APPENDIX 5

GUIDELINES FOR DEVELOPERS VOLUME 4

CONCERNING SLUDGE TREATMENT AND DISPOSAL

APPENDIX 5
GUIDELINES VOL. 4 SEWAGE SLUDGE TREATMENT AND DISPOSAL

Sewage sludge generated in the course of sewage treatment has a moisture content of 98-99% and the generated sludge volume is about 1-2% of incoming sewage volume. Sewage sludge contains a great deal of organic matter and is easily putrefied and generate offensive odour, if left untreated. Since untreated sludge is not good from a public hygiene viewpoint, sludge treatment is required to reduce the sludge volume and also to stabilize the matter to be suitable for either reuse or reclamation.

Sewage sludge ordinarily consists of water, inorganic compounds similar to natural rock, and fertile organic matter. It is also a valuable resource due to its organic matter calorific value which is equivalent to that of coal. Hence, owing to such properties, sludge is favourable to be reused for green and farmland, construction material or energy source.

1 Sludge treatment processes

1.1 Description

Sewage sludge treatment is done to reduce sludge volume (moisture content reduction), decrease solid content and stabilize the sludge to reduce pathogens, eliminate offensive odors, and control the potential for putrefaction. The alternative unit processes corresponding to these treatment objectives are as follows:

Treatment Objectives	Alternative Unit Processes
Reduce sludge volume	Thickening, dewatering and drying
Reduce solid content	Digestion and incineration
Stabilization	Digestion, composting and incineration

Sewage sludge treatment is a combination system of unit processes and how to select and combine unit processes is crucial in planning.

The combination of appropriate unit processes is determined on the basis of the sludge amount, the sludge characteristics, the form of reuse and disposal, developments in treatment technology, environmental conditions, demographic conditions of the area, future conditions and process stability. The technical considerations, etc. in selection are as described below.

Sludge thickening is important to make succeeding treatment processes such as digestion, dewatering, etc. more efficient, in particular thickening of low concentration sludge generated in some sewage treatment plants. Sludge becomes easily putrefied, especially in dry season when water temperature rises, and sludge thickening becomes more difficult. In this situation, mechanized equipment such as floating thickeners and centrifuge thickeners can be looked into. However, there should be close attention on power cost and a comprehensive study should be required.

In sludge digestion, it is essential to maintain the sludge digestion tanks properly, promote the generation of digestion gas by improving the digestion rate, and to utilize digestion gas. For efficient digestion, the input of high concentration sludge into the sludge digestion tanks is desirable. Digestion gas can be used as fuel for heating, power generation and so on.

In sludge dewatering, it is crucial to reduce the moisture content of dewatered sludge. Vacuum filters requiring the use of non-organic coagulant have been often used in the past, but from the viewpoint of controlling dewatered sludge volume which can be increased by substantial chemical dosage, easiness in maintenance, reduction of water content, improvement in solids recovery rate, and considering the development of new organic coagulants, dewatering machines such as centrifuges using organic coagulant are now preferred.

Sludge drying is employed so as to make succeeding processes more effective and the sludge stable as required. There are two types of sludge drying, namely, natural drying and mechanized drying. In case of the latter, it is important to reduce water content as much as possible in the preceding dewatering process, as mechanized drying requires large energy. Moreover, since exhaust gas emitted from sludge drying processes contains high concentration of odour constituent, it is necessary to undertake countermeasures.

In sludge incineration, the multi-hearth incinerator had been often used due to its technical adequacy in the past. But now, the adoption of fluidized incinerators is becoming more accepted in view of the capacity of the this system to accept varying dewatered sludge characteristics, contain odour, reuse exhaust heat, and reuse incinerated ash. The exhaust gas in exhaust gas is collected to save on fuel and is particularly used for preliminary heating of air for burning, drying of dewatered sludge, and so on.

1.2 Major Sludge Treatment Processes

The major sludge treatment processes are shown in **Figure 1.1**.

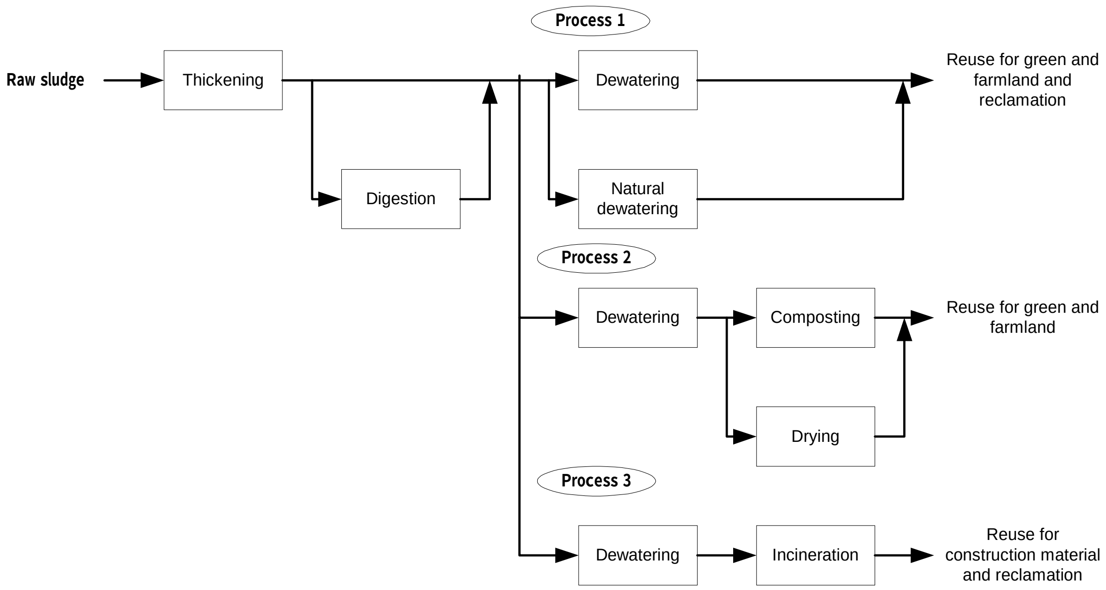


Figure 1.1 Typical Flow of Sludge Treatment Processes

Process 1 is considered when dewatered sludge in used for greens and farmland or used in reclamation works. In this case, the process to reuse sludge for greens and farmland is inexpensive and simple with respect to final disposal, but poses safety risks from the bacteriological aspect. It would be desirable to stabilize the sludge prior to disposal by applying digestion. There are also considerations to be made for odour and conveyance, and requires careful study on the impacts on the surrounding environment. Especially when natural dewatering systems are selected, risks and impacts must be mitigated or carefully managed.

Process 2 is considered when sludge is used for greens and farmland as fertilizer after further processing of dewatered sludge. The processed sludge is more favourable in quality for application on greens and farmland, since through composting or mechanical drying, sludge is converted into dry sludge which is safer and easier to handle.

Process 3 is considered when sludge is used as construction material in the form of ash or slug or for reclamation by incinerating dewatered sludge. In particular, sludge has been reused as construction material, as raw material for cement, soil improvement agent, road-base material, light aggregate, brick, tile, permeable concrete block, concrete aggregate, clay pipe, etc. Sludge can also be used for reclamation for both marine and inland applications.

1.3 Selection of Sludge Treatment Process

In the developing the sludge treatment process, the combination of unit processes is decided on, taking into account: (1) design sludge flow and sludge property, (2) stabilization requirements for reuse and disposal, (3) location of the facilities and disposal areas, and (4) environmental conditions and requirements.

For each unit process, there are several systems and equipment types, and therefore a variety of combinations has to be considered. Therefore, it is necessary to make a comprehensive study and decide on the appropriate sludge treatment processes, based on a comprehensive evaluation of the construction cost, operation and maintenance (O&M) cost, O&M complexity, etc. by proposed combination alternative.

The sludge volume generated is expected to increase in future, accompanied with the progress of sewerage provision. In such a situation that the surrounding conditions involved in the sludge treatment and disposal have been changing, the comprehensive and systematic framework is required to promote the efficient treatment and utilization of sewage sludge.

1.4 Centralised Treatment of Sludge

Centralised treatment of sludge involving collection of sludge from several sewage treatment plants and individual septic tanks (ISTs) offer an advantage in terms of economies of scale, both for construction cost and operation and maintenance cost. Centralised sludge treatment can be more economical in terms of sludge treatment, in consideration of efficiencies in energy recovery and reuse as resource.

It is expected that there will be cost reduction in personnel cost for operation and maintenance.

For conveying sewage sludge to a central treatment plant, special vehicles can be used to haul dewatered sludge. For conveying liquid sludge, there is a choice between vehicle transport and a conveyance pipeline.

Attention must be paid on new technologies, as there is rapid technology innovation in the field.

1.5 Sludge Treatment for Small-Scale Sewage Treatment Plants

In small-scale sewage treatment plants, it is necessary to make sludge treatment easy and economical especially in view of the high personnel expense share to the overall O&M cost and it will be favourable to promote centralised sludge treatment for several sewage treatment plants.

Plant patrol-type sludge treatment involves touring patrol sewage treatment plants with vehicle-mounted sludge dewatering equipment and operators. In this case, O&M cost is reduced since there is no need for operators for sludge treatment at each plant. Since a sludge dewatering facility is not required at each plant, there is clearly also a reduction in construction cost. However, there may be limitations on responding to the variations in quantity and quality of sewage sludge. This will depend on the capacity of the vehicle-mounted dewatering equipment.

In planning for plant patrol-type sludge treatment, it is necessary to investigate the number of sewage treatment plants that will be covered, the distance among these plants, and the running route, treatment capacity size and sludge characteristics of each plant. It will be necessary to estimate the vehicle specifications for sludge dewatering, patrol frequency, traveling time, treatment time, sludge volume and characteristics of sludge after dewatering.

Also, as sludge dewatering is not done every day, a sludge storage facility is required at the sewage treatment plant. Moreover, a power source for the dewatering vehicle, chemicals to be used for dewatering operations, and a supernatant treatment plant should all be provided in the sewage treatment plant.

2 Sludge Conveyance

2.1 Description

For sludge conveyance, it is important to select the most economical sludge conveyance method, taking into account the objectives of sludge conveyance, quantity and quality of sludge to be conveyed, and full consideration of surrounding environment. When sludge is conveyed in the state of liquid, a pipeline or tanker truck is used, while in case of solid sludge like dewatered sludge, a tanker truck is used. In a pipeline system, it is possible to convey a large amount of sludge, but the construction and operation of sludge pumping facilities are required. A truck conveyance system is not suitable for mass sludge conveyance, but clearly applicable for small-scale sludge conveyance, as in this case, it is not necessary to provide special facilities at each sewage treatment plant.

In a pipeline system, it is essential to pump liquid sludge as promptly as possible. Sludge pumps for the purpose of relay and sludge holding tanks are usually constructed to ensure smooth operations among the various sludge facilities.

2.2 Design Criteria for a Pipeline Conveyance System

A sludge pipeline in a pipeline conveyance system shall be designed in consideration of the following items:

(1) The pipeline shall be single line in principle for short lengths, but double for long lengths.
(2) The pipe material shall be ductile cast iron pipes or equivalent in terms of rigidness and durability.
(3) The in-line velocity shall be 1.0-1.5 m/s as a standard and the minimum pipe diameter shall be around 150 mm to avoid clogging.
(4) The cleaning unit shall be installed in a pipeline, as required.

3 Sludge Thickening

3.1 Description

The role of sludge thickening is to thicken low concentration sludge generated in sewage treatment facilities and to make subsequent sludge digestion and sludge dewatering efficiently function. There are two types of sludge, namely raw sludge from primary sedimentation tanks and excess sludge from final sedimentation tanks.

The sludge thickening is categorized into three, or (1) gravity thickening, (2) floatation thickening, and (3) centrifugal thickening.

(1) Gravity thickening

Gravity thickening is the method to retain sludge in a tank. Sludge is thickened by gravity and to settled sludge on the tank bottom is collected by a raking sludge collector to the sludge outlet.

(2) Floatation thickening

For floatation thickening, there are two types, pressurized flotation thickening and normal pressure flotation thickening. The former has been largely used in the past, but the latter is now being applied more, especially at small-scale sewage treatment plants, due to high percent solids recovery, compactness of the equipment and less repair frequency which is attributed to a low-speed rotating body. Floatation thickening is mainly used for excess sludge which is difficult to thicken using gravity thickening.

The pressurized floatation thickening is to make apparent specific gravity of sludge lighter than that of water by allowing fine bubbles to attach to the sludge particles for floatation and segregation.

The normal pressure flotation thickening is based on an idea that solids in sludge is absorbed by bubble generated by addition of bubbling aid and floated to the water surface by buoyancy for thickening.

(3) Centrifugal thickening

Centrifugal thickening is used to thicken sludge through solids-liquid separation by applying high centrifugal forces. It is normally used for waste sludge which is difficult to thicken by gravity thickening.

A centrifugal thickener is able to thicken waste sludge by around 4% in a short time, has less space requirements, but is the most energy-consuming in comparison with other thickening methods.

In case that thickening is insufficient, it leads not only to a drop in efficiency in the subsequent sludge treatment processes but also possible water quality deterioration of the effluent as a result of the return of suspended solids-rich supernatant to the main sewage treatment process. For this reason, centrifugal thickening and floatation thickening applications have been increasing particularly for waste sludge that is difficult to thicken by gravity thickeners. If the water content of thickened sludge is more than or equal to 98%, it is better to consider floatation thickening.

Furthermore, in case of centralized sludge treatment, since sludge with different characteristics is collected, forced sludge thickening process like mechanized thickening equipment is indispensable.

It is better to provide degritting and screening equipment as preliminary treatment before sludge thickening.

3.2 Design criteria

(1) Gravity thickening

1) The configuration of a tank shall be circular in principle.
2) The number of tanks shall be more than or equal to two in principle.
3) The solids loading rate shall be 60-90 kg dry solids/m^2/day.
4) The effective water depth of a tank shall be around 4 m.

(2) Pressurised floatation thickening

The system is composed of pressurised floatation tanks, pressure pumps, air dissolving tanks , etc.

1) The configuration of a tank shall be circular, square and rectangular in principle.
2) The number of tanks shall be more than or equal to two in principle.
3) The solids loading rate shall be 100-120 kg dry solids/m^2/day and solid collection rate shall be 85-95%.
4) The effective water depth of a tank shall be 4.0-5.0 m.

(3) Normal pressure floatation thickening

The system is composed of pressurised floatation tanks, bubble-feed and mixing units, chemical feed units, etc.

1) The configuration of a tank shall be circular in principle.
2) The number of tanks shall be more than or equal to two in principle.
3) The solids loading rate shall be 25 kg dry solids/m^2/hour and solids collection rate shall be more than or equal to 95%.
4) The effective water depth of a tank shall be 4.0 m.

(4) Centrifugal thickening

1) The system is composed of centrifugal thickeners, sludge feed tanks, sludge feed pumps, etc.
2) The number of units shall be more than or equal to two in principle.
3) The moisture content of thickened sludge shall be around 96% and the percent solids recovery shall be 85-95%.

4 Sludge digestion

4.1 Description

There are two types of sludge digestion, namely aerobic digestion and anaerobic digestion. The main purpose of sludge digestion is to decompose and stabilize the organic matter in sewage sludge. The aerobic digestion is generally used at small-scale sewage treatment plants temporarily for a while after commissioning when there is still excess plant capacity. Anaerobic digestion is a treatment process to make the organic matter low molecular, through liquefaction and gasification by anaerobic microorganisms, resulting in a decrease of sludge volume, increase in stabilisation and hygienic safety.

Sludge volume reduction also leads to a reduction of volume requirement for succeeding treatment processes such as dewatering, incineration facilities and so on.

Digested sludge is sent to the sludge dewatering equipment after decomposition of the organic matter. Digested sludge can be finally disposed in the form of sludge cake. When supernatant is generated at the two-stage sludge digestion system, it is sent to a wastewater treatment facility for treatment. On the other hand, digestion gas, which is mainly composed of methane and a byproduct of anaerobic digestion, is used as fuel for heating or supplemental fuel for an incinerator after sulfurisation.

When sludge is stored in the sludge digestion tanks for an enough detention time at the proper digestion temperature, the organic matter in input sludge is reduced by 40 to 60 % through liquefaction and gasification.

4.2 Design Criteria

Design criteria is summarised in **Table 4.1**.

Table 4.1 Design Parameters for Aerobic and Anaerobic Digestion

Description	Unit	Design Criteria	
		Aerobic Digestion	Anaerobic Digestion
Minimum nos.	No.	2	2
Min. solids retention time	Days	10 (to check)	18 (to check)
Organic loading rate	KgVS/m^3.d	1.6 – 4.8	0.8 – 1.6
Typical feed solids soncentration	%	2	2 - 6
Type of mixing		Aerators Diffusers	Gas injection Mechanical stirring Mechanical pumping
Min. water depth	m	3	7.5
Tank Shape		Cylindrical Rectangular	Cylindrical Egg-Shaped
Max. tank dimension	m	25 dia 25 length	25 dia
DO	mg/L	1 - 2	-

5 Sludge dewatering

5.1 Description

The moisture content of thickened sludge or digested sludge is, in general, 96 to 98%. When it is dewatered to approximately 80%, sludge volume is reduced by about one-fifth to one-tenth and liquid matter becomes so as called sludge cake in a state of easily handling.

In dewatering, there are generally two types of system: filtration type and centrifuge type. The former includes the belt filter press, filter press, vacuum filter and screw press dewatering equipment. Applications of the filter press and vacuum filter have been recently decreasing, as compared to other systems, as such equipment have less dewatering and maintainability caused by an increase in dewatered sludge as a result of substantial coagulant feed. Screw press dewatering equipment has been employed at small-scale plants.

Belt filter presses filters coagulated sludge by gravity using parallel-running filter cloths which are squeezed between two rolls. Sludge is dewatered through sludge pooling and backward rolling action.

In centrifuge dewatering, coagulated sludge is placed into a high-speed rotating cylinder bowl and dewatered under a 200G centrifuge field.

In both belt filter press and centrifuge dewatering equipment, to facilitate dewatering, sludge conditioning with organic coagulant is done to generate coagulated floc. Recently, in some cases, inorganic coagulant is used with organic coagulant.

Screw press dewatering equipment is composed of a cylindrical screen and screw impeller and the volume between both is reduced toward to the exit of dewatered sludge. The organic coagulant such as cationic high polymer coagulant is solely added with a dosage rate of 1.0-1.3% per dry solids. A combination with inorganic matter such as polyferric sulfate and PAC and the use of bipolar organic coagulant is also done

5.2 Design criteria

(1) Belt filter press

1) Sizing and number of equipment is determined using the following equation.

$$B = \frac{1{,}000\,(1 - w/100) \cdot Q}{V \cdot t}$$

Where

B：effective width requirement of filter cloth (m)

w：moisture content of sludge (%)

Q：feed sludge (m^3/d)

V：filtration rate (kg/(m•h))

t：daily operation hour (h/d)

$$N = \frac{B}{b}$$

Where

N：number (unit)

b：effective width of filter cloth per unit (m/unit)

2) The moisture contents of dewatered sludge shall be 76-83% in standard type and 76-80% in high efficiency type.
3) The filter cloth shall be non-cloggy and durable.
4) The rotating speed and tension of cloth shall be variable.
5) The equipment cover shall be provided for odour control.

(2) Centrifuge Thickener

1) Sizing and number of equipment is determined using the following equation.

$$N = \frac{Q}{q \cdot t}$$

Where

N：number (unit)

Q：feed sludge (m^3/d)

q：capacity per unit (m^3/m)

t：daily operation hour (h/d)

2) The moisture contents of dewatered sludge shall be 80-84% in standard type and 77-81% in high efficiency type.
3) The material of screw part shall be durable.
4) The differential speed shall be variable.

(3) Screw Press

1) Sizing and number of equipment is determined using the following equation.

$$N = \frac{Q}{q \cdot t}$$

Where

N：number (unit)

Q：feed sludge (m^3/d)

q：capacity per unit (m^3/m)

t：daily operation hour (h/d)

2) The moisture contents of dewatered sludge shall be 74-83% in standard type.
3) The material of screw part shall be durable.
4) The differential speed shall be variable.

6 Sludge drying

The sludge drying facility is used to reduce the sludge water content, making it very suitable for utilisation on greens and farmlands. In general, it stabilizes the sludge and improves handling of sludge, and makes it suitable for various kinds of use.

6.1 Sludge drying beds

6.1.1 Description

Sludge drying beds is advantageous in terms of operational cost as it uses natural energy, but also because it requires no dewatering aid, and it requires no complicated O&M systemsworks as with mechanized systems. The main disadvantage is that manual work is needed to scraping and collecting the dried sludge.

If there is no fear of impact on surrounding area and the large land is available at small-scale treatment plants, use of sludge drying beds is considered.

In general, sludge drying is suitable to digested sludge. A larger area is required for raw sludge or not well digested sludge than digested sludge. There is also the risk of generating secondary nuisance such as odour and flies. In such cases, it may be necessary to undertake improvement measures by sludge stabilisation using lime, odour control using lime and coagulants, and improvement of permeability rate.

The area requirement of sludge drying beds is based on the sludge quality, and volume, dry days based on the meteorological condition by locality, and input solid loading. Sludge loading rates are shown in **Table 6.1**.

The subbase of sludge drying beds is composed of 200-300 mm thick gravel layer, and 150-300 mm coarse sand layer with a diameter of 0.7-2.0 mm. The underdrain system is provided with a proper slope under the gravel layer. The perforated pipe is installed at the deepest portion for drain collection with a slope of 10/1000.

To lessen or avoid the effect of rainfall on the drying process, a fixed or movable roof may be installed, as required. The need for it should be based on the study of economy and durability of the structure.

In the planning of sludge drying beds, it is necessary to study how to scrape and convey dried sludge and to provide replacement sand.

6.1.2 Design Criteria

Design criteria is summarised in **Table 6.1**.

Table 6.1 Typical Area Requirements for Open Sludge Drying Beds for Various Types of Biosolids

Type of Biosolids	Area (m^2/Person)	Sludge Loading Rate (kg dry solids/m^2・yr)
Primary digested	0.1	120 – 150
Primary and trickling-filter humus digested	0.12 – 0.16	90 – 120
Primary and waste-activated digested	0.16 – 0.23	60 – 100
Primary and chemically precipitated digested	0.19 – 0.23	100 – 160

6.2 Sludge lagoon

6.2.1 Description

Drying lagoons may be used as a substitute for drying beds for dewatering of digested sludge. Lagoons are not suitable for dewatering untreated sludges, limed sludges, or sludges with a high-strength supernatant because of their odor and nuisance potential. The performance of lagoons, like that of drying beds, is affected by climate; precipitation and low temperatures inhibit dewatering. Lagoons are most applicable in areas with high evaporation rates. Dewatering by subsurface drainage and percolation is limited by increasingly stringent environmental and groundwater regulations. If a groundwater aquifer used for a potable water supply underlies the lagoons site, it may be necessary to line the lagoon or otherwise restrict significant percolation.

Unconditioned digested biosolids are discharged to the lagoon in a manner suitable to accomplish an even distribution. Biosolids depth usually range from 0.75 to 1.25m. Evaporation is the prime mechanism for dewatering. Facilities for decanting of supernatant are usually provided, and the liquid is recycled to the treatment facility. Biosolids are removed mechanically, usually at a solids content of 25 to 30 percent. The cycle time for lagoons varies from several months to several years. Typically, biosolids are pumped to the lagoon for 18 months, and then the lagoon is rested for 6 months. Solids loading criteria range from 36 to 39 kg/m^3・yr of lagoon capacity. A minimum of two cells is essential, even in very small plants, to ensure availability of storage space during cleaning, maintenance, or emergency conditions.

6.2.2 Design Criteria

Design criteria is summarised in **Table 6.2**.

Table 6.2 Design Criteria for Sludge Lagoon

Items	Criteria
No. of Lagoon	Min. 2 cells
Biosolids Depth	0.75 – 1.25 m
Solids loading Rate	36 – 39 kg/m^3・yr

7 Sludge incineration

7.1 Description

Sludge incineration involves burning of dewatered sludge by supplying air more than theoretically required for sludge incineration under the atmosphere. Sludge volume is substantially reduced by combustion of the organic matter in dewatered sludge and evaporation of water content and ash or inorganic matter simultaneously remains as combustion residual.

Sludge incinerators are classified into a fluidized-bed incinerator, multiple-hearth incinerator, step grate stoker furnace and rotary kiln based on its structure, but fluidized-bed incinerators have been adopted in most recent projects.

In planning a sludge incineration facility, considerations to be taken are the location of the sewage treatment plant, economy, complexity of O&M, safety, environmental measures, the individual sludge treatment processes and the final disposal system.

The characteristics of a fluidized-bed incinerator are as follows:

1) High combustion efficiency with less not-burn portion.
2) Can be operated with little excess air (air ratio is 1:3)
3) Simplicity in O&M since there is no mechanically/moving systems in the incinerator
4) Easy automatic control and heat recovery in the incinerator
5) Odour control for exhaust gas is not necessary, since the temperature of exhaust gas is controlled over the temperature for odour decomposition in the incinerator.
6) Due to high heat storage capacity of fluidized media, there is no need for burner operation for starting, in case of short stoppages in operations. There is almost no functional problem in case of intermittent operation.

The fluidized-bed incinerator is in the form of a vertical hollow cylinder and the inside of a furnace is composed of a windbox, fluidized-bed and free board for bed expansion. The incinerator body is made of refractory-lined steel sheet shell structure. At the bottom of a fluidised sand bed is an arrangement of air distribution plates for even distribution of fluidising air and protection of a windbox or fluidized sand bed (media) from dropping at the stoppage of a incinerator.

The fluidised media (generally silica sand) forming fliuidised-bed in the incinerator behaves in a fluidised state like boiled water in a freeboard and is heated by supplementary fuel injection.

7.2 Design Criteria

The treatment size and the number of units are decided based on the following:

1) For the sludge volume to be treated, annual increases/change should be considered.
2) The treatment size is decided taking into account an annual variation of sludge characteristics and the operation rate of equipment.
3) The number of units shall be more than or equal to two, in principle, to cope with regular inspection and stoppage of incineration equipment.
4) The equipment and device should have an allowance in capacity to cope with temporary load fluctuation.
5) The space for equipment repair/rehabilitation shall be provided.

8 Sludge Reuse

8.1 Greens and farmland reuse (Compost)

8.1.1 Description

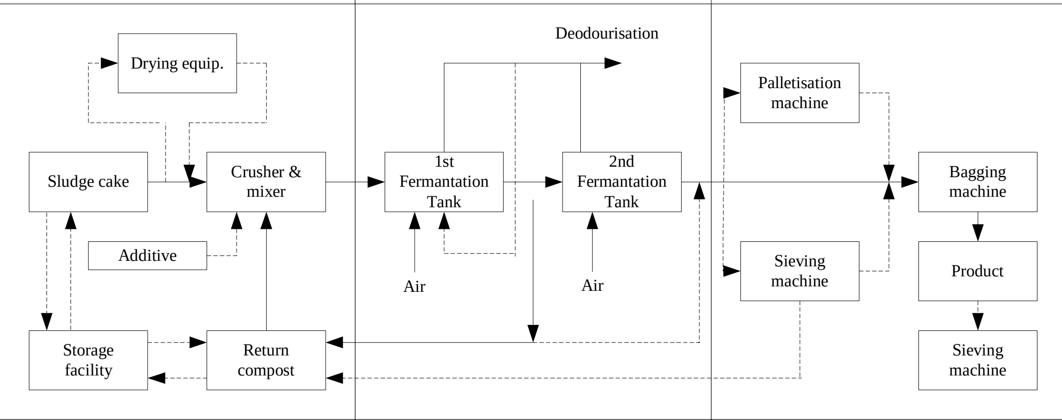
Sewage sludge is composed of various organic and inorganic matter in addition to fertile constituents such as nitrogen and phosphorus and valuable as supplemental material of organic constituents.

There are various forms of treated sewage sludge that can be disposed to greens and farmland: there are raw sludge, compost, dried sludge, dewatered sludge, incineration ash and others. However, in consideration of fertile matter content, handling and hygienic aspects, composted sewage sludge is a favourable form.

Composting of sewage sludge involves decomposing the biodegradable organic matter in sewage sludge in aerobic conditions by the action of organisms producing a stabilized composted sludge suitable for disposal/reuse on greens and farmlands.

The basic process and major equipment used for a composting facility is shown in **Table 8.1**.

Table 8.1 Basic process and major equipment used for composting

	Pre-conditioning	Fermentation	Manufacturing
Basic process			
Major facilities	- Various hoppers - Measuring devices - Crusher and mixer - Conveyance equip. - Storage facility - (Drying equip.)	- Fermentation tank - Plowing machine - Ventilation device - Drawing and return equip. - Conveyance equip. - (Deodourisation equip)	- Drawing equip. - Hoppers - Measuring device - Bagging machine - (Return equip.) - (Sieving machine) - (Palletisation machine) - (Storage facility)

In the pre-conditioning process, improvement of ventilation, adjustment of moisture content and pH adjustment is done to ensure good composting. For this purpose, compost is returned and sub-material like chaff and sawdust is added to dewatered sludge which is considered the raw material for composting. The said materials are broken, mixed and put into a fermentation tanks.

In the fermentation process, decomposition of the organic matter and evaporation of water content takes place. The reaction process is divided into first fermentation and secondary fermentation. In the first fermentation, a rise of temperature and evaporation of water is going on rapidly, but slowly in the secondary fermentation. During this fermentation period, oxygen required for fermentation is fed and the mixture on the way of fermentation are agitated with proper frequency to accelerate the reaction.

In the manufacturing process, sieving, palletisation and bagging is done to improve handling of the product compost, use, storage and so on.

8.1.2 Design Criteria

Compost products are required following qualities.

1) For urging growth and preventing obstacles of the target crops, plant, etc.
2) Consideration of the handling and storage

3) No bad influence to soil and crops by the heavy metal contained in compost products (Observance of related regulations)

Main qualities required to compost products are as follows.

Table 8.2 Main qualities required to compost products

Items	Criteria
Moisture content	30 – 40 %
pH	6 - 8.5
C/N(Carbon to Nitrogen ratio)	Less or equal 20
BOD_5	Less or equal 30mg/g･DS

8.2 Reuse for construction material

Other forms of treated sewage sludge for reuse is dewatered sludge and incineration ash, and these can be used or processed further for use as construction material and soil improvement.

As reuse for construction material, the composition of dewatered sludge and incineration ash is similar to conventional construction materials, and various applications of sludge as construction material or raw material have been developed.

For soil improvement, incineration ash derived from lime is effective in improving surplus soil of the construction sites.

In the report, “Feasibility Study on the possibility of implementing a model project for the efficient use of biomass and other wastes for cement plants” (2006, NEDO ; New Energy and Industrial Technology Development Organization), it is mentioned that sewage sludge may perform as an alternative fuel replaced with a fossil fuel.

In selection of the method for construction material reuse, taking into account the local conditions and other considerations, it is better to prepare alternative methods and ensure flexibility in operation, avoiding options to one, until the method for construction material reuse is finally established.

8.3 Reclamation

Sewage sludge will always be generated, as long as sewerage facilities are operated, and it is favourable to use it for functional use as much as possible. Therefore, even in case that the reclamation is selected initially if there are no viable reuse option, use of treated sewage sludge in the locality should reviewed periodically, in consideration of changing local needs and technological development for the utilization of sewage sludge

Reference

Layout Examples of sludge treatment facilities are shown below.

Table 8.3 List of Example Treatment Facilities

No.	Name	Location	Outline		Note
			Q: Design Flow (m^3/d) P: Design Population (Person)	Treatment Process Upper: Sewerage Lower: Sludge	
1	Pantai STP	Kuala Lumpur	Q=93,000 P=377,000	Conventional Activated Sludge Thickening + digestion + dewatering	Including Septic Tank Sludge ($256m^3/d$)
2	Bundar Tun Razak STP	Kuala Lumpur	Q=25,000 P=100,000	Sequencing Batch Reactor Thickening (Mechanical) + dewatering	
3	Puchong STP	Kuala Lumpur	Q=37,000 P=150,000	Conventional Activated Sludge Thickening + dewatering	
4	Kota Setar CSTP* *) Centralize Sludge Treatment Facility	Kedah	Q= - P= -	Accelerated Nitrifying Activated Sludge Thickening + dewatering	Including Septic Tank Sludge ($210m^3/d$)
5	Damansara STP	Kuala Lumpur	Q=25,000 P=100,000	Oxidation Ditch Thickening + dewatering	
6	Kuala Sawah STP	Negeri Sembilan	Q=89,000 P=360,000	Oxidation Ditch Thickening + dewatering	Including Septic Tank Sludge ($260m^3/d$)

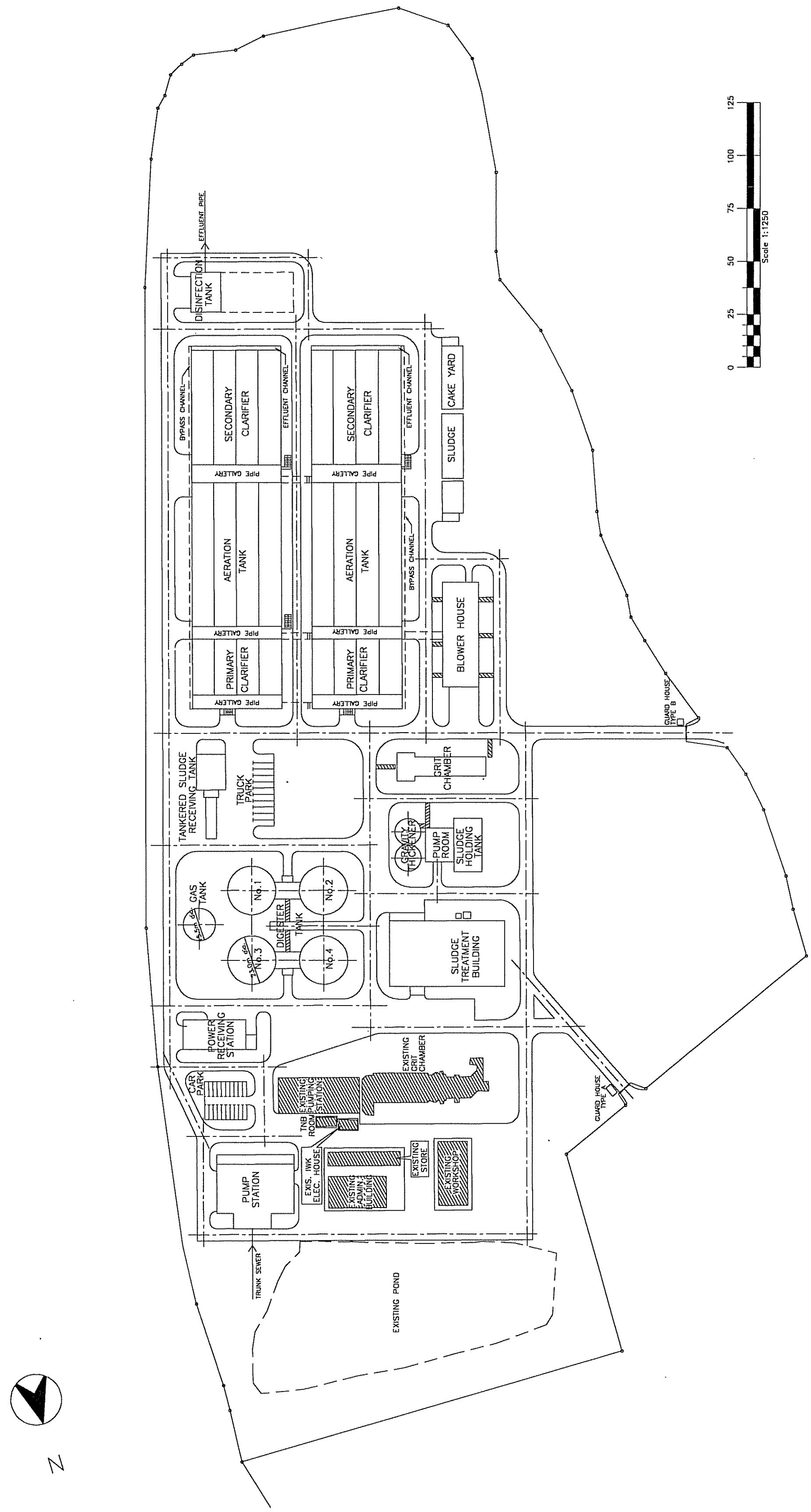


Figure 8.1 Pantai STP (Kuala Lumpur)

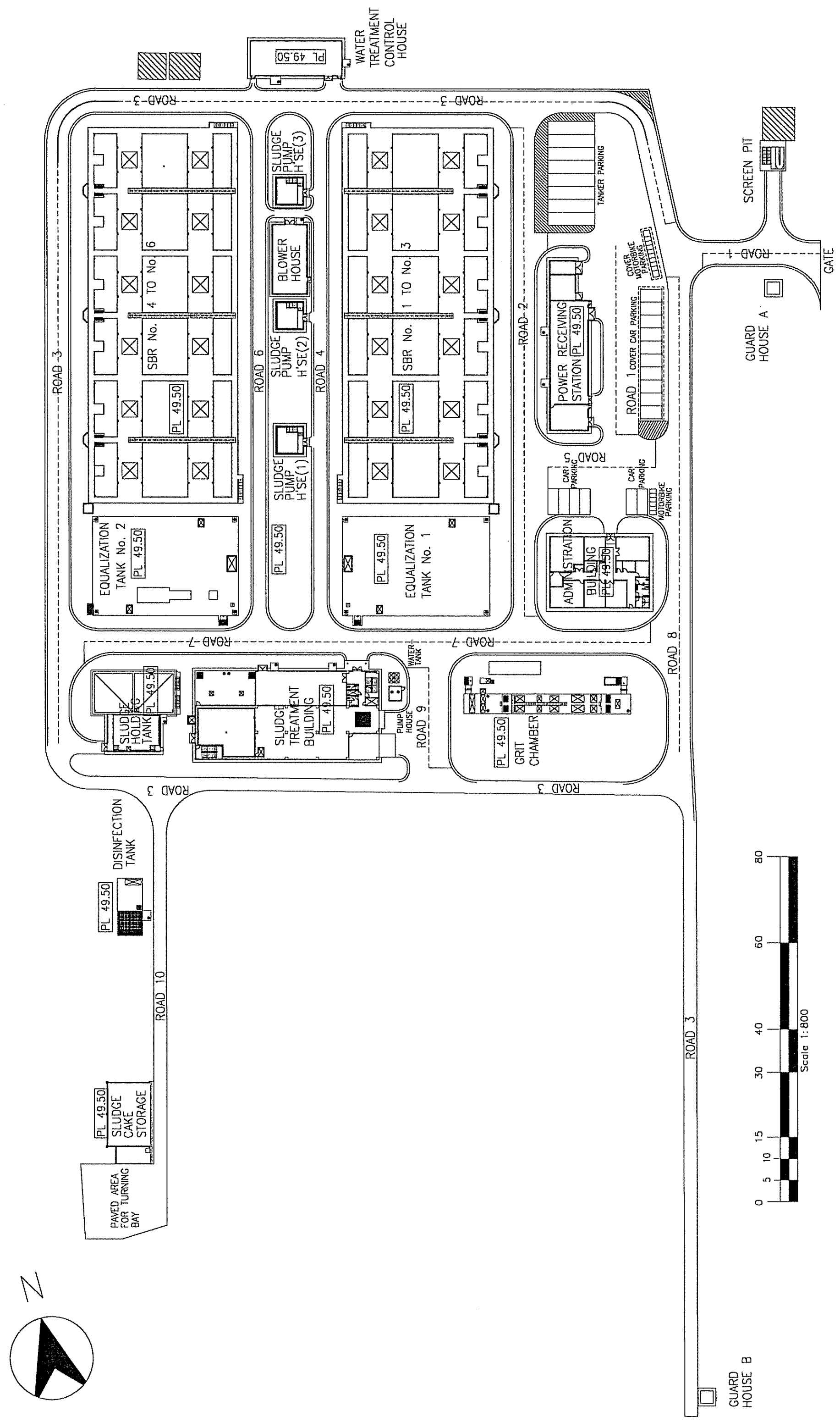


Figure 8.2 Bundar Tun Razak STP (Kuala Lumpur)

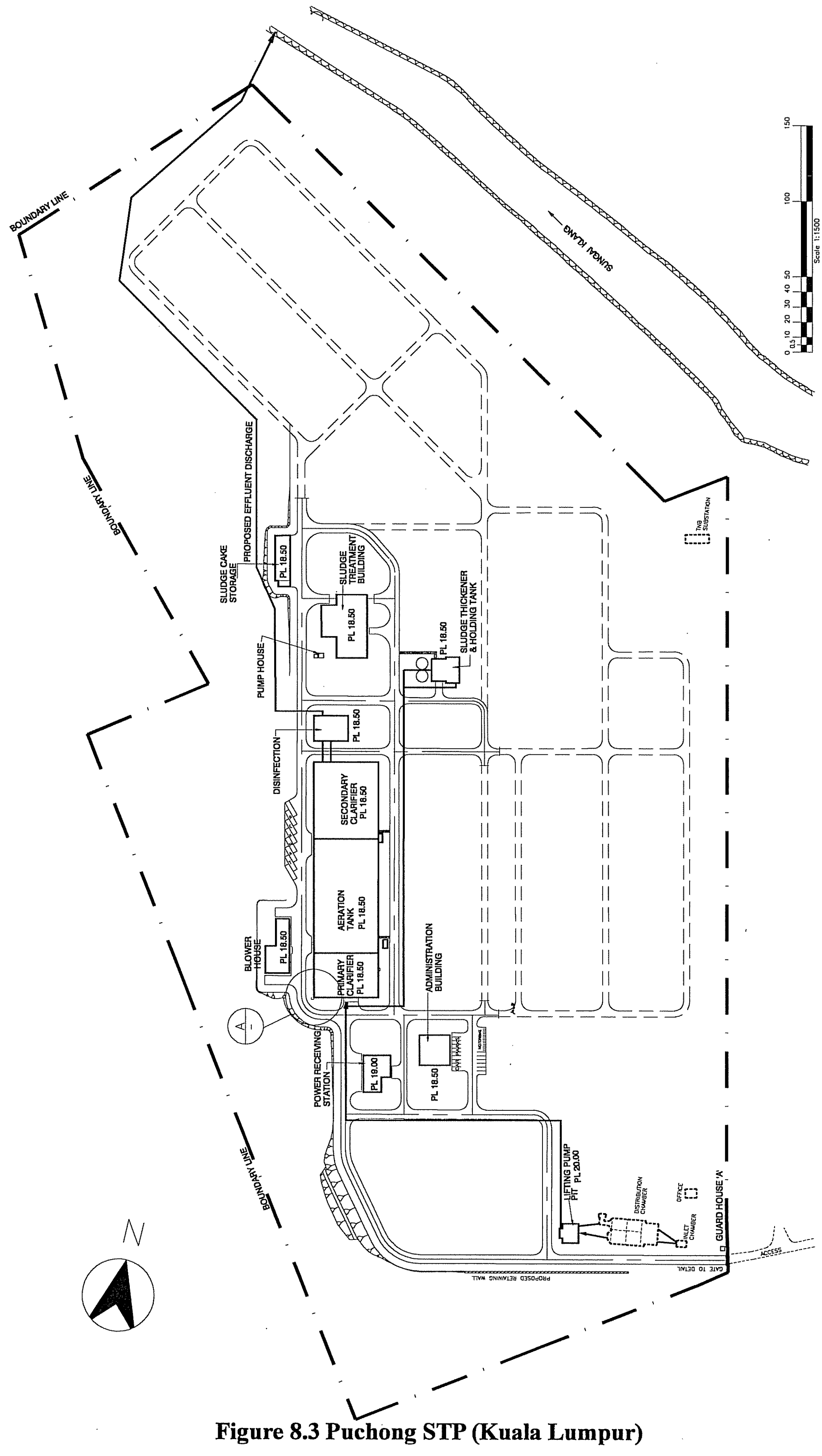


Figure 8.3 Puchong STP (Kuala Lumpur)

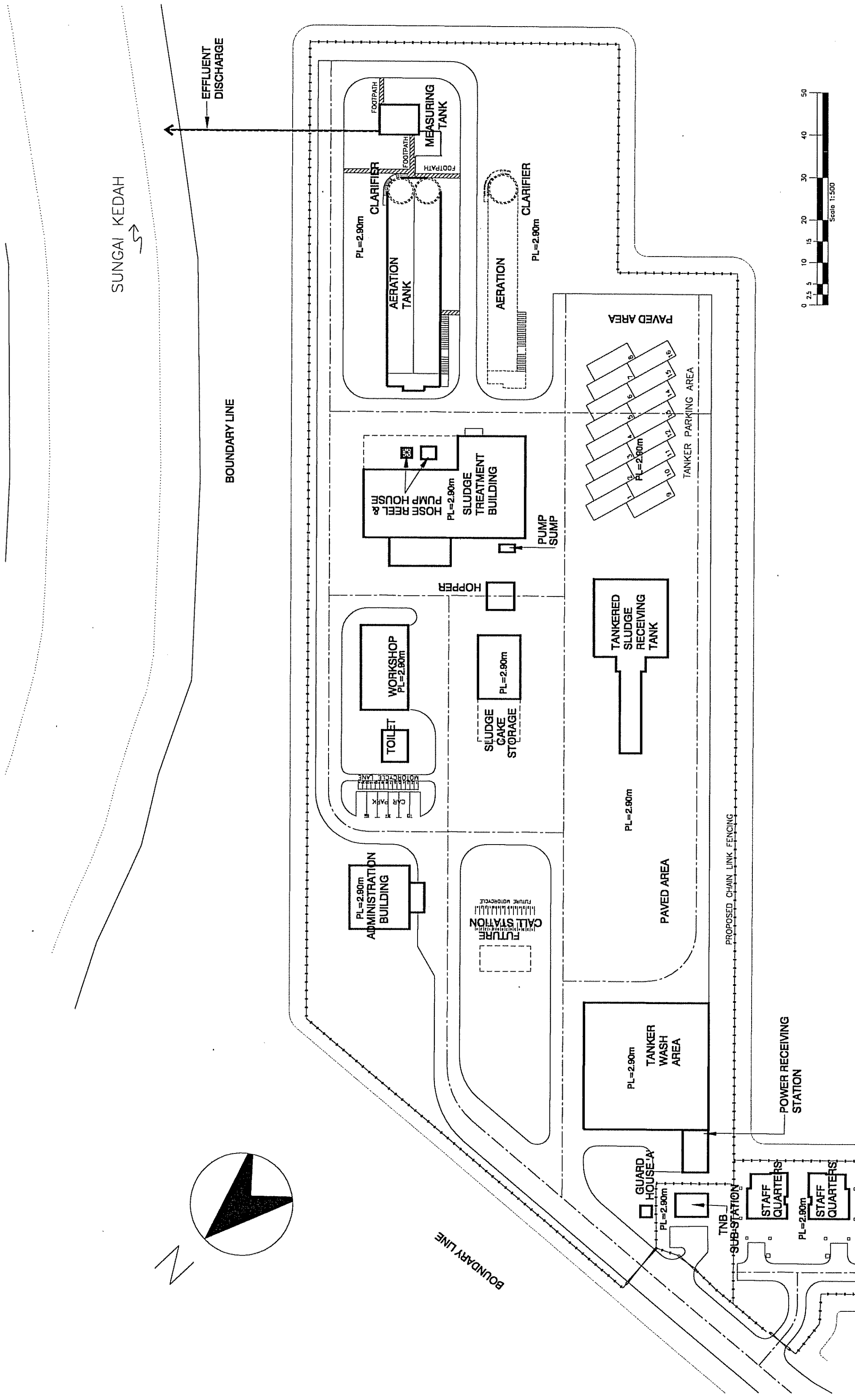


Figure 8.4 Kota Setar CSTP (Kedah)

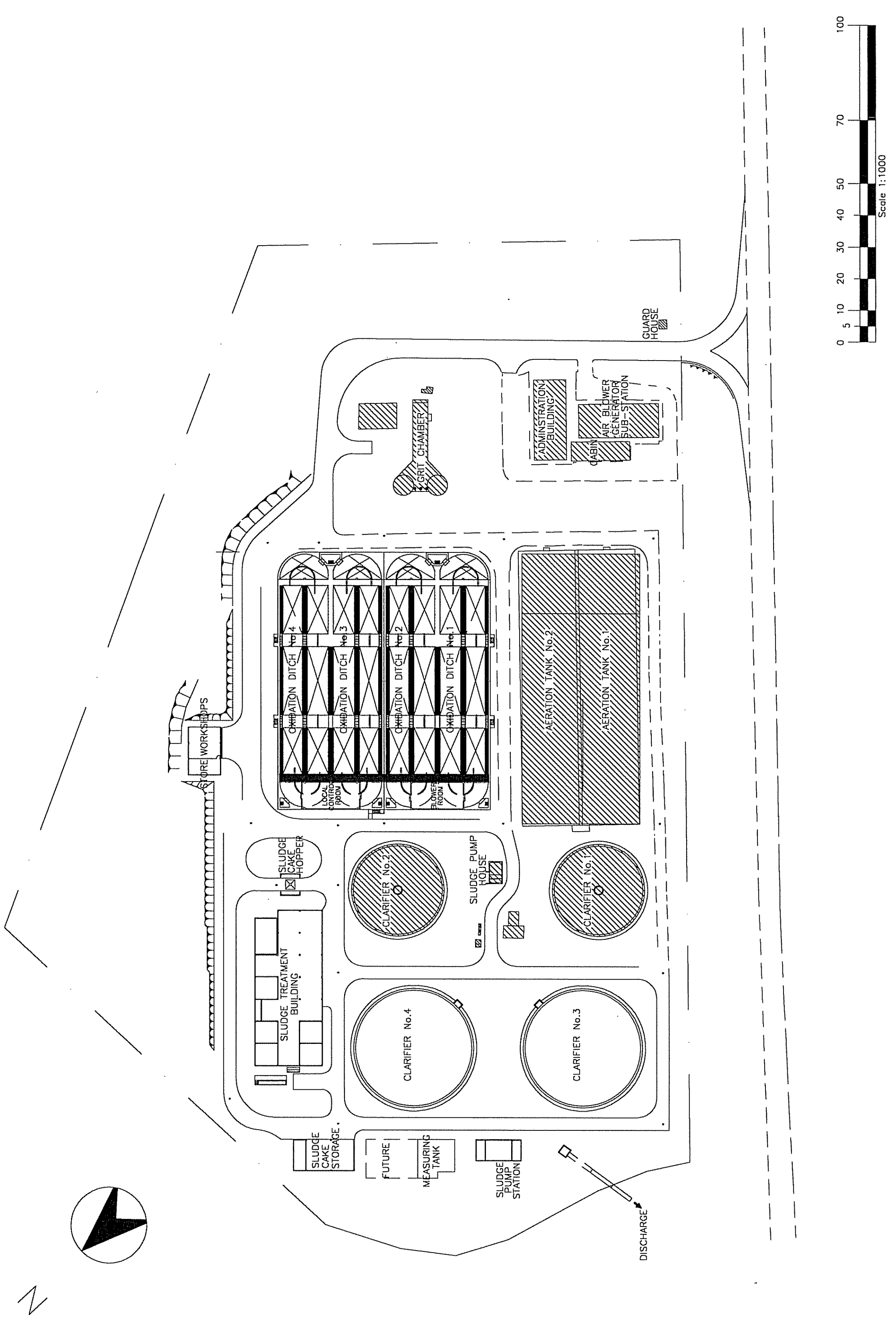


Figure 8.5 Damansara STP (Kuala Lumpur)

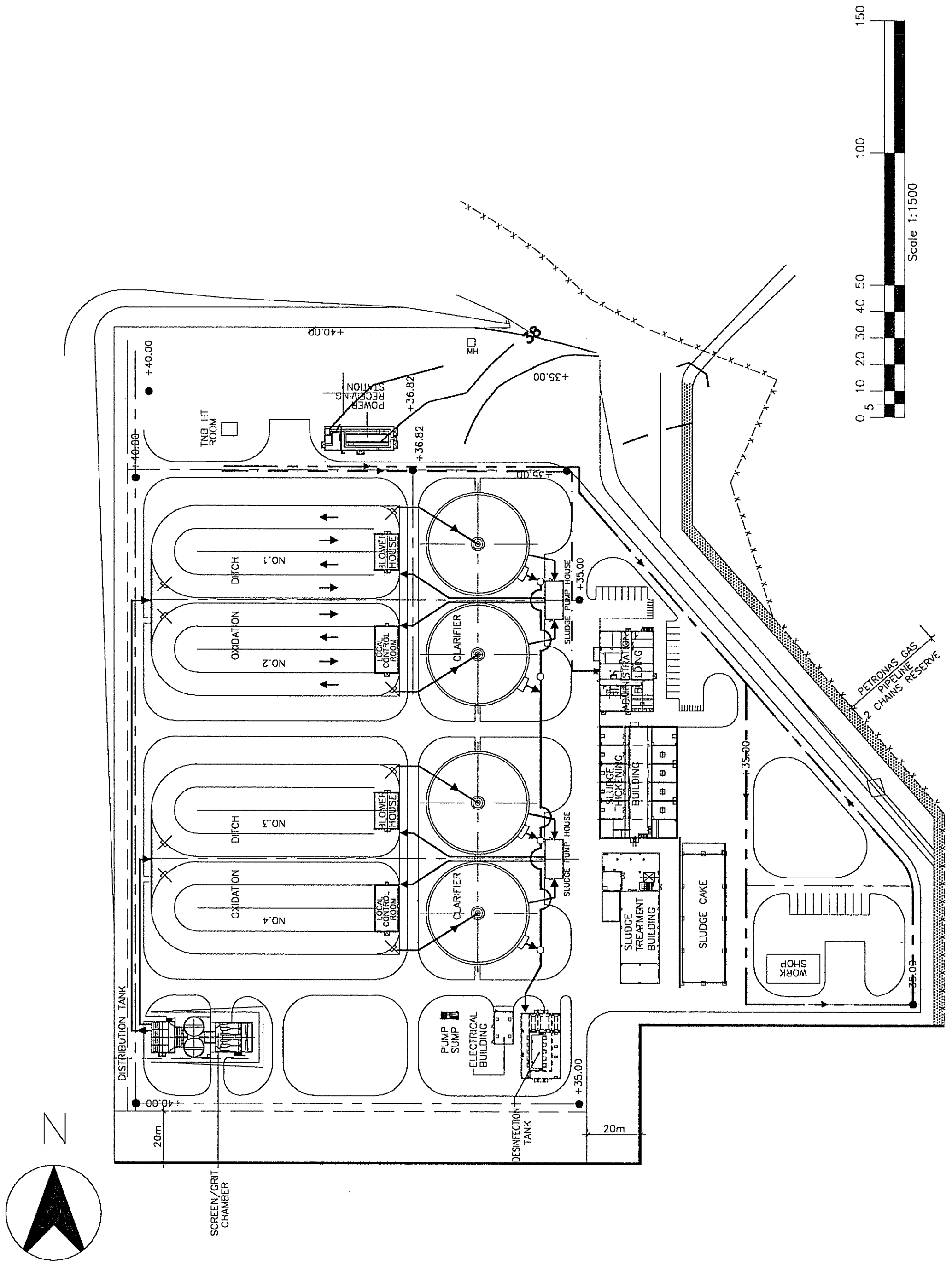


Figure 8.6 Kuala Sawah STP (Negeri Sembilan)

APPENDIX 6

EXAMPLE OF CONSTRUCTION COST AND

O&M COST CURVE

APPENDIX 6
EXAMPLE OF CONSTRUCTION COST AND O&M COST CURVE

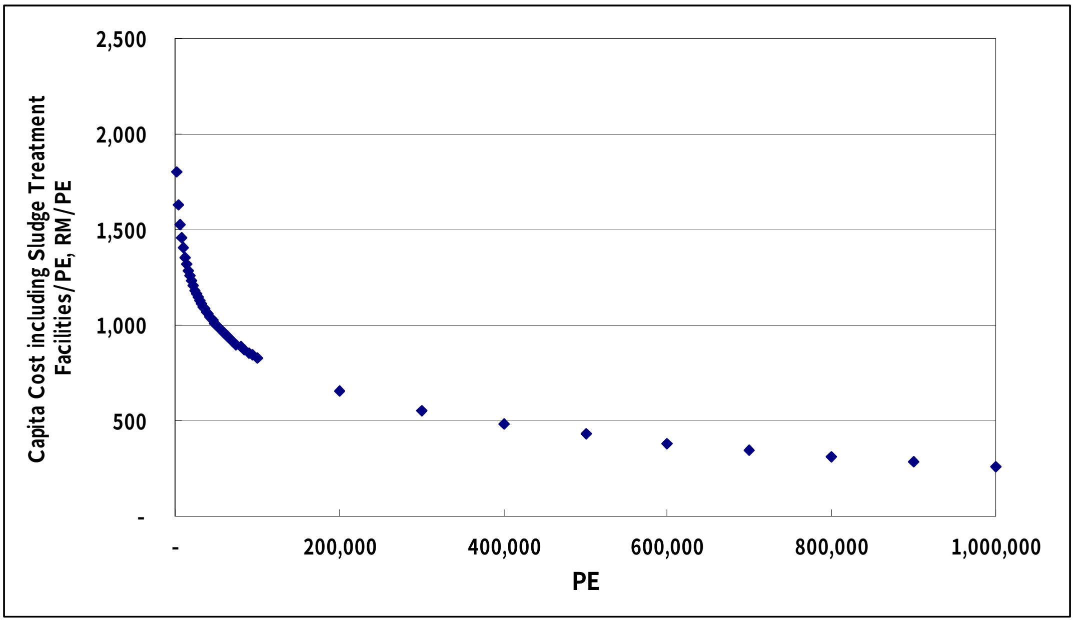


Figure 1 Capital Costs per PE for Mechanised Plants with Sludge Treatment Facilities

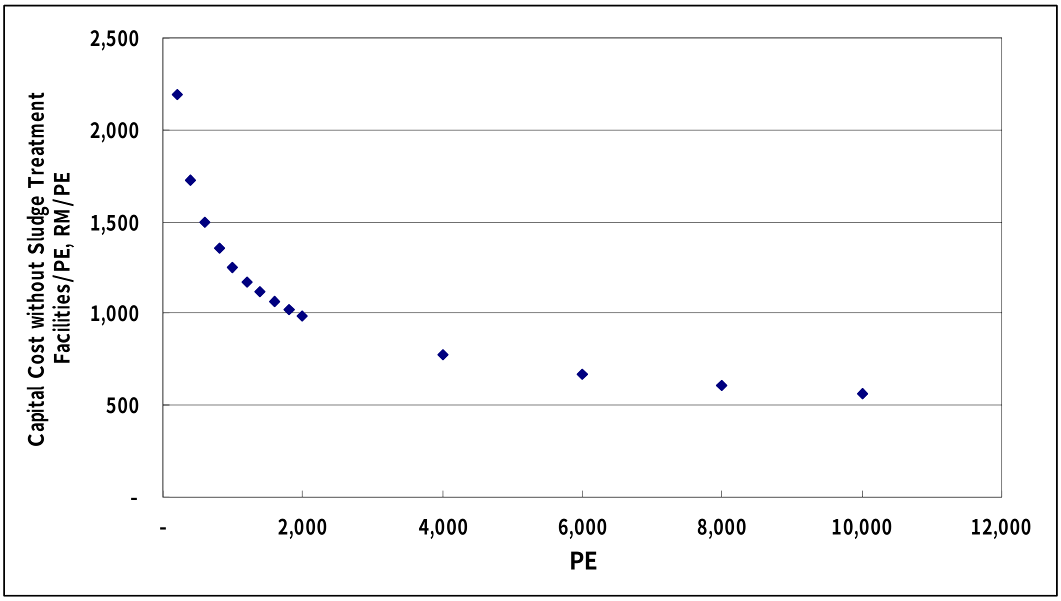


Figure 2 Capital Costs per PE for Mechanised Plants without Sludge Treatment Facilities

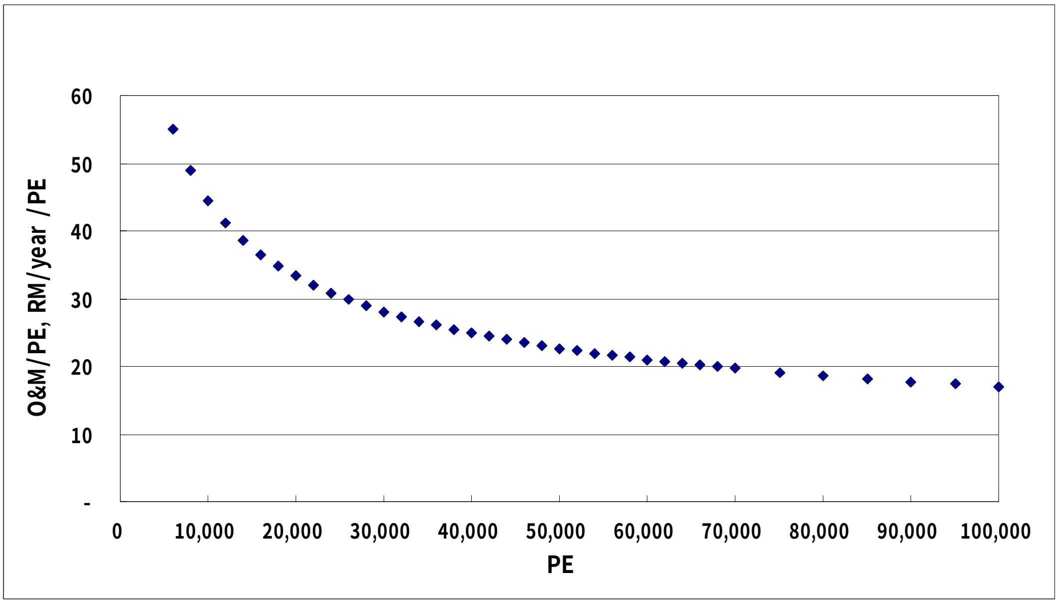


Figure 3 O&M Costs per PE for Mechanised Plants

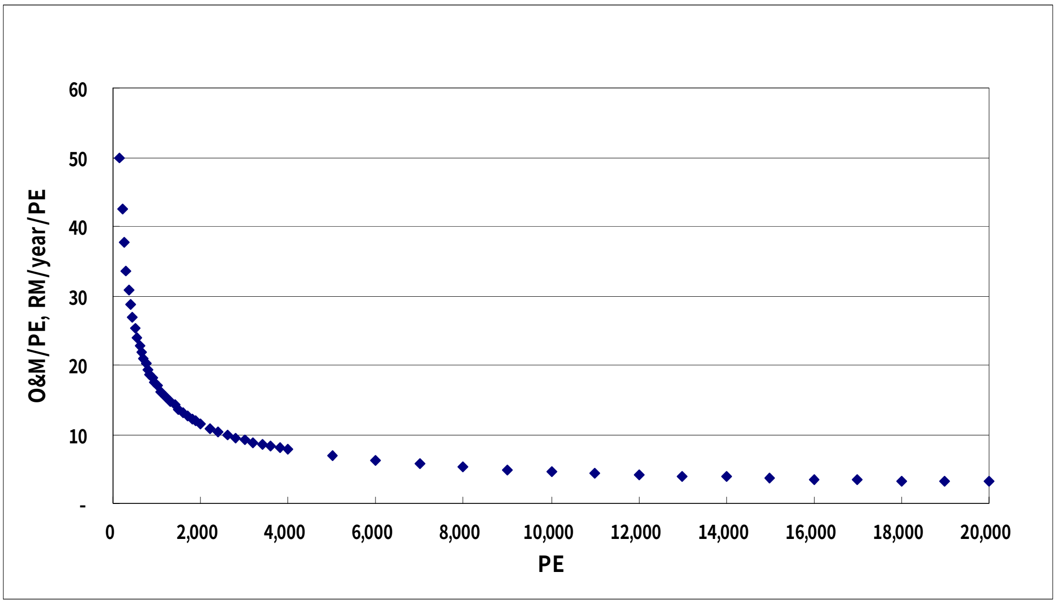


Figure 4 O&M Costs per PE for Oxidation Pond

APPENDIX 7

SOCIAL CONSIDERATION AND

INITIAL ENVIRONMENTAL EXAMINATION (IEE)

APPENDIX 7
SOCIAL CONSIDERATION AND INITIAL ENVIRONMENTAL EXAMINATION (IEE)

7.1 Outline of the Study

7.1.1 Objectives

To strengthen the sewerage planning capability of Sewerage Services Department in Malaysia and related agencies through the following interventions:

- To prepare a manual for reviewing/evaluation/prioritising catchment strategies and sewerage projects
- To revise the Guidelines for Developers Vol.1 and Vol.4 (Section 4 and 5, only concerning sludge treatment and disposal)
- To recommend measures for the improvement of planning capability in the sewerage sector in Malaysia

To evaluate the effectiveness of the manual and guidelines prepared in this JICA project, the trial application of the draft manual and guidelines was conducted.

The manual is to be applied to the Hulu Langat Catchment Area, while for the application of the revised guidelines, two areas of interest was selected. They are as follows:

1) Ipoh
2) Kota Kinabalu

IEE is conducted only within the sewerage catchment planning phase, specifically targeted towards the recommended option, while the manual is to be utilised for the prioritisation of projects identified within the recommended option and other needs as specified within the manual, for example; to review, evaluate and prioritise all identified projects from various catchment studies towards creation of a national sewerage projects list.

The results of these trial applications at Ipoh and Kota Kinabalu Catchments are reflected in the environmental and social consideration aspects of the guidelines.

7.1.2 Justification of the Study

In urbanized areas of Malaysia, private developers are obligated to provide sewerage facilities including private systems, individual septic tanks, etc. to serve the area being developed. After the completion of the facilities, they are normally handed over to the Government and to be maintained by the national company, Indah Water Konsortium Sdn. Bhd (hereinafter referred to as “IWK”). IWK also provides operation and maintenance (O&M) services of the sewerage facilities taken over from the local authorities after the privatisation of the National Sewerage Industry in 1993, within its capacity as the National Concessionaire.

Currently, there are more than 9,000 existing treatment plants. These facilities comprise a wide range of capacities and treatment processes, and the wide diversity of the facilities complicates the O&M process. Consequently, a large proportion of the treated wastewater might not meet the effluent discharge standards.

To overcome and mitigate possible future compliance issues, centralization and rationalization of existing sewerage facilities should be given due considerations. Since the concept of centralization and rationalization is a part of planning, the improvement of planning capability through the revision of the existing guidelines and creation of a manual is necessary to improve this sewerage situation in Malaysia.

7.1.3 Location

Trial areas for guidelines were selected among cities having the following characteristics:

1) deteriorating river water quality
2) actively developing areas
3) large number of small STPs.

For confirming effectiveness of the revised guidelines, trial areas were determined based on the following two distinct characteristics as requested by Sewerage Services Department, Ministry of Energy, Water, and Communications and JICA.

1) Trial area which had already sewerage catchment strategies and need to be revised them.
2) Trial area which did not have sewerage catchment strategies.

Based on the above two characteristics, the following two places were identified for conducting the trial application of the manual and revised guidelines.

1) Ipoh - trial area having already sewerage catchment strategies
2) Kota Kinabalu - trial area not having sewerage catchment strategies

7.1.4 Proposed Activities

The proposed study activities were as follows:

1) Preparation of a manual for reviewing/evaluation/prioritizing catchment strategies and sewerage projects
2) Revision of the Guidelines for Developers Vol.1 and Vol.4 (Section 4 and 5, only concerning sludge treatment and disposal)
3) Trials using the manual and revised guidelines
4) Improvement and finalisation of the manual and revised guidelines

7.1.5 Scope of the trial study of the revised guidelines

The scopes of the trial study were:

1) To apply the revised guidelines in reviewing existing catchment strategies that were previously carried out for Ipoh, while for Kota Kinabalu, it was utilised for producing new catchment strategies and,
2) To evaluate the effectiveness of the proposed revised guidelines based on the quality of the catchment study produced and acceptance of the recommended option by common stakeholders.

7.2 Description of the Trial application Site

The trial application sites are shown in Figure 7.2.1.

7.2.1 Ipoh

Ipoh is the capital city of Perak State and one of the fastest growing cities in Malaysia. The city was founded on mining and much of the city's area has been the site of open cast tin mines. However over the past 20 years most of the mines have closed and reclamation and development of ex-mining lands are well under way.

Ipoh is located in a generally flattish valley sited between high limestone hills. The land falls towards the south. The valley bottom has a number of isolated limestone pinnacles and ridges rising up to several hundred feet from the valley floor. The Sungai Kinta flows north to south through the centre of Ipoh.

Historically Ipoh developed around the railway, with the commercial centre near to the railway station and industry to the north and south, also adjacent to the railway. The other main axis of older development is the road to Tambun, bordered by low density housing, government and military areas, and educational institutions. Tin mining took place over much of undeveloped area.

Over the past 10 years major, new highways have been constructed around Ipoh. They run around the eastern side of Ipoh from Pulai in the south east, to the north of Jelapang (North of Ipoh). The airport is sited 2 km south of the city centre and includes a military base. The city's development then moved outwards with extensive development in Bercham, Gunung Rapat, and between the centre and airport.

The population of Ipoh recently increases from 468,765 in 1991 (census data) to 574,041 in 2000 (Census data).

7.2.2 Kota Kinabalu

Kota Kinabalu, is the capital of the Malaysian State of Sabah occupying the northern part of the land of Borneo which incidentally was called North Borneo before the State gained its independence from the British and joined Malaysia in 1963. Kota Kinabalu is also currently the one and only local authority in the State that is a city. It thus comes under the jurisdiction of the Chief Ministers Department even though its Town Planning roles still remains under the control of the Minister of Local Government and Housing under the Town and Country Planning Ordinance Sabah.

Kota Kinabalu is located on the west coast of Sabah. The city lies on a narrow flatland, being enveloped by the mountains known as the Crocker Range in the east, and by the South China Sea in the west. The city itself contains several hills which are mostly covered with tropical rainforest. The flat areas are mostly built up commercial, industrial or residential areas. The northeast part of the city around Likas Bay used to contain an extensive mangrove forest, but most of it has disappeared (following the development of the Likas Sprots Complex) leaving only a 10 hectare sanctuary designated as Kota Kinabalu City Bird Sanctuary in 2000.

Kota Kinabalu's Central Business District (CBD) is located on a narrow strip of land bordered by Signal Hill and the sea. Because of swampy ground where the land is relatively flat and steep slopes where lands are hilly, most of the CSD had to be built on reclaimed land.

The climate of Kota Kinabalu can be characterised as tropical monsoon, marked by high a degree of humidity, and high rainfall alternating with lesser periods of dry spells. Temperatures generally range from 21 to 29 degree Celsius. Average annual rainfall is of the order of 2540 mm. Most intense rainfalls occur from December to February.

Recently the population growth and urbanization and industrial development have been particularly rapid. The Kota Kinabalu District population grew from 60,382 in 1970 to 108,725 in 1980 to 209,175 in 1991 and 355,435 in year 2000.

Figure 7.2.1 Location of Trial Places

7.3 Legal Frame and Related Agencies

7.3.1 Legal Frame

The followings are all the laws and regulations that need to be considered for the production of a comprehensive EIA report in Malaysia

1) Environmental Quality Act, 1974
   This act requires the person intending to carry out any prescribed activity to submit the report on the impact on the environment.
2) Environmental Quality (Amendment) Act, 1985
3) Environmental Quality (Amendment) Act, 1996
4) Environmental Quality (Amendment) Act, 1998
5) Environmental Quality (Amendment) Act, 2001
6) Environmental Quality (Sewerage and Industrial Effluents) Regulations, 1979
7) Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order, 1987
   This order describes the prescribed activities as follows. The prescribed activities on sewerage are described on Schedule 18 (c).

LIST OF PRESCRIBED ACTIVITIES
〔EXTRACT FROM THE ENVIRONMENTAL QUALITY (PRESCRIBED ACTIVITIES) (ENVIRONMENTAL IMPACT ASSESSMENT) ORDER 1987〕

(1) Agriculture

- (a) Land development schemes covering an area of 500 hectares or more to bring forest land into agriculture production.
- (b) Agriculture programmes necessitating the resettlement of 100 families or more.
- (c) Development agricultural estates covering an area of 500 hectares or more involving changes in type of agricultural use.

(2) Airport

- (a) Construction of airports (having an airstrip of 2,500 meters or longer).
- (b) Airstrip development in state and national parks.

(3) Drainage And Irrigation

- (a) Construction of dams and man-made lakes and artificial enlargement of lakes with surface areas of 200 hectares or more.
- (b) Drainage of wetland, wild-life habitat or of virgin forest covering an area of 100 hectares or more.

(c) Irrigation schemes covering an area of 5,000 hectares or more.

(4) Land Reclamation

Coastal reclamation involving an area of 50 hectares or more.

(5) Fisheries

(a) Construction of fishing harbours.
(b) Harbour expansion involving an increase of 50 per cent or more in fish landing capacity per annum.
(c) Land based aquaculture projects accompanied by clearing of mangrove swamp forests covering an area of 50 hectares or more.

(6) Forestry

(a) Conversion of hill forest land to other land use covering an area of 50 hectares or more.
(b) Logging or conversion of forest land to other land use within the catchment area of reservoirs used for municipal water supply, irrigation or hydropower generation or in areas adjacent to state and national parks and national marine parks.
(c) Logging covering an area of 500 hectares or more.
(d) Conversion of mangrove swamps for industrial, housing or agricultural use covering an area of 50 hectares or more.
(e) Clearing of mangrove swamps in islands adjacent to national marine parks.

(7) Housing

Housing development covering an area of 50 hectares or more.

(8) Industry

(a) Chemical - Where production capacity of each product or of combined products is greater than 100 tonnes/day
(b) Petrochemicals - All sizes.
(c) Non-ferrous - Primary smelting:
Aluminium - all sizes
Copper - all sizes
Others - producing 50 tonnes/day and above of product.
(d) Non-Metalic - Cement - for clinker through put of 30 tonnes-hour and above.
- Lime - 100 tonnes/day and above burnt lime rotary kiln or 50 tonnes/day and above vertical kiln.
(e) Iron and Steel - Require iron ore as raw materials for production greater than 100 tonnes/day; or Using scrap iron as raw materials for production greater than 200 tonnes/day

(f) shipyards - Dead Weight Tonnage greater than 5000 tonnes.
(g) Pulp and Paper Industry - Production capacity greater than 50 tonnes/day.

(9) Infrastructure

(a) Construction of hospitals with out fall into beachfronts used for recreational purposes.
(b) ndustrial estate development for medium and heavy industries covering an area of 50 hectares or more.
(c) Construction of expressways.
(d) Construction of national highways.
(e) Construction of new townships.

(10) Ports

(a) Construction of ports
(b) Port expansion involving an increase of 50 per cent or more in handling capacity per annum.

(11) Mining

(a) Mining of minerals in new areas where the mining lease covers a total area in excess of 250 hectares.
(b) Ore processing, including concentrating for aluminium, copper, gold or tantalum.
(c) Sand dredging involving an area of 50 hectares or more.

(12) Petroleum

(a) Oil and gas fields development.
(b) Construction of off-shore and on-shore pipelines in excess of 50 kilometers in length.
(c) Construction of oil and gas separation, processing, handling, and storage facilities.
(d) Construction of oil refineries.
(e) Construction of product deports for the storage of petrol, gas or diesel (excluding service stations) which are located within 3 kilometers of any commercial, Industrial areas and which have a combined storage capacity of 60,000 barrels or more.

(13) Power Generation And Transmission

(a) Construction of steam generated power stations burning fossil fuels and having a capacity of more than 10 megawatts.
(b) Dams and hydroelectric power schemes with either or both of the following:
(i) dams over 15 meters high and ancillary structures covering a total area in excess of 40 hectares;

(ii) reservoirs with a surface area in excess of 400 hectares.

(c) Construction of combined cycle power stations.

(d) Construction of nuclear-fueled power stations.

(14) Quarries

Proposed quarrying of aggregate, limestone, silica quartzite, sandstone, marble and decorative building stone within 3 kilometers of any existing residential, commercial or industrial areas, or any area for which a licence, permit or approval has been granted for residential, commercial or industrial development.

(15) Railways

(a) Construction of new routes.

(b) Construction of branch lines

(16) Transportation

Construction of Mass Rapid Transport projects.

(17) Resort And Recreational Development

(a) Construction of coastal resort facilities or hotels with more than 80 rooms.

(b) Hill station resort or hotel development covering an area of 50 hectares or more.

(c) Development of tourist or recreational facilities in national parks.

(d) Development of tourist or recreational facilities or islands in surrounding waters which are gazetted as national marine parks.

(18) Waste Treatment And Disposal

(a) Toxic and Hazardous Waste
- (i) Construction of incineration plant (on-site)
- (ii) Construction of recovery plant (off-site)
- (iii) Construction of wastewater treatment plant (off-site)
- (iv) Construction of secure landfill facility
- (v) Construction of storage facility (off-site)

(b) Municipal Solid Waste
- (i) Construction of incineration plant
- (ii) Construction composting plant
- (iii) Construction of recovery/recycling plant
- (iv) Construction of municipal solid waste landfill facility

(c) Municipal Sewage
- (i) Construction of wastewater treatment plant
- (ii) Construction of marine out fall.

(19) Water Supply

(a) Construction of dams, impounding reservoirs with a surface area of 200 hectares or more.

(b) Groundwater development for industrial, agricultural or urban water supply of greater than 4,500 cubic meters per day.

According to Environmental Impact Assessment (EIA) - Procedure and Requirements in Malaysia, the steps in the EIA procedure are shown in **Figure 7.3.1**. The EIA procedure consists of three major steps which are a Preliminary assessment step, a detailed assessment step, and a review step.

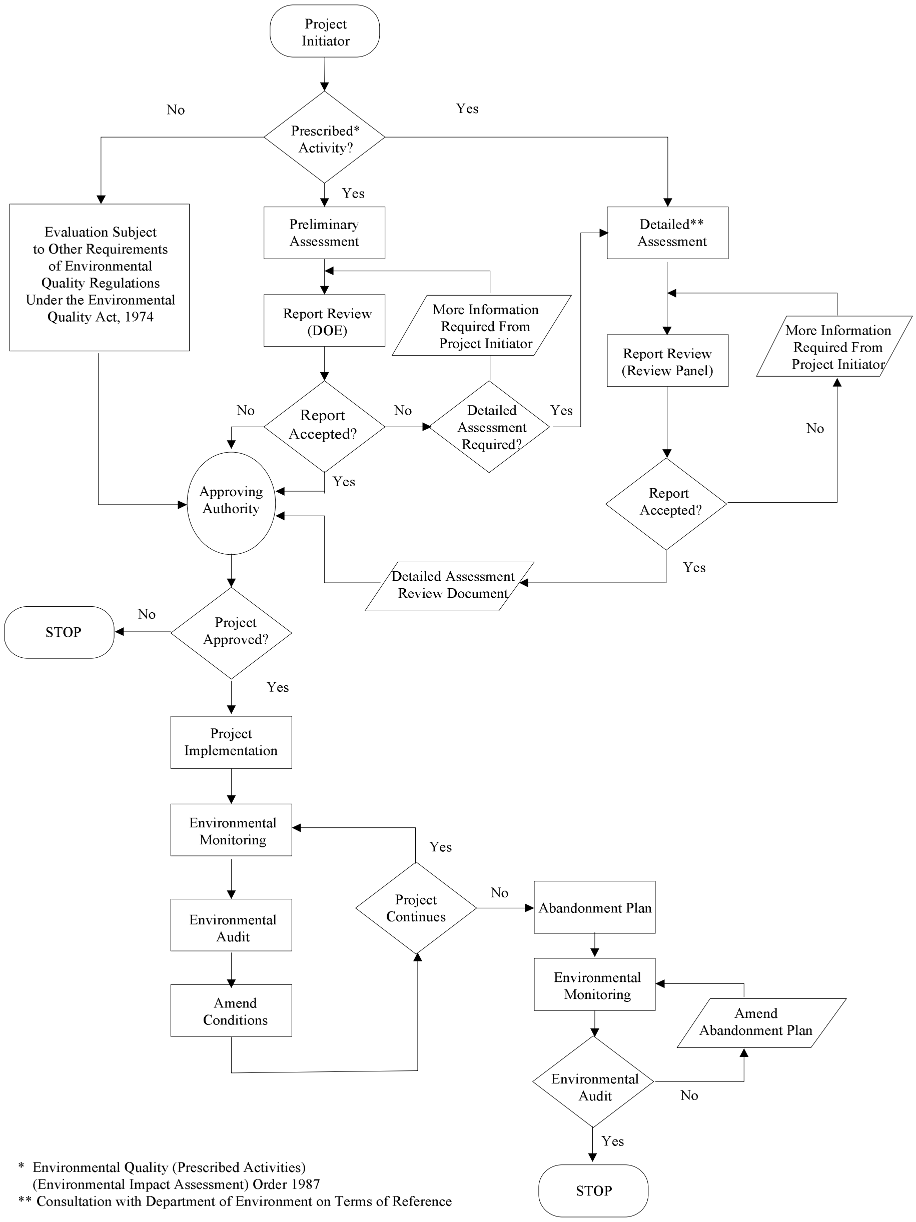


Figure 7.3.1 Outline of Environmental Impact Assessment Procedure in Malaysia

With reference to the order highlighted above, please take note that the current JICA Study only addresses the need of sustainable sewerage planning, which does not include the construction of any sewerage facilities. Therefore, no submission of an EIA study based on the Malaysian Environmental Act is required or expected out of the trial study. The above regulations were only reviewed at a desktop level towards the preparation of the IEE report.

Other related regulations that were taken into consideration for the IEE study are as follows:

1) Malaysian Standard 1228, 1991
   This code of practice deals with the planning design, construction and installation and testing of sewerage system.
2) Handbook of Environmental Impact Assessment Guidelines
   This handbook describes the normalized project planning sequence. Public participation and information disclosure on the detailed assessment stage are required.
   The following figure showed the relationship between the JICA Study and Malaysian project planning sequence. The trial application studies conducted in the JICA Study were the upper planning than Malaysian project planning required to do environmental impact assessment. Therefore, these trial application studies were not subject to Malaysian EIA process.
3) National Land Code, 1965 and Land Acquisition Act, 1960
   This code describes national policy and procedure pertaining to land acquisition within Peninsular Malaysia.
   The land acquisition procedures are as given below.

Department/Applicant's Agency
↓
Approval By State Authority
↓
Gazette Notification under Section 4 of the Land Acquisition Act
(that land is likely to be acquired)
↓
Gazette Notification under Section 8 of the Land Acquisition Act
(the declaration of intended acquisition for public purpose)
↓
Valuation Report by JPPH
↓
Enquiry by Land Administrator under Section 12 of the Land Acquisition Act
↓
Written Award by Land Administrator in Form G
↓
Notice of Formal Possession of the Land in Form K

Figure 7.3.2 Land Acquisition Flow Chart (Reference: Brochure of Valuation for Land Acquisition, Valuation and Property Services Department, Ministry of Finance, Malaysia)

4) Land ordinance (Sabah Cap. 68), 1950
This ordinance describes the policy and procedure for land acquisition within the state of Sabah.

7.2.2 Related Agencies to the IEE Report

1) National Water Services Commission (SPAN)
2) Indah Water Consortium (IWK)
3) Town and Rural Planning Department (JPBD)
4) Department of Environment (JAS)
5) Ministry of Tourism, Culture & Environment
6) Land & Survey Department
7) Road Works Department
8) Ministry of Housing & Local Covernment
9) Drainage & Irrigation Department
10) Ipoh City Council (MBI)
11) Kota Kinabalu City Hall

7.4 Outline of trial Catchment Studies

7.4.1 Ipoh

The basic data of sewerage catchment strategy is shown in Table 7.4.1, and a sewerage catchment plan is shown in Figure 7.4.1.
Study areas are about 40,800 ha which is same as 70% of special wards in Tokyo. They consist of five catchments, Ipoh City Centre, Menglembu, Gunung Rapat, Bercham, and Chemor catchments. Presently 60% of the population equivalent is connected to public sewerage networks including 222 STPs. In devising the strategy, a regionalised approach is advocated due to the high density of population and land availability. After realisation of the recommended strategy, the number of STPs is expected to be reduced from 222 to 3 in 2035, due to rasionalisation. Discharged BOD pollution load seems to be reduced from 23.8 t /d to 9.1 t/d (60 % reduction) in 2035. As the identified/proposed three regional STP sites had already been acquired and also currently being used for sewerage and sludge treatment, no future acquisition or requirement of land is anticipated. In sewerage catchment area there is no significant historic preservation area and national park.

Table 7.4.1 Basic Data in Ipoh Sewerage Catchment Strategy

Contents	Data
Target year for planning	2035
Study area	About 40,800 ha
Sanitary system	Regionalised System
Design population	About 2,015,000 (About 1,123,000 in 2007)
Average Flow	454,000 m^3/d (253,000m^3/d in 2007)
Design effluent quality	BOD = 20mg/L SS = 50 mg/L
Number of STPs	3 Sites (Papan, Tanah Hitam, Meru Raya) (222 sites in 2007)
STP land status	Three sites are owned by government. No expansion of STP sites.
Sludge production	About 160 m^3/d

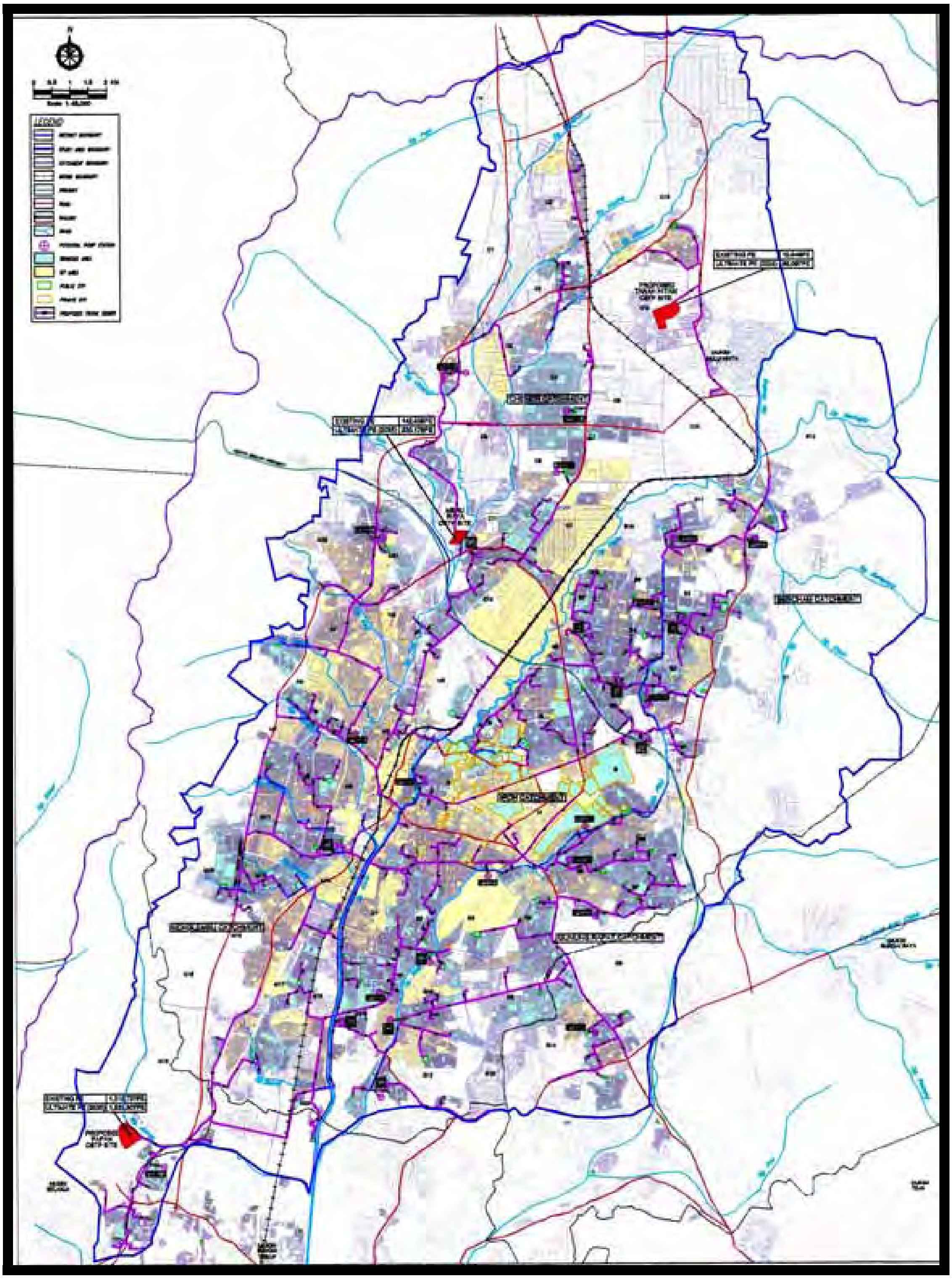


Figure 7.4.1 Ipoh Sewerage Catchment Strategy

7.4.2 Kota Kinabalu

The basic data of sewerage catchment strategy is shown in **Table 7.4.2**, and a sewerage catchment plan is shown in **Figure 7.4.2**.

The Study area concentrates on the northern catchment of Kota Kinabalu and covers an area of about 13,500 ha. The Study area consists of eight sub-catchments, Inanam, Kuala Inanam, Menggatal, Menggatal North, Kuala Menggatal, Telipok, KKIP, and Karambunai.

Presently, 34% of the population equivalent is connected to public sewerage networks including 29 STPs. In devising the strategy, a regionalised approach is considered for all sub-catchments with exception to Karambunai, where a decentralised system such as multipoint or septic tanks is to be considered due to low population density. After realisation of the recommended strategy, the numbers of STPs are expected to be reduced from 29 to 3 in 2035, due to rasionalisation. Discharged BOD pollution load seems to be reduced from 8.86 t /d to 3.72 t/d (60 % reduction) in 2035.

As the identified/proposed three regional STP sites had already been approved or owned by the state government and also currently being used for sewerage treatment, no future acquisition or requirement of land is anticipated, except for Kuala Mengatal STP, where extra land would need to be acquired for future expansions.

In sewerage catchment area there is no significant historic preservation area and national park. Kinabalu City Bird Sanctuary is located out of the catchment area and is about 5 km distant.

Table 7.4.2 Basic Data in Kota Kinabalu Sewerage Catchment Strategy

Contents	Data
Target year for planning	2035
Study area	About 13,500 ha
Sanitary system	Regionalised System for Inanam, Kuala Inanam, Menggatal, Menggatal North, Kuala Menggatal, Telipok catchments Decentralised system for Karambunai catchment
Design population	About 586,000 (About 201,000 in 2007)
Average Flow	132,000 m^3/d (46,000 m^3/d in 2007)
Design effluent quality	BOD = 20mg/L SS = 50 mg/L
Number of STPs	3 Sites(Inanam, Kuala Menggatal, KKIP) (29 sites in 2007)
STP land status	Three sites are owned by government. Kuala Menggatal STP will need for an expansion area.
Sludge production	About 57 m^3/d

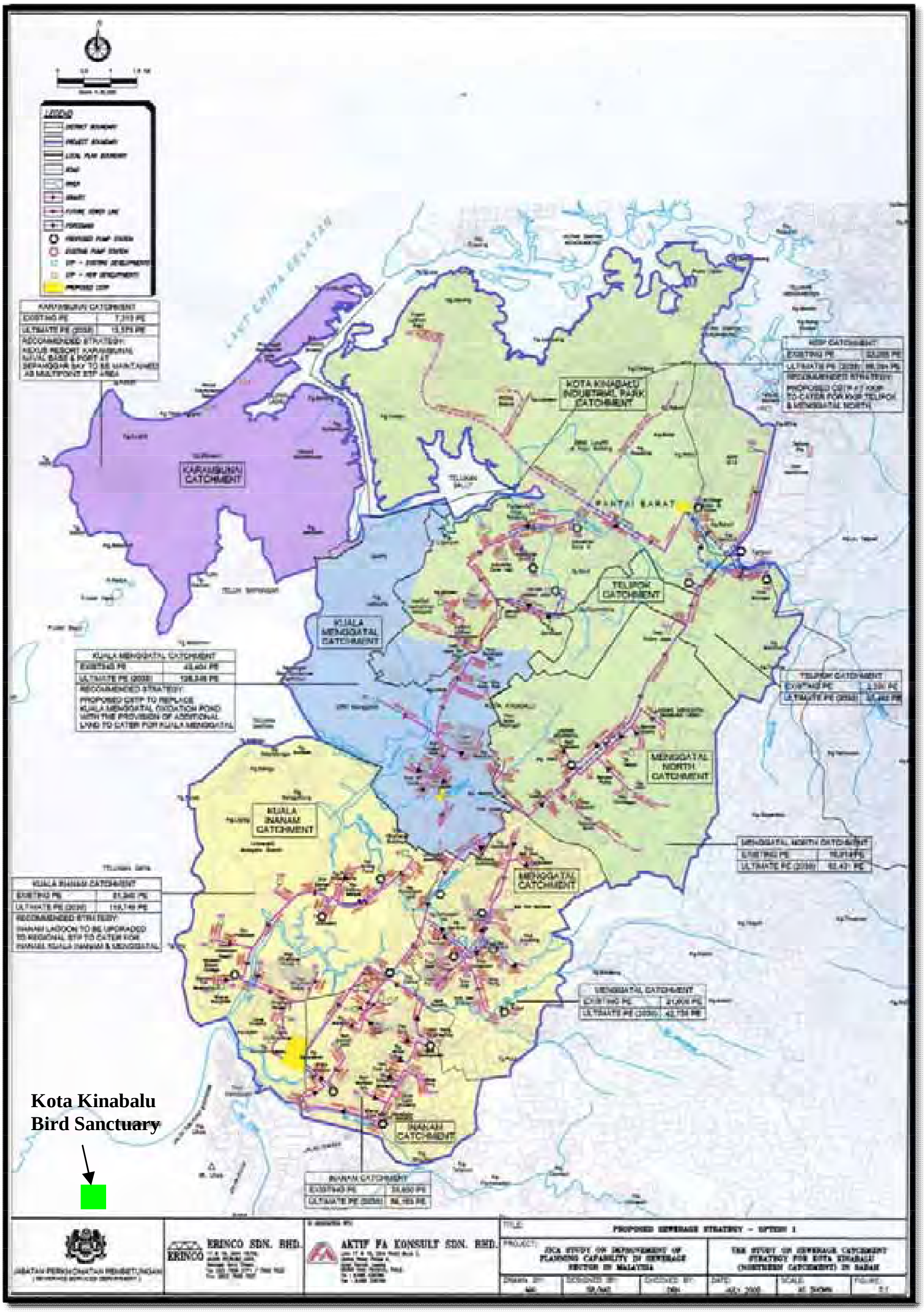


Figure 7.4.2 Northern Kota kinabalu Sewerage Catchment Strategy

7.5 Environmental and Social Considerations

The following figure shows the schedule of the JICA Main Study, its outputs and its relationship to the process of environmental and social considerations (where the decision to carry out an IEE study is made).

An IEE can be defined as that a study including analysis of alternative plans, prediction and assessment of environmental impacts, and preparation of mitigation measures and monitoring plans on the basis of secondary data and simple field surveys.

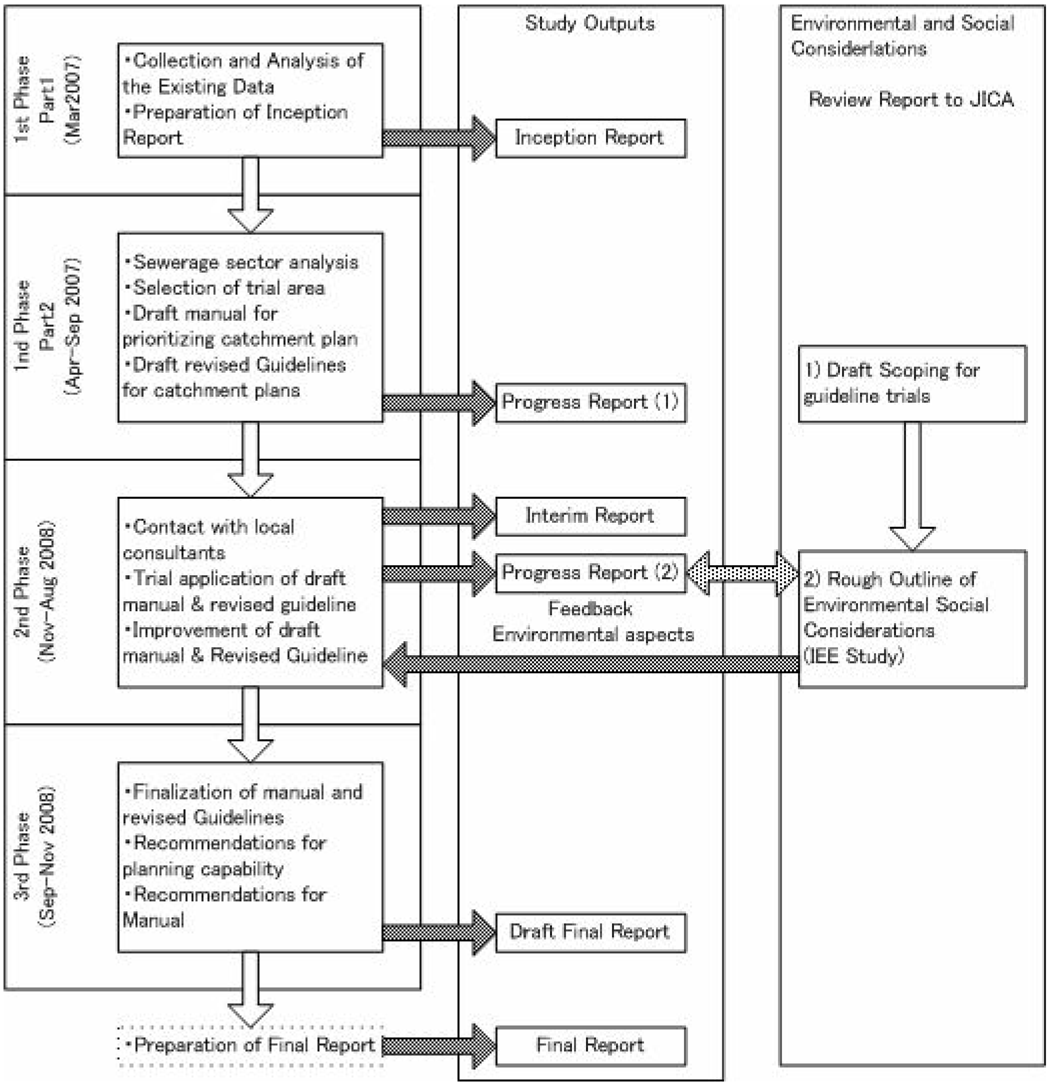


Figure 7.5.1 Processes of Environmental and Social Considerations

The draft revision of the guidelines and a draft manual was created in the 1st phase. During the 2nd phase, trial application of the manual and guidelines was conducted. At the end of the 3rd phase, the results from the trial applications will be used for the finalisation of the manual and guidelines.

The IEE study is an integral part of the JICA study, which is conducted during the Environmental and Social Consideration stage and done upon the result of draft scoping for guideline trials. ***Findings of an IEE determine if an EIA would be required.***

7.6 Scoping of Environmental and Social Impact Study

A draft scoping covering environmental and social factors in trial studies was conducted before IEE (Initial Environmental Evaluation). For the draft scoping covering environmental and social factors, a total of 22 Environmental Items are taken into consideration and an evaluation grading ranging from A-D (details are as highlighted at the bottom of each Tables) is assigned to each of the items. A distinction on the decision to carry out an EIA can be made based on the results of IEE study. When serious impacts are expected based on an IEE study, EIA should be carried out.

The results of scoping and examination for both Ipoh and Kota Kinabalu are as summarized in **Tables 7.6.1 and 7.6.2** below.

Table 7.6.1 Scoping Checklist for Ipoh

No	Environmental Items	Evaluation	Reason
1	Resettlement	C	Land acquisition for expanding sewerage treatment plants may be necessary depending on the Catchment Strategy. Some proposed sites might need to be acquired.
2	Local Economy such as employment and livelihood	C	Ditto.
3	Existing social infrastructures and services	B	Some form of traffic congestion can be expected during the construction stage.
4	Land use and utilization of local resources	D	No impact is expected.
5	Cultural Property	D	No impact is expected.
6	Water Rights and Rights of Common	D	Water rights problem is not expected.
7	Public Health Condition	C	During blockage, untreated wastewater discharge may be expected.
8	Waste	B	Treatment of sludge may be necessary.
9	Hazards (Risk)	D	No large scale construction is expected.
10	Topography and geology	D	No large scale construction is expected.
11	Soil erosion	D	No large scale construction is expected.
12	Groundwater	C	During the excavating work, pumping out of groundwater may be expected in order to lower groundwater level.
13	Lake/River	C	During blockage, untreated wastewater discharge to river may be expected.
14	Sea/Coastal zone	D	There is no sea and coastal zone.
15	Flora and Fauna	D	No conservation areas around the site
16	Climate	D	No large scale construction is expected
17	Landscape	D	No large scale construction is expected
18	Air pollution	D	No impact is expected
19	Water contamination	C	During blockage, untreated wastewater discharge may be expected.
20	Soil contamination	D	No impact is expected
21	Noise and vibration	B	Noise and vibration during the construction period are expected.
22	Offensive odor	C	Possible offensive odor can be expected, if failure in operations or maintenance occurred.

Reference: *"Environmental Guidelines for Infrastructure Projects", JICA, 1992 (some modifications)*
Note: Evaluation classification A: Expected serious impact B: Expected somewhat impact
C: Not clear D: IEE or EIA is not necessary (no expected impact)

Table 7.6.2 Scoping Checklist for Kota Kinabalu

No	Environmental Items	Evaluation	Reason
1	Resettlement	C	Land acquisition for expanding sewerage treatment plants may be necessary depending on the Catchment Strategy. Some proposed sites might need to be acquired.
2	Local Economy such as employment and livelihood	C	Ditto.
3	Existing social infrastructures and services	B	Some form of traffic congestion can be expected during the construction stage.
4	Land use and utilization of local resources	D	No impact is expected.
5	Cultural Property	D	No impact is expected.
6	Water Rights and Rights of Common	D	Water rights problem is not expected.
7	Public Health Condition	C	During blockage, untreated wastewater discharge may be expected.
8	Waste	B	Treatment of sludge may be necessary.
9	Hazards (Risk)	D	No large scale construction is expected.
10	Topography and geology	D	No large scale construction is expected.
11	Soil erosion	D	No large scale construction is expected.
12	Groundwater	C	During the excavating work, pumping out of groundwater may be expected in order to lower groundwater level.
13	Lake/River	C	During blockage, untreated wastewater discharge to river may be expected.
14	Sea/Coastal zone	B	Mangrove forest designated as Kota Kinabalu City Bird Sanctuary exists. The treatment of sewage would have a positive effect for mangrove, but the negative effect of the discharge of collected treated water at the discharge point can be expected. The discharge point may be necessary to be constructed away from sanctuary.
15	Flora and Fauna	B	A 10 hectare sanctuary designated as Kota Kinabalu City Bird Sanctuary exists near coast. The discharge point may be necessary to be constructed away from sanctuary.
16	Climate	D	No large scale construction is expected
17	Landscape	D	No large scale construction is expected
18	Air pollution	D	No impact is expected
19	Water contamination	C	During blockage, untreated wastewater discharge may be expected.
20	Soil contamination	D	No impact is expected
21	Noise and vibration	B	Noise and vibration during the construction period are expected.
22	Offensive odor	C	Possible offensive odor can be expected, if failure in operations or maintenance occurred.

Reference*: "Environmental Guidelines for Infrastructure Projects", JICA, 1992 (some modifications)*

Note: Evaluation classification A: Expected serious impact B: Expected somewhat impact

C: Not clear D: IEE or EIA is not necessary (no expected impact)

7.7 Initial Environmental Examination (IEE)

7.7.1 Ipoh

Based on the scoping on the IEE level study, eight (8) items concerning social environment, natural environment and pollution aspects are checked and the results of the IEE level study are summarized in **Table 7.7.1**. Based on the existing information and the results of the field survey, no precious fauna and flora in/around the proposed STP sites are identified. In addition, the proposed STP sits are not located at preservation area of wildlife, wetlands, national park and culture heritage.

Table 7.7.1 Results of IEE Level Study on Ipoh

No	Environmental Items	Evaluation With Project	Reason
1	Resettlement	D	The proposed STP sites (Papan, Tanah Hitam, Meru Raya) had already been acquired for sewerage purposes. Squatter was no found. The space of each area is also adequate for the constructions of the proposed STPs.
2	Local Economy such as employment and livelihood	D	The proposed STP sites had already been acquired for sewerage purposes. No impact on local economy is expected.
3	Existing social infrastructures and services	C	Some sewers are planned for construction within city area. Traffic congestion during the construction period can be expected. However, the period of impacts will be short.
7	Public Health Condition	C	During blockage due to improper maintenance, untreated wastewater discharge can be expected.
8	Waste	C	Sludge is produced continuously. It may be necessary to reduce the sludge disposal volume in order to reduce the impact of disposing sludge to landfill sites.
12	Groundwater	C	A leachate monitoring system is not commonly built in an existing dumping site. Although sludge can be mechanically dewatered, leachate from dewatered sludge may be expected.
13	Lake/River	C	Water quality will be improved by a project. However, discharging untreated wastewater to river can be expected due to blockage caused by improper maintenance in sewers.
19	Water contamination	C	Water intake points are located on upward of the catchment area. There is no effect expected from implementation of proposed projects on drinking water. However, discharging untreated wastewater to river can be expected by blockage due to improper maintenance.
21	Noise and vibration	B	There is no residential area around STPs of Tanah Hitam and Meru Raya. At Papan STP, there is only one access road to Papan STP. This road is located in front of a residential area. During transportation of waste sludge, some vibration and noise is to be expected.
22	Offensive odour	B	There is only one access road to Papan STP. This road was located in front of a residence area. During transportation of waste sludge, some emission of odour is to be expected.

Reference: "Environmental Guidelines for Infrastructure Projects", JICA, 1992 (some modifications)

Note: Evaluation classification A: Serious impact B: Some impact
C: Light impact D: Negligible impact

In order to mitigate these negative impacts, some countermeasures and recommendations from an environmental viewpoint were given in **Table 7.7.2**.

Table 7.7.2 Recommendations for Ipoh

No	Environmental Items	Recommendations for Mitigation Measures on Negative Impact
3	Existing social infrastructures and services	① To prepare a proper construction plan for sewers and STPs to reduce traffic conjunction.
7	Public Health Condition	① To prepare a sewer maintenance plan. ② To establish a monitoring system to check sewage flow.
8	Waste	① To prepare a stage wise installation plan of sludge treatment facilities to cater for increasing sludge production. ② To prepare a reuse plan of sludge such as agricultural uses and promote the reuse of sludge to public.
12	Groundwater	① To check the water content of dewatered sludge for preventing leachate from sludge. ② To select proper dumping site operators following DOE regulations. ③ To monitor groundwater and river water frequently to detect the occurrence of leachate quickly. ④ To prepare a reuse plan of sludge such as agricultural uses for reducing dumping sludge.
13	Lake/River	① To prepare a O&M plan on STPs to meet the required treated water quality regulations. ② To prepare a sewer maintenance plan to prevent blockage.
19	Water contamination	① To prepare a O&M plan on STP to meet the required treated water quality regulations. ② To prepare a sewer maintenance plan to prevent blockage.
21	Noise and vibration	① To plant a tree belt around STP sites to mitigate noise. ② To set buffer zone around STP sites ③ To prepare an operation schedule for avoiding nighttime noise and vibration. ④ To make a diversion route for a Papan STP to reduce traffics in front of residences.
22	Offensive odor	① To plant a tree belt around STP sites to mitigate odour. ② To set buffer zone around STP sites. ③ To make a diversion route for a Papan STP to reduce the emission of odour by reducing traffics in front of residences.

7.7.2 Kota Kinabalu

Based on the scoping on the IEE level study, eight (8) items concerning social environment, natural environment and pollution aspects are checked and the results of the IEE level study were summarized in **Table 7.7.3**. Based on the existing information and the results of the field survey, no precious fauna and flora in/around the proposed STP sites were identified. The Kota Kinabalu City Bird Sanctuary is located out of the catchment area and is about 5 km distant from Inanam STP, which is the only closest STP to it. There is no negative impact of STPs on the sanctuary. In addition, none of the proposed STP sites are located at preservation area of wildlife, wetlands, national park and culture heritage.

Table 7.7.3 Results of IEE Level Study on Kota Kinabalu

No	Environmental Items	Evaluation With Project	Reason
1	Resettlement	D	Land acquisition for expanding sewerage treatment plants is necessary for Kuala Menggatal STP. Currently, the proposed land is used as an agricultural land, no resettlement is expected due to expansion of STP site (about0.5ha) for buffer zone.
2	Local Economy such as employment and livelihood	C	Three sites (Inanam, KKIP, and Kuala Menggatal) are already having existing sewerage facility or approved by the state government. Inanam and KKIP STP's site is adequate and no impact is expected. However, the expansion of Kuala Menggatal site is necessary and some impact is expected as proposed site is currently used as an agricultural land.
3	Existing social infrastructures and services	C	Some sewers are planned for, within the city area. However, the road in which proposed trunk sewers are located has four or six lanes. The road has enough space for traffic during construction. The period of impacts will be short.
7	Public Health Condition	C	During blockage due to improper maintenance in sewers, discharging untreated wastewater may be expected.
8	Waste	C	Present dumping site has an enough volume (46 ha). However, sludge is produced continuously. It may be necessary to reduce the sludge disposal volume in order to reduce the impact of disposing sludge to landfill sites.
12	Groundwater	C	Although sludge is mechanically dewatered in a project, leachate from dewatered sludge may be expected.
13	Lake/River	C	Water intake points are located at upstream of discharge point to rivers. There is no effect on drinking water. However, discharging untreated wastewater to river may be expected by blockage due to improper maintenance.
14	Sea/Coastal zone	D	Mangrove forest designated as Kota Kinabalu City Bird Sanctuary is out of catchment area. The nearest STP site (Inanam) is 5 km away from the Sanctuary. The treated water will be discharged to ocean through a river. No treated water flows directly into the sanctuary.
15	Flora and Fauna	D	The sanctuary designated as Kota Kinabalu City Bird Sanctuary is 5 km away located from a STP site. No destruction of flora and fauna around the sanctuary is expected due to construction activities..
19	Water contamination	C	Water intake points are located at upstream of the catchment area. There is no effect on drinking water. However, discharging untreated wastewater to river may be expected by blockage due to improper maintenance.
21	Noise and vibration	C	There are residential areas near Menggatal STP. During transportation of waste sludge, some vibration and noise can be expected.
22	Offensive odour	C	There are residential areas near Menggatal STP. During transportation of waste sludge, emission of odour can be expected.

Reference: "Environmental Guidelines for Infrastructure Projects", JICA, 1992 (some modifications)

Note: Evaluation classification A: Serious impact B: Some impact
C: Light impact D: Negligible impact

In order to mitigate these negative impacts, some countermeasures and recommendations from an environmental viewpoint were given in **Table 7.7.4**.

Table 7.7.4 Recommendations for Kota Kinabalu

No	Environmental Items	Recommendations for Mitigation Measures on Negative Impact
2	Local Economy such as employment and livelihood	① To acquire the land for proposed STP site following Malaysia land acquisition procedures and make consultation with land owners
3	Existing social infrastructures and services	① To prepare a proper construction plan of sewers and STP, traffic control plan during construction period
7	Public Health Condition	① To prepare a sewer maintenance plan. ② To establish a monitoring system to check sewage flow.
8	Waste	① To prepare a stage wise installation plan of sludge treatment facilities to cater for increasing sludge production. ② To prepare a reuse plan of sludge such as agricultural uses and promote the reuse of sludge to public.
12	Groundwater	① To check the water content of dewatered sludge for preventing leachate from sludge. ② To select proper dumping site operators following DOE regulations. ③ To monitor groundwater and river water frequently to detect the occurrence of leachate quickly. ④ To prepare a reuse plan of sludge such as agricultural uses for reducing dumping sludge.
13	Lake/River	① To prepare a O&M plan on STP to meet the required treated water quality regulations. ② To prepare a sewer maintenance plan to prevent blockage.
19	Water contamination	① To prepare a O&M plan on STP to meet the required treated water quality regulations. ② To prepare a sewer maintenance plan to prevent blockage.
21	Noise and vibration	① To plant a tree belt around STP sites to mitigate noise. ② To set buffer zone around STP sites ③ To prepare an operation schedule for avoiding nighttime noise and vibration.
22	Offensive odor	① To plant a tree belt around STP sites to mitigate odour. ② To set buffer zone around STP sites.

7.8 Presentation on the outline of the IEE study

7.8.1 External Meeting

An external meeting with related stakeholders was conducted to present and explain the proposed catchment strategies for both Ipoh and Kota Kinabalu. In this meeting, the IEE's study results were also explained based on its environmental and social consideration. **Table 7.8.1** shows the details and contents of the external meetings.

Table 7.8.1 Contents of External Meetings

External Meeting	Ipoh	Kota Kinabalu
Date	29th July 2008 9:30-12:30	30th July 2008 10:00-13:00
Place	Hotel Casuarina, Ipoh	Promenade Hotel, Kota Kinabalu
Attendants	Relevant government agencies	
Contents of Presentation	1) Outline of JICA Study on Improvement of Planning Capability in Sewergae Sector in Malaysia 2) Results of sewerage catchment strategies in Ipoh and Kota Kinabalu 3) Results of IEE level study	

Participants of the external meetings are as shown in **Tables 7.8.2 and 7.8.3**. As the objectives of the trial studies were solely to confirm the effectiveness of the revised guidelines and no further implementation is planned, attendees for the external meetings are confined to related government agencies only.

Table 7.8.2 Participants for External Meeting at Ipoh

Participants	Ipoh
SSD (Sewerage Services Department)	Mr. Hazmi Bin Ramli
SPAN (National Water Services Commission):	Mr. Wan Sallehuddin
IWK (Indah Water Consortium):	Mrs. Hartini Binti Ali Mr. Mohd Shariman Bin mohd Shariff Mr. Tiah Oon Han Mr. Sri Ruthira Kumar
LAP (Perak Water Board):	Mr. Hj. Abu Bakar Bin Othman
JPBD (Town and Rural Planning Department):	Mr. Faizulzila Mohammad
MBI (Ipoh City Council):	Mrs. Jaslina Shaidin Mrs. Zuraina Kamarul Ariff Mr. Mustaffa Albasre Harun
JAS (Department of Environment):	Mrs. Nisah Muhd @ Hanafi
JICA Team:	Mr. Tetsuo Wada Mr. Thanapalan Kanapathippillai

Table 7.8.3 Participants for External Meeting at Kota Kinabalu

Participants	Kota Kinabalu
JICA Malaysia	Hideo Tsukamoto
JICA Study Team JICA Study Team	Tetsuo Wada Thanapalan Kanapathippillai
DG of DBKK	Chua Kim Hing
Ministry of Tourism, Culture & Environment	William Baya
Land And Survey Department	Joseph Lim
Tuaran District Council	Tang Yang Ming
Environmental Protection Department	Elin Empan
Department of Environment	Zuraini Siam
Road Works Department	Paul Thien
JPBIW (Town & Planning Department)	Terence Chia
Drainage & Irrigation Department	Yap Siew Fah
KKIP Sdn. Bhd	Lam Kin Yee
Ministry of Housing & Local Government	Nor Isham Narawi
Drainage & Irrigation Department	Joseph Dinor
DBKK DBKK DBKK DBKK DBKK	Ir. Lee Tet Fon Beddu Ahmad Jack Lo Poon Chee Kong Victor Wong
Erinco Sdn Bhd Erinco Sdn Bhd Erinco Sdn Bhd	Ir. Dr. Dhileepan Nair Nor Akmal Tarmizi Sharmini Ramanathan
Aktif FA Konsult	Mr. Fung Yin Khun

Programs of each external meeting are as shown in **Tables 7.8.4 and 7.8.5**.

Table 7.8.4 Program of External Meeting at Ipoh

Program	Oranization in Charge
Opening statment	Mr. HJ. Abu Baicar B. Othman
Part I: Outline of JICA Study on Improvement of Planning Capability in Sewergae Sector in Malaysia	Mr. T. WADA, JICA Study Team
Part II: Outline of Sewerge Catchment Strategy for Ipoh	Dr. Dhileepan Nair, Local Consultant for Trial Study
Coffee break	
Part III: Explanation of Result of the IEE Level Study	Mr. T. WADA, JICA Study Team
Part V: Questions and answers	All Attendances
Closing remarks	Mr. HJ. Abu Baicar B. Othman

Table 7.8.5 Program of External Meeting at Kota Kinabalu

Program	Oranization in Charge
Opening statment	Dr. Chua Kim Hing, Director General of Kota Kinabalu City Hall
Part I: Outline of JICA Study on Improvement of Planning Capability in Sewergae Sector in Malaysia	Mr. T. WADA, JICA Study Team
Part II: Outline of Sewerge Catchment Strategy for Ipoh	Dr. Dhileepan Nair, Local Consultant for Trial Study
Coffee break	
Part III: Explanation of Result of the IEE Level Study	Mr. T. WADA, JICA Study Team
Part V: Questions and answers	All Attendances
Closing remarks	Mr. Hideo TSUKAMOTO, JICA Malaysia Assistant Resident Representative

7.8.2 Main Topic Discussed

The main topics discussed in External Meetings at Ipoh and Kota Kinabalu are provided in the form of a comment sheet as summarized in **Tables 7.8.6 and 7.8.7**, respectively.

Table 7.8.6 Main Topics Discussed at Ipoh

Question and Comments		Answer
1	Will the strategy incorporate treatment of leachate from the sludge disposed at the proposed dumping site?	The study advocates that proper leachate treatment must be provided for, but the decision would be based on the jurisdiction of concerned agency. For example, if the sludge is to be sent to a sanitary landfill area, then the jurisdiction on provision of treatment lays with the Ministry of Housing and Local Government, not MEWC. Commonly, every sanitary landfill will have its own leachate treatment for solid waste, therefore it is advised to direct the leachate produced by the sludge to the existing facility. The facility might need to be upgraded to cater for increased flow. Furthermore the sludge leachate is also a good stabiliser. It was also advised that in future planning of new landfill sites, all the concerned agencies/department should discuss and make a decision on the above issue.
2	Does CSTPs provide leachate treatment?	In design of CSTP, wastewater from sludge treatment is retuned to sewage treatment facility and is further treated.

Question and Comments		Answer
3	Can proposed STP provide for treatment of leachate from a solid waste dumping site?	Certainly not. It was never a practise to treat leachate from a dumping site at a STP due to the characteristics of the leachate.
4	Can the effluent from STPs be used for other industries?	Yes but it is dependant of many factors. It was proposed that if the need arises, at the stage of implementation, reuse of treated water could be further studied in terms of demand and costs benefits.

Table 7.8.7 Main Topics Discussed at Kota Kinabalu

Question and Comments		Answer
1	What will be the mitigation measures for offensive odour related to sewage treatment plants?	Anaerobic conditions are one of the primary causes of odour. Therefore, the solution is to have aerobic systems. Another solution would be to have covered treatment systems and enclosures at points where odour is to be expected. Providing adequate buffer zones and odour treatment facilities is to be considered too.
2	Although there are no water intake points within the Study Area, the discharge will eventually drain into the sea. Will the effluent be treated to Standard A as there are recreational areas in coastal zones?	The plant will be designed to meet 20mg/L BOD effluent discharge based on DOE's Standard A. Provided the effect is severe or it is a requirement.
3	What is the basis used for PE projections?	The PE projections were based on the future land use method and also structure plan. These projections are just an approximation as both the land use plan and structure plan are being formulated by DBKK.
4	Will the STP be designed to treat oil and grease and is this taken into account in terms of cost?	It is not standard practice to design STPs to treat oil and grease. This has to be tackled at source by installing grease traps and effective enforcement by local authorities to ensure that measure is complied with.
5	Will reuse of sludge be included in the strategy?	Reuse of sludge such as compositing is planned in the strategy.
6	The approval from the DOE in terms of a feasibility study for site suitability will have to be obtained prior to this project being carried out.	The relevant authorities will be consulted in the event this catchment study is be implemented by the local government or any other agencies concerned.

7.9 Feedback on IEE of trial studies to Revised Guideline

Based on the social consideration and initial environmental examination that was carried out during the trial studies of Ipoh and Kota Kinabalu, the draft Guideline was partly revised.

From the examination and feedbacks received, it was concluded that it is best to include two addition items in the summary sheet of Sewerage Catchment Strategies. The summary sheet is a new introduction that is currently being proposed for the revised guideline Vol.1 Part B. The two additional items are Land Status of STPs and Special Conditions (e.g. National Heritage Area, Sanctuary and etc).

These two items was introduced to assist in confirming the extent of impact to local economy and the possibility of damage to natural environment during the stage of construction.

These items are expected to be effective information for ensuring smooth implementation of sewerage projects that were proposed within a strategy.