine storage and dosing facilities, the threat posed by these installations can be minimized and any leaks contained.

No other hazardous chemicals will be used or stored on site with the exception of aluminum sulfate (alum). A solution of alum is acidic and safety showers should be provided in the chemical house in case workers get splashed.

### 13.4.10 Topography and Geology

This aspect is not relevant to the operation of the treatment plant and pump station.

### 13.4.11 Soil Erosion

Adequate means for disposing overflows from the treatment plant and the reservoirs should be provided to prevent soil erosion which will possibly occur if the potentially large flows are not conducted safely to suitable watercourses. Creeks with reasonably large stream flows at the vicinity of the treatment plant site and some reservoir sites may prove satisfactory. No such watercourse can be found close to the Antipolo Reservoir site and the problem should be addressed in detail at the earliest opportunity.

### 13.4.12 Groundwater

No effects will be caused to the groundwater by the operation of the treatment plant or pump stations.

### 13.4.13 Lakes, Marshes and Rivers

Withdrawal of water from Laguna de Bay for Cavite area water supply will have negligible effect on the lake. The Cavite area average daily requirement of about 480 thousand $m^3$ is very small compared to the

Laguna de Bay capacity of approximately 900 million $m^3$. However, a potential problem will be with the fish pond owners. During the operation phase, particularly during dry season, the gate facilities used to prevent the inflow of sea water from Manila Bay to the lake may be used more frequently to minimize the salinity of irrigation and drinking water supply. This may not be acceptable to the fish pond owners who may prefer higher lake water salinity.

With the La Mesa Reservoir No. 2 already constructed and operating inside the Novaliches raw water reservoir, the capacity of the raw water reservoir will be reduced, however, this reduction will be negligible. The surface area of Novaliches reservoir when full is approximately 300 ha. and, during dry season , about 1/3 to 2/3 smaller. This area will still be significantly larger than the area occupied by the new treated water reservoir which is only about 5 ha or 1.7% of it Considering also that Novaliches reservoir is exclusively used by MWSS, no other users will be effected during the operation of La Mesa Reservoir No. 2.

### 13.4.14 Coastline and Sea

The operation of the treatment plant and pump station is not relevant to this item.

### 13.4.15 Flora and Fauna

No effects will be caused to the flora and fauna by the operation of the treatment plants, reservoirs, pump stations or the pipelines.

### 13.4.16 Weather

The volume of stored water upstream of Laiban Dam will be 650 x $10^6$ $m^3$ which will form an apparently big lake which will likely increase rainfall and therefore affect the weather. The other facilities are relatively small to affect the weather.

### 13.4.17 View

Generally, the constructed structures will be relatively small compared to the surrounding areas. No major institutions, residential or recreational areas will have their view impaired during the use of the new structures some of which will be partly or completely hidden by trees in adjacent areas.

### 13.4.18 Air Pollution

The only possible cause of air pollution would be an escape of chorine gas. The careful design of the chlorine storage and dosing facilities will minimize this risk.

### 13.4.19 Water Pollution

In general, between 5 percent and 8 percent of the flow entering a treatment plant will be discharged as wastewater from the sedimentation and filtration stages. The exact amount will depend on the design and efficiency of the settled sludge removal system, the frequency of filter washing and the quantity of water needed for each wash.

The design proposed for the new treatment plant incorporates a washwater return system to the plant inlet, thereby recycling a significant portion of the washwater. The solid content of the washwater will then be removed by the sedimentation stage.

Sludge discharged from the sedimentation basins will flow to batch thickening tanks, the thickened sludge will then be discharged to a set of sludge drying beds. The supernatant water from the thickening tanks will be withdrawn for disposal to the stream. Sludge solids will be retained on the beds but a portion of the water will filter through to a series of underdrains. For the underdrains the filtrate will flow to a collection chamber and from there to the stream. The water remaining in the sludge will be evaporated by the action of wind and sun, leaving a dry sludge cake which has to be removed periodically for disposal off-site.

The worst situation will occur should the drying beds be bypassed for any reason. Under these circumstances the sludge from the sedimentation basins will flow directly to the stream causing a highly noticeable discharge. During the dry season, when the flow in the stream is at its lowest, the majority of the suspended particles may be expected to settle on the stream bed and along its sides before reaching the main river.

Drains and overflows from the chemical house are a potential source of water pollution. An interceptor tank should be provided to collect all such discharges for eventual removal, via a tanker, to an acceptable disposal site.

### 13.4.20 Soil Pollution

None of the operations at the intakes, treatment plants, reservoirs and pump stations will lead to soil pollution.

### 13.4.21 Noise and Vibration

Noise will be generated from the pumps at the intake, transmission, distribution and pressure control facilities. These pumps, however, will be enclosed in buildings and will not be close enough to any residential area or institution to cause nuisance.

No vibration will be caused other than minimal ones from the pump sets and pressure control facilities. These vibrations will not be felt outside of the pump houses.

### 13.4.22 Ground Subsidence

This item is not relevant to the operation of the scheme.

### 13.4.23 Noxious Odors

No noxious odors will be produced.

Table 13.2 Screening Check List

| | Item | Cause | EI | | | Comments |
|---|---|---|---|---|---|---|
| | | | Yes | No | ? | |
| 1 | Resettlement | Land acquisition | X | | | Will be some |
| 2 | Economic Activities | Loss of production from acquired land | | | X | Fruit trees on some sites |
| 3 | Transport | Disruption of local transport by construction traffic and excavations | X | | | Pipeline routes alongside roadways |
| 4 | Separation of Community | From pipelaying activities and work force | X | | | Will be some |
| 5 | Cultural Assets and Archeology | Loss or damage to shrines etc. due to construction activities | | | X | None |
| 6 | Water and Common Rights | Interference with fishing etc. due to construction activities | | X | | Little fishing carried out |
| 7 | Sanitation | Sewage from construction work force | | | X | Depends on adequate latrines |
| 8 | Waste | Construction waste, sludge etc. | | X | | Should be minor |
| 9 | Dangers | Excavation cave-ins, chemicals | | X | | Only minor excavations and two chemicals |
| 10 | Topography and Geology | Changes due to construction | | X | | Only minor structures |
| 11 | Soil Erosion | Soil wash off from sites | | X | | Only little uncovered |
| 12 | Groundwater | Abstraction and pollution due to construction | | X | | Very little to be used if any |
| 13 | Lake, Marsh and River | Abstraction from river | X | | | |
| 14 | Coastline and Sea | Erosion and /or deposition due to construction | | X | | Not close to the sea |
| 15 | Flora and Fauna | Destruction or interference with habitats by construction | | X | | No special species on or near sites |
| 16 | Weather | Structures causing change | | X | | Only minor structures |
| 17 | View | Obstruction due to structures | | X | | Only minor structures |
| 18 | Air Pollution | Exhaust gas emissions by plant etc. | | X | | Not much generated |
| 19 | Water Pollution | Discharge of Wastewater | X | | | Some expected |
| 20 | Soil Pollution | Discharge of wastewater | | | X | Depends on latrines |
| 21 | Noise and Vibration | From site vehicles and construction activities | X | | | Some will occur |
| 22 | Ground Subsidence | Reduction of groundwater level | | X | | Very little if any used |
| 23 | Noxious Odors | Exhaust fumes, rotting waste | | X | | Very little generated |

| Conclusion | Does the development require the implementation of an IEE or EIA ? | YES | NP |
|---|---|---|---|
| | | X | |

Table 13.3 Scooping Check List

| | Item | Eval. | Reasons |
|---|---|---|---|
| 1 | Resettlement | B | Land acquisition for intake and treatment works |
| 2 | Economic Activities | C | Fruit trees on treatment and reservoir site |
| 3 | Transportation and Institution | B | Delivery of plant and pipe laying activities |
| 4 | Separation of the Community | B | Mostly for pipe laying activities |
| 5 | Cultural Assets and Archeology | C | None on sites but some nearby |
| 6 | Water and Common Rights | D | Little fishing, slight at low river flows |
| 7 | Sanitation | C | Maybe at construction |
| 8 | Waste | D | Very little generated |
| 9 | Dangers | D | Slight during excavation |
| 10 | Topography and Geology | D | Only minor structures |
| 11 | Soil Erosion | D | Minor stripped areas for short time |
| 12 | Groundwater | D | Little or none used |
| 13 | Lake, Marsh and River | B | Some impact during low river flows |
| 14 | Coastline and Sea | D | Not near to the sea |
| 15 | Flora and Fauna | D | No rare or endangered species |
| 16 | Weather | D | Only minor structures |
| 17 | View | D | Only minor structures |
| 18 | Air Pollution | D | Only exhaust gasses during construction |
| 19 | Water Pollution | B | Maybe sewage during construction, sludge sometimes during operation |
| 20 | Soil Pollution | C | Possibly from latrines |
| 21 | Noise and Vibration | B | During construction only |
| 22 | Ground Subsidence | D | No activities to cause any |
| 23 | Noxious Odors | D | None generated |

Evaluation Key:

A Serious impact expected
B Minor impact expected
C Uncertain (may become clear on investigation)
D Almost no impact expected, no need for EIA

## 13.5 Conclusions

From the foregoing it may be concluded that:

1) During the Construction Phase

- Major environmental impacts:
  - None
- Minor environmental impacts:
  - Resettlement
  - Transportation and daily life
  - Disruption to the community
  - Water pollution
  - Noise and vibration
- Uncertain environmental impacts:
  - Economic activities
  - Sanitation
  - Soil pollution

2) During the Operation Phase

- Major environmental impacts:
  - None
- Minor environmental impacts:
  - River flow
  - Water pollution
  - Noise and vibration
- Uncertain environmental impacts:
  - None

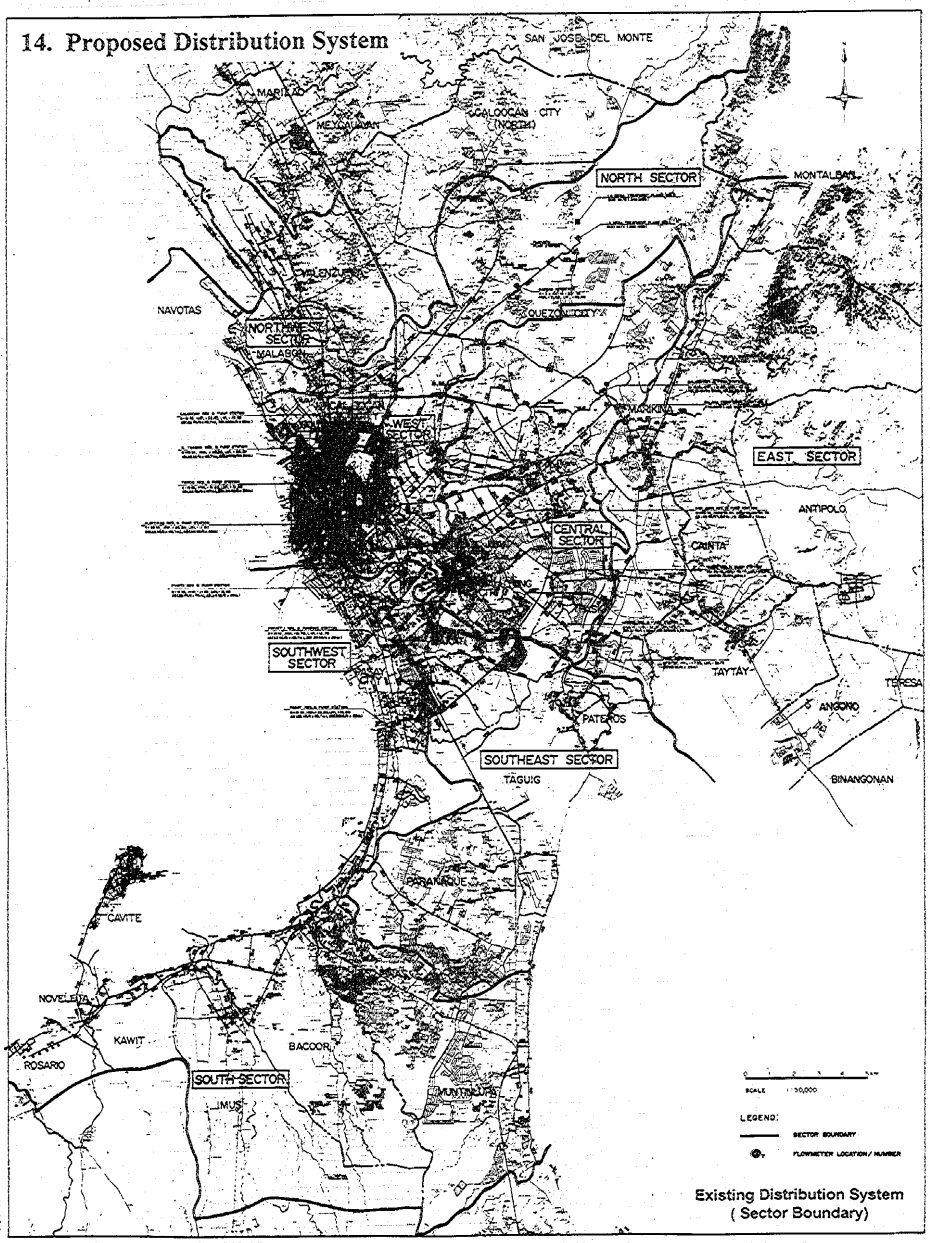
The environmental impacts associated with the construction phase will be of limited duration with the exception of the resettlement requirements. None of them are judged to be serious.

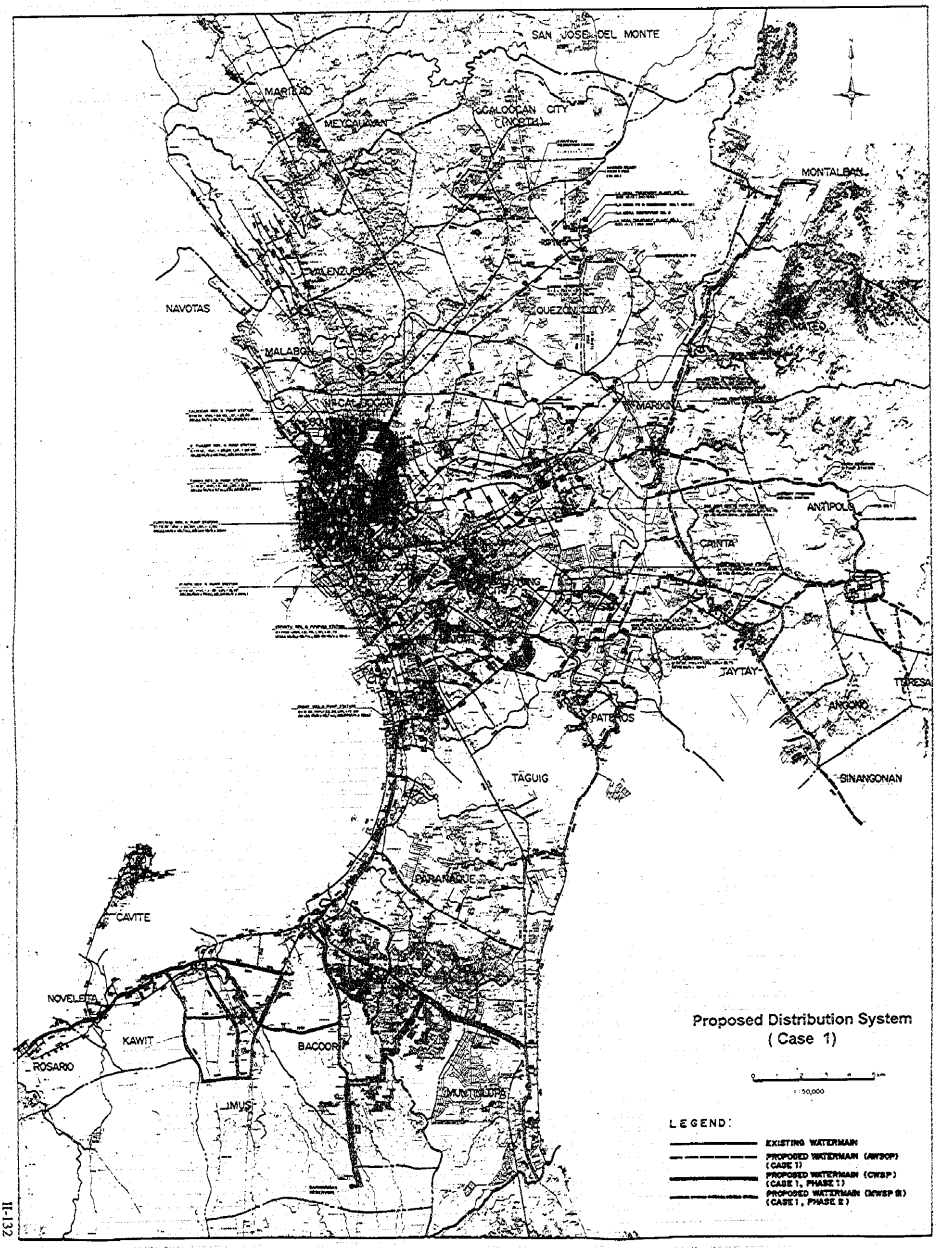
The two factors highlighted for the operation phase of the project will be present for the life of the treatment plant. It should be recognized however that the river flow problem is only likely to occur on rare occasions and can be contained, if necessary, by reducing the output of the plant. The water pollution problem should also occur very infrequently and, at worst, will only

significantly affect the small creeks which run near the project sites. These creeks have no known abstractions and any sludge deposits will be scoured away during the high flows of the rainy season into Laguna de Bay and Manila Bay. No noticeable deterioration is expected in the river water quality at such times as the rivers will also be in flood.

Provided practical countermeasures are taken, the overall conclusion of the EIA is that the effects of both the construction and operation phases will cause no significant or lasting harm to the environment and should not rule against the implementation of the project.

## 14. Proposed Distribution System

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MUNTINLUPA
Proposed Distribution System
( Case 1)
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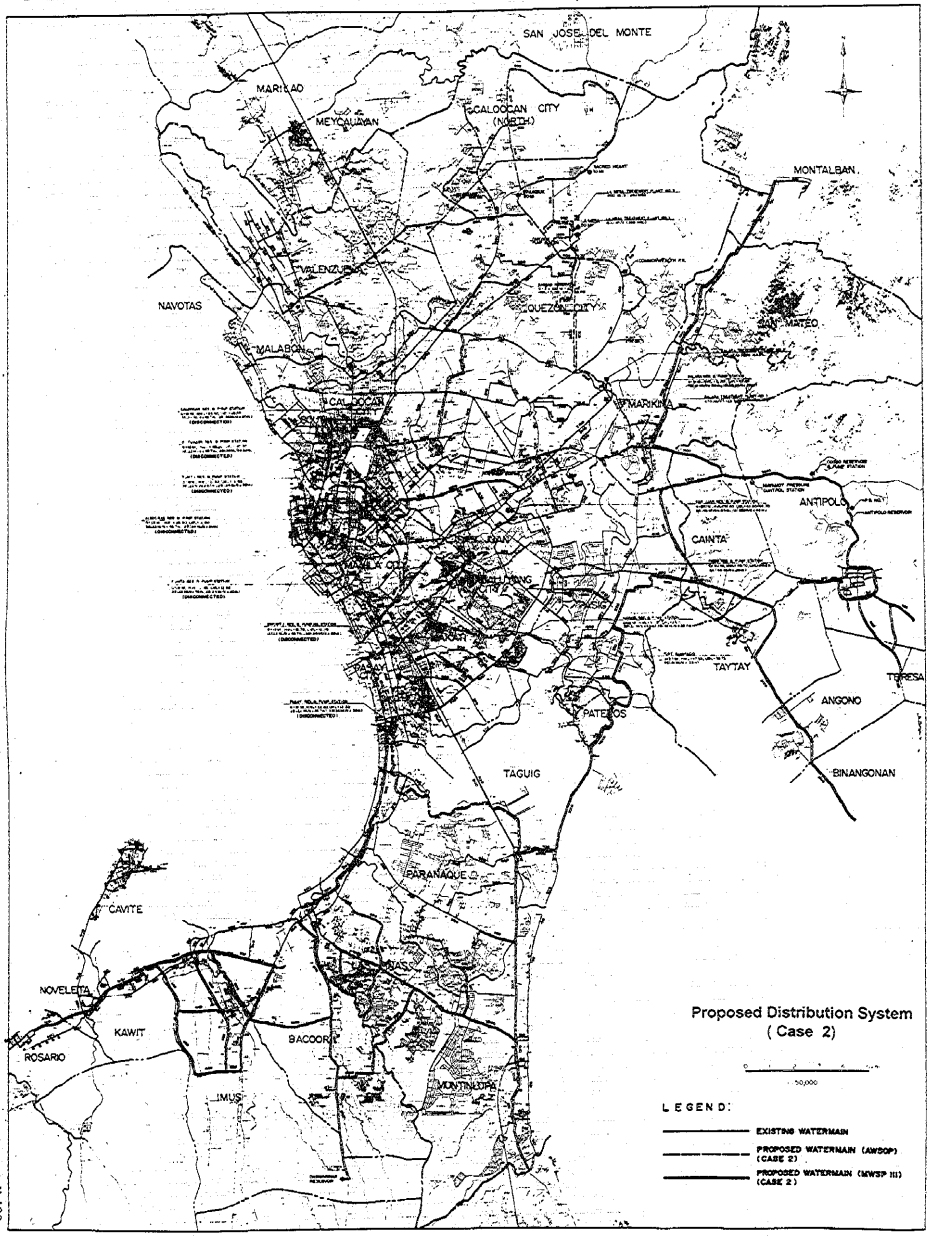
EXISTING WATERMAIN
PROPOSED WATERMAIN (AWSOP) (CASE 1)
PROPOSED WATERMAIN (CWSP) (CASE 1, PHASE 1)
PROPOSED WATERMAIN (MWSP III) (CASE 1, PHASE 2)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PROPOSED WATERMAIN (AWSOP) (CASE 2)
PROPOSED WATERMAIN (MWSP III) (CASE 2)

# Part III

# Sewerage and Sanitation

# Chapter 2.

# Review of Current Conditions

## Chapter 2. Review of Current Conditions

### 2.1 Existing Sewerage/Sanitation and Drainage System

### 2.1.1 Sewerage Systems and Sanitation Facilities

#### (1) Sewerage Systems

There are four sewerage systems in operation in the study area, all under MWSS supervision. These are the Central System, the Ayala System, the Dagat-Dagatan System, and the Quezon City Separate System. The outline of each system, its operating status, and maintenance condition are summarized below:

a. Central System

According to the feasibility study report prepared by ADB consultant in 1991, the Central system covers 2,617 has in the City of Manila, meaning that 68% Manila is connected to the sewerage system. The report stated that the population in the sewer-covered area was 1,186,860 persons, based on the 1980 population. It was assumed that the future population projection of the Central System will be stagnant, meaning there will be no population increase. The population census has shown that the assumption is correct. However, the actual number of households served by Central System is reported at 85,000 as of November 1994, and the estimated population is, therefore, at 690,000 persons calculating the average persons per household at 8.1 persons.

The big difference is due to the fact that more than 500,000 squatters who occupy 30 % of the City of Manila live outside of the sewer-covered area, and that more than 20,000 households within the Central System are not sewer connected.

This system has seven transfer lift stations, one pump station, and a 305 km-long sewer pipe, mostly of vitrified clay, ranging from 200 mm to 1800 mm in diameter. Each lift station has 3-5 submersible wastewater pump, with the Tondo Pumping Station having four vertical mixed flow volute pumps. Two of them are of the variable speed type while the other two are of the fixed speed type with a total maximum capacity estimated at 5 cu.m / s. Wastewater is collected through lift stations into the sanitary sewer pipe to the Tondo Pump Station. The wastewater is then discharged into the Manila Bay, through an outfall without any treatment. Discharge point is 3.5 km off the sea shore .

This system was originally constructed in 1907, and had not undergone any repair since then. Because of the deterioration of the system, old outfall was abandoned. From 1982, METROSS-I was implemented based on the 1979 Sewerage and Sanitation Master plan. Large scale of repair and expansion were completed in 1990. However, many system defects still remained unchecked, such as the lack of flap valves at the overflow pipelines, the unrepaired cracks and leakage along the sewer line, the clogged siphon, to name a few. At present, the existing is again being reviewed under the Manila Second Sewerage Project (MSSP).

One problem that needs addressing is the unconnected or missing service pipes to the sewer main. The numbers are estimated, as of 1991, about 21,000. Although sewer connection is mandatory, the refusal of these households is on the payment for such connection services and the monthly wastewater tariff being charged.

The volume of wastewater volume discharged in 1994 is shown in Table 3.2.1 alongside other treatment plant inflow data. An average of 210,000 cu.m of raw sewage was discharged; and its quality is shown in data report.

**Table 3.2.1 Inflow Data in 1994**

| | Central System | | Ayala System | | Dagat-Dagatan System | |
|---|---|---|---|---|---|---|
| | Monthly (m3/mo) | Daily (m3/d) | Monthly (m3/mo) | Daily (m3/d) | Monthly (m3/mo) | Daily (m3/d) |
| Jan. | 6,203,640 | 200,117 | 631,267 | 20,363 | 197,441 | 6,369 |
| Feb. | 5,062,400 | 180,800 | 560,142 | 20,005 | 179,046 | 6,395 |
| Mar. | 5,844,165 | 188,521 | 621,105 | 20,036 | 204,799 | 6,606 |
| Apr. | 5,765,040 | 192,168 | 573,654 | 19,122 | 218,289 | 7,276 |
| May. | 6,434,410 | 207,562 | 627,250 | 20,234 | 231,778 | 7,477 |
| Jun. | 5,428,170 | 180,939 | 661,997 | 22,067 | 241,589 | 8,053 |
| Jul. | 7,156,790 | 230,864 | 748,143 | 24,134 | 196,214 | 6,329 |
| Aug. | 6,551,530 | 211,340 | 664,116 | 21,423 | 98,107 | 3,165 |
| Sep. | 6,471,220 | 215,707 | 635,804 | 21,193 | 251,400 | 8,380 |
| Oct. | 5,565,530 | 179,533 | 510,748 | 16,476 | 351,960 | 11,354 |
| Nov. | 7,356,510 | 245,217 | 618,431 | 20,614 | 203,572 | 6,786 |
| Dec. | 7,356,510 | 237,307 | 626,266 | 20,202 | 142,255 | 4,589 |
| Total | 75,195,915 | 2,470,076 | 7,478,923 | 245,864 | 2,516,450 | 82,778 |
| Average | 206,016 | | 20,490 | | 6,894 | |

Source : MWSS

Waste flow per capita and wastewater quality are summarized below, although waste water is considered to be diluted by the infiltration water from the esteros or rivers.

In the Central system catchment area, there is a small number of industrial firms which discharge industrial wastewater. However, at present, MWSS does not accept industrial wastewater into its system because it can not check or ascertain how polluted such industrial wastewater is.

**b. Ayala System**

This System was constructed by the developer in Makati Commercial and residential area and was turned over to MWSS in 1991. The system covers 600 hectares of the 1,000-hectares Ayala subdivision development area, of which 370 hectares is residential, 200 hectares is commercial and institutional, and the rest 30 hectares is open space. The balance of 400 hectares remains unsewered due to geographical and/or economical reasons.

The population of the sewer-covered area is estimated at 24,000 persons, judging from the number of service connections of 3,009, using 8.1 persons/ household as the calculation average. For the commercial/Institutional area, the design took into account 85,000 persons as the service population.

Sewage from the area flows down by gravity to the treatment plant through a 73 km-sanitary sewer pipe. Pipe diameters range from 200 to 1,050 mm. The pipes are pre-cast plain concrete for sewer pipes 250 mm or smaller, and reinforced concrete for sewers 300 mm or bigger.

The treatment method utilized is the activated sludge method. Inflow is pumped up to a primary sedimentation tank, and flows down to aeration tank, then to a secondary sedimentation tank, and then into creeks. There is no disinfection done. The sludge generated is introduced into a digestion tank and poured into a drying bed. The sludge is not made use of in any recyclable way.

This system has many defects. Illegally connected to the sewer collection pipes are drainage pipes which introduce materials that clog the sewer pipes, causing these to overflow during the rainy season. The treatment of wastewater is downright low and ineffective, due to deteriorated facilities. The upgrading of this system has been identified as one component of the MSSP.

The quality of influent and effluent are shown in data report. The effluent often fail to observe the DENR-EMB discharge limit.

As compared to the Central system's Influent water quality, BOD of the Ayala System is two times higher. This figure accounts for the higher commercial activity ratio in Makati than in the City of Manila.

**c. Dagat -Dagatan System**

Dagat-Dagatan is an area developed as part of the Sites and Service Program of the National Housing Authority (NHA) in 1979-1986, funded by WB. It covers a part of the City of Manila, Navotas, Malabon, and Caloocan City, totaling some 333 hectares. The system has not completely turned over to MWSS as only the operation of wastewater treatment plant has been entrusted to MWSS. Sewer length is 18 km. Treatment system is the aerated lagoon method. Aeration may seem insufficient, but effluent water quality is comparably good due to the long detention time. Water quality (influent and effluent) is shown in data report.

The two existing modules of the Dagat-Dagatan System were constructed with the projected population 104,000 persons and projected flow of 12,600 cu.m/d. At present only one module is in operation due to sewer pipe defects and the unwillingness of households to connect to the sanitary pipes. Judging from flow rate, about 50,000 persons are estimated to have access to the system.

**d. Quezon City Separate System**

Quezon City has 41 separate communal sewerage system covering a total of 1,300 hectares. Total sewer length is about 114 Kms. Of all the treatment facilities, only two are Imhoff tanks and the rest are septic tanks. As of 1994, 23,295 households were connected to the system, meaning about 190,000 persons had access to sewer pipes, assuming an average of 8.1 persons per households. Some treatment facilities have become inaccessible due to the blockade of illegal buildings. Desludging of these communal treatment facilities are not undertaken regularly due to the lack of appropriate equipment, and they have not been functioning well.

e. Other systems

The MWSS is expecting other sewerage systems of the completed NHA housing projects to be turned over to it. These are:

1.Karangalan Sewerage System ,Cainta ,Rizal

2.Martin de Porres Sewerage System ,Cubao ,Quezon City

3.Tangos Sewerage System,Tangos,Navotas

4.Capri Sewerage System,Novaliches,Quezon City

5.Maricaban Sewerage System,Pasay City

6.Maharlika Village Sewerage System,Taguig,

7.Leveriza Sewerage System Malate Manila City

8.Juan Luna Sewerage System,Tond Manila City

9.Bagong-Nayon Sewerage System Antipolo Rizal

The locations of above-mentioned systems are shown in Fig 3.2.1.

In addition to the above system, the 1979 Sewerage Master Plan indicated that some subdivision and military facilities have their own small separate sewerage systems managed by them.

(2) Sanitation Facilities

In areas where the public sewerage system is not available, septic tanks are mandatory as a sanitary facility according to "the code on sanitation of the Philippines"-Presidential Decree No.856 or the Sanitation Code, and "The National Building Code of the Philippines" or the Building Code. Some septic tanks receive all the wastewater, while other type treats only night soil and sullage finds its way directly to drainage system in the latter type. This is why present drainage system is said to be "practically combined sewer system". The material, installation and the sizing of the septic tanks are also regulated in the Sanitation Code, and "The National Plumbing Code of the Philippines" or the Plumbing Code.

According to the Sanitation Code, the average unit sewage flow per person is 50 gallons /day (=189 l/day ) and detention time is not definitely described; but is usually 24 hours. In Plumbing Code, the inner dimension of the digestion tank is decided according to the numbers of persons served by the tank.

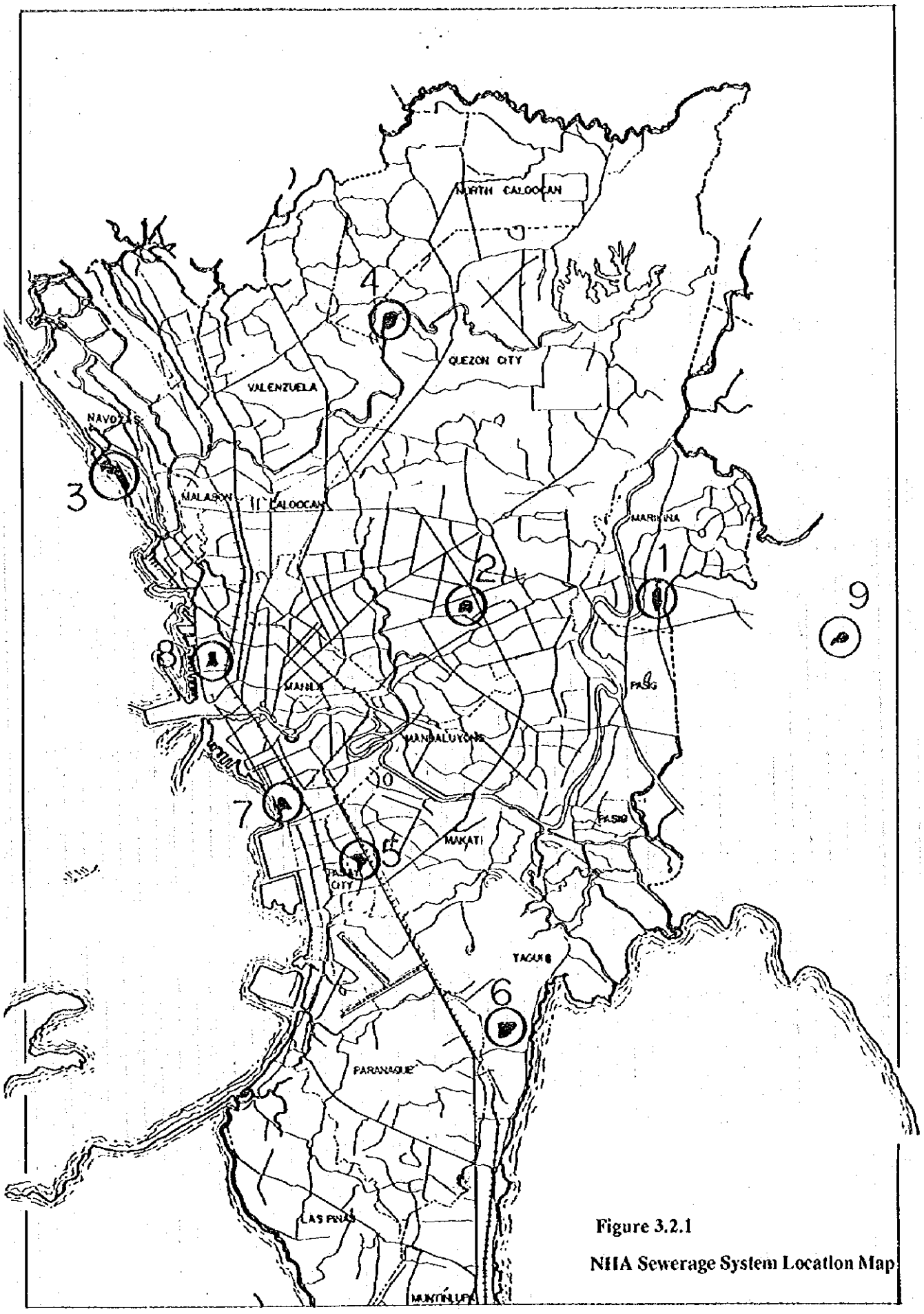



**Figure 3.2.1**

**NHA Sewerage System Location Map**

The owner or builder of the house is requested to file an application form to the Building Official to obtain building permit with the signature of licensed engineers. As to septic tank, plans and specifications signed by licensed sanitary engineer or master plumber shall be submitted to the Building Official of each City/Municipality. In case of extension or demolition, same procedure is requested. Although supposedly regulated by the Building Code, the functional design and construction of septic tank are actually highly dependent on the owner's wishes, the capability of the designer, and the craftsmanship of the builder. In reality, construction inspection is not always undertaken for compliance of the code.

Septic tank vary in design from a vertical cylindrical pipe with no bottom slab to a rectangular box with one or several compartments with or without bottom slabs. Subsurface absorption field is also sometimes omitted due to constraints of housing lot and economic reason. In that case, overflow from the septic tank directly finds its way to the drainage facility.

The numbers of the septic tanks is estimated first by the ADB consultant at 600,000 in Metro Manila Regions in 1990 and reviewed upward by WB consultant assuming smaller number of family in each household. And also they proposed detailed survey of number and dimension of septic tanks in MSSP. The gross septic tank volume (including leaching pit) is estimated 6 cu.m, while effective septage storage capacity is 1.8 cu m, according to the ADB feasibility study. The study assumed 32 l/capita/year septage production rate, and calculated the desirable desludging year as:

$$1{,}800\ l / (8.1\ \text{persons} \times 32\ l / \text{person} / \text{year}) = 6.9\ \text{year}$$

**(3) Operation and Maintenance works by MWSS**

At present, there is no new sewerage system construction. MWSS is only engaged in the operation and maintenance of the existing facilities. Of the three divisions of Sewerage System Department (SSD), Operation and Maintenance Division is related to the cleaning of sewer pipes and manholes, operation and maintenance of sewage pumping stations. Sewer maintenance works accomplished in recent years are shown in Table 3.2.2. Operation and Maintenance Division has only one jet-cleaning machine and cleaning efficiency is very low.

Desludging is one of the major works by SSD, and it is now operating desludging work in two different ways. One is septage collection and disposal by MWSS personnel on a request base, and the other is septage collection and disposal by Contractors on a regular work base in a projected areas. These works are responsibilities of Septic Tank Maintenance Division of SSD. This division is also in charge of operation and maintenance of wastewater treatment plants, sewage water quality analysis and wastewater monitoring.

**Table 3.2.2 MWSS Sewer-maintenance Works**

| year | Total Length of Sewer Line Cleaned (km) | Total No, of Manhole Cleaned |
|---|---|---|
| 1990 | 110.3 | 2,541 |
| 1991 | 153.8 | 3,004 |
| 1992 | 129.5 | 2,556 |
| 1993 | 87.7 | 1,775 |
| 1994 | 143.0 | 1,729 |

Source :MWSS

Septage Collection and Disposal by SSD

SSD currently administers the desludging program on the pay-as-you-request basis with five desludging units composed of a 11.7 cu.m tank truck, a portable gasoline-driven diaphragm pump and a five-member operation crew. These trucks and pumps have already exceeded their working life resulting in breakdown, thus delay in operations. Sludge drawn from the septic tank into the tank track is delivered either to the Tondo Pumping Station or to the Dagat-Dagatan Treatment Plant. The numbers of houses desludged in recent years is shown in Table 3.2.3. The tariff of desludging is now P 100 per time, but MWSS staff are now requesting the tariff raise.

Septage Collection and Disposal by Contractors

MWSS also has been operating the desludging program in a projected area based on the STAMP in METROSS-I and the inter-agency project "The Navotas-Malabon-Tullahan-Tenejeros (NMTT) River Revival Program". But the accomplishment has been far from satisfaction due to some economic or institutional constraints. At present only two contractors are working for MWSS desludging, each Contractor has four 5.4 cu.m tank trucks and two portable gasoline-driven diaphragm pumps. Septage is disposed of in the site secured and managed by Contractor in compliance with the standards of the Environmental Management Bureau(EMB). One big problem now is the difficulty in finding disposal site and in acquiring the ECC(Environmental

Clearance Certificate). The only disposal site is located in a stone quarry at Santa Rosa II near Marilao, Province of Bulacan, about 60 km far from the center of Metro Manila. Ddesludging work in the project areas is a service given by MWSS free of charge.

The accomplishment of desludging in recent years is reported below.

**Table 3.2.3 MWSS Desludging Works**

| | Contractor-base | | Administration-base |
|---|---|---|---|
| year | No. of Septic Tank | Location | No. of Septic Tank |
| 1990 | No Operation | | 565 |
| 1991 | No Operation | | 390 |
| 1992 | 897 | Valenzuela | 537 |
| 1993 | 3,343 | Valenzuela,Fairview | 997 |
| 1994 | 3,760 | Valenzuela,Fairview, Malabon,Pasig | 712 |

Source : MWSS

Third division of SSD, Sewer Connection Extension and Field Investigation Division, is responsible for 1) install and repair sewer mains, service connections, 2) conduct field investigations of existing systems and inspection of new collection system. This division is suffering from many unconnected service pipes, especially in Central System. Sewerage system developed by NHA is turned over to MWSS after the inspection and analysis of this division. Sewer maps and records are updated in this section.

As to the design criteria, MWSS has their own design standard for sanitary sewer system. Pipe material shall comply with the ASTM(American Society for Testing and Materials) standards. On the other hand, MWSS has no established standard for treatment facilities except septic tanks.

## 2.2 Previous Studies Relevant to Sewerage/Sanitation Project

### 2.2.1 Manila Second Sewerage Project (MMSSP)

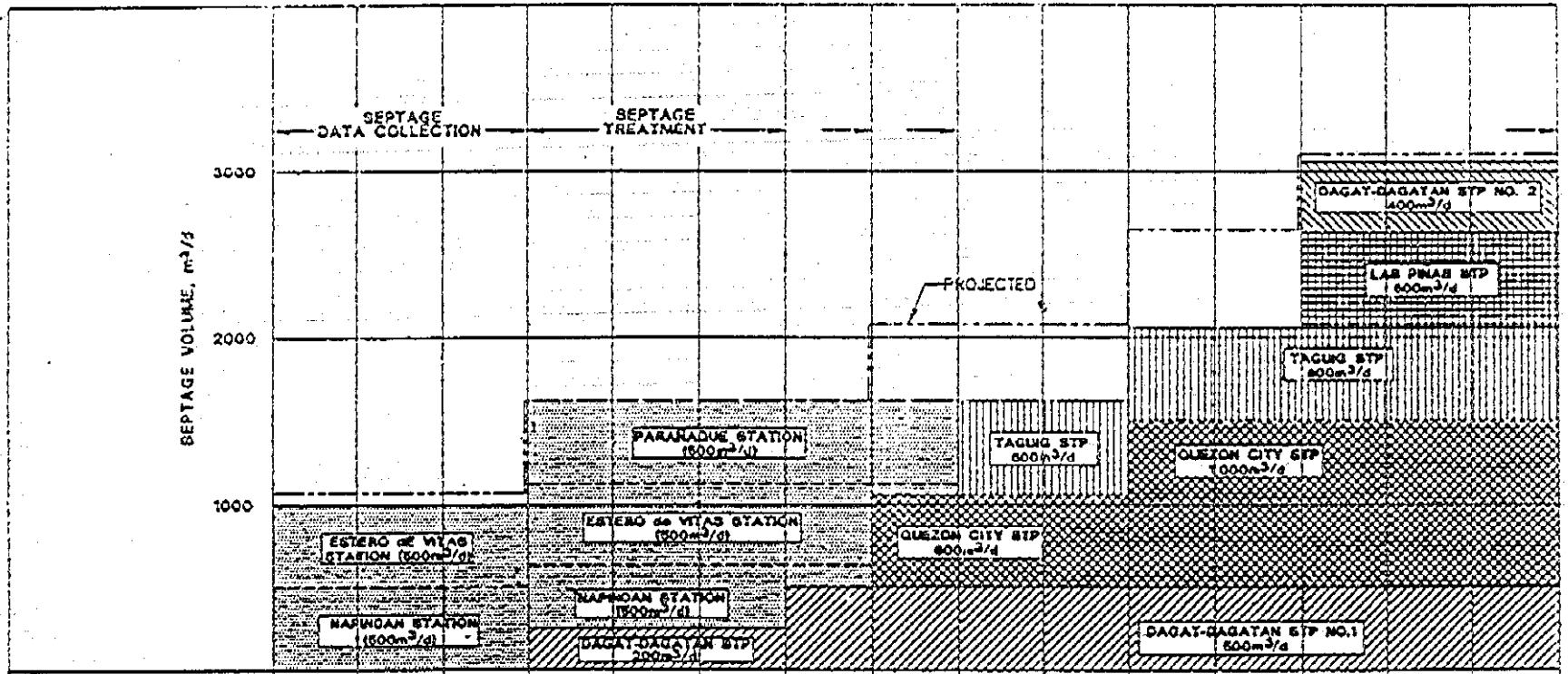
This Project has not completely finished as of January 1995. The following information came from draft final report of the Project. According to the report, main components are 1) Septage management, 2) Ayala and Manila Central sewerage system upgrading, 3) Street drainage improvement, 4) Laboratory and equipment support, 5) Environmental Impact assessment, and 6) Institutional framework and financing. Of all the components, the project focused on the septage management, and environmental, financial, and institutional study / analysis are concentrated to septage management.

- Septage Management Plan and its implementation action.

  The plan aims to collect and dispose an average of 1,000 $m^3$/d of septage in 1996 to ultimate 3,100 $m^3$/d in 2010. These volumes are equivalent to desludging annually 60,830 septic tanks in 1996 ( about 15 times of present condition) and 188,580 tanks in 2010. This figure is calculated on the condition that 700,000 households are desludged every 5 to 10 years. In the initial years of the plan (1996 to 2002 ), the collected septage is mainly dumped into sea.

  From 1999, the pilot septage treatment plant with the capacity of 200 $m^3$/d will start operating in the premises of Dagat-Dagatan wastewater treatment plant. Total septage treatment capacity of the plan will gradually rise by expansion and addition of the plants, to 3,100 $m^3$/d in 2008. Four treatment plant are scheduled to open in Dagat-Dagatan, Quezon City, Taguig, and Las Pinas, dividing NCR into four areas. Ocean dumping will be abandoned in 2003. In the initial 3 years, an extensive data collection and tests is planned to develop a reliable database on the distribution and types of septic tanks, and the characteristics of the septage. Schedule table is shown in Figure 3.2.2. Figure 3.2.3 is location map of each facility with the projected septic tank number.

  Pilot plant adopts physical-chemical method for solid-liquid separation as the primary treatment process and secondary treatment process is usage of existing lagoon system. Sludge is dewatered mechanically and delivered into landfill site.The bid documents were already prepared for 1) Construction of Dagat-Dagatan pilot treatment plant, 2) Construction of barge loading station, 3) Septage collection and hauling service, and 4) Barging of septage for sea dumping (service).




| YEAR | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEPTAGE IN METRO MANILA ($m^3/d$) | 1,120 | 1,120 | 1,120 | 1,700 | 1,700 | 1,700 | 1,700 | 2,100 | 2,100 | 2,100 | 2,700 | 2,700 | 3,100 | 3,100 | 3,100 |
| STP CAPACITY ($m^3/d$) | 0 | 0 | 0 | 200 | 200 | 200 | 500 | 1,100 | 1,700 | 1,700 | 2,100 | 2,100 | 3,100 | 3,100 | 3,100 |
| SEA DUMPING QUANTITY ($m^3/d$) | 1,000 | 1,000 | 1,000 | 1,500 | 1,500 | 1,500 | 1,200 | 600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COLLECTED SEPTAGE ($m^3/d$) | 1,000 | 1,000 | 1,000 | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 | 2,100 | 2,100 | 3,100 | 3,100 | 3,100 |
| NO. OF COLLECTION VEHICLE | $4m^3$-46(4 STAND-BY) $10m^3$-50(4 STAND-BY) | | | | | $4m^3$-78 (7) $10m^3$/CAR-84 (7) | | | | | $4m^3$-97(10) $10m^3$-106(10) | | | $4m^3$-143(14) $10m^3$-155(14) | |
| NO. OF BARGE TANKER (600 ton CAPACITY) | 4 | 4 | 4 | 6 | 6 | 6 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EQUIV. NUMBER OF SEPTIC TANKS DESLUDGED PER YEAR | 60,830 | 60,830 | 60,830 | 103,420 | 103,420 | 103,420 | 103,420 | 103,420 | 103,420 | 103,420 | 127,750 | 127,750 | 188,580 | 188,580 | 188,580 |

Figure 3.2.2 Septage Management Plan

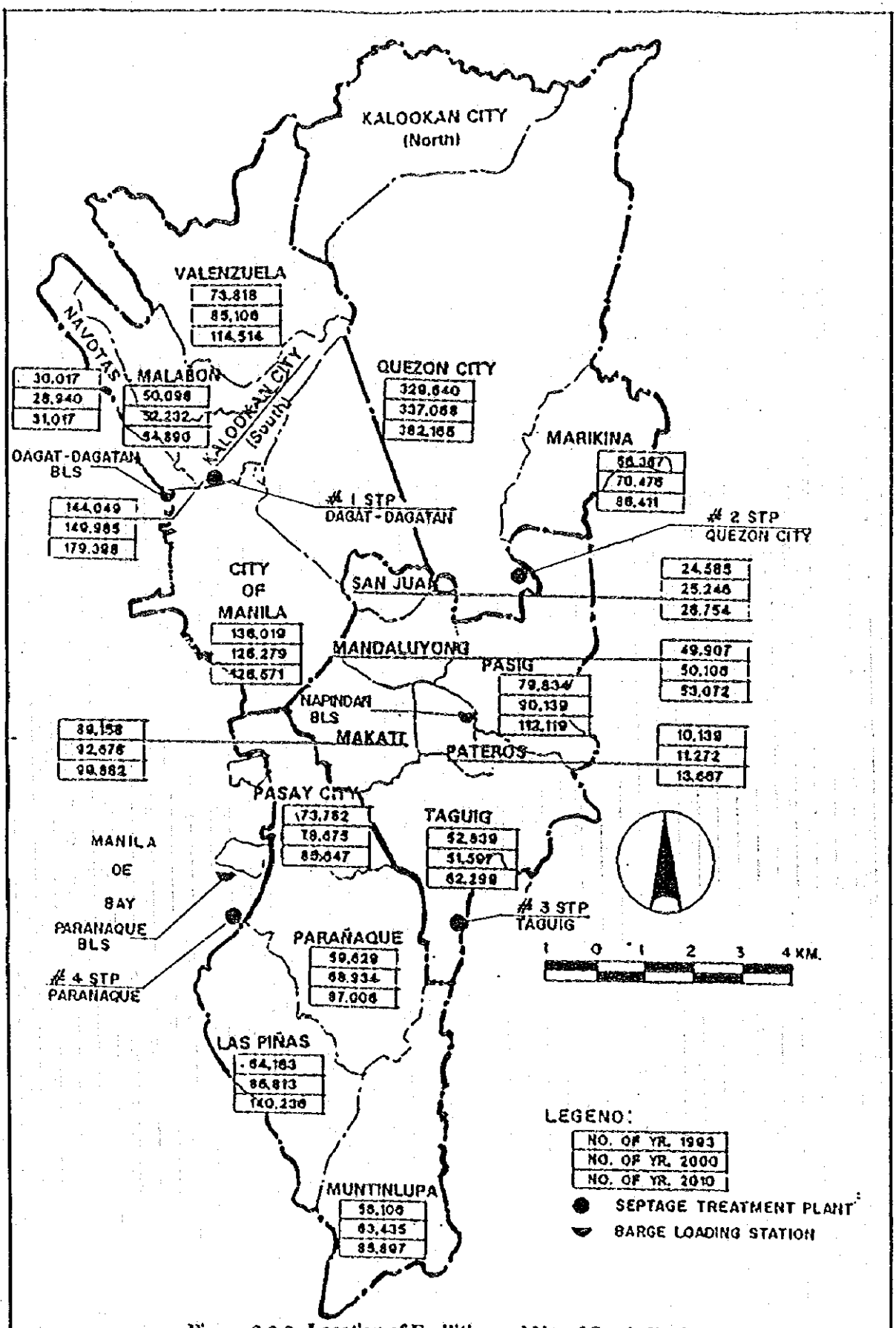



Figure 3.2.3 Location of Facilities and No. of Septic Tank

- Ayala Sewerage System Rehabilitation

  As to the sewage treatment plant, proposed projects are mainly replacement / repair works except new adoption of sludge thickening system and odor control system.

  The rehabilitation/upgrading works for the collection system are basically maintenance works including construction of new siphon, by-pass sewers, and manholes. Expansion of the catchment area is not considered.

- Central Sewerage System Rehabilitation

  Construction of a new grit chamber, adoption of emergency generator system, and repair /expansion of electrical and instrumentation controls are main works for Tondo pump station

  Each lift station shall have 1) replacement of the submersible pump, 2) electrical and instrumentation replacement, 3) installation of slide gate, odor control system, and flow monitoring device. Flap gate is installed to existing overflow by-pass pipe.

  One new pump station was designed as the alternate to the Pasig River inverted siphon.

- Laboratory strengthening

  In response to the septage management program, sampling /analysis plan was made and efficient laboratory use plan was elaborated including the consignment to outside laboratories.

- Financial study

  Based on the project cost and previous cost performance of MWSS and SSD (Sewerage System Department), future financial study with the Manila Second Sewerage Project was developed.

- Institutional framework

  Some recommendation, like establishment of new sewerage and sanitation sub-sector, discussion for the preparation of a sewerage and sanitation master plan, e.t.c were made from the review of MWSS organization efficiency and legal framework.

- Environmental Impact Assessment

  Environmental Impact on MSSP, especially sea dumping and construction of septage treatment plant, was considered in compliance with Philippine environmental standard.

- Street drainage improvement

  12 locations are selected as the street drainage installation area for the improvement of sanitary condition and preliminary design was completed. But due to the uncertainty of funding, this component ended in preliminary stage.

### 2.2.2 Other Related Environmental Studies

The inclusion of sewerage system and sanitation facilities in proposals as a component of environmental improvement projects has been pushed for by many government agencies. It is widely recognized and accepted that sewerage systems are big contributor to the uplift of the water environment. In the past, various government agencies focused on a review of on-going (at that time ) and proposed environmental improvement programs which included sewerage and sanitation program, as well as on prioritization of environmental problems. These are DENR/EMB Manila Metropolitan Region Environment Improvement Study in 1990 funded by ADB, River Rehabilitation Program for the Manila Bay Region, Phase 1 and Seminar Work Shop, also implemented by DENR/EMB in 1991, and Environmental Management Strategy in 1992 under DENR/DTI which was funded by WB. Many waste water-related projects have been proposed.

As a part of this project, JICA study team is conducting a thorough review of all on-going and proposed projects according to its classified purpose.

**a. Total Environmental Improvement Program**

1) Manila Metropolitan Region Environmental Improvement Study (MMREIS)

This Study concentrated on a review of on-going and proposed projects and on the prioritization of environmental problems. They recommended action plan, summarized below identified five major invest programs.

- Environmental Management and Monitoring Program

  This Program is composed of public education, environmental data base, THS data bank, mapping of environmentally critical areas, feasibility study on hospital waste management, air quality monitoring, training programs for DENR/EMB and MMA. To date, only the public education program, a vehicle emission monitoring program and some training of DENR/EMB staff have been implemented.
- Integrated Solid Waste Management Program

  This program includes supply of collection equipment, construction of transfer stations and two sanitary landfills. As of 1992 November, a project preparation study was being conducted under WB administration.
- Flood Control and Drainage Programs

This is made up of four sub-projects which are on -going under the DPWH administration.

- Water Quality Management Program

  This recommended feasibility study for sludge disposal site, septic tank desludging, second Manila sewerage project, NMTT river rehabilitation. As to the desludging of septic tank, MWSS is undertaking the detailed design funded by WB. NMTT is slowly on-going as stated in this section.

- Industrial Pollution Control Project

  The project was formulated into WB-assisted IEPC program in 1992 (refer another project).

2).Environmental Management Strategy (EMS)

This study was completed by the same consultant which conducted MMREIS and this EMS and IEPC (described later ) are in pairs. Reviewed were the priority of the environmental problems, where recommendations were made on the specific environmental sectorial strategies, in addition to the development of an institutional strengthening and public education strategy. The EMS's projected BOD load reduction in 2,000 is shown as follows.

Table 3.2.4 EMS Proposed BOD Reduction

| | BOD discharge load in 2,000 with no action | BOD discharge load in 2,000 with EMS | Remarks |
|---|---|---|---|
| Industrial Wastewater | 573 | 130 | |
| Domestic Wastewater | 365 | 195 | |
| Solid Waste | 223 | 90 | |
| Total | 1,161 | 415 | |

Source : Environmental Management Strategy Final Report (1992)

More specifically, the recommendations are as follows.

- Water Quality Management Strategy

  The WB consultants first proposed achievable water quality in Metro Manila River by 2,000. As for the domestic wastewater, desludging of septic tank is urgently recommended. Pilot plant for septage treatment was required for the first stage. As to the collection system of sewerage covering extension (South Sewerage Project), recommended was the combined system as the alternative of separate system. The strategy aims 170 ton BOD/d reduction -- 110 ton by septic tank desludging, 60 ton

by the South Sewerage extension. Industrial wastewater was to be tackled in another IECP study.

- Land Use Strategy

  It included the development of an urban land information system, review and updating of the Model Zoning Ordinance, preparation of a comprehensive planning and development framework, preparation of land use planning standard, guidelines and procedure and preparation of Updated Comprehensive Land use Plan and Ordinance.

- Solid Waste Management

  Strongly recommended was the resolution of the MMA status and establishing it as a permanent body. Also recommended was implementation of Solid Waste Management Program which aimed to reduce 133 ton BOD /d with improved collection.(see another section)

- Flood Control

  The study provided early implementation of the three projects proposed in the Flood Control Master Plan by JICA in 1990, namely, 1) East-West Manggahan, 2) Malabon-Navotas, and 3)Pasig-Marikina River Project

- Toxic and Hazardous Waste Management

  The EMS put high priority on Toxic and Hazardous Waste, next to solid waste pollution and flooding. The study recommended the development of monitoring system of THS, proper on-site storage, development of a centralized facility, etc. The above mentioned strategies are also in the IECP study.

- Other Strategies

  The study also provided Slum and Squatter Settlement Strategy, Air Quality Management Strategy, Institutional Strengthening Strategy and Financing Strategy. As an additional work, the study recommend water quality models of each watershed, ground water management work, and the development of THS data bank.

3).Laguna Lake Master Plan (Draft)-Environmental Management Program

In the Laguna Lake Master Plan (Draft), a total environmental management program was proposed. Main component is as follows

- Water Quality Monitoring Program
- Pollution Control Program

- Watershed Management Program
- Erosion ,Siltation ,Sedimentation Monitoring and Control Program
- Environmental Data Base Management Program
- Barging Operation and Monitoring Program

**b. River Revival Program**

1). Navotas-Malabon-Tullahan-Tenejeros Rehabilitation Program(NMTTRP)

For the purpose of restoring the function of the river, this program has bee implemented since 1987 headed by DENR and in cooperation with 16 organization and 2 NGOs. The Navotas-Malabon-Tullahan-Tenejeros River, most polluted river in Metro Manila, was selected as the object river to reduce the pollution loading as of 1987 to the half by 1992, and to reduce further pollution loading step-by-step, setting the target year at 1995 and 2000. The following summary of actual vs. targeted accomplishments by each of main participating agencies shows a low accomplishment rate.

**Table 3.2.5 NMTTRP Accomplishment**

| Description | Agency | Target | Actual(1991) |
|---|---|---|---|
| Industrial Waste | DENR/LLDA | 23,254 kg BOD/day | 19,941 kg BOD/day |
| Flood Waste | DPWH | 700,000 $m^3$ | 213,000 $m^3$ |
| Domestic Sewage (Septic Tank Desludging) | MWSS | 48,000 units | 442 units |
| Squatter Relocation | NHA | 10,026 families | 21 families |
| Solid Waste | MMA | 6,290 kg BOD/day | 59 kg BOD/day |

Source : Environmental Management Strategy Final Report (1992)

2).Pasig River Rehabilitation Project (PRRP)

This project, funded by Danish government, was set up to improve the water quality up to class-C criteria. The feasibility study was completed in 1991, and proposed 21 projects in the next 10 years. With the full implementation of the project, the expected BOD loading of the river basin is targeted to be reduced from 415 tons /day to 209 tons /day by the year 2005. The components of the project are as follows.

1. Organization of the RRS (River Rehabilitation Secretariat)
2. Flushing of the Pasig River
3. Conversion of Industrial Waste into Energy
4. Secondary Industry for Resource Recovery
5. Hazardous Waste Treatment
6. Collection of Solid Waste in Rivers
7. Upgrading of Squatter Settlement
8. Upgrading of Water Quality Laboratory
9. Determination of the Absorption Capacity of Manila Bay
10. Construction of Sanitation Sewerage System

11. Septic Tank Maintenance Program
12. Local Treatment of Sewage in High-income Residential areas and Complexes
13. Diversion of the San Juan River
14. Collection of Solid Waste from inaccessible Barangays
15. Integrated Solid Waste Management Program
16. Flood Control
17. Drainage Improvement System
18. Development Plan for NCR
19. Removal of Sunken Derelicts
20. Construction of River Parks
21. Urban Renewal of Escolta District

The Program started in June 1993 when River Rehabilitation Secretariat (RRS) is constituted to coordinate mechanism and to lay the groundwork for the PRRP's long-term objective. The first twelve month witnessed following accomplishment

- Establishment of network comprising 121 government agency and private organization
- Creation of Presidential Task Force for Pasig River Rehabilitation as political support
- Involvement of industries through the implementation of waste minimization plans and the improvement or upgrading of their wastewater treatment facilities.
- Reduction of the amount of floating debris and the dumping of solid waste through the effort of Local Government Units(LGUs) and Philippine Coast Guard(PCG),Metro Manila Authority(MMA)
- Removal of most of sunken vessels through the effort of PCG
- Conversion of garbage dumping site and implementation of a model riverside development project with the Manila-City Government and Marikina Municipality Government respectively.
- Relocation of urban poor families through the effort of respective LGUs and National Housing Authority(NHA).
- Enlightenment of the public awareness through the media

Of the proposed 21 projects, No 2, 3, and 13 are deferred or canceled due to political or social opposition. In January 1995, Danish Government promised to continue providing monetary support to the PRRP.

**c. Solid Waste Management Program**

Metro Manila Solid Waste Management Program (MMSWMP)

A project preparation team, assisted by local consultant and advisors from DPWH and EMB, was established in MMA to prepare the details of the Metro Manila Solid Waste Management Program project. This program is composed of seven components, namely; 1) the construction of two sanitary landfills, 2) the construction of four transfer stations, 3) the procurement of transfer trucks and trailers to meet the projected demand for the first 10 years of operations, 4) the procurement of land fill equipment to meet the first 10 years operational demand in the two landfill sites, 5) the provision of spare parts for approximately 3 years of all equipment supplied, 6) the upgrading of the solid waste improvement program workshop, and 7) the provision of technical assistance to support the implementation of the project and to prepare for the next phase of waste management investment. With this program, collection rate is expected to rise to 90 %.

**d. Industrial waste/wastewater Project**

1).Industrial Efficiency and Pollution Control Program(IEPC)

This program was established in November 1992 to reduce the industrial pollution load which account for quite a large percentage of the organic water pollution. This Program, funded by WB and Japan Grant Fund, was completed by the same consultants who did the EMS. The Program recommended for the following 1) Institutional Strengthening, 2) Technical Assistance, 3) Waste Minimization plan for the existing firms, 4) THS management, 5) Wastewater Treatment facilities, 6) Waste Minimization plan for new firms and 7) Air Pollution Abatement. With IEPC, the industrial efficiency will improve and industrial pollution will be reduced from 573 ton /day to 130 ton/day in the year 2000.

2).Common and Individual Wastewater Treatment Facilities for Industrial Enterprises in Metro Manila Area

This WB-funded project undertaken by DENR has just commenced, in accordance with the above IEPC program item 5 .The aim of the Project are 1) establishment of common collection and treatment facilities (CTFs) for groups of industries whose small size limits the opportunity to develop cost-effective pollution controls, and 2) development of waste abatement and treatment facilities in individual Industrial Enterprises(IEs) whose current controls are inadequate or ineffective.

**e. Flood Control and drainage project**

1). Flood Control and Drainage Projects

The Flood Control and Drainage Division of DPWH has, other than regular maintenance and rehabilitation project, several on-going projects including the Master Plan in Metro Manila. On-going projects are as follows

- Metro Manila Flood Control II

  This project is funded by OECF and consists of two drainage systems improvement projects. One is for Vitas and Balut Drainage system which provides for the construction of two pumping stations and improvement (dredging ,cleaning etc.) of Esteros. The other for the San Andres Drainage System which provides for the construction of one pumping station as well as the improvement of Esteros.

- Malabon-Navotas-Valenzuela Drainage Improvement Project

  This project, funded through a grant from the Dutch Government and intended to provide drainage improvement to the municipality of Malabon-Navotas and Valenzuela. It includes provision and installation of eighteen relief pumping stations and five sets of dredging equipment.

- Retrieval of Flood prone area in Metro Manila Project

  This project aims to clean/rehabilitate drainage facilities for the central Manila area, the City of Manila and portion of Pasay and Quezon City

- Flood Control and Drainage Master Plan in Metro Manila

  The old master plan formulated by former Bureau of Public Works in 1952 was reviewed by JICA study team in 1990. It includes framework plan ,Master Plan whose target year is 2,020 and priority projects Priority projects are 1) Drainage Improvement of the East-West Manggahan and Marikina-Manggahan Area, 2) Drainage Improvement of Malabon-Navotas Area, and 3)River Improvement of Pasig -Marikina River.

2). MMINUTE project

A project management office for Metro Manila Infrastructure Utilities and Engineering (MMINUTE) was set up under DPWH with funds from the WB. Its function is to provide barangay-based infrastructure in the depressed urban areas within Metro Manila and fringe areas in the Bulakan, Laguna, Cavite and Rizal provinces. The on-going MMINUTE II-Fringe Program, which started in 1990, will see completion in 1995. It has set the improvement of city or municipal level streets including minor drainage facilities, bridge and river wall.

## 2.3 Water Pollution Status and Future Problems

### 2.3.1 Future Water Pollution Problems in Main River System

**(1) Pollutional Estimation**

Water qualities in main rivers are estimated as future environmental degradation indicators. Estimation procedure is as follows.

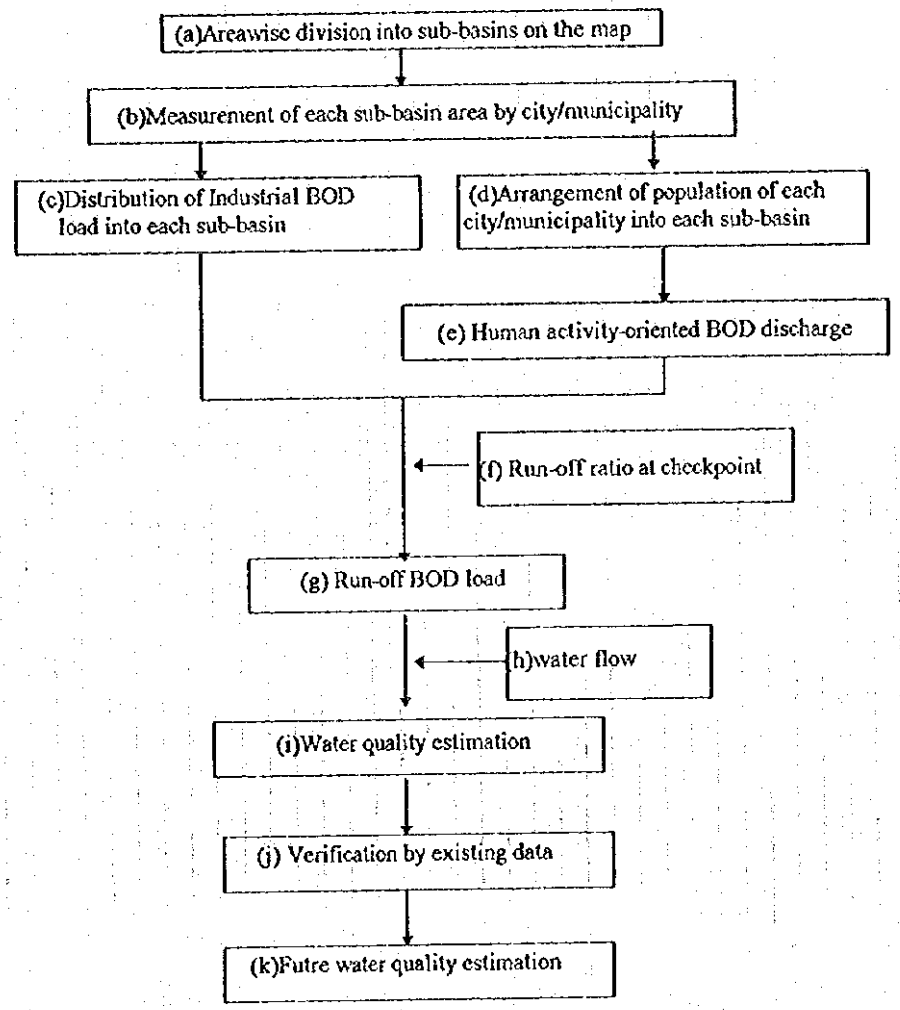



Figure 3.2.4 Procedure

**a)Areawise division into sub-basins on the map**

This division is basically in accord with "The Study on Flood Control and Drainage Project in Metro Manila" conducted by JICA-study team in 1990. Sub-basin code name ( PM-1,-2 etc) is same name in the Study. Areawise division is shown in main report..

**b)Measurement of each sub-basin area by city/municipality**

Areal measurement and adjustment between sub-basin and each city/municipality are made on the map. Matrix is shown in Table 3.2.8.

**c) Distribution of Industrial BOD load into each sub-basin**

Industrial BOD-load discharge data are adopted from "Industrial Efficiency and Pollution Control Program (IEPC)" conducted by the World Bank consultant in 1992. According to the report total discharged BOD load is 304 ton/day. This industrial BOD load is re-distributed into each sub basin of this report according to Table 3.2.7.

**d)Arrangement of population of each city/municipality into each sub-basin**

Basically, population density is assumed to be same within one city/municipality. Exceptions are Rodriguez, Antipolo, Quezon City, Calockan City, Tanay and San Mateo. In these city/municipalities, population is locally concentrated in some areas.

Population density is assumed as follows.

**Table 3.2.6 Population density**

| City/Munic. | Density in 1990 (pers/ha) | Density in 2015 (pers/ha) | City/Munic. | Density in 1990 (pers/ha) | Density in 2015 (pers/ha) |
|---|---|---|---|---|---|
| Manila | 416 | 447 | Marikina | 136 | 226 |
| Pasay | 209 | 294 | Navotas | 170 | 271 |
| Quezon City | 126 | 208 | Paranaque | 77 | 150 |
| Caloocan N | 54 | 85 | Pasig | 126 | 219 |
| Caloocan S | 405 | 641 | Taguig | 59 | 142 |
| Mandaluyong | 222 | 268 | Valenzuela | 76 | 148 |
| Las Pinas | 91 | 236 | Bacoor | 30 | 69 |
| Makati | 246 | 304 | Imus | 9 | 18 |
| Malabon | 161 | 214 | Cainta | 58 | 164 |
| Taytay | 33 | 73 | Obandon | 34 | 51 |
| Marilao | 23 | 41 | SJdelMonte | 17 | 27 |
| Meycauayan | 44 | 72 | | | |

- Quezon City - exclude Novaliches area from density calculation.
- 10% of Tanay total population and 10% of Antipolo population are allocated to PM-1, 30% of Antipolo population is to PM-3 , 60% of Antipolo population is divided into Baho-Buli basin in proportion to the area.
- All the population of Rodriguez is to PM-2, San Mateo to PM-3.

**e)Human activity oriented BOD discharge**

Assuming one person generates 40 g-BOD / day and adding 6g from littered garbage, 90% of the BOD generated on-site is discharged through imperfect sanitation facilities. Central System in Manila City discharges no BOD load into river system. 40 g will increase to 50 in 2015 but 6 g is assumed to be reduced to zero. Total BOD discharge is shown in Table 3.2.8 for each sub-basin.

Table3.2.7 Re-distribution of IEPC BOD load

| IEPC | | JICA-Study | | | |
|---|---|---|---|---|---|
| | | | 1990 | 1990 | 2015 |
| | T/day | | T/day | kg/day | kg/day |
| Marilao | 0.1 | ME-1 | 0 | - | - |
| | | ME-2 | 0 | - | - |
| | | ME-3 | 0 | - | - |
| | | ME-4 | 0 | - | - |
| | | ME-5 | 0.1 | 100 | 43 |
| Meycauayan River | 4.2 | ME-6 | 3.1 | 3,098 | 1,327 |
| | | ME-7 | 1.1 | 1,102 | 472 |
| Longos River | 12.3 | ME-8 | 6.0 | 6,046 | 2,590 |
| | | ME-9 | 6.3 | 6,254 | 2,679 |
| Bulacan | 87.6 | Direct | 87.6 | 87,600 | 37,522 |
| | | | | - | - |
| Novaliches | 0.1 | MT-1 | 0 | - | - |
| | | MT-2 | 0 | - | - |
| | | MT-3 | 0.1 | 100 | 43 |
| Tullahan River | 8.1 | MT-4 | 8.1 | 8,100 | 3,470 |
| Navotas | 8.3 | MA | 14.3 | 14,300 | 6,125 |
| Caloocan City | 6 | | 0 | - | - |
| | | | | - | - |
| Antipoli/SanMateo | 7.1 | PM-1 | 2.4 | 2,367 | 1,014 |
| | | PM-2 | 2.4 | 2,367 | 1,014 |
| | | PM-3 | 2.4 | 2,367 | 1,014 |
| Marikina River | 8.8 | PM-4 | 8.8 | 8,800 | 3,769 |
| San Juan | 5.4 | SJ-7 | 0.8 | 825 | 353 |
| | | SJ-8 | 2.8 | 2,805 | 1,201 |
| | | SJ-9 | 1.5 | 1,517 | 650 |
| | | SJ-10 | 0.3 | 253 | 108 |
| Quezon City | 11.1 | SJ-1 | 3.8 | 3,787 | 1,622 |
| | | SJ-2 | 1.7 | 1,714 | 734 |
| | | SJ-3 | 0.4 | 355 | 152 |
| | | SJ-4 | 1.6 | 1,621 | 694 |
| | | SJ-5 | 1.3 | 1,341 | 574 |
| | | SJ-6 | 2.3 | 2,282 | 977 |
| Pasig River | 13.9 | PM-5 | 13.9 | 13,900 | 5,954 |
| Mandaluyong | 53.9 | PM-6 | 9.0 | 8,983 | 3,848 |
| | | PM-7 | 9.0 | 8,983 | 3,848 |
| | | SM-1 | 9.0 | 8,983 | 3,848 |
| | | Direct | 27.0 | 26,950 | 11,544 |
| Manila | 13.4 | SM-2 | 3.4 | 3,350 | 1,435 |
| | | SM-3 | 0 | - | - |
| | | NM-1-1 | 3.4 | 3,350 | 1,435 |
| | | NM-3 | 3.4 | 3,350 | 1,435 |
| | | NM-4 | 0.0 | - | - |
| | | Direct | 3.4 | 3,350 | 1,435 |
| Makati | 2.2 | Direct | 2.2 | 2,200 | 942 |
| Taguig River | 11.1 | WM | 11.1 | 11,100 | 4,755 |
| | | | | - | - |
| Paranaque River | 1.6 | PL-1 | 0.5 | 499 | 214 |
| | | PL-2 | 0.1 | 149 | 64 |
| | | PL-3 | 0.8 | 836 | 358 |
| | | PA-4 | 0.1 | 115 | 49 |

| IEPC | | JICA-Study | | | |
|---|---|---|---|---|---|
| | | | 1990 | 1990 | 2015 |
| | T/day | | T/day | kg/day | kg/day |
| Zapote River | 2 | PL-4 | 0.3 | 337 | 144 |
| | | PL-5 | 0.5 | 522 | 224 |
| | | PA-1 | 0.5 | 475 | 203 |
| | | PA-2 | 0.1 | 130 | 55 |
| | | PA-3 | 0.1 | 83 | 36 |
| | | ZP-1 | 0.0 | 0 | - |
| | | ZP-2 | 0.2 | 197 | 84 |
| | | ZP-3 | 0.3 | 256 | 110 |
| | | | | 0 | - |
| Bacoor/Cavite | 0 | | 0 | 0 | - |
| | | | | 0 | - |
| Cainta/Sucat | 31 | BB-1 | 6.2 | 6169 | 2,642 |
| | | BB-2 | 2.5 | 2471 | 1,059 |
| | | BB-3 | 2.1 | 2069 | 886 |
| | | BB-4 | 9.9 | 9885 | 4,234 |
| | | BB-5 | 1.6 | 1569 | 672 |
| | | BB-6 | 1.7 | 1662 | 712 |
| | | BB-7 | 3.9 | 3910 | 1,675 |
| | | EM-1 | 0.6 | 622 | 267 |
| | | EM-2 | 0.9 | 902 | 386 |
| | | EM-3 | 1.0 | 1014 | 434 |
| | | EM-4 | 0.7 | 727 | 311 |
| | | | | 0 | - |
| Muntinlupa/San Pe | 15.3 | | 15.3 | 15300 | 6,554 |
| | | | | 0 | - |
| Total | 304 | | 304 | 303,500 | 130,000 |

**f) Run-off ratio up to checkpoint**

Total run-off ratio includes, in this study, concentration ratio and remaining ratio after river self-purification.

In Japanese desigh stage, following concentration ratio is often adopted.

| Land use type | Concentration ratio | Remarks |
|---|---|---|
| Rural area | 0.0 - 0.20 | The ratio is depending on the arrangement status of drainage facilities |
| Urban area<br>1) med.-low pop.density<br>2) high pop.density | <br>0.1 - 0.60<br>0.6 - 1.00 | |
| Sewerage system | 1.00 | |

River self-purification ratio is difficult to decide without past data, and in this study, total run-off ratio is set up as follows considering the existing watwer quality data; Industrial farms are usually situated beside river and run-off rate is higher than that of domestic BOD;

| | |
|---|---|
| Domestic BOD run-off ratio | 0.2 |
| Industrial BOD run-off ratio | 0.6 |

**g) Run-off BOD load**

Domestic and Industrial run-off BOD is calculated by multiplying run-off ratio and discharged BOD. At the check point shown in Fig 3.2.3 in main report, accumulative run-off BOD is calculated.

**h)River flow**

River flow data comes from "Philippine Water Resources Summary Data " (Volume. 2 - Streamflow and Lake or River Stage Ending December 31, 1980).

Only the Marikina River is gauged in Metro Manila Region, of which 2 points data can be represented in the unit of cu.m/sec. Other data are shown in gauge height. 2 points are Sto. Nino, Marikina, Metro Manila and San. Rafael, Montalban,Rizal

From the Sto. Nino data, specific flow factor ( SFF ) in cu.m/sec/ha is calculated using the dry season(Jan.- April) data ( case 1) and all year average data ( case 2 )from the below table 3.2.9.

Drainage Area is 499 $km^2$ and flow is 3.09 cu.m/sec in dry season and 19.5 cu.m/sec in round year., which ends up 0.0062 cu.m/sec/$km^2$ and 0.039 cu.m/sec/$km^2$ in specific flow factor.

**i)Water quality estimation**

Table 3.2.10 shows the calculation result of case 1 and case 2.

Table 3.2.9 Mean Monthly Discharge in cu.m/sec

| | Jan. | Feb. | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | - | - | - | - | - | - | - | 258.8 | 52.4 | 11.7 | 2.82 | .71 |
| 1973 | 3.18 | 2.93 | 1.87 | 1.41 | 1.88 | 3.19 | 6.73 | 27.99 | 7.22 | 29.6 | 9.99 | 7.76 |
| 1974 | 5.59 | 3.01 | 2.33 | 2.32 | 2.88 | 8.85 | 18.3 | - | 11.7 | - | - | 18.8 |
| 1975 | 8.03 | 4.95 | 2.50 | 2.44 | 2.82 | 4.61 | 5.08 | 41.1 | 17.8 | 11.1 | 13.9 | 25.8 |
| 1976 | 6.03 | 2.62 | 2.18 | 2.17 | - | 47.1 | 41.6 | 49.8 | 125 | 23.9 | 13.4 | 9.07 |
| 1977 | 4.37 | 1.65 | 1.08 | 1.20 | 2.60 | 2.02 | 50.9 | 69.8 | 23.2 | - | 72.3 | 3.97 |
| Ave. | 5.44 | 3.03 | 1.99 | 1.91 | 2.55 | 13.2 | 24.5 | 89.5 | 39.5 | 19.1 | 22.5 | 11.0 |
| | | Jan- | Apr | 3.09 | | | | | | Jan- | Dec | 19.5 |

**j) Verification by existing data**

Judging from existing water quality, case 2 is more likely than case 1 and future estimation will be done using case 2 river flow

**k)Futre water quality estimation**

Without any preventive countermeasures, the water quality will becomes worse in proportion to the population growth. The area where population density exceed 200 persons per hectare is shown in Figure 3.2.5 based on the data in Table 3.2.11.

Water quality in target year 2015 is estimated in the same method assuming that future industrial BOD load will be constant after 1992. Industrial expansion is likely to happen outside of MMR. Table 3.2.11 is BOD discharge estimation and water quality is calculated in Table 3.2.12.

As a reference, future condition with IEPC countermeasures is considerwd. IEPC strategy is industrial pollutive load abatement by waste minimization/clean technology and wastewater common/individual treatment. It reduces future 573 ton/day discharged loads to 130 ton/day. In this report calculation, IECP target is assumed to be acccomplished in 2015.
This estimation is also shown in Table 3.2.12.

Table 3.2.8 (1) PM - Basin BOD discharge(present)

| | | PM-1 | PM-2 | PM-3 | PM-4 | PM-5 | PM-6 | PM-7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Taguig | Area(km2) | 33.32 | - | - | - | - | - | - | 33.32 |
| | Pop.(persons) | 5,841.00 | - | - | - | - | - | - | 5,841 |
| Antipolo | Area(km2) | 174.93 | - | 40.61 | - | - | - | - | 215.54 |
| | Pop.(persons) | 21,059.00 | - | 63,176.00 | - | - | - | - | 84,235 |
| Rodriguez | Area(km2) | 69.41 | 97.53 | - | - | - | - | - | 166.94 |
| | Pop.(persons) | - | 67,074.00 | - | - | - | - | - | 67,074 |
| San Mateo | Area(km2) | - | - | 64.90 | - | - | - | - | 64.90 |
| | Pop.(persons) | | | 82,310.00 | | | | | 82,310 |
| Quezon | Area(km2) | - | - | 23.30 | 1.50 | 3.90 | - | - | 28.70 |
| | Pop.(persons) | | | 183,960 | 15,900 | 49,140 | - | - | 252,000 |
| Marikina | Area(km2) | - | - | 8.20 | 2.95 | - | - | - | 11.15 |
| | Pop.(persons) | | | 111,520 | 40,120 | | | | 151,640 |
| Pasig | Area(km2) | - | - | - | 1.73 | 7.43 | 1.94 | - | 11.10 |
| | Pop.(persons) | | | | 21,798 | 93,618 | 24,444 | | 139,860 |
| Taguig | Area(km2) | - | - | - | - | - | 3.30 | - | 3.30 |
| | Pop.(persons) | | | | | | 19,470 | | 19,470 |
| Mandaluyong | Area(km2) | - | - | - | - | - | 0.80 | - | 0.80 |
| | Pop.(persons) | | | | | | 17,760 | | 17,760 |
| Makati | Area(km2) | - | - | - | - | - | 2.70 | 3.83 | 6.53 |
| | Pop.(persons) | | | | | | 66,420 | 94,218 | 160,638 |
| Manila City | Area(km2) | - | - | - | - | - | - | 0.75 | 0.75 |
| | Pop.(persons) | | | | | | | 31,200 | 31,200 |
| Total | Area(km2) | 277.66 | 97.53 | 137.01 | 6.18 | 11.33 | 8.74 | 4.58 | 543.03 |
| | Pop.(persons) | 26,900 | 67,074 | 410,966 | 80,818 | 142,758 | 128,094 | 125,418 | 1,012,028 |
| | BOD-domestic(kg/D) | 1,614 | 2,777 | 18,256 | 3,346 | 5,910 | 5,303 | 5,192 | 41,898 |
| | BOD-industry(kg/D) | 2,367 | 2,367 | 2,367 | 8,800 | 13,900 | 8,983 | 8,983 | 47,767 |
| | Total BOD discharge | 3,481 | 5,144 | 20,623 | 12,146 | 19,810 | 14,286 | 14,175 | 89,665 |

Table 3.2.8 (2) SJ - Basin BOD discharge(present)

| | | SJ-1 | SJ-2 | SJ-3 | SJ-4 | SJ-5 | SJ-6 | SJ-7 | SJ-8 | SJ-9 | SJ-10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quezon City | Area(km2) | 23.27 | 10.53 | 2.18 | 9.96 | 8.24 | 14.02 | 3.55 | 6.00 | - | - | 77.75 |
| | Pop.(persons) | 293,202 | 132,678 | 27,468 | 125,496 | 103,824 | 176,652 | 44,730 | 75,600 | - | - | 979,650 |
| Pasig | Area(km2) | - | - | - | - | - | - | - | 0.30 | - | - | 0.30 |
| | Pop.(persons) | - | - | - | - | - | - | - | 3,780 | | | 3,780 |
| San Juan | Area(km2) | - | - | - | - | - | - | - | 3.52 | 2.68 | | 6.20 |
| | Pop.(persons) | - | - | - | - | - | - | - | 72,160 | 54,940 | - | 127,100 |
| Mandaluyong | Area(km2) | - | - | - | - | - | - | - | 2.25 | 2.80 | 1.09 | 6.14 |
| | Pop.(persons) | | | | - | | | | 49,950 | 62,160 | 24,198 | 136,308 |
| Manila City | Area(km2) | - | - | - | - | - | - | - | - | 1.05 | - | 1.05 |
| | Pop.(persons) | | | | | | | | - | 43,680 | | 43,680 |
| Total | Area(km2) | 23.27 | 10.53 | 2.18 | 9.96 | 8.24 | 14.02 | 3.55 | 12.07 | 6.53 | 1.09 | 91.44 |
| | Pop.(persons) | 293,202 | 132,678 | 27,468 | 125,496 | 103,824 | 176,652 | 44,730 | 201,490 | 160,780 | 24,198 | 1,290,518 |
| | BOD-domestic(kg/D) | 12,139 | 5,493 | 1,137 | 5,196 | 4,298 | 7,313 | 1,852 | 8,342 | 6,656 | 1,002 | 53,427 |
| | BOD-industry(kg/D) | 3,787 | 1,714 | 355 | 1,621 | 1,341 | 2,282 | 825 | 2,805 | 1,517 | 253 | 16,500 |
| | Total BOD discharge | 15,926 | 7,207 | 1,492 | 6,817 | 5,639 | 9,595 | 2,677 | 11,147 | 8,173 | 1,255 | 69,927 |

Table 3.2.8 (3) SM/NM - Basin BOD discharge(present)

| | | SM-1 | SM-2 | SM-3 | NM-3 | NM-1-1 | NM-4 | Total |
|---|---|---|---|---|---|---|---|---|
| Manila City | Area(km2) | 1.12 | 7.26 | 1.41 | 7.94 | 2.68 | 0.69 | 21.30 |
| | Pop.(persons) | 46,592 | 302,016 | 58,656 | 330,304 | 119,808 | 28,704 | 886,080 |
| Makati | Area(km2) | 4.87 | - | - | - | - | - | 4.87 |
| | Pop.(persons) | 119,802 | - | - | - | - | - | 119,802 |
| Quezon City | Area(km2) | - | - | - | 1.12 | - | - | 1.12 |
| | Pop.(persons) | - | - | - | 14,112 | - | - | 14,112 |
| Total | Area(km2) | 5.99 | 7.26 | 1.41 | 9.06 | 2.68 | 0.69 | 27.29 |
| | Pop.(persons) | 166,394 | 302,016 | 58,656 | 344,416 | 119,808 | 28,704 | 1,019,994 |
| | BOD-domestic(kg/D) | 8,889 | 12,503 | 2,428 | 14,259 | 4,960 | 1,188 | 42,228 |
| | BOD-industry(kg/D) | 8,983 | 3,350 | - | 3,350 | 3,350 | - | 19,033 |
| | Total BOD discharge | 15,872 | 15,853 | 2,428 | 17,609 | 8,310 | 1,188 | 61,261 |

Table 3.2.8(4) ME - Basin BOD discharge(present)

| | | ME-1 | ME-2 | ME-3 | ME-4 | ME-5 | ME-6 | ME-7 | ME-8 | ME-9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| San Nicolas | Area(km2) | 21.22 | 9.93 | - | - | - | - | - | - | - | 31.15 |
| | Pop.(persons) | 36,074 | 15,881 | | | | | | | | 52,955 |
| Caloocan N | Area(km2) | 2.45 | 5.13 | 18.43 | 1.00 | - | 9.12 | 2.60 | 1.57 | - | 40.30 |
| | Pop.(persons) | 13,171 | 27,579 | 99,080 | 5,376 | - | 49,029 | 13,978 | 8,440 | - | 216,653 |
| Quezon City | Area(km2) | - | - | 3.38 | - | - | 1.30 | - | - | - | 4.68 |
| | Pop.(persons) | - | - | 42,588 | | | 16,380 | | | | 58,968 |
| Meycauayan | Area(km2) | - | - | - | 3.60 | 7.04 | 10.58 | - | - | 2.33 | 23.55 |
| | Pop.(persons) | - | - | | 15,840 | 30,976 | 46,552 | - | - | 10,252 | 103,620 |
| Marilao | Area(km2) | - | - | - | 17.38 | 2.28 | - | - | - | - | 19.66 |
| | Pop.(persons) | - | - | | 39,974 | 5,244 | - | - | - | - | 45,218 |
| St Maria | Area(km2) | - | - | - | 7.25 | - | - | - | - | - | 7.25 |
| | Pop.(persons) | - | - | | 12,325 | | | | | | 12,325 |
| Valenzuela | Area(km2) | - | - | - | - | - | 3.52 | 8.22 | 16.24 | 12.03 | 39.01 |
| | Pop.(persons) | - | - | | | | 26,752 | 47,272 | 123,424 | 91,428 | 288,876 |
| Malabon | Area(km2) | - | - | - | - | - | - | - | - | 0.93 | 0.93 |
| | Pop.(persons) | - | - | | | | | | | 14,973 | 14,973 |
| Obando | Area(km2) | - | - | - | - | - | - | - | - | 3.13 | 3.13 |
| | Pop.(persons) | - | - | | | | | | | 10,642 | 10,642 |
| Total | Area(km2) | 23.67 | 15.06 | 21.81 | 29.23 | 9.32 | 24.52 | 8.82 | 17.81 | 18.42 | 168.56 |
| | Pop.(persons) | 49,245 | 44,460 | 141,668 | 73,515 | 36,220 | 138,713 | 61,250 | 131,864 | 127,295 | 804,230 |
| | BOD-domestic(kg/D) | 2,039 | 1,841 | 5,865 | 3,044 | 1,500 | 5,743 | 2,536 | 5,459 | 5,270 | 33,295 |
| | BOD-industry(kg/D) | - | - | - | - | 100 | 3,098 | 1,102 | 6,046 | 6,254 | 16,600 |
| | Total BOD discharge | 2,039 | 1,841 | 5,865 | 3,044 | 1,600 | 8,841 | 3,638 | 11,505 | 11,524 | 49,895 |

Table 3.2.8(5) MT/MA - Basin BOD discharge(present)

| | | MT-1 | MT-2 | MT-3 | MT-4 | MA | Total |
|---|---|---|---|---|---|---|---|
| Quezon City | Area(km2) | 25.82 | 13.38 | 16.40 | - | - | 55.60 |
| | Pop.(persons) | - | 168,588 | 206,640 | - | - | 375,228 |
| Valenzuela | Area(km2) | - | - | 2.20 | 5.30 | - | 7.50 |
| | Pop.(persons) | | | 18,720 | 40,280 | | 57,000 |
| Malabon | Area(km2) | - | - | - | 3.84 | 9.12 | 12.96 |
| | Pop.(persons) | | | | 61,824 | 146,832 | 208,656 |
| Caloocan S | Area(km2) | - | - | 1.48 | 0.83 | 3.68 | 5.99 |
| | Pop.(persons) | | | 59,916 | 33,602 | 148,981 | 242,499 |
| Navotas | Area(km2) | - | - | - | - | 4.93 | 4.93 |
| | Pop.(persons) | | | | | 83,810 | 83,810 |
| Manila City | Area(km2) | - | - | - | - | 0.90 | 0.90 |
| | Pop.(persons) | | | | | 37,440 | 37,440 |
| Total | Area(km2) | 25.82 | 13.38 | 20.08 | 9.97 | 18.63 | 87.88 |
| | Pop.(persons) | - | 168,588 | 285,276 | 135,706 | 417,063 | 1,004,633 |
| | BOD-domestic(kg/D) | - | 6,990 | 11,728 | 5,618 | 17,256 | 41,592 |
| | BOD-industry(kg/D) | - | - | 100 | 8,100 | 14,300 | 22,500 |
| | Total BOD discharge | - | 6,990 | 11,828 | 13,718 | 31,556 | 64,092 |

Table 3.2.8(6) BB/EM - Basin BOD discharge(present)

| | | BB-1 | BB-2 | BB-3 | BB-4 | BB-5 | BB-6 | BB-7 | EM-1 | EM-2 | EM-3 | EM-4 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antipolo | Area(km2) | 2.48 | 0.93 | - | 22.24 | - | - | 1.38 | - | - | - | - | 27.03 |
| | Pop.(persons) | 11,593 | 4,347 | - | 100,962 | - | - | 6,451 | - | - | - | - | 129,353 |
| Marikina | Area(km2) | 12.66 | - | 0.50 | - | - | - | - | - | - | - | - | 13.16 |
| | Pop.(persons) | 172,176 | - | 6,800 | - | - | - | - | - | - | - | - | 178,976 |
| Cainta | Area(km2) | 1.41 | 5.70 | 1.48 | 4.28 | 4.21 | - | 2.50 | - | 2.42 | - | - | 22.10 |
| | Pop.(persons) | 8,178 | 33,060 | 8,584 | 24,824 | 24,418 | - | 15,080 | - | 14,036 | - | - | 128,180 |
| Pasig | Area(km2) | - | - | 3.57 | - | - | 4.46 | - | 1.67 | - | - | - | 9.70 |
| | Pop.(persons) | - | - | 44,582 | - | - | 56,196 | - | 21,042 | - | - | - | 122,220 |
| Taytay | Area(km2) | - | - | - | - | - | - | 6.51 | - | - | 2.72 | 1.95 | 11.18 |
| | Pop.(persons) | | | | | | | 21,483 | - | - | 8,976 | 6,435 | 36,894 |
| Total | Area(km2) | 16.55 | 6.63 | 5.55 | 26.52 | 4.21 | 4.46 | 10.49 | 1.67 | 2.42 | 2.72 | 1.95 | 83.17 |
| | Pop.(persons) | 191,947 | 37,407 | 60,366 | 128,786 | 24,418 | 56,196 | 43,014 | 21,042 | 14,036 | 8,976 | 6,435 | 592,623 |
| | BOD-domestic(kg/D) | 7,947 | 1,543 | 2,499 | 5,332 | 1,011 | 2,327 | 1,781 | 871 | 581 | 372 | 266 | 24,535 |
| | BOD-industry(kg/D) | 6,169 | 2,471 | 2,069 | 9,885 | 1,569 | 1,662 | 3,910 | 622 | 902 | 1,014 | 727 | 31,000 |
| | Total BOD discharge | 14,116 | 4,020 | 4,568 | 15,217 | 2,580 | 3,989 | 5,691 | 1,493 | 1,483 | 1,386 | 993 | 55,535 |

Table 3.2.8 (7) PL/PA/ZP - Basin BOD discharge(present)

| | | PL-1 | PL-2 | PL-3 | PL-4 | PL-5 | PA-1 | PA-2 | PA-3 | PA-4 | ZP-1 | ZP-2 | ZP-3 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pasay | Area(km2) | 1.73 | - | - | - | - | 5.98 | - | - | - | - | - | - | 5.98 |
| | Pop.(persons) | 36,157 | - | - | - | - | 124,982 | - | - | - | - | - | - | 124,982 |
| Paranaque | Area(km2) | 9.76 | 3.44 | 14.55 | - | 1.15 | 2.86 | 1.60 | 0.87 | - | - | - | - | 6.48 |
| | Pop.(persons) | 75,152 | 26,488 | 112,035 | - | 8,855 | 22,022 | 12,320 | 6,699 | - | - | - | - | 49,896 |
| Las Pinas | Area(km2) | - | - | 4.70 | 6.27 | 8.57 | - | 0.81 | 0.68 | 2.65 | 5.85 | 3.67 | - | 28.50 |
| | Pop.(persons) | | | 42,770 | 57,057 | 77,987 | - | 7,371 | 6,188 | 24,115 | 53,235 | 33,397 | - | 259,350 |
| Bacoor | Area(km2) | - | - | - | - | - | - | - | - | - | 16.35 | - | 4.76 | 21.11 |
| | Pop.(persons) | | | | | | | | | | 49,050 | | 14,280 | 63,330 |
| Imus | Area(km2) | - | - | - | - | - | - | - | - | - | 5.50 | - | - | 5.50 |
| | Pop.(persons) | | | | | | | | | | 4,950 | | | 4,950 |
| Dasmarinas | Area(km2) | - | - | - | - | - | - | - | - | - | 9.09 | - | - | 9.09 |
| | Pop.(persons) | | | | | | | | | | 8,181 | | | 8,181 |
| Total | Area(km2) | 11.49 | 3.44 | 19.25 | 6.27 | 9.72 | 8.84 | 2.41 | 1.55 | 2.65 | 36.79 | 3.67 | 4.76 | 76.66 |
| | Pop.(persons) | 111,309 | 26,488 | 154,805 | 57,057 | 86,842 | 147,004 | 19,691 | 12,887 | 24,115 | 115,416 | 33,397 | 14,280 | 510,689 |
| | BOD-domestic(kg/D) | 4,608 | 1,097 | 6,409 | 2,362 | 3,595 | 6,086 | 815 | 534 | 998 | 4,778 | 1,383 | 591 | 21,143 |
| | BOD-industry(kg/D) | 499 | 149 | 836 | 337 | 522 | 475 | 130 | 83 | 115 | - | 197 | 256 | 2,115 |
| | Total BOD discharge | 5,107 | 1,246 | 7,245 | 2,699 | 4,117 | 6,561 | 945 | 617 | 1,113 | 4,778 | 1,580 | 847 | 23,258 |

Table 3.2.10(1) San Juan and Pasig-Marikina river water quality

case 1 (SFF=0.0062m3/sec/km2)

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | 1990 BOD con. (mg/l) | Existing Quality (mg/l) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 277.66 | 1.72 | 1,114 | 2,367 | 0.2 | 0.6 | 1,643 | 11 | |
| 2 | 277.66 | 1.72 | 1,114 | 2,367 | 0.2 | 0.6 | 1,643 | 11 | |
| 3 | 375.19 | 2.33 | 3,891 | 4,734 | 0.2 | 0.6 | 3,619 | 13 | |
| 4 | 512.2 | 3.18 | 22,147 | 7,101 | 0.2 | 0.6 | 8,690 | 32 | Rosario 16 |
| 5 | 518.38 | 3.21 | 25,493 | 15,901 | 0.2 | 0.6 | 14,639 | 53 | |
| 6 | 518.38 | 3.21 | 25,493 | 15,901 | 0.2 | 0.6 | 14,639 | 53 | Vargas 21 |
| 7 | | | | | | | | | |
| 8 | 549.07 | 3.40 | 48,787 | 56,750 | 0.2 | 0.6 | 43,807 | 149 | Lambingan 22 |
| 9 | 640.51 | 3.97 | 102,215 | 73,250 | 0.2 | 0.6 | 64,393 | 188 | Jones 30 |
| 10 | 23.27 | 0.14 | 12,139 | 3,787 | 0.2 | 0.6 | 4,700 | 377 | Congress 38 |
| 11 | 10.53 | 0.07 | 5,493 | 1,714 | 0.2 | 0.6 | 2,127 | 377 | |
| 12 | 33.8 | 0.21 | 17,632 | 5,501 | 0.2 | 0.6 | 6,827 | 377 | Quezon Blu 59 |
| 13 | 71.75 | 0.44 | 37,428 | 11,925 | 0.2 | 0.6 | 14,541 | 381 | Dario Creek 70 |
| 14 | 91.44 | 0.57 | 53,428 | 16,500 | 0.2 | 0.6 | 20,586 | 420 | Sanchez 58 |
| 15 | 661.81 | 4.10 | 102,215 | 73,250 | 0.2 | 0.6 | 64,393 | 182 | |

case 2 (SFF=0.039m3/sec/km2)

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | 1990 BOD con. (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 277.66 | 10.83 | 1,114 | 2,367 | 0.2 | 0.6 | 1,643 | 2 |
| 2 | 277.66 | 10.83 | 1,114 | 2,367 | 0.2 | 0.6 | 1,643 | 2 |
| 3 | 375.19 | 14.63 | 3,891 | 4,734 | 0.2 | 0.6 | 3,619 | 3 |
| 4 | 512.2 | 19.98 | 22,147 | 7,101 | 0.2 | 0.6 | 8,690 | 5 |
| 5 | 518.38 | 20.22 | 25,493 | 15,901 | 0.2 | 0.6 | 14,639 | 8 |
| 6 | 518.38 | 20.22 | 25,493 | 15,901 | 0.2 | 0.6 | 14,639 | 8 |
| 7 | | | | | | | | |
| 8 | 549.07 | 21.41 | 48,787 | 56,750 | 0.2 | 0.6 | 43,807 | 24 |
| 9 | 640.51 | 24.98 | 102,215 | 73,250 | 0.2 | 0.6 | 64,393 | 30 |
| 10 | 23.27 | 0.91 | 12,139 | 3,787 | 0.2 | 0.6 | 4,700 | 60 |
| 11 | 10.53 | 0.41 | 5,493 | 1,714 | 0.2 | 0.6 | 2,127 | 60 |
| 12 | 33.8 | 1.32 | 17,632 | 5,501 | 0.2 | 0.6 | 6,827 | 60 |
| 13 | 71.75 | 2.80 | 37,428 | 11,925 | 0.2 | 0.6 | 14,541 | 61 |
| 14 | 91.44 | 3.57 | 53,428 | 16,500 | 0.2 | 0.6 | 20,586 | 67 |
| 15 | 661.81 | 25.81 | 102,215 | 73,250 | 0.2 | 0.6 | 64,393 | 29 |

Table 3.2.10(2) Meycauyan and Marilao river water quality

case 1

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | 1990 BOD con. (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.67 | 0.15 | 2,039 | - | 0.2 | 0.6 | 408 | 32 |
| 2 | 38.73 | 0.24 | 3,880 | - | 0.2 | 0.6 | 776 | 37 |
| 3 | 89.77 | 0.56 | 12,789 | - | 0.2 | 0.6 | 2,558 | 53 |
| 4 | 99.09 | 0.61 | 14,289 | 100 | 0.2 | 0.6 | 2,918 | 55 |
| 5 | 24.52 | 0.15 | 5,743 | 3,098 | 0.2 | 0.6 | 3,007 | 229 |
| 6 | 26.63 | 0.17 | 7,995 | 7,148 | 0.2 | 0.6 | 5,888 | 413 |
| 7 | 51.15 | 0.32 | 13,738 | 10,248 | 0.2 | 0.6 | 8,895 | 325 |
| 8 | 168.66 | 1.05 | 33,297 | 16,600 | 0.2 | 0.6 | 16,619 | 184 |

case 2

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | 1990 BOD con. (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.67 | 0.92 | 2,039 | - | 0.2 | 0.6 | 408 | 5 |
| 2 | 38.73 | 1.51 | 3,880 | - | 0.2 | 0.6 | 776 | 6 |
| 3 | 89.77 | 3.50 | 12,789 | - | 0.2 | 0.6 | 2,558 | 8 |
| 4 | 99.09 | 3.86 | 14,289 | 100 | 0.2 | 0.6 | 2,918 | 9 |
| 5 | 24.52 | 0.96 | 5,743 | 3,098 | 0.2 | 0.6 | 3,007 | 36 |
| 6 | 26.63 | 1.04 | 7,995 | 7,148 | 0.2 | 0.6 | 5,888 | 65 |
| 7 | 51.15 | 1.99 | 13,738 | 10,248 | 0.2 | 0.6 | 8,895 | 52 |
| 8 | 168.66 | 6.58 | 33,297 | 16,600 | 0.2 | 0.6 | 16,619 | 29 |

Table 3.2.10(3) Malabon-Tullahan river water quality

case 1

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) | Existing Quality (mg/l) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 25.82 | 0.16 | - | - | 0.2 | 0.6 | - | 0 | |
| 2 | 25.82 | 0.16 | - | - | 0.2 | 0.6 | - | 0 | |
| 3 | 39.2 | 0.24 | 6,980 | - | 0.2 | 0.6 | 1,396 | 66 | Guiod 20 |
| 4 | 59.28 | 0.37 | 18,708 | 100 | 0.2 | 0.6 | 3,802 | 120 | North Exp. 60 |
| 5 | 69.25 | 0.43 | 24,326 | 8,200 | 0.2 | 0.6 | 9,785 | 264 | Mac. High w.78 |
| 6 | 87.88 | 0.54 | 41,592 | 22,500 | 0.2 | 0.6 | 21,818 | 463 | Gov Pascual 45 |

case 2

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | 1990 BOD con. (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 25.82 | 1.01 | - | - | 0.2 | 0.6 | - | 0 |
| 2 | 25.82 | 1.01 | - | - | 0.2 | 0.6 | - | 0 |
| 3 | 39.2 | 1.53 | 6,980 | - | 0.2 | 0.6 | 1,396 | 11 |
| 4 | 59.28 | 2.31 | 18,708 | 100 | 0.2 | 0.6 | 3,802 | 19 |
| 5 | 69.25 | 2.70 | 24,326 | 8,200 | 0.2 | 0.6 | 9,785 | 42 |
| 6 | 87.88 | 3.43 | 41,592 | 22,500 | 0.2 | 0.6 | 21,818 | 74 |

Table 3.2.10(2) Bahe-Suli river water quality

Case 1

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 16.55 | 0.10 | 7,947 | 6,169 | 0.2 | 0.6 | 5,291 | 597 |
| 2 | 6.63 | 0.04 | 1,549 | 2,471 | 0.2 | 0.6 | 1,792 | 505 |
| 3 | 28.73 | 0.18 | 11,995 | 10,709 | 0.2 | 0.6 | 8,824 | 573 |
| 4 | 26.52 | 0.16 | 5,332 | 9,885 | 0.2 | 0.6 | 6,997 | 493 |
| 5 | 61.88 | 0.38 | 18,919 | 23,065 | 0.2 | 0.6 | 17,623 | 532 |
| 6 | 6.13 | 0.04 | 3,198 | 2,284 | 0.2 | 0.6 | 2,010 | 612 |
| 7 | 68.01 | 0.42 | 22,117 | 25,349 | 0.2 | 0.6 | 19,633 | 536 |
| 8 | 15.16 | 0.09 | 2,419 | 5,651 | 0.2 | 0.6 | 3,874 | 477 |
| 9 | 83.17 | 0.52 | 24,536 | 31,000 | 0.2 | 0.6 | 23,507 | 528 |

Case 2

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | 1990 BOD con. (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 16.55 | 0.65 | 7,947 | 6,169 | 0.2 | 0.6 | 5,291 | 95 |
| 2 | 6.63 | 0.26 | 1,549 | 2,471 | 0.2 | 0.6 | 1,792 | 80 |
| 3 | 28.73 | 1.12 | 11,995 | 10,709 | 0.2 | 0.6 | 8,824 | 91 |
| 4 | 26.52 | 1.03 | 5,332 | 9,885 | 0.2 | 0.6 | 6,997 | 78 |
| 5 | 61.88 | 2.41 | 18,919 | 23,065 | 0.2 | 0.6 | 17,623 | 85 |
| 6 | 6.13 | 0.24 | 3,198 | 2,284 | 0.2 | 0.6 | 2,010 | 97 |
| 7 | 68.01 | 2.65 | 22,117 | 25,349 | 0.2 | 0.6 | 19,633 | 86 |
| 8 | 15.16 | 0.59 | 2,419 | 5,651 | 0.2 | 0.6 | 3,874 | 76 |
| 9 | 83.17 | 3.24 | 24,536 | 31,000 | 0.2 | 0.6 | 23,507 | 84 |

Table 3.2.10(3) South Paranaque-Las Pinas river water quality

case 1

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) | Existing Quality (mg/l) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 11.49 | 0.07 | 4,608 | 499 | 0.2 | 0.6 | 1,221 | 198 | |
| 2 | 19.25 | 0.12 | 6,409 | 836 | 0.2 | 0.6 | 1,783 | 173 | Panana Brid. 14 |
| 3 | 22.69 | 0.14 | 7,506 | 985 | 0.2 | 0.6 | 2,092 | 172 | |
| 4 | 34.18 | 0.21 | 12,114 | 1,484 | 0.2 | 0.6 | 3,313 | 181 | |
| 5 | 6.27 | 0.04 | 2,362 | 337 | 0.2 | 0.6 | 675 | 201 | |
| 6 | 15.99 | 0.10 | 5,957 | 859 | 0.2 | 0.6 | 1,707 | 199 | |
| 7 | 36.79 | 0.23 | 4,778 | - | 0.2 | 0.6 | 956 | 48 | |
| 8 | 45.22 | 0.28 | 6,752 | 453 | 0.2 | 0.6 | 1,622 | 67 | |
| | | | | | | | | | MIA road 43 |

case 2

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | 1990 BOD con. (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 11.49 | 0.45 | 4,608 | 499 | 0.2 | 0.6 | 1,221 | 32 |
| 2 | 19.25 | 0.75 | 6,409 | 836 | 0.2 | 0.6 | 1,783 | 27 |
| 3 | 22.69 | 0.88 | 7,506 | 985 | 0.2 | 0.6 | 2,092 | 27 |
| 4 | 34.18 | 1.33 | 12,114 | 1,484 | 0.2 | 0.6 | 3,313 | 29 |
| 5 | 6.27 | 0.24 | 2,362 | 337 | 0.2 | 0.6 | 675 | 32 |
| 6 | 15.99 | 0.62 | 5,957 | 859 | 0.2 | 0.6 | 1,707 | 32 |
| 7 | 36.79 | 1.43 | 4,778 | - | 0.2 | 0.6 | 956 | 8 |
| 8 | 45.22 | 1.76 | 6,752 | 453 | 0.2 | 0.6 | 1,622 | 11 |

| Table 3.2.11(1) PM - Basin BOD discharge (2015) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | PM-1 | PM-2 | PM-3 | PM-4 | PM-5 | PM-6 | PM-7 | Total |
| Taytay | Area(km2) | 33.32 | - | - | - | - | - | - | 33.32 |
| | Pop.(persons) | 12,774 | - | - | - | - | - | - | 12,774 |
| Antipolo | Area(km2) | 174.93 | - | 40.61 | - | - | - | - | 215.54 |
| | Pop.(persons) | 60,986 | - | 182,959 | - | - | - | - | 243,945 |
| Rodriguez | Area(km2) | 59.41 | 97.53 | - | - | - | - | - | 156.94 |
| | Pop.(persons) | - | 146,684 | - | - | - | - | - | 146,684 |
| San Mateo | Area(km2) | - | - | 64.90 | - | - | - | - | 64.90 |
| | Pop.(persons) | | | 184,616 | | | | | 184,616 |
| Quezon | Area(km2) | - | - | 23.30 | 1.50 | 3.90 | - | - | 28.70 |
| | Pop.(persons) | | | 303,680 | 31,200 | 81,120 | - | - | 416,000 |
| Marikina | Area(km2) | - | - | 8.20 | 2.95 | - | - | - | 11.15 |
| | Pop.(persons) | | | 185,320 | 66,670 | | | | 251,990 |
| Pasig | Area(km2) | - | - | - | 1.73 | 7.43 | 1.94 | - | 11.10 |
| | Pop.(persons) | | | | 37,887 | 162,717 | 42,486 | | 243,090 |
| Taguig | Area(km2) | - | - | - | - | - | 3.30 | - | 3.30 |
| | Pop.(persons) | | | | | | 46,860 | | 46,860 |
| Mandaluyong | Area(km2) | - | - | - | - | - | 0.80 | - | 0.80 |
| | Pop.(persons) | | | | | | 21,440 | | 21,440 |
| Makati | Area(km2) | - | - | - | - | - | 2.70 | 3.83 | 6.53 |
| | Pop.(persons) | | | | | | 82,080 | 116,432 | 198,512 |
| Manila City | Area(km2) | - | - | - | - | - | - | 0.75 | 0.75 |
| | Pop.(persons) | | | | | | | 33,525 | 33,525 |
| Total | Area(km2) | 277.66 | 97.53 | 137.01 | 6.18 | 11.33 | 8.74 | 4.58 | 543.03 |
| | Pop.(persons) | 73,760 | 146,684 | 856,575 | 135,757 | 243,837 | 192,866 | 149,957 | 1,799,436 |
| | BOD-domestic(kg/D) | 3,319 | 6,601 | 38,546 | 6,109 | 10,973 | 8,679 | 6,748 | 80,975 |
| | BOD-industry(kg/D) | 2,367 | 2,367 | 2,367 | 8,800 | 13,900 | 8,983 | 8,963 | 47,767 |
| | Total BOD discharge | 5,686 | 8,968 | 40,913 | 14,909 | 24,873 | 17,662 | 15,731 | 128,742 |

| Table 3.2.11(2) SJ - Basin BOD discharge (2015) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SJ-1 | SJ-2 | SJ-3 | SJ-4 | SJ-5 | SJ-6 | SJ-7 | SJ-8 | SJ-9 | SJ-10 | Total |
| Quezon City | Area(km2) | 23.27 | 10.53 | 2.18 | 9.96 | 8.24 | 14.02 | 3.55 | 6.00 | - | - | 77.75 |
| | Pop.(persons) | 484,015 | 219,024 | 45,344 | 207,168 | 171,392 | 291,616 | 73,840 | 124,800 | - | - | 1,617,200 |
| Pasig | Area(km2) | - | - | - | - | - | - | - | 0.30 | - | - | 0.30 |
| | Pop.(persons) | - | - | - | - | - | - | - | 6,570 | | | 6,570 |
| San Juan | Area(km2) | - | - | - | - | - | - | - | 3.52 | 2.68 | | 6.20 |
| | Pop.(persons) | - | - | - | - | - | - | - | 87,296 | 66,464 | - | 153,760 |
| Mandaluyong | Area(km2) | - | - | - | - | - | - | - | 2.25 | 2.80 | 1.09 | 6.14 |
| | Pop.(persons) | | | | - | | | | 60,300 | 75,040 | 29,212 | 164,552 |
| Manila City | Area(km2) | - | - | - | - | - | - | - | - | 1.05 | - | 1.05 |
| | Pop.(persons) | | | | | | | | - | 46,935 | | 46,935 |
| Total | Area(km2) | 23.27 | 10.53 | 2.18 | 9.96 | 8.24 | 14.02 | 3.55 | 12.07 | 6.53 | 1.09 | 91.44 |
| | Pop.(persons) | 484,015 | 219,024 | 45,344 | 207,168 | 171,392 | 291,616 | 73,840 | 278,966 | 188,439 | 29,212 | 1,989,017 |
| | BOD-domestic(kg/D) | 21,781 | 9,856 | 2,040 | 9,323 | 7,713 | 13,123 | 3,323 | 12,553 | 8,480 | 1,315 | 89,506 |
| | BOD-industry(kg/D) | 3,787 | 1,714 | 355 | 1,621 | 1,341 | 2,282 | 825 | 2,805 | 1,517 | 253 | 16,500 |
| | Total BOD discharge | 25,568 | 11,570 | 2,395 | 10,944 | 9,054 | 15,405 | 4,148 | 15,358 | 9,997 | 1,568 | 106,006 |

| Table 3.2.11(3) SM/NM - Basin BOD discharge (2015) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | SM-1 | SM-2 | SM-3 | NM-3 | NM-1-1 | NM-4 | Total |
| Manila City | Area(km2) | 1.12 | 7.26 | 1.41 | 7.94 | 2.88 | 0.69 | 21.30 |
| | Pop.(persons) | 50,064 | 324,522 | 63,027 | 354,918 | 128,736 | 30,843 | 952,110 |
| Makati | Area(km2) | 4.87 | - | - | - | - | - | 4.87 |
| | Pop.(persons) | 148,048 | - | - | - | - | - | 148,048 |
| Quezon City | Area(km2) | - | - | - | 1.12 | - | - | 1.12 |
| | Pop.(persons) | - | - | - | 23,296 | - | - | 23,296 |
| Total | Area(km2) | 5.99 | 7.26 | 1.41 | 9.06 | 2.88 | 0.69 | 27.29 |
| | Pop.(persons) | 198,112 | 324,522 | 63,027 | 378,214 | 128,736 | 30,843 | 1,123,454 |
| | BOD-domestic(kg/D) | 8,915 | 14,603 | 2,836 | 17,020 | 5,793 | 1,388 | 50,555 |
| | BOD-industry(kg/D) | 8,983 | 3,350 | - | 3,350 | 3,350 | - | 19,033 |
| | Total BOD discharge | 17,898 | 17,953 | 2,836 | 20,370 | 9,143 | 1,388 | 69,588 |

Table 3.2.11(4) ME - Basin BOD discharge (2015)

| | | ME-1 | ME-2 | ME-3 | ME-4 | ME-5 | ME-6 | ME-7 | ME-8 | ME-9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SanNoseAef | Area(km2) | 21.22 | 9.93 | - | - | - | - | - | - | - | 31.15 |
| | Pop.(persons) | 57,294 | 26,811 | | | | | | | | 84,105 |
| Caloocan N | Area(km2) | 2.45 | 5.13 | 18.43 | 1.00 | - | 9.12 | 2.60 | 1.57 | - | 40.30 |
| | Pop.(persons) | 20,842 | 43,641 | 156,784 | 8,507 | - | 77,584 | 22,118 | 13,356 | - | 342,832 |
| Quezon City | Area(km2) | - | - | 3.38 | - | - | 1.30 | - | - | - | 4.68 |
| | Pop.(persons) | - | - | 70,304 | | | 27,040 | | | | 97,344 |
| Meycauyan | Area(km2) | - | - | - | 3.60 | 7.04 | 10.58 | - | - | 2.33 | 23.55 |
| | Pop.(persons) | - | - | | 25,920 | 50,668 | 76,176 | - | - | 16,776 | 169,560 |
| Marikao | Area(km2) | - | - | - | 17.38 | 2.28 | - | - | - | - | 19.66 |
| | Pop.(persons) | - | - | | 71,256 | 9,348 | - | - | - | - | 80,606 |
| St.Maria | Area(km2) | - | - | - | 7.25 | - | - | - | - | - | 7.25 |
| | Pop.(persons) | - | - | | 13,575 | | | | | | 13,575 |
| Valenzuela | Area(km2) | - | - | - | - | - | 3.52 | 6.22 | 16.24 | 12.03 | 38.01 |
| | Pop.(persons) | - | - | | | | 52,096 | 92,056 | 240,352 | 178,044 | 562,548 |
| Malabon | Area(km2) | - | - | - | - | - | - | - | - | 0.93 | 0.93 |
| | Pop.(persons) | - | - | | | | | | | 19,902 | 19,902 |
| Obando | Area(km2) | - | - | - | - | - | - | - | - | 3.13 | 3.13 |
| | Pop.(persons) | - | - | | | | | | | 15,963 | 15,963 |
| Total | Area(km2) | 23.67 | 15.06 | 21.81 | 29.23 | 9.32 | 24.52 | 8.82 | 17.81 | 18.42 | 168.66 |
| | Pop.(persons) | 78,136 | 70,452 | 227,088 | 125,260 | 60,016 | 232,896 | 114,174 | 253,708 | 230,685 | 1,392,435 |
| | BOD-domestic(kg/D) | 3,515 | 3,170 | 10,219 | 5,637 | 2,702 | 10,480 | 5,138 | 11,417 | 10,381 | 62,660 |
| | BOD-industry(kg/D) | - | - | - | - | 100 | 3,098 | 1,102 | 6,046 | 6,254 | 16,600 |
| | Total BOD discharge | 3,518 | 3,170 | 10,219 | 5,637 | 2,802 | 13,578 | 6,240 | 17,463 | 16,635 | 79,260 |

Table 3.2.11(5) MT-MA - Basin BOD discharge (2015)

| | | MT-1 | MT-2 | MT-3 | MT-4 | MA | Total |
|---|---|---|---|---|---|---|---|
| Quezon City | Area(km2) | 25.82 | 13.38 | 16.40 | - | - | 55.60 |
| | Pop.(persons) | - | 278,304 | 341,120 | - | - | 619,424 |
| Valenzuela | Area(km2) | - | - | 2.20 | 5.30 | - | 7.50 |
| | Pop.(persons) | | | 32,560 | 78,440 | | 111,000 |
| Malabon | Area(km2) | - | - | - | 3.84 | 9.12 | 12.96 |
| | Pop.(persons) | | | | 82,176 | 195,168 | 277,344 |
| Caloocan S | Area(km2) | - | - | 1.48 | 0.83 | 3.68 | 5.99 |
| | Pop.(persons) | | | 94,813 | 53,172 | 235,752 | 383,737 |
| Navotas | Area(km2) | - | - | - | - | 4.93 | 4.93 |
| | Pop.(persons) | | | | | 133,603 | 133,603 |
| Manila City | Area(km2) | - | - | - | - | 0.90 | 0.90 |
| | Pop.(persons) | | | | | 40,230 | 40,230 |
| Total | Area(km2) | 25.82 | 13.38 | 20.08 | 9.97 | 18.63 | 87.88 |
| | Pop.(persons) | - | 278,304 | 468,493 | 213,788 | 604,753 | 1,565,338 |
| | BOD-domestic(kg/D) | - | 12,524 | 21,082 | 9,629 | 27,214 | 70,449 |
| | BOD-industry(kg/D) | - | - | 100 | 8,100 | 14,300 | 22,500 |
| | Total BOD discharge | - | 12,524 | 21,182 | 17,729 | 41,514 | 92,949 |

Table 3.2.11(6) BB-EM - Basin BOD discharge (2015)

| | | BB-1 | BB-2 | BB-3 | BB-4 | BB-5 | BB-6 | BB-7 | EM-1 | EM-2 | EM-3 | EM-4 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antipolo | Area(km2) | 2.48 | 0.93 | - | 22.24 | - | - | 1.38 | - | - | - | - | 27.03 |
| | Pop.(persons) | 33,573 | 12,590 | - | 301,074 | - | - | 18,682 | - | - | - | - | 365,919 |
| Marikina | Area(km2) | 12.66 | - | 0.50 | - | - | - | - | - | - | - | - | 13.16 |
| | Pop.(persons) | 286,116 | - | 11,300 | - | - | - | - | - | - | - | - | 297,416 |
| Cainta | Area(km2) | 1.41 | 5.70 | 1.48 | 4.28 | 4.21 | - | 2.80 | - | 2.42 | - | - | 22.19 |
| | Pop.(persons) | 23,124 | 93,480 | 24,272 | 70,192 | 69,044 | - | 42,640 | - | 39,688 | - | - | 362,440 |
| Pasig | Area(km2) | - | - | 3.57 | - | - | 4.45 | - | 1.67 | - | - | - | 9.70 |
| | Pop.(persons) | - | - | 78,183 | - | - | 97,674 | - | 36,573 | - | - | - | 212,430 |
| Taytay | Area(km2) | - | - | - | - | - | - | 6.51 | - | - | 2.72 | 1.95 | 11.18 |
| | Pop.(persons) | | | | | | | 47,523 | - | - | 19,856 | 14,235 | 81,614 |
| Total | Area(km2) | 16.55 | 6.63 | 5.55 | 26.52 | 4.21 | 4.45 | 10.49 | 1.67 | 2.42 | 2.72 | 1.95 | 83.17 |
| | Pop.(persons) | 342,813 | 106,070 | 113,755 | 371,266 | 69,044 | 97,674 | 108,845 | 36,573 | 39,688 | 19,856 | 14,235 | 1,319,818 |
| | BOD-domestic(kg/D) | 15,427 | 4,773 | 5,119 | 16,707 | 3,107 | 4,395 | 4,898 | 1,646 | 1,786 | 894 | 641 | 59,392 |
| | BOD-industry(kg/D) | 6,169 | 2,471 | 2,069 | 9,885 | 1,569 | 1,682 | 3,910 | 622 | 902 | 1,014 | 727 | 31,000 |
| | Total BOD discharge | 21,596 | 7,244 | 7,188 | 26,592 | 4,676 | 6,057 | 8,808 | 2,268 | 2,688 | 1,908 | 1,368 | 90,392 |

| Table 3.2.11(7) | PL/PA/ZP - Basin BOD discharge (2015) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PL-1 | PL-2 | PL-3 | PL-4 | PL-5 | PA-1 | PA-2 | PA-3 | PA-4 | ZP-1 | ZP-2 | ZP-3 | Total |
| Pasay | Area(km2) | 1.73 | - | - | - | - | 5.98 | - | - | - | - | - | - | 5.98 |
| | Pop.(persons) | 50,862 | - | - | - | - | 175,812 | - | - | - | - | - | - | 175,812 |
| Paranaque | Area(km2) | 9.76 | 3.44 | 14.55 | - | 1.15 | 2.86 | 1.60 | 0.87 | - | - | - | - | 6.48 |
| | Pop.(persons) | 146,400 | 51,600 | 218,250 | - | 17,250 | 42,900 | 24,000 | 13,050 | - | - | - | - | 97,200 |
| Las Pinas | Area(km2) | - | - | 4.70 | 6.27 | 8.57 | - | 0.81 | 0.68 | 2.65 | 5.85 | 3.67 | - | 28.50 |
| | Pop.(persons) | | | 110,920 | 147,972 | 202,252 | - | 19,116 | 16,048 | 62,540 | 138,060 | 86,612 | - | 672,600 |
| Bacoor | Area(km2) | - | - | - | - | - | - | - | - | - | 16.35 | - | 4.76 | 21.11 |
| | Pop.(persons) | | | | | | | | | | 112,815 | | 32,844 | 145,659 |
| Imus | Area(km2) | - | - | - | - | - | - | - | - | - | 5.50 | - | - | 5.50 |
| | Pop.(persons) | | | | | | | | | | 9,900 | | | 9,900 |
| Dasmarinas | Area(km2) | - | - | - | - | - | - | - | - | - | 9.09 | - | - | 9.09 |
| | Pop.(persons) | | | | | | | | | | 16,362 | | | 16,362 |
| Total | Area(km2) | 11.49 | 3.44 | 19.25 | 6.27 | 9.72 | 8.84 | 2.41 | 1.55 | 2.65 | 36.79 | 3.67 | 4.76 | 76.66 |
| | Pop.(persons) | 197,262 | 51,600 | 329,170 | 147,972 | 219,502 | 218,712 | 43,116 | 29,098 | 62,540 | 277,137 | 86,612 | 32,844 | 1,117,533 |
| | BOD-domestic(kg/D) | 8,877 | 2,322 | 14,813 | 6,659 | 9,878 | 9,842 | 1,940 | 1,309 | 2,814 | 12,471 | 3,898 | 1,478 | 50,289 |
| | BOD-industry(kg/D) | 499 | 149 | 836 | 337 | 522 | 475 | 130 | 83 | 115 | - | 197 | 256 | 2,115 |
| | Total BOD discharge | 9,376 | 2,471 | 15,649 | 6,996 | 10,400 | 10,317 | 2,070 | 1,392 | 2,929 | 12,471 | 4,095 | 1,734 | 52,404 |

Table 3.2.12(1) San Juan and Pasig-Marikina river water quality(2015)

case 3 (2015 without IEPC)

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged Industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 277.66 | 10.83 | 3,319 | 2,367 | 0.2 | 0.6 | 2,084 | 2 |
| 2 | 277.66 | 10.83 | 3,319 | 2,367 | 0.2 | 0.6 | 2,084 | 2 |
| 3 | 375.19 | 14.63 | 9,920 | 4,734 | 0.2 | 0.6 | 4,824 | 4 |
| 4 | 512.2 | 19.98 | 48,466 | 7,101 | 0.2 | 0.6 | 13,954 | 8 |
| 5 | 518.38 | 20.22 | 54,575 | 15,901 | 0.2 | 0.6 | 20,456 | 12 |
| 6 | 518.38 | 20.22 | 54,575 | 15,901 | 0.2 | 0.6 | 20,456 | 12 |
| 7 | | | | | | | | |
| 8 | 549.07 | 21.41 | 89,890 | 56,750 | 0.2 | 0.6 | 52,028 | 28 |
| 9 | 640.51 | 24.98 | 179,397 | 73,250 | 0.2 | 0.6 | 79,829 | 37 |
| 10 | 23.27 | 0.91 | 21,781 | 3,787 | 0.2 | 0.6 | 6,628 | 85 |
| 11 | 10.53 | 0.41 | 9,856 | 1,714 | 0.2 | 0.6 | 3,000 | 85 |
| 12 | 33.8 | 1.32 | 31,637 | 5,501 | 0.2 | 0.6 | 9,628 | 85 |
| 13 | 71.75 | 2.80 | 67,159 | 11,925 | 0.2 | 0.6 | 20,587 | 85 |
| 14 | 91.44 | 3.57 | 89,507 | 16,500 | 0.2 | 0.6 | 27,801 | 90 |
| 15 | 661.81 | 25.81 | 179,397 | 73,250 | 0.2 | 0.6 | 79,829 | 36 |

case 4 (2015 with IEPC)

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged Industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 277.66 | 10.83 | 3,319 | 1,014 | 0.2 | 0.6 | 1,272 | 1 |
| 2 | 277.66 | 10.83 | 3,319 | 1,014 | 0.2 | 0.6 | 1,272 | 1 |
| 3 | 375.19 | 14.63 | 9,920 | 2,028 | 0.2 | 0.6 | 3,201 | 3 |
| 4 | 512.2 | 19.98 | 48,466 | 3,042 | 0.2 | 0.6 | 11,518 | 7 |
| 5 | 518.38 | 20.22 | 54,575 | 6,811 | 0.2 | 0.6 | 15,002 | 9 |
| 6 | 518.38 | 20.22 | 54,575 | 6,811 | 0.2 | 0.6 | 15,002 | 9 |
| 7 | | | | | | | | |
| 8 | 549.07 | 21.41 | 89,890 | 24,309 | 0.2 | 0.6 | 32,563 | 18 |
| 9 | 640.51 | 24.98 | 179,397 | 31,374 | 0.2 | 0.6 | 54,704 | 25 |
| 10 | 23.27 | 0.91 | 21,781 | 1,622 | 0.2 | 0.6 | 5,329 | 68 |
| 11 | 10.53 | 0.41 | 9,856 | 734 | 0.2 | 0.6 | 2,412 | 68 |
| 12 | 33.8 | 1.32 | 31,637 | 2,358 | 0.2 | 0.6 | 7,741 | 68 |
| 13 | 71.75 | 2.80 | 67,159 | 5,106 | 0.2 | 0.6 | 16,495 | 68 |
| 14 | 91.44 | 3.57 | 89,507 | 7,065 | 0.2 | 0.6 | 22,140 | 72 |
| 15 | 661.81 | 25.81 | 179,397 | 31,374 | 0.2 | 0.6 | 54,704 | 25 |

Table 3.2.12(2) Meycauyan and Marilao river water quality(2015)

case 3 (2015)

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | industrial run-off ratio (-) | Run-off BOD (kg/day) | 2015 BOD con. (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.67 | 0.92 | 3,516 | - | 0.2 | 0.6 | 703 | 9 |
| 2 | 38.73 | 1.51 | 6,686 | - | 0.2 | 0.6 | 1,337 | 10 |
| 3 | 89.77 | 3.50 | 22,542 | - | 0.2 | 0.6 | 4,508 | 15 |
| 4 | 99.09 | 3.86 | 25,244 | 100 | 0.2 | 0.6 | 5,109 | 15 |
| 5 | 24.52 | 0.96 | 10,480 | 3,098 | 0.2 | 0.6 | 3,955 | 48 |
| 6 | 26.63 | 1.04 | 16,555 | 7,148 | 0.2 | 0.6 | 7,600 | 85 |
| 7 | 51.15 | 1.99 | 27,035 | 10,246 | 0.2 | 0.6 | 11,555 | 67 |
| 8 | 165.66 | 6.58 | 62,680 | 16,600 | 0.2 | 0.6 | 22,492 | 40 |

case 4 (2015) w IEPC

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | industrial run-off ratio (-) | Run-off BOD (kg/day) | 2015 BOD con. (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.67 | 0.92 | 3,516 | - | 0.2 | 0.6 | 703 | 9 |
| 2 | 38.73 | 1.51 | 6,686 | - | 0.2 | 0.6 | 1,337 | 10 |
| 3 | 89.77 | 3.50 | 22,542 | - | 0.2 | 0.6 | 4,508 | 15 |
| 4 | 99.09 | 3.86 | 25,244 | 43 | 0.2 | 0.6 | 5,075 | 15 |
| 5 | 24.52 | 0.96 | 10,480 | 1,327 | 0.2 | 0.6 | 2,892 | 35 |
| 6 | 26.63 | 1.04 | 16,555 | 3,062 | 0.2 | 0.6 | 5,148 | 57 |
| 7 | 51.15 | 1.99 | 27,035 | 4,389 | 0.2 | 0.6 | 8,040 | 47 |
| 8 | 165.66 | 6.58 | 62,660 | 7,111 | 0.2 | 0.6 | 16,799 | 30 |

Table 3.2.13(3) Malabon-Tullahan river water quality(2015)

case 3 (2015)

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 25.82 | 1.01 | - | - | 0.2 | 0.6 | - | 0 |
| 2 | 25.82 | 1.01 | - | - | 0.2 | 0.6 | - | 0 |
| 3 | 39.2 | 1.53 | 12,524 | - | 0.2 | 0.6 | 2,505 | 19 |
| 4 | 59.28 | 2.31 | 33,606 | 100 | 0.2 | 0.6 | 6,781 | 34 |
| 5 | 69.25 | 2.70 | 43,226 | 8,200 | 0.2 | 0.6 | 13,565 | 58 |
| 6 | 87.88 | 3.43 | 70,440 | 22,500 | 0.2 | 0.6 | 27,588 | 93 |

case 4 (2015) w IEPC

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 25.82 | 1.01 | - | - | 0.2 | 0.6 | - | 0 |
| 2 | 25.82 | 1.01 | - | - | 0.2 | 0.6 | - | 0 |
| 3 | 39.2 | 1.53 | 12,524 | - | 0.2 | 0.6 | 2,505 | 19 |
| 4 | 59.28 | 2.31 | 33,606 | 43 | 0.2 | 0.6 | 6,747 | 34 |
| 5 | 69.25 | 2.70 | 43,226 | 3,513 | 0.2 | 0.6 | 10,753 | 46 |
| 6 | 87.88 | 3.43 | 70,440 | 9,838 | 0.2 | 0.6 | 19,871 | 67 |

Table 3.2.12(1) Baha-Bull river water quality(2015)

Case 3 (2015)

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged Industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 16.55 | 0.65 | 15,427 | 6,169 | 0.2 | 0.6 | 6,787 | 122 |
| 2 | 6.63 | 0.26 | 4,773 | 2,471 | 0.2 | 0.6 | 2,437 | 109 |
| 3 | 28.73 | 1.12 | 25,319 | 10,709 | 0.2 | 0.6 | 11,489 | 119 |
| 4 | 26.52 | 1.03 | 16,707 | 9,885 | 0.2 | 0.6 | 9,272 | 104 |
| 5 | 61.88 | 2.41 | 46,919 | 23,065 | 0.2 | 0.6 | 23,223 | 111 |
| 6 | 6.13 | 0.24 | 6,041 | 2,284 | 0.2 | 0.6 | 2,579 | 125 |
| 7 | 68.01 | 2.65 | 52,960 | 25,349 | 0.2 | 0.6 | 25,801 | 113 |
| 8 | 15.16 | 0.59 | 6,433 | 5,651 | 0.2 | 0.6 | 4,677 | 92 |
| 9 | 83.17 | 3.24 | 59,393 | 31,000 | 0.2 | 0.6 | 30,479 | 109 |

Case 4 (2015)w IEPC

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged Industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 16.55 | 0.65 | 15,427 | 2,642 | 0.2 | 0.6 | 4,671 | 84 |
| 2 | 6.63 | 0.26 | 4,773 | 1,059 | 0.2 | 0.6 | 1,590 | 71 |
| 3 | 28.73 | 1.12 | 25,319 | 4,587 | 0.2 | 0.6 | 7,816 | 81 |
| 4 | 26.52 | 1.03 | 16,707 | 4,234 | 0.2 | 0.6 | 5,882 | 66 |
| 5 | 61.88 | 2.41 | 46,919 | 9,879 | 0.2 | 0.6 | 15,311 | 73 |
| 6 | 6.13 | 0.24 | 6,041 | 979 | 0.2 | 0.6 | 1,796 | 87 |
| 7 | 68.01 | 2.65 | 52,960 | 10,858 | 0.2 | 0.6 | 17,107 | 75 |
| 8 | 15.16 | 0.59 | 6,433 | 2,420 | 0.2 | 0.6 | 2,739 | 54 |
| 9 | 83.17 | 3.24 | 59,393 | 13,278 | 0.2 | 0.6 | 19,345 | 71 |

Table 3.2.12(1) South Paranaque-Las Pinas river water quality(2015)

case 3 (2015)

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged Industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 11.49 | 0.45 | 8,877 | 499 | 0.2 | 0.6 | 2,075 | 54 |
| 2 | 19.25 | 0.75 | 14,813 | 836 | 0.2 | 0.6 | 3,464 | 53 |
| 3 | 22.69 | 0.88 | 17,135 | 965 | 0.2 | 0.6 | 4,018 | 53 |
| 4 | 34.18 | 1.33 | 26,012 | 1,484 | 0.2 | 0.6 | 6,093 | 53 |
| 5 | 8.27 | 0.24 | 6,659 | 337 | 0.2 | 0.6 | 1,534 | 73 |
| 6 | 15.99 | 0.62 | 16,537 | 859 | 0.2 | 0.6 | 3,823 | 71 |
| 7 | 36.79 | 1.43 | 12,471 | - | 0.2 | 0.6 | 2,494 | 20 |
| 8 | 45.22 | 1.76 | 17,847 | 453 | 0.2 | 0.6 | 3,841 | 25 |

case 4 (2015)w IEPC

| Check Point | Catchment Area (km2) | River Flow (m3/sec) | Discharged domestic BOD (kg/day) | Discharged Industrial BOD (kg/day) | domestic run-off ratio (-) | Industrial run-off ratio (-) | Run-off BOD (kg/day) | BOD concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 11.49 | 0.45 | 8,877 | 214 | 0.2 | 0.6 | 1,904 | 49 |
| 2 | 19.25 | 0.75 | 14,813 | 358 | 0.2 | 0.6 | 3,177 | 49 |
| 3 | 22.69 | 0.88 | 17,135 | 422 | 0.2 | 0.6 | 3,680 | 48 |
| 4 | 34.18 | 1.33 | 25,012 | 636 | 0.2 | 0.6 | 5,584 | 48 |
| 5 | 8.27 | 0.24 | 6,659 | 144 | 0.2 | 0.6 | 1,418 | 67 |
| 6 | 15.99 | 0.62 | 16,537 | 368 | 0.2 | 0.6 | 3,528 | 65 |
| 7 | 36.79 | 1.43 | 12,471 | - | 0.2 | 0.6 | 2,494 | 20 |
| 8 | 45.22 | 1.76 | 17,847 | 194 | 0.2 | 0.6 | 3,686 | 24 |

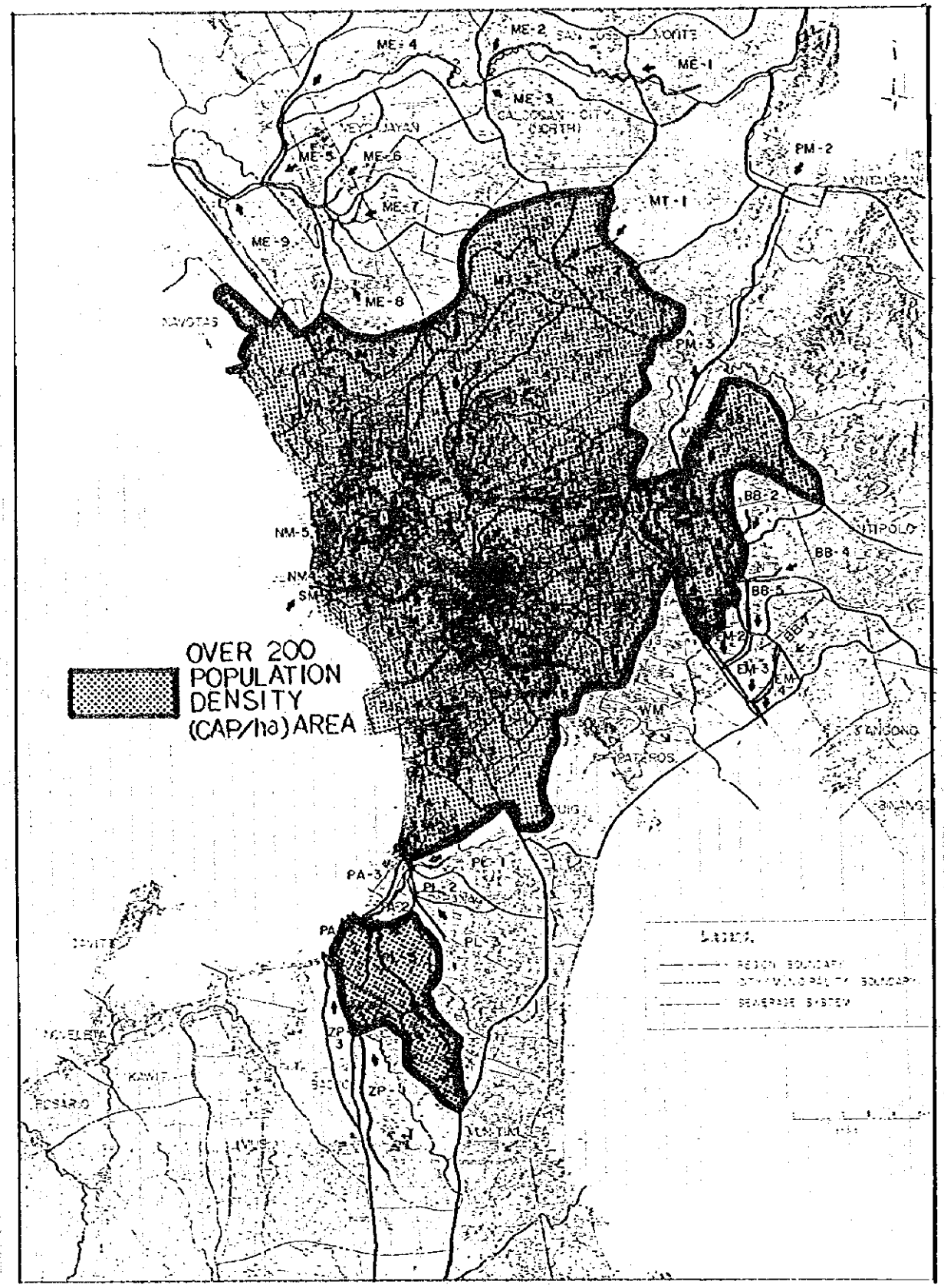



FIGURE 3.2.5 POPULATION DISTRIBUTION