PART III

SEWERAGE

1 Outline of Study Area

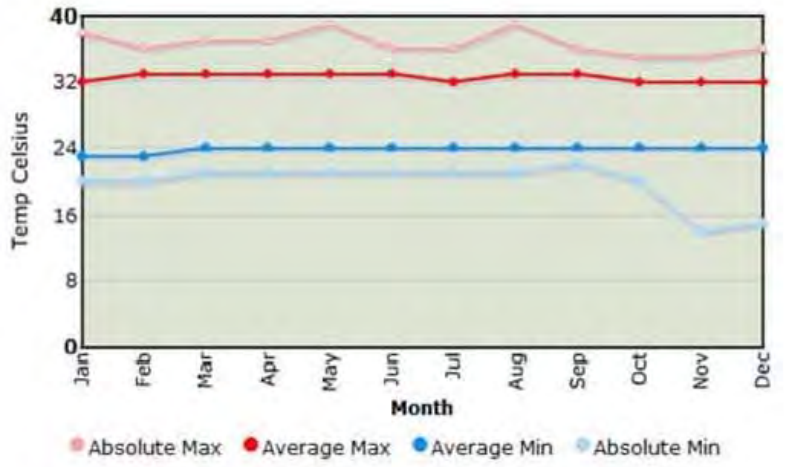
1.1 Natural Condition

(1) Location

Cheras and Kajang is a part of Kajang which is a town in the eastern part of Selangor and the district capital of Hulu Langat. It is located 21 kilometers from Kuala Lumpur, the Capita of Malaysia.

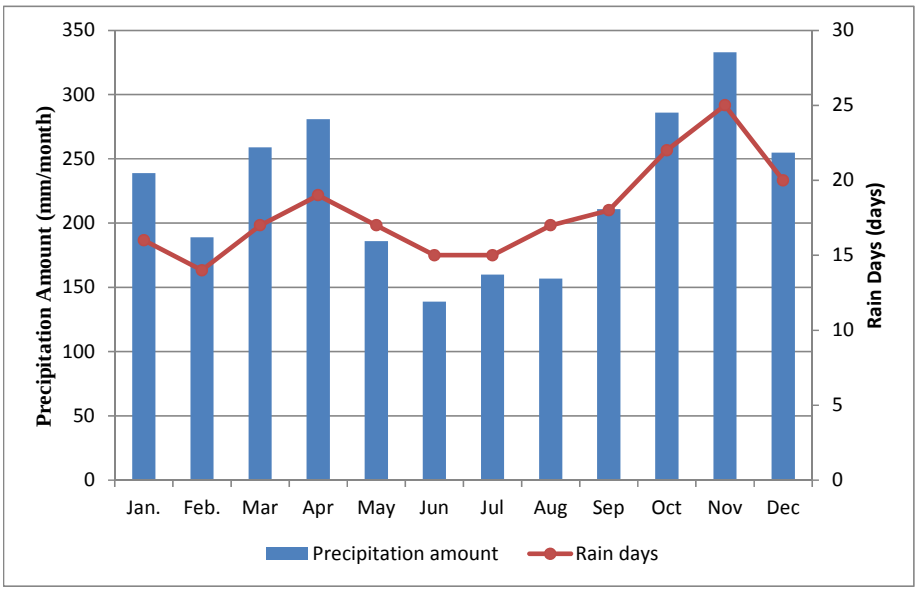
(2) Climate

The temperature of Kajang varies in the range of 24 ºC at night to 32ºC in daytime with a little monthly fluctuation as shown in **Figure III-1.1**.



Source: http://www.myweather2.com/City-Town/Malaysia/Kajang/climate-profile.aspx

Figure III-1.1 Monthly Fluctuation of Average and Extreme Temperature of Kajang



Source: http://www.myweather2.com/City-Town/Malaysia/Kajang/climate-profile.aspx

Figure III-1.2 Monthly Average Precipitation Amount and Rain Days

An annual average precipitation of Kajang is 2,695 mm with the maximum of 333 mm in November and the minimum 139 mm in June in the monthly average precipitation amount. as shown in **Figure III-1.2**.

1.2 Social condition

(1) Population

The Metropolitan Kuala Lumpur has kept expansion accompanied with the industrial and economic development in the whole country. The population growth rate of Kuala Lumpur has declined from 2.0% during 1980 to 1991 (national average: 2.7%), 1.5% during 1991 to 2000 (2.6%) to 2.2% during 2000 to 2010 (2.2%) and already settled. Adversely, the state of Selangor surrounding the Capital shows remarkable development with an annual average growth rate of 4.4% during the 1980's, 6.2% during the 1990's and 3.2% during the 2000's. The population percentage of Selangor State in the country has been increasing from 10.9% in 1980, 13.1% in 1991, 17.8% in 2000 and 19.6% in 2010, which is one of only two states to continue increasing the percentage as well as Sabah State.

In Selangor State, Ulu Langat shows the highest annual growth rate of 8.5% during 1991 to 2000 followed by Sepang (7.9%), Petaling (7.2%), Klang (5.2%) and Gompak (4.8%). Cheras and Kajang is the core in what is called Sg. Ulu Langat Basin (Ampang in the same Ulu Langat belongs to Sg. Klan Basis same as Kuala Lumpur.)

The study area or Cheras & Kajang is adjoining to Kuala Lumpur across the ridge and shows a remarkable development as the commutable area of Kuala Lumpur by the provision of highways. The annual average population growth rates for 20 years during 1980 to 2000 were an amazing value of 9.1% starting from 69,000 in 1980 to 393,000 in 2000 and 3.6% (460,000) during 2000 to 2010 declining due to heavy mother body but still rather exceeding a national average of 2.2%.

(2) Traffic

Kajang have well connected with many major highway and expressway like Kajang Dispersal Link Expressway as a ring road of Kajang, Cheras-Kajang Expressway (CKE, **E7)**, North-South Expressway (NSE) with Kajang exit and Kajang-Seremban Expressway (LEKAS, **E7**) at the south of Kajang near Semenyih. Because of the position of Kajang between three major city (Kuala Lumpur, Seremban and Putrajaya), Kajang is included in Klang Valley or Greater Kuala Lumpur as shown in **Figure III-1.3** . Public transport such as bus, taxi, and train are also available in Kajang.

Mini.KTM Komuter is a commuter train service through Kajang from KL Sentral to Seremban route and stop at Kajang Komuter station. By 2010 under one of the National Key Economic Area (NKEA) and under Government Transformation Programmed (GTP), the Federal Government have announced to improve a public transport system by build a Mass Rapid Transit "MRT" system in the Klang Valley or Greater Kuala Lumpur. Kajang are included of this system with nine stations in Kajang Municipal Council (MPKj) area. The system will be built in June 2011 and will be completed in 2016.

Source: http://www.mpkj.gov.my/hubungi_kami/peta_lokasi

Figure III-1.3 Expressway and Major Roads in Kajang

2 Situation of Sewerage Development, and Operation and Maintenance in the Study Area

2.1 Situation of Sewerage Development in the Study Area

From the situation mentioned-above housing schemes has been extended throughout the study area, resulting in the construction of 177 small-scale sewage treatment plants or 94 STPs in Cheras and 83 STPs in Kajang. They are now under IWK's operation and maintenance.

Beside the above, there are private STPs or 19 plants in Cheras and 29 plants in Kajang which were constructed for schools, universities, clinics, hospitals, shopping centres, golf course, stadium, etc. The largest one has a capacity of 4,000 PE followed by hospital and stadium with a capacity of around 1,000 PE, respectively. Total capacities are 4,211 PE in Cheras and 7,460 PE in Kajang, although including unknown capacities, which is equivalent to only 3% of that of public STPs.

Individual septic tanks count 5,687 in Cheras Batu 11 and Cheras Jaya, 6,304 in Kajang 1&3 and 11,991 in total equivalent to 34,630 PE. They are not dispersed in the study area but located collectively in several areas. The lands might be developed by the private companies as the residential areas and the land purchasers have installed their ISTs individually.

Table III-2.1 Situation of Sewerage Development in Upper Langat Area

Catchment	Public STP				Private STP			IST	
	No. of Units	Design PE	Connected PE	No. of NPSs	No. of Units	Design PE	PE-Unknown Units	No. of Units	Design PE
Langat	7	25,890	17,837	4	6	983	1	2,414	12,070
Cheras Bt 11	65	269,141	194,122	2	18	7,215	7	5,413	17,455
Cheras Jaya	29	145,119	111,755	5	1	499	-	274	1,310
Cheras East	17	116,750	78,824	5	5	1,240	3	720	3,600
Sub-total	111	531,010	384,701	12	24	8,954	10	4,473	22,365
Kajang 1	34	94,406	66,430	1	3	15	2	2,649	8,055
Kajang 2	7	49,445	36,260	1	6	1,098	1	2,179	5,465
Kajang 3	49	181,688	91,136	4	26	7,445	8	3,655	7,810
Sub-total	90	325,539	193,826	6	35	8,558	11	4,266	21,330
BBB North	4	102,900	52,852	1	24	2,213	16	-	-
BBB South	8	30,179	18,928	6	4	665	1	322	1,610
Sub-total	12	133,079	71,780	7	28	2,878	17	322	1,610
Bangi South	8	148,905	56,991	2	1	-	1	254	-
Semenyih	31	192,989	110,995	3	17	385	17	2,935	14,675
Beranang	3	97,313	32,447	4	3	23	2	-	-
Total	262	1,454,725	868,577	38	114	21,781	59	20,815	104,075

Source: Antara Jurutera Perunding Sdn Bhd,"Sewerage Catchment Planning and Sludge Management Strategy Study for Upper Langat Basin - Volumes 1 & 2", JPP, November 2009
Note: Design PE of private STPs excludes those of unknown PE.

2.2 Situation of Operation and Maintenance of Exiting Sewerage Facilities

In, Malaysia, the Sewerage Services department of the Ministry of Energy, Green Technology and Water has taken a leadership to solve the various problems in operation and maintenance of exiting sewerage facilities and initiated the improvement of the current sewerage systems.

In 2000, the National Sewage Treatment Plant Project has been extended under the JICA loan to construct the thirteen (13) sewage treatment plants or sludge treatment facilities with high priority, including sewerage related facilities, sewage treatment facilities, sludge treatment facilities, sewer systems and pumping stations.

Based on such situation, "National Water Services Master Plan (NWSM)" prepared in 2010 proposes the data renewal and utilization of new business approach using experience and knowhow of the Tokyo Metropolitan Government.

2.2.1 Sewerage System

In the study area in Langat River Basin, land development including housing development, etc. in accordance with Malaysia 2020 Plan etc. have been actively extended, resulting in expansion of an urban area, concentration of population, upgrading of living style and so on. Especially in Cheras and Kajang, the housing development has done disorderly at a glance and urban areas have been spreading like amoeba. Such expansion of urbanization has brought the proliferation of small sewage treatment plants with an impact on the Langat River as drinking water source.

(1) Current Situation and Problems

- Among a number of these small sewage treatment plants spread in the study area, some plants has been left aging or out of order.
- Inevitably, water quality of sewage effluent has deteriorated and promoted water pollution in public water bodies. For drinking water source, the content of ammoniacal nitrogen is problematic.
- Some sewage treatment plants among existing ones have been operated over capacity in quantity and quality which causes a bad cycle by phenomenon attributed to such results.
- Some areas have been not yet served by sewerage and insufficient desluding from and malfunction of individual septic tanks have resulted in water pollution of rivers..

(2) Solution Proposal

- Not only technical approach but also evolution of new policies so as to achieve the rationalization of management and operation and maintenance are required.
- The new sewerage system should be established by integrating a number of existing small sewage treatment plants spread into a centralized sewage treatment plants to be constructed as well as the development of a required sewer system.
- In constructing a new sewerage system, technical devices must be developed in consideration of water quality environment of water bodies receiving sewage effluent.
- The extent of sub-catchments to be integrated shall have a scale contributing to execution of efficient operation and maintenance.
- It is an urgent matter to hasten the construction of sewerage facilities using public funds in order to eliminate unserved areas by sewerage

2.2.2 Sewer System

The sewerage development is implemented in the study area through the manner that each developer has constructed a sewerage system at his housing development area in accordance with the legal requirements. A separate system in which sanitary water and storm water is collected separately is adopted and all sewage discharged from the house such as toilet, kitchen and bathroom is basically collected by gravity to a public sewer system and treated at a public sewage treatment plant so as to meet the sewage effluent discharge standards to the public water bodies. Such development manner has played a certain level of role to alleviate environmental load by treating sewage generated from respective houses. However, the construction of sewerage facilities in the housing development area are entrusted to the developers and it cannot be said that the quality control of such facilities has well assured. In addition, most of them are small in development scale and a sewer system constructed includes a number of small size sewers.

(1) Current Situation and Problems

- The information of sewer installation including size, location, material, slope, manhole type, installation year, etc. is insufficient as well as the information of house connection pipes
- Since a sewer system laid under the ground is invisible, daily patrol and inspection are dispensable for operation and maintenance of a sewer system in addition to the regular checking inside the pipes. But due to a budgetary constraint, such works are hardly done.
- For this reason, the conditions of damage and deterioration of a sewer system is unknown and proper measures for problematic points are not taken.
- Therefore, measures always follow the residents' complaints, occurrence of road collapse and so on under the present situation.
- It is found that manhole covers are hidden with road pavement during the field survey,
- The scope of administrative responsibility is vague due to no installation of a chamber between house connection and a public sewer system. A chamber is installed to clarify the private and public boundary in Tokyo.
- The grey water problem is derived from an incomplete sewerage system in which sullage or a part of sanitary sewage, are directly discharge into storm water drains, resulting in the progress of water pollution in rivers. While it causes the shortage of incoming sewage flow and low loads of sewage influent at a sewage treatment plant, which makes the operation and maintenance of sewage treatment more difficult.
- As seen at the Pantai sewage treatment plant in Kuala Lumpur, wet weather sewage flow incoming to a sewage treatment plant is repeatedly five times of dry weather sewage flow, which is attributed to an incomplete separate system in the present sewerage system and and causes the operation and maintenance problems especially in sewage treatment.

(2) Solution Proposal

- The damage, breakage, etc. of a sewer system should not be responded after the occurrence of operation and maintenance problems. The operation and maintenance system mainly focusing on preventive maintenance be established and promoted from the viewpoint of minimization of life cycle cost.
- Construct the database of information control concerned with a sewer system, which is the basis of operation and maintenance works, be thoroughly prosecuted.
- Construction the database of an existing sewer system first and consider the introduction of an information management system based on digitalized information but not paper-based information, which is adopted by the Tokyo Metropolitan Government.
- Be painstaking daily patrol and inspection based on this facility management information, conduct regular cleaning and the in-pipe survey using a TV camera, and make an endeavor for elevation of a sewer system function and understanding of the present situation of facilities.
- Conduct necessary facility refurbishment and improvement in a planned manner based on such works
- Establish such a Plan/Do/ Check/Action cycle.
- Since grey water problem is not solved without the residents' cooperation, It is considered necessary to establish a subsidiary system using a public fund and extend the policies, asking for understanding to the residents
- It is also recommended to implement the pilot project to refurbish an existing storm water drainage system and separate sullage during dry weather as one of measures.

2.2.3 Sewage Treatment Facilities

In Malaysia, the Federal Government had a requirement to housing developers to construct a sewage treatment plant in order to promote sewerage development as the measures against epidemic diseases and water environment conservation, which is similar to the approach that the Tokyo Metropolitan Government previously taken for development of community sewage treatment plants. This had advantages to construct sewage treatment facilities together with housing development, but

disadvantages that a variety type and size of small sewage treatment plants were constructed resulting in many problems in operation and maintenance.

From the viewpoint of water quality aspect, the existence of a variety type and size of small sewage treatment plants causes many problems. As already reported by Antara's Report, the situation that water quality has deteriorated has been confirmed through the field survey conducted in this Study. Furthermore, the problems that sewage treatment facilities has been left aging or out of order, defects in water quality control, and difficulty to operate and maintain the existing sewerage systems have been closed up and urgent response is highly required.

(1) Current Situation and Problems

- Although the sewage treatment processes are different, biological treatment processes using microorganism, etc. are basically used. For this reason, the performance of sewage treatment process is sharply susceptible to qualitative and quantitative fluctuation of sewage influent. However, it is difficult to create and keep the favorable biological environment in the current operation and maintenance manner.
- The present operation and maintenance system for a number of sewage treatment plants spread is based on the regular patrol and inspection, which is not proper to the characteristics of present sewage treatment processes.
- To keep the water quality of sewage effluent meeting the effluent standards, it is necessary to thoroughly control the water quality in sewage treatment process. However, at present, water quality expertise concerning verification of sewage effluent, operational requirement for improvement, etc., proper man-power, required budget and so on are, in general, lack
- From the viewpoint of water quality aspect, the problems are listed as follows:

  Some sewage treatment facilities show low BOD_5 removal efficiency and require cause clarification and proper improvement.

  Ammoniacal nitrogen cannot be expected at the existing sewage treatment plants.

  Some facilities are improper to withdraw settled sludge from the sewage treatment process.

  In spite of the provision of disinfection equipment, disinfection is not carried out which is not good from the viewpoint of prevention of epidemic diseases.

  In Malaysia, the grit chamber is generally arranged after a pumping station as seen at existing sewage treatment plants. This arrangement, however, causes wear and short lifespan of main pump impellers and abnormal scum generation.

  No practice of sewage effluent reuse.

  The site of a sewage treatment plant is not effectively used in spite of its large extent

(2) Solution Proposal

- Not only technical approach but also evolution of new policies so as to achieve the rationalization of management and operation and maintenance are required.
- Through the integration of existing sewage treatment plants, the structural and water quality problems derived from the aging and so on of existing facilities can be solved as well as elaborate water quality control in the sewage treatment process, development of human resources such as acquisition of professional expertise, etc. creation of favorable biological environment such as ammoniacal nitrogen removal through introduction of new technology.
- In the new facilities, the grit chamber shall be arranged before a pumping station but not after a pumping station, to remove screenings and grit firmly, contain the trouble occurrence in main pumps, integrate the inspection points and control scum generation. This arrangement is strongly recommended based on the long history and experience of the Tokyo Metropolitan Government.
- If a certain level of advanced treatment is applied to sewage effluent, it can be used not only in-plant miscellaneous use as usual but also external use such as toilet flushing, landscaping, equipment washing, gardening, etc.

  It is recommended to utilize the upper large space of sewage treatment facilities for other

purposes, for example, park, playground, solar panel installation for power generation and so on.

2.2.4 Sludge Treatment Facilities

It cannot be said that sludge treatment and disposal is done properly at ISTs and small sewage treatment plants. As, in general, the discharge of sewage effluent has a tendency to easily show a direct impact on water source pollution or living environment pollution, measures for sludge receive a lower priority than sewage treatment in many cases.

Although there is a movement to seek for the measures in fear of checkmate of sludge treatment and disposal in future, the importance of sludge treatment and disposal is less recognized as a whole. The problems are potentially piled up at present.

(1) Current Situation and Problems

- The practice of sludge treatment and disposal at small sewage treatment plants are generally done by gravity thickening followed by natural drying at sludge drying beds. Sludge cake with a moisture content of approximately 20% is hauled outside a plant for disposal.
- However, in some cases, sludge drying beds are not in use and even provided with a dewatering unit such as filter press, there are some cases that such equipment is not operated.
- As a result, settled sludge is not fully collected and discharged into rivers as SS in sewage effluent resulting in the cause of water pollution.
- On the contrary, even at large sewage treatment plant, sludge cannot be fully collected as planned due to low level of concentrations (SS and BOD5) in sewage influent, which affect adversely on sewage treatment process and make sludge digestion difficult.
- Also, as seen the situation that all the rotary drum type sludge thickeners stop operation,
- Final disposal of sludge is done through hauling outside a plant and dumping at the mountain-ridged region under IWK's control or disposed at the land reclamation site under the control of a private company as general municipal waste.
- In addition, by insufficient desludging at ISTs, there is a fear of the discharge of sludge resulting in environmental pollution.
- It is required to reuse sludge in order to extend the lifespan of reclaimed disposal sites and utilization of resources

(2) Solution Proposal

- To continue the proper and efficient operation and maintenance of sludge treatment, it is necessary to integrate existing small sewage treatment plants.
- In integration, the challenge for recycle making use of sludge characteristics and introduction of new technologies aiming at reduction of environmental load must be proceeded.
- Model Project considers to adopt the belt type sludge thickener with features of energy-saving and high sludge thickening efficiency
- The proper maintenance system of ISTs must be established as well as the construction of a holding tank receiving withdrawn sludge.
- Sludge cake dewatered after volume reduction at sludge digesters contains nitrogen (N) and phosphorous (P) richly which is effective as plant fertilizer. If it is utilized as resources, environmental destruction occurred through simple sludge dumping at the reclaimed land as municipal waste can be stopped.

2.2.5 Operation and Maintenance System of IWK

In the operation and maintenance of sewerage facilities, it is ideal that a series of works such as daily patrol and inspection, examination of sewage effluent, regular cleaning works, conduct of deterioration survey, and execution of refurbishment and improvement works corresponding to the

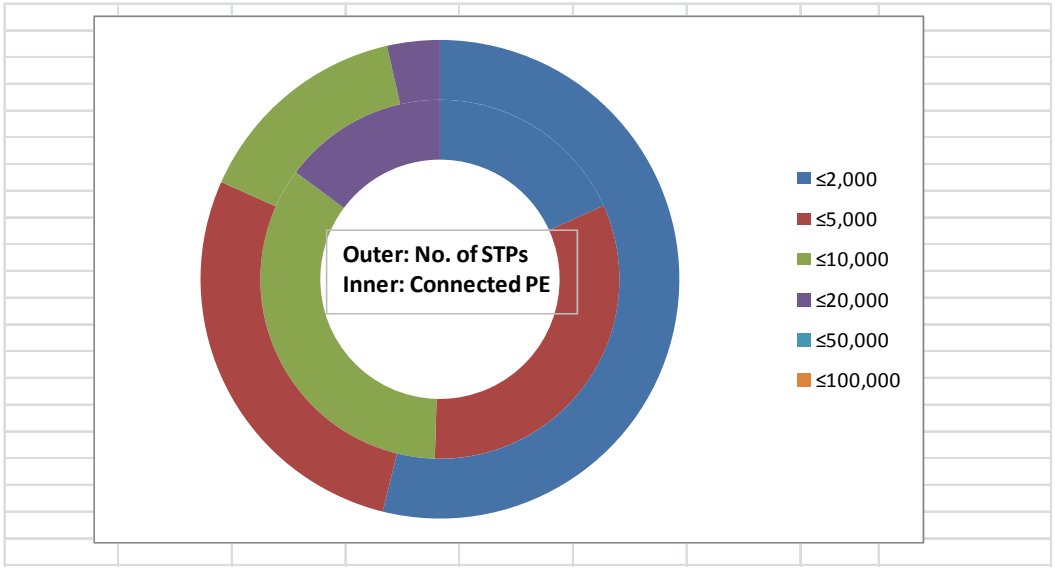
results, are done as planned to perform the purpose of sewerage efficiently.

(1) Current Situation and Problems
- Taking into account the operation and maintenance structure of IWK, the number of employees is not proper in comparison with a huge number of sewer systems, pumping stations and sewage treatment plants.
- It cannot be said that adequate capital cost is not fully acquired for required facility refurbishment and improvement.
- Even at present, a number of facilities to be operated and maintained have been increasing, with which the operation and maintenance structure of IWK cannot catch up.
- As a result, full business activities become impossible in a variety of constraints and limit the contents of operation and maintenance. It seems that the structure is falling into negative spiral
- For example, the inspection is done only one or two times a month for sewage treatment plant and pumping stations as well as one or two times water quality examination a month. It is difficult to keep good operation and maintenance of facilities and water quality control in such a manner..
- While, depending on national characteristics, career change, job relocation, resignation, etc. strides, as if it were common sense, which makes accession and elevation of skill difficult.
- Also, from the situation that sewerage master plan is none, the staff has less understanding of environmental condition in the entire basin largely owing to technical capacity of the staff in charge as well as less consideration for damage extent of sewer facilities, cycle and retention of sludge in treatment facilities and so on, and the ability how to handle such problems is not brought up.

(2) Solution Proposal
- Formulate the basin-wide sewerage master plan to integrate and abandon existing small sewage treatment plants and restructure subcatchments to the proper scale of larger subcatchments as the measures to promote an efficient operation and maintenance, carry forward management rationalization and to improve the water quality of public water bodies such as rivers,
- Introduce new technologies for sewage treatment, sludge treatment, etc. proposed by the Tokyo Metropolitan Government and make operation and maintenance more efficient,
- Promote the human resource development and skill accession based on the knowhow for technical training experienced by the Tokyo Metropolitan Government.
- Promote the human resource development and skill accession based on the knowhow for water quality control in the course of support to treatment technologies
- Construct the operation and maintenance structure so as totake the lead of sewerage sector as a model project in Malaysia.

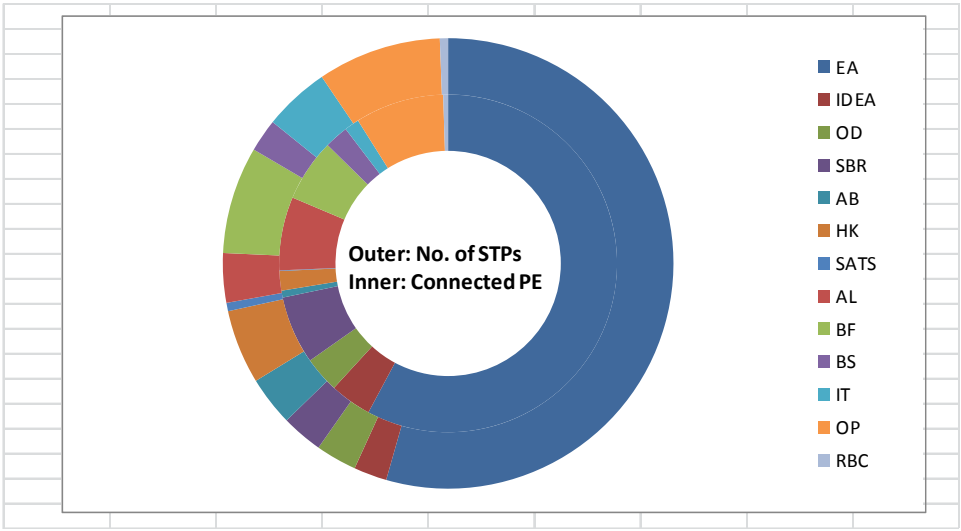
2.2.6 Situation of Existing STPs in the Study Area

- STPs with a capacity of less than or equal to 2,000 PE shares 53.8% in number but only 18.3% in total capacity and there is no STP with a capacity of more than 20,000 PE as shown in **Figure III-2.1**.
- The activated sludge processes well known by its high performance and stability in BOD_5 removal, are composed of extended aeration (EA), intermediate decanter extended aeration (IDEA), oxidation ditch (OD), sequential batch reactor (SBR), Actil Bio (AB), Hi Kleen (HK), Solar Air Treatment System (SATS) shares 72.3% in number and 74.3% in total capacity.
  Note: AB, HK and SATS are brand names of manufacturers
- An extended aeration process is most popular in both number and total capacity、or 92 plants (54.4%) out of 169 plants and 276,000 PE (57.8%) out of a total capacity of 477,000 connected PE.



Souce: Prepared by the Study Team Based on IWK data

Figure III-2.1 Number and Total Treatment Capacity by STP Size

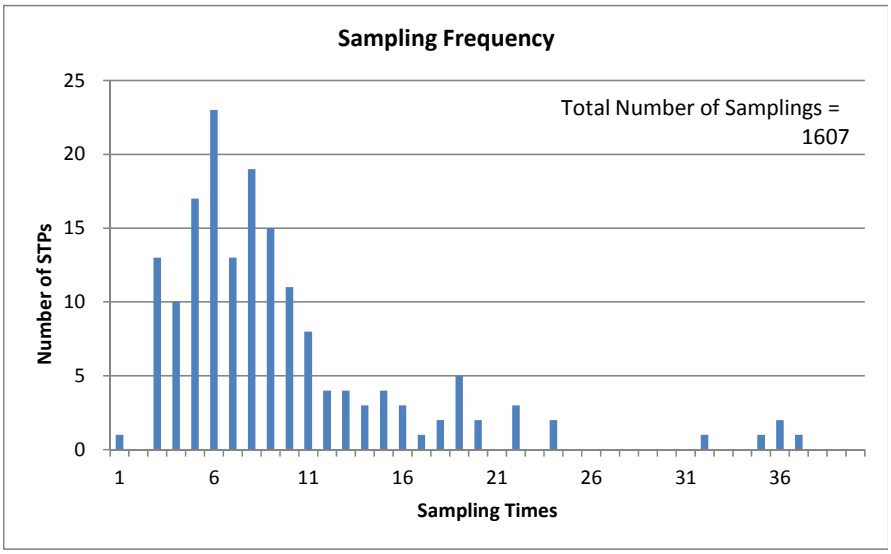


Souce: Prepared by the Study Team Based on IWK data

AL: Aerated Lagoon, BF: Biological Filter, BS: Biological Soil, IT: Imhoff Tank,
OP: Oxidation Pond, RBC: Rotating Biological Contactor

Figure III-2.2 Connected PE by Treatment Process

- In 2007, water examination was done 1,607 times for 169 STPs in the study area, or the number of samplings was 9.5 times per STP on average, but it is different by STP in the range of 1 to 72 times and six times sampling is most popular at 23 STPs as shown in **Figure III-2.3**. Parameters examined are BOD_5, COD, AMN, O&G and SS.



Souce: Prepared by the Study Team Based on IWK data

Figure III-2.3 Sampling Frequency for Sewage Effluent from Existing STPs

- In the study area, 13 kinds of treatment processes are used for sewage treatment. The compliance status to sewage effluent standard is shown in **Table III-2.2** (for more details see **Appendix III-2.1**), which shows the difficulty in compliance especially for AMN and O&G. When excluding Rotating Biological Contactor (RBC) and Solar Air Treatment System (SATS) due to the limited number of data, Hi Kleen (HK) shows the highest performance for BOD_5 removal followed by Intermediate Decanter Extended Aeration (IDEA).

Table III-2.2 Average Concentration of Sewage Effluent by Treatment Process

(Unit: mg/L)

	Treatment Process													Eff.
	EA	IDEA	OD	SBR	AB	HK	SATS	AL	BF	BS	IT	OP	RBC	Std.
BOD_5	14.1	9.9	20.5	15.0	11.4	8.5	12.8	20.9	37.2	13.4	39.7	27.6	11.8	20
COD	64.3	48.9	72.3	59.3	59.0	45.1	44.0	83.6	119.5	50.3	116.7	99.9	72.4	120
NAMN	12.8	11.0	17.9	10.8	15.0	13.6	7.0	21.5	26.8	11.6	28.0	13.4	25.4	10
O&G	9.1	8.4	9.0	7.0	8.8	7.0	14.7	7.3	11.3	8.0	12.7	7.0	4.5	5
SS	28.3	18.0	30.2	22.8	24.2	19.8	5.6	30.9	56.8	17.9	27.3	46.0	28.6	50
No. of STP s	92	4	5	5	6	9	1	6	13	4	8	15	1	169

Source: Prepared by the Study Team based on IWK water quality data of sewage effluent in 2007.

Not complied with standards

- From the viewpoint of sewage effluent standard compliance by parameter, they are 69.8% in BOD5, 87.0% in COD, 36.9%in AMN, 14.8% in O&G and 84.0% in SS and ANMN and O&G are the bottleneck of existing treatment process. The STPs that clear all five parameters counts only 10 out of 169 STPS.

Table III-2.3 Number of STPs in Compliance with Sewage Effluent Standard

Parameter	BOD_5	COD	AMN	O&G	SS	All
Cheras Batu 11	42	58	25	9	55	5
Cheras Jaya	21	25	15	2	24	-
Kajang 1	24	28	7	9	28	3
Kajang 3	31	36	15	5	35	2
Total	118	147	62	25	142	10
Compliance Rate (%)	(69.8)	(87.0)	(36.9)	(14.8)	(84.0)	(6.0)

Souce: Prepared by the Study Team Based on IWK data

- The pollutant loads currently discharged from existing STPs are 1,870 kg/day in BOD5, 7,655 kg/day in COD, 1,557 kg/day in AMN, 937 kg/day in O&G and 3,273 kg/day in SS. When all the existing STPs will be integrated into only one centralised sewage treatment plant, the above pollutant loads have to be reduced by 42.6% in BOD5, 15.9% in COD, 65.6% in AMN, 77.1% in O&G and 34.5% in SS under the concept of design effluent values, as shown in **Table III-2.4** which is more stringent that EAQ Effluent Standards. Even in case of no integration, EQA Effluent Standards requires that all existing STPs constructed after January 1999 to comply with new standards by the end of 2016 except for communal septic tanks (CST) and Imhoff tanks (IT).

Table III-2.4 Effluent Loads from Existing STPs

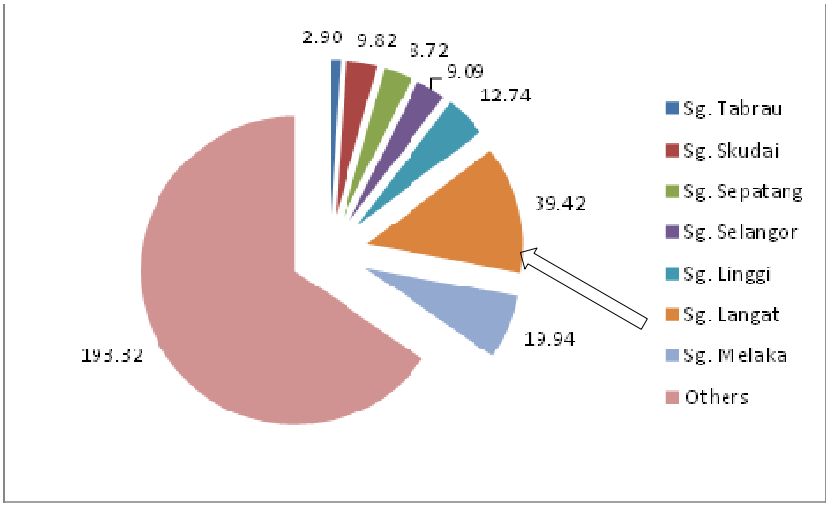
Subcatchment	CPE/DPE	BOD	COD	AMM	O&G	SS
(PE)	(g/day)	(g/day)	(g/day)	(g/day)	(g/day)	(PE)
Cheras Batu 11	188,189	751,922	3,000,664	590,516	336,169	1,346,142
Cheras Jaya	108,259	449,165	1,816,310	354,943	247,686	772,371
Kajang 1	69,425	260,453	1,085,297	252,256	134,091	451,336
Kajang 3	110,810	408,532	1,752,589	359,041	218,874	703,439
Total	**476,683**	**1,870,072**	**7,654,860**	**1,556,756**	**936,820**	**3,273,288**
Effluent loads and reduction efficiency under new design effluent value						
Design Effluent Value	(mg/L)	10	60	5	2	20
Effluent Load	(g/day)	1,072,537	6,435,221	536,268	214,507	2,145,074
Reduction Rate	(%)	42.6	15.9	65.6	77.1	34.5

Souce: Prepared by the Study Team Based on IWK data

*1 Connected PE (CPE) is calculated assuming that Design PE (DPE) equals to CPE in case of unknown DPE.

*2 Effluent loads (kg/day) =Water quality of sewage influent (mg/L) × Connected PE × 225 (Lpcd) × 10^{-6}

- IWK has addressed to the refurbishment and upgrading of existing STPs one after the other and allocated the biggest budget of RM 39.42 million out of RM 388.88 million to the Langat River Basin located at critical river basins according to ”Corporate Sustainability Report 2007” (**Figure III-2.4**).



Souce: IWK Sustainability Report 2007

Figure III-2.4 Budget Allocated for Refurbishment and Upgrading of Plants at Critical River Basins

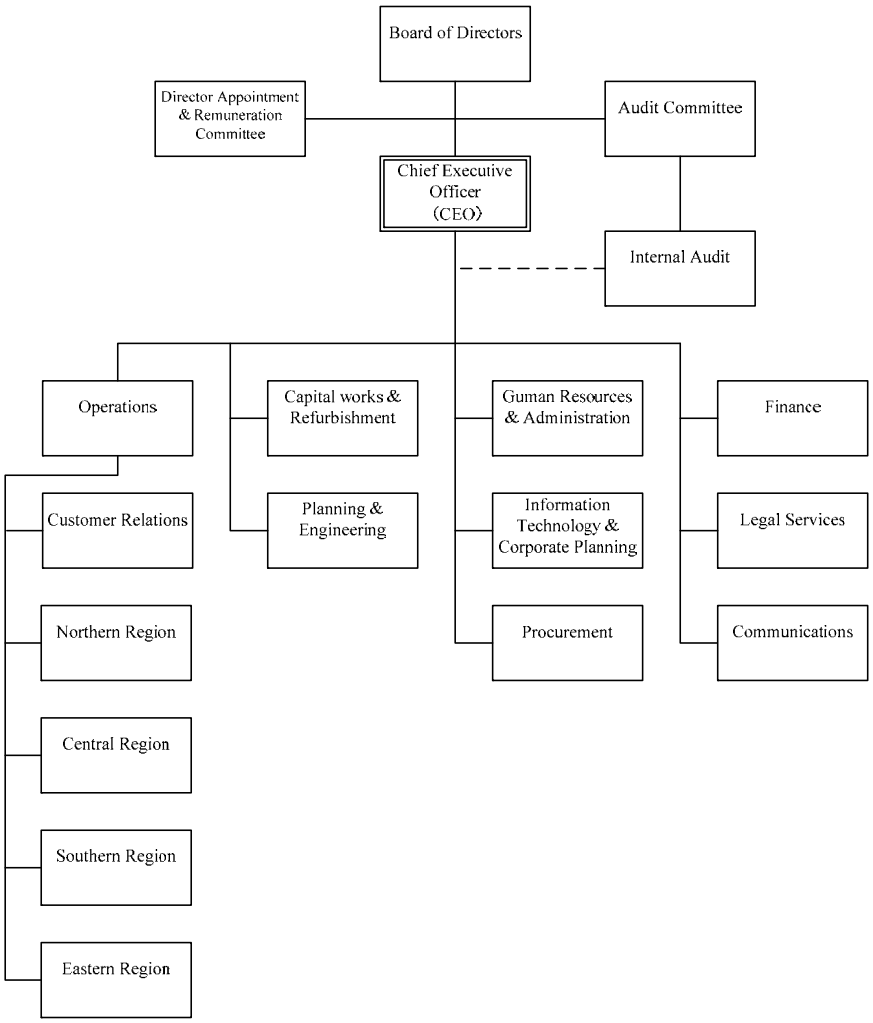
2.3 Outline of IWK as A Sewerage Services Operator

As described in **2.3, Part I**, IWK or the 100% subsidiary of the Ministry of Finance, is responsible

for the operation and maintenance of sewerage fcilities in the Study Area.

2.3.1 Organization of IWK

The current organization of IWK is shown in **Figure III-2.5**.



Source: http://www.iwk.com.my/v/corporate-profile/corporate-structure

Figure III-2.5 Organization Structure of IWK

In 2010, the total number of employees is 2,743 persons which are deployed 363 in the head office, 748 in Northern, 884 in Central, 537 in Southern and 211 in Eastern Office, respectively. The female employees count 547 persons or approximately 20% of the total.

2.3.2 Financial Status of IWK

As referred to the above, IWK is wholly owned by Ministry of Finance in Malaysia and a company for serving sewerage service. IWK's financial status fell into very bad situation in that it run a deficit every year and could barely escape from the bankruptcy due to the subsidy and loan from the government. The main items of its financial statements in 2006 to 2009 are mentioned below;

Table III-2.5 Income Statements

(RM '000)

	2009	2008	2007	2006
Revenue	**713,301**	**555,043**	**591,905**	**517,198**
(Sewerage charge)	(434,298)	(374,801)	(370,850)	(354,564)
(Government subsidy etc.)	(250,000)	(150,000)	(194,150)	(140,000)
Cost	▲647,073	▲596,343	▲536,991	▲474,366
Operating profit	**66,227**	**▲41,301**	**▲54,913**	**42,832**
Interest profit and finance cost	▲99,579	▲90,065	▲83,556	▲76,236
Profit before tax	**▲33,352**	**▲131,366**	**▲28,642**	**▲33,403**
Profit after tax	**▲33,109**	**▲131,366**	**▲27,767**	**▲33,403**

Source: IWK

Table III-2.6 Balance Sheets

(RM '000)

	2009	2008	2007	2006
Current assets	699,547	617,996	631,425	554,148
Non-current assets	536,694	542,696	533,777	546,792
Total assets	**1,236,241**	**1,160,692**	**1,165,175**	**1,100,940**
Current liabilities	162,839	169,063	144,097	150,605
Non-current liabilities	1,693,655	1,578,772	1,476,883	1,378,346
(Loans from government)	(1,686,074)	(1,575,760)	(1,472,799)	(1,376,697)
Total liabilities	**1,856,493**	**1,747,835**	**1,620,980**	**1,528,951**
Common stock	100,000	100,000	100,000	100,000
Accumulated losses	▲720,252	▲687,143	▲555,778	▲528,011
Total equity	**▲620,252**	**▲587,143**	**▲455,778**	**▲428,011**

Source: IWK

Table III-2.7 Cash Flow Statements

(RM '000)

	2009	2008	2007	2006
Cash Flow from Operating activities	75,027	▲7,731	105,006	69,751
Cash Flow from Investing activities	▲24,600	▲33,600	▲16,908	▲19,304
Cash Flow from Financing activities	▲9,221	▲5,691	▲5,190	▲3,701
Net (decrease) increase in cash and cash equivalents	41,205	▲47,023	82,908	46,746

Source: IWK

Loans from government have been increasing, but the cash flow from financing activities indicated

"cash-out". This is because IWK could not pay even the interest on the loans from government, and the interest cost is added to the loan principal. Therefore, there is a serious doubt on IWK as a going concern due to its heavy difficulty of covering its operational cost by its revenues and thus, a drastic sewerage service reform plan to utilize private funding is required.

2.3.3 Sewerage Tariff, Billing and Collection

The IWK bills and collects from its customers a sewerage charge for both septic tank desludging and for connecting to public sewers. The tariff tables for four categories of customers – domestic, commercial, industrial, and government premises – are shown in the **Table III-2.8**, **Table III-2.9**, **Table III-2.10**, and **Table III-2.11**. The concepts of tariff setting are as follows;

- to restrain the rate for domestic premises low,
- to set cross subsidy for domestic premises by setting higher rate for commercial, governmental and industrial premises,
- to provide exemption for charitable organizations.

Tariff for domestic customer (**Table III-2.8**) is set at constant price for each three categories responding to the value of houses. Domestic premises also include Government quarters used exclusively by Government servants classifying the quarters into class A to class I for various grades. Most of domestic customers are charged at RM 6.00/month (septic tank) or RM 8.00/month (connected). Bills are prepared by a subsidiary company of Post Malaysia and sent through post office to the customers twice a year for each six- month charge. Customers can pay for the sewerage bill at the 17 IWK offices around the country by cash or cheque. They can also pay at Post Office, and the banks by over-the-counter, ATM, internet banking, and credit card, and so on.

Table III-2.8 Sewerage Tariff in Domestic Premises

Type of premises	Septic tank	Connected
House with annual value more than RM 600.00 & Government quarters in Grade A, B, C, D & E	RM 6.00/month 6 Monthly Bills	RM 8.00/month 6 Monthly Bills
Low-cost house with annual value less than RM 600.00 & Government quarters for civil servants in Grade F, G, H & I.	RM 2.00/month 6 Monthly Bills	RM 2.00/month 6 Monthly Bills
House that is located on land declared to be a village, new village or estate by the relevant State Authority	RM 3.00/month 6 Monthly Bills	RM 3.00/month 6 Monthly Bills

Source: IWK

Table III-2.9 Sewerage Tariff in Industrial Premises

Type of Premises	Septic tank	Connected
Industrial premises based on head-count/number of users.	RM 2.00/person Monthly Bill	RM 2.50/person Monthly Bill

Source: IWK

Table III-2.10 Sewerage Tariff in Commercial Premises

Monthly basic charge			
Band	Annual value (RM)*1	Basic charge (RM)	
		Connected	Septic tank
1	0 - 2,000	8.00	7.00
2	2,001 - 5,000	14.00	8.00
3	5,001 - 10,000	20.00	14.00
4	10,001 - 20,000	26.00	19.00
5	20,001 - 30,000	29.00	21.00
6	30,001 - 40,000	32.00	23.00
7	40,001 - 50,000	35.00	25.00
8	50,001 - 60,000	38.00	27.00
9	60,001 - 70,000	41.00	29.00
10	70,001 - 80,000	44.00	31.00
11	80,001 - 90,000	47.00	33.00
12	90,001 - 100,000	50.00	35.00
13	100,001 - 200,000	180.00	120.00
14	200,001 - 400,000	495.00	330.00
15	400,001 - 600,000	522.00	348.00
16	600,001 - 800,000	1,980.00	1,320.00
17	800,001 - 1,000,000	2,160.00	1,440.00
18	1,000,001 - 3,000,000	4,320.00	2,880.00
19	3,000,001 - 5,000,000	8,800.00	5,400.00
20	5,000,001 - 7,000,000	9,200.00	6,000.00
21	More than 7,000,001	9,600.00	6,600.00

Monthly excess charge *2	
Water usage	Excess charge
Up to 100 m^3	No charge
More than 100 m^3	30 sen / m^3
More than 200 m^3	45 sen / m^3

Source: IWK

Note: *1. Estimation of yearly rental charge for the premises
*2. Monthly Excess Charge, which is calculated based on the water usage, is the additional charge to the monthly basic charge.

In **Table III-2.11**, Government premises are those owned and occupied by any Government department, local authority, statutory body established by Federal or State law or court. For Commercial premises, annual values are decided by estimation of yearly rental charge for the premises.

Table III-2.11 Sewerage Tariff in Government Premises

Monthly basic charge		Monthly excess charge	
Sewerage services	Basic charge (RM)	Water usage	Excess charge
Connected	40.00	Up to 100 m^3	No charge
Septic tank	25.00	More than 100 m^3	45 sen / m^3
		More than 200 m^3	95 sen / m^3

Source: IWK

Concerning the Domestic premises, sewerage tariff have not been changed yet for 12 years since January 1997. For other premises, some tariff revisions have been conducted. The latest revision for Commercial and Government premises was implemented on 1st August 2004. Major changes are as follows:

- Some of the Bands for Commercial premises were narrowed and numbers were increased from 10 Bands to 21 Bands.

- Excess water charge for Commercial premises was revised from two to three tiers. The consumption more than 100 m^3 was divided into two tiers for each 100 m^3 to 200 m^3 and over 200 m^3 which were one tier. Before August 2004, more than 100 m^3 was charged 45 sen/m^3. After August 2004, first tier (100 m^3 – 200 m^3) is charged at 30 sen/m^3 and second tier (200 m^3 -) is charged at 45 sen/m^3.
- Excess water charge for Government premises was raised.

2.3.4 Current Performance of IWK in Selangor

This section provides an assessment and analysis of the financial structure in the sewerage sector as well as the challenges faced in terms of operational inefficiency in Selangor. The key challenges faced by IWK can be broadly categorised into two (2) categories which are as follows:

- Financial Constraints; and
- Inefficiency of Operating Cost.

(1) Financial Constraint

1) Revenue and Cost Structure

In 2009, IWK's revenue of RM473 million is supplemented with subsidy from the Federal Government amounting to RM250 million, which is still not sufficient to cover the gap between total costs and revenue. Clearly revenue from sewerage tariff is not adequate to finance the total operating costs of RM539 million, what more capital costs (depreciation and interest costs amounts to RM161 million). As operating costs escalates with the number of public STPs transferred to IWK from developers on a frequent basis, subsidy from the Government is expected to increase further. The table below shows the gap between revenue and O&M costs for Selangor in 2009.

Table III-2.12 Profit and Loss Account in Selangor (2009)

Profit and Loss Account in Selangor	RM
Revenue	160,180,756
Expenditure	217,291,332
EBITDA	(57,110,576)
Depreciation	9,036,991
GSL Interest Expenses	21,107,425
HP Interest	103,101
Government Subsidy	80,892,322

Source: IWK

From the table above, it is shown that Selangor is operating at a loss even before taking into account depreciation and interest expenses. It is imperative to note that this is due to the low current sewerage tariff which is insufficient to cover the expenses incurred by the STPs. In addition to that, the proliferation of small STPs which are more costly to maintain also attribute to the high expenditure.

2) Doubtful Debts

In 2009, IWK provided approximately RM57 million or 7.5% of total costs for doubtful debt. Some consumers are refusing to pay for sewerage services as they are not aware of the extent of service that they are receiving. Unlike other utilities, sewerage services do not provide the consumers with something that they can touch, feel, smell or use consciously.

As at December 2009, the total outstanding balance of unpaid bills in Selangor amounted to RM246 million, making up approximately 34% of the national total outstanding balance. Of the RM246 million, RM169 million or 89.5% is from domestic accounts, RM67.3 million or 9.15% from commercial accounts and the rest is from other accounts including Government and

Industrial accounts. It appears that on average, households in Malaysia are not willing to pay for sewerage services. The tables below show the amount of outstanding balance for over 12 months of each State respectively.

Table III-2.13 Outstanding Balance of Account in Arrears (as at December 2009)

State	Total No. Accts	Outstanding Balance (RM)	No. Accts	Domestic (RM)	No. Accts	Commercial (RM)	No. Accts	Others (RM)
Johor	245,746	60,965,709.25	89.31%	37,880,205.91	9.31%	20,554,811.55	1.37%	2,530,691.79
Kedah	153,091	39,270,493.29	88.78%	26,808,488.93	8.09%	8,408,692.57	3.14%	4,053,311.79
Melaka	105,423	28,280,195.65	87.47%	18,973,386.08	10.74%	8,013,615.12	1.79%	1,293,194.45
Negeri Sembilan	167,149	44,693,498.46	88.28%	33,881,319.26	9.21%	8,608,928.35	2.51%	2,203,250.85
Pahang	70,897	17,376,951.31	84.30%	10,685,050.90	8.81%	4,263,859.07	6.89%	2,428,041.34
Perak	268,949	64,427,947.91	87.89%	43,276,153.95	9.21%	14,862,351.48	2.89%	6,289,442.48
Perlis	12,295	2,213,374.81	78.72%	1,392,205.18	6.95%	317,418.94	14.33%	503,750.69
Pulau Pinang	297,523	76,901,069.16	86.53%	36,750,899.49	10.49%	32,883,157.84	2.98%	7,267,011.83
Selangor	1,030,568	246,224,391.87	89.46%	169,042,691.48	9.15%	67,346,515.33	1.39%	9,835,185.06
Terengganu	26,324	9,960,541.16	81.81%	3,882,060.66	6.59%	1,836,212.68	11.60%	4,242,267.82
WP Labuan	6,906	2,340,114.31	74.12%	621,136.56	11.90%	1,267,377.88	13.97%	451,599.87
WP Kuala Lumpur	363,409	125,183,389.47	73.47%	46,643,540.70	10.27%	62,232,896.68	16.26%	16,306,952.09
WP Putrajaya	9,662	2,137,519.13	25.65%	271,775.80	3.08%	721,736.17	71.27%	1,144,007.16
Total	2,757,942	719,975,195.78	86.17%	430,108,914.90	9.41%	231,317,573.66	4.42%	58,548,707.22

Source: IWK

With the integration of water and sewerage services, combined tariff can be implemented to alleviate the amount of doubtful debts.

(2) Inefficiency of Operating Cost

The inefficiency challenges of IWK Selangor mainly come from the operational aspect. The following sections will provide a detailed analysis and showcase the impact of operational inefficiency on IWK's margin.

1) High Operational and Maintenance Cost

Based on our high level computations of the revenue and operating costs for the main catchment areas in Langat, it is found that the total operating costs surpasses the revenue in each catchment area, as shown in **Table III-2.14**.

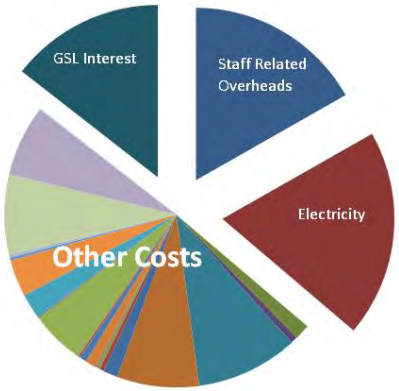
Table III-2.14 High Level Computation of Revenue and Total O&M Cost in 2010

Catchment Area	Revenue (RM)	Total O&M Cost (RM)
Kajang 1&3	1,958,760	3,307,421
Cheras Jaya	1,488,360	2,312,908
Batu 11	2,144,136	3,408,840
Total	**5,591,256**	**9,029,169**

Source: Prepared by the Study Team

Figure III-2.6 illustrates the breakdown of the operating costs for the three catchment areas in Langat. The bulk of the cost is for electricity, staff related overheads, and Government Service Loan (GSL) interest. The high GSL interest is due to the fact that as at December 2009, the Federal Government has extended RM250 million subsidies to IWK.

Going forward, with the newly established PAAB in play, fixed and immovable sewerage assets will be transferred to PAAB and operators will no longer be burdened with capital costs. Operators will be paying lease to PAAB for the right to use the assets at a rate that is based on affordability.

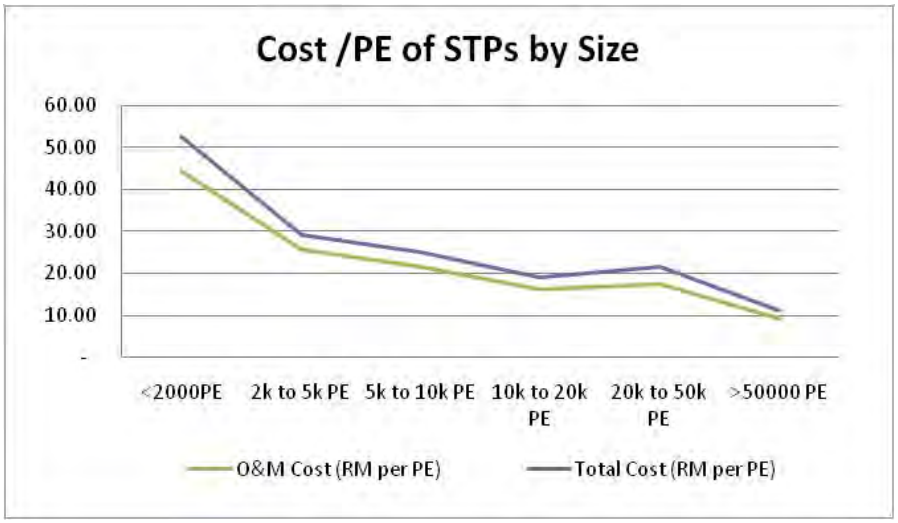


Source: Prepared by the Study Team

Figure III-2.6 Cost Component Breakdown (2009)

2) Cost of Operating and Maintaining Large and Small STPs

Cost per PE to operate the many different types and sizes of STPs were analysed to determine the most cost efficient size. In 2010, IWK operates and maintains 148 STPs serving 465,938 PE in Langat. It costs IWK an average total cost (excluding costs for operating associated network & pumping station and decommissioned plants and GSL interest) of RM24.86 per PE to provide sewerage services. The total cost to operate treatment plants increases with the decrease in plant size, as shown in **Figure III-2.7**.



Source: IWK

Figure III-2.7 Annual Cost / PE by PE Range

Of the 148 STPs, 78% consists of small plants with capacity to serve PE of less than 5000. An examination of the housing development profile show that implementation of dwellings are in most cases limited to relatively small block sizes (i.e. 3,000 to 5,000 units per development). This has influenced the sizing of individual STPs, and has led to small capacity STPs proliferating over time.

Small treatment plants (serving less than 2000 PE) are the most cost inefficient, approximately four times more expensive to operate as compared to large plants (serving more than 50,000 PE). The O&M cost per PE to operate and maintain small STPs (<2000 PE) is RM52.79, which is above even the average total cost of RM24.86. **Table III-2.15** shows the escalation in operating cost with the reduction in STP size.

Table III-2.15 Annual Cost per PE for IWK STPs

PE Range (PE)	No. of STPs (nos.)	Total PE (PE)	O&M Cost (RM/PE)	Total Cost (RM/PE)
Nil	2			
<2000	3,831	2,778,914	44.48	52.79
2,000 to 5,000	925	2,817,243	25.58	29.19
5,000 to 10,000	386	2,697,157	21.49	24.92
10,000 to 20,000	174	2,352,184	16.18	18.98
20,000 to 50,000	80	2,279,082	17.40	21.59
>50,000	30	5,189,423	9.26	11.26
Total	5,428	18,114,003	21.04	24.86

Source: IWK

Of the total of 5,428 STPs in **Table III-2.15**, a total of 4,251 STPs are mechanised plants (incl. aerated lagoons). It was found that the aerated lagoon is less expensive to operate as compared to a mechanised STP. The average O&M cost per PE of operating a mechanised plant (excl. aerated lagoons) is RM30.11[1] while the average O&M cost per PE of operating an aerated lagoon is only have the cost at RM8.26[2], lower than the average O&M cost per PE of operating a non-mechanised plant of RM15.64[3].

Based on the analysis, the key highlights are as follows:

- Costs for Mechanised STPs are higher than the RM17.62 per PE for year 2009 charged by IWK annually. Only STPs above 50,000PE are able to operate at a lower cost than the current rate charged by IWK.
- Costs for Non Mechanised STPs are lower; however the land requirements are larger than Mechanised STPs and may not reach Class A BOD discharge requirements.
- Small STPs run at an increased cost per PE, hence they are not efficient.

[1] Source: IWK (2009)
[2] Source: IWK (2009)
[3] Source: IWK (2009)

3 Existing Reports and Plan in the Study Area

3.1 Sewerage Catchment Strategy Report

Antara's "Sewerage Catchment Planning and Sludge Management Strategy Study for Upper Langat Basin" (hereinafter referred to as "Antara Report") prepared in November 2009 is the latest report concerned with sewerage catchment strategy in the upper Langat Basin.

According to this report, the study area is divided into seven sewerage catchment, namely Langat, Cheras, Kajan, Bandar Baru Bangi (BBB), Semenyih, Beranang and Bangi South, and then further subdivided into subcatchments as shown in **Table III-3.1**. Finally, the construction of 15 Centralised Sewage Treatment Plants (CSTPs) are proposed.

Table III-3.1 Sewerage Catchment Strategy in the Upper Langat Basin

Catchment	Subcatchment	Sewerage Type	Population Equivalent (PE)	Treatment Capacity (PE)
Kajang	Kajang 1	CSTP	190,358	200,000
	Kajang 2	CSTP	52,860	60,000
	Kajang 3	CSTP	187,373	200,000
Langat		CSTP MPS	229,748	237,000
Cheras	Cheras Batu 11	CSTP	285,147	300,000
	Cheras Jaya	CSTP	247,375	250,000
	Cheras East	MPS (1 CSTP + 3 STPs)	264,517	300,000
Bandar Baru Bangi (BBB)	BBB North	CSTP	156,450	157,000
	BBB South	CSTP *1	541,476	150,000
Semenyih	(Phase 1)	CSTP	470,457	120,000
	(Phase 2)	CSTP		75,000
	(Phase 3)	CSTP		85,000
	(Phase 4)	CSTP		33,000
Beranang		CSTP	253,224	260,000
Bangi South		CSTP *2	86,073	38,000
Total		**15 CSTPs**	**2,965,058**	**2,205,000**

Source: Antara Report

CSTP: Centralised Sewage Treatment Plant

MPS: Multi Point System

*1 Sewerage catchment strategy for BBB South is no clear in the Antara Report. The proposed CSTP (HLT006) caters 150,000 PE only out of a total PE of 541,476.

*2 The proposed CSTP caters 38,000 PE only out of a total PE of 86,073.

While sludge management strategy aims at separate sludge treatment in each (sub)catchment for the long-term except for Cheras East (transfer to Cheras Batu 11) and Beranang (transfer to Semenyih) as shown **Table III-3.2**.

Table III-3.2 Long-term Sludge Management Strategy in the Upper Langat Basin

Catchment	Subcatchment	Sludge Treatment Facility	Estimated Sludge Production in 2035 (m^3/year)
Kajang	Kajang 1	Kajang 1CSTF	76,143
	Kajang 2	Kajang 2 CSTF	21,144
	Kajang 3	Kajang 3 CSTF	74,949
Langat		Langat CSTF (HLT094)	91,899
Cheras	Cheras Batu 11	Cheras Batu 11 CSTF	114,059
	Cheras Jaya	Cheras Jaya CSTF	98,950
	Cheras East	To Cheras Batu 11 CSTF	105,807
Bandar Baru Bangi (BBB)	BBB North	BBB CSTF (HLT217)	62,580
	BBB South		216,590
Semenyih		Semenyih CSTF (HLT287)	188,183
Beranang		To Semenyih CSTF (HLT287)	101,290
Bangi South		Bangi South CSTF	34,429
Total			**1,186,023**

Source: Antara Report

3.2 Kajang 2 CSTP Construction Project

Among 15 CSTPs proposed in the Antara Report, the construction of Kajang 2 CSTP and its sewer system is now under the implementation stage and the contractors have selected respectively as of the end of January, 2012, in which sequential batch reactor (SBR) process to meet the Effluent Standards A is proposed for a treatment capacity of 150,000 PE.

The service area by Kajang 2 CSTP is extended to the area bigger than those proposed in the Antara Report so as to cover a part of Kajang 3, Section 5 of Bandar Baru Bangi and an extension of Kajang 2 (refer to **Table III-3.3**).

Table III-3.3 Additional Service Area of Kajang 2 CSTP under Implementation

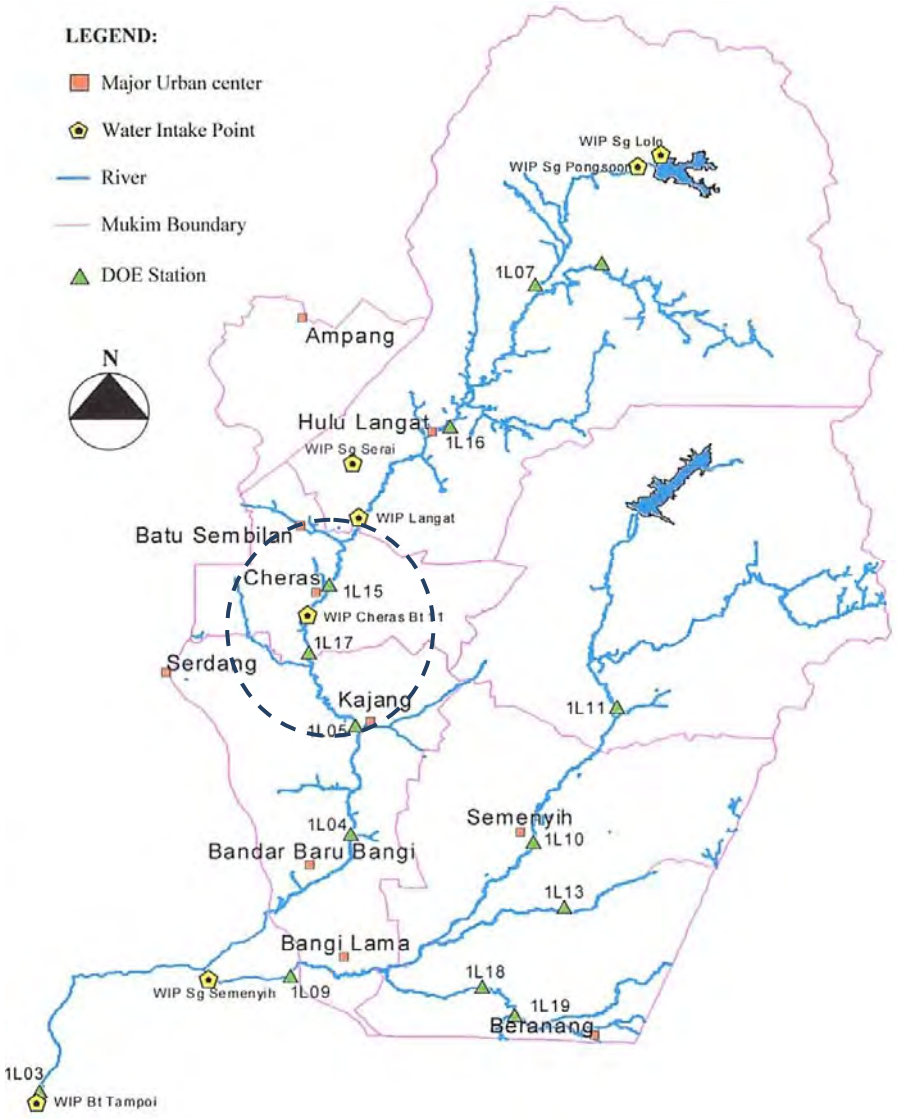
ASSET NO	CONNECTED PE	DESIGN PE	CATEGORY	Subcatchment	CPE (2010)	DPE (2035)
HLT007	694	3,190	OP	BBB-S (Sec.5)	694	3,190
HLT065	1,920	1,920	IT	BBB-S (Sec.5)	1,920	1,920
HLT070	200		NPS	BBB-S (Sec.5)	200	200
HLT131	1,480	1,480	IT	BBB-S (Sec.5)	1,480	1,480
HLT150	1,256	6,200	EA	BBB-S (Sec.5)	1,256	6,200
HLT241	2,150	3,730	EA	BBB-S (Sec.5)	2,150	3,730
HLT297	405	1,100	NPS	BBB-S (Sec.5)	405	1,100
					8,105	**17,820**
HLT244	3,840	2,500	EA	Kajang 2 Ext.	3,840	2,500
					3,840	**2,500**
HLT015	3,600	3,600	SBR	Kajang 3	3,600	3,600
HLT016	3,000	3,000	OP	Kajang 3	3,000	3,000
HLT017	900	900	ITPS	Kajang 3	900	900
HLT018	1,400	1,400	OP	Kajang 3	1,400	1,400
HLT060	1,705	1,705	BF	Kajang 3	1,705	1,705
HLT077	2,180	10,900	EA	Kajang 3	2,180	10,900
HLT093	3,105	3,105	EA	Kajang 3	3,105	3,105
HLT116	6,869	6,369	EA	Kajang 3	6,869	6,369
HLT151	3,845	17,200	EA	Kajang 3	3,845	17,200
HLT156	550	4,500	BF	Kajang 3	550	4,500
HLT215	3,910	4,350	EA	Kajang 3	3,910	4,350
HLT246	1,009	5,250	EA	Kajang 3	1,009	5,250
HLT264	504	4,010	EA	Kajang 3	504	4,010
HLT289	1,795	4,900	EA	Kajang 3	1,795	4,900
			Subtotal		**34,372**	**71,189**
			Total		**46,317**	**91,509**

Source: JPP Kajang 2 Centralised SewageTreatment Plant Engineering Report, January 2011

4 Situation of Water Quality Environment in the Study Area

4.1 Situation of Water Use in the Upper Langat River Basin

As shown in **Table III-4.1** and **Figure III-4.1**, there are eight water intake points (WIP) in the Upper Langat River Basin. Out of them, especially in the surrounding area of Cheras WIP located in the main stream of the Langat River, rapid urbanization has been going on. Bukit Tampoi WIP is located downstream of the Langat River away from the urban area. The most important Langat WIP upstream of Cheras WIP and Seminyih WIP located in the tributary of the Langat River are out of the urbanization area.



Source: Antara Jerutera Perunding Sdn Bhd, "Sewerage Catchment Planning and Sludge Management Strategy Study for Upper Langat River Basin", November 2009

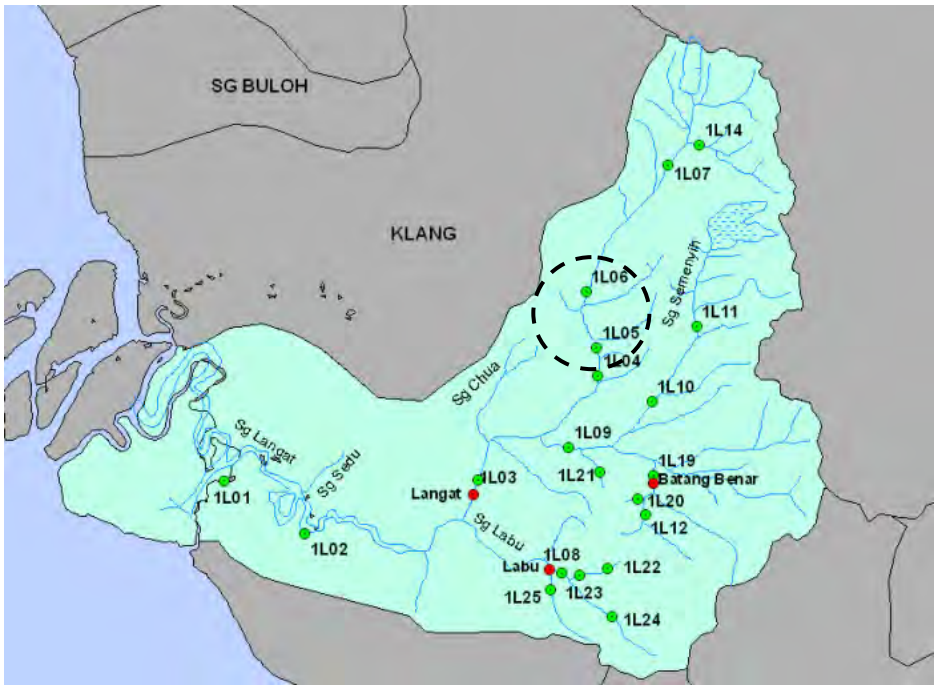
Figure III-4.1 Water Intake Points in the Upper Langat River Basin

Table III-4.1 Water Intake Points in the Upper Langat River Basin

	WIP	Nominal Capacity (MLD)	Water Sources	District
1	Pangsoon	1.82	Langat River	Ulu Langat
2	Lolo	0.41	Langat River	Ulu Langat
3	Serai	0.90	Langat River	Ulu Langat
4	Langat	4.54	Langat River	Ulu Langat
5	Cheras	27	Langat River	Ulu Langat
6	Semenyih	636	Semenyih River	Ulu Langat
7	Bukit Tampoi	28	Langat River	Ulu Langat

Source: Antara Jerutera Perunding Sdn Bhd, "Sewerage Catchment Planning and Sludge Management Strategy Study for Upper Langat River Basin", November 2009

In the Langat River Basin, the water quality monitoring stations are placed from the estuary to the uppermost stream by the Department of Environment (DOE) as shown in **Figure III-4.1** and **Figure III-4.2** (for exact locations see **Appendix III-4.1**).



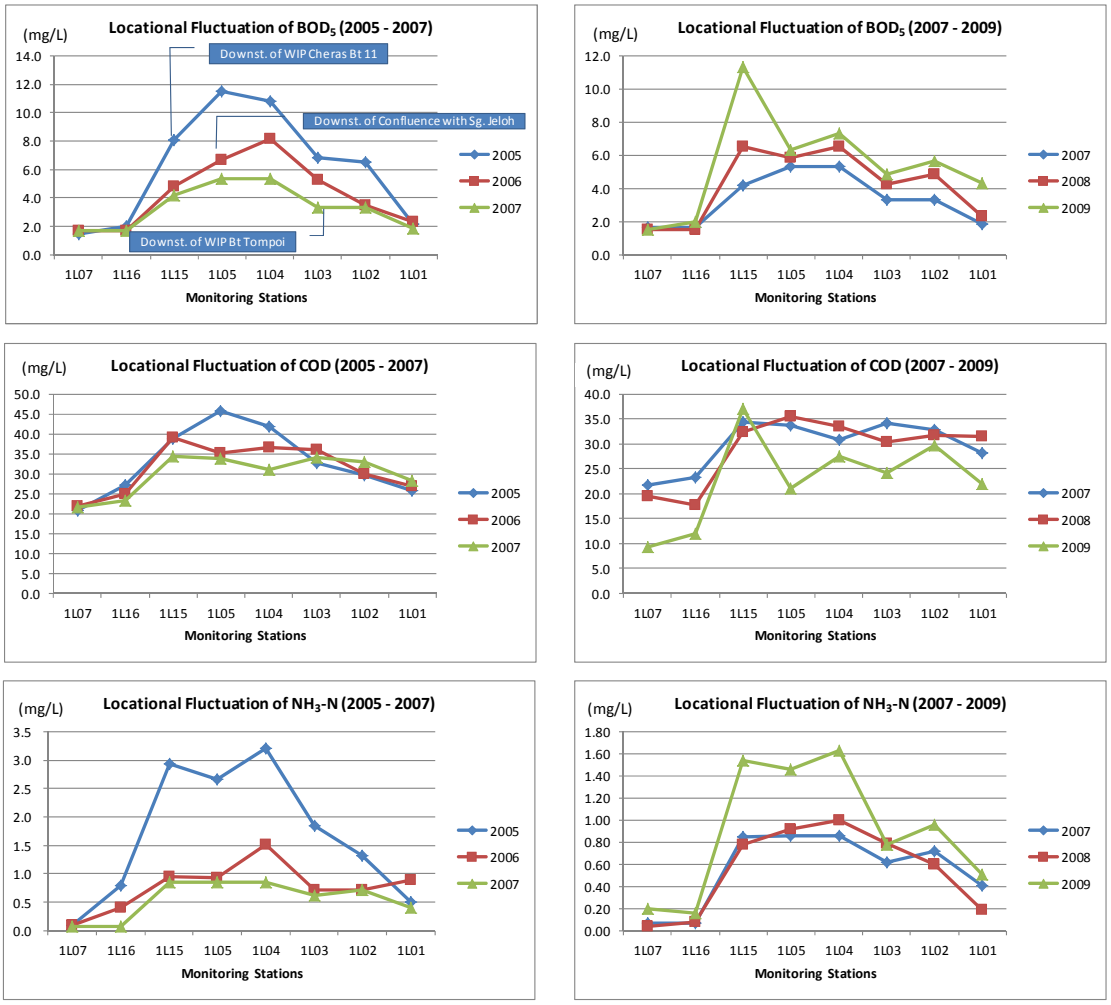
Source: ASMA Website

Figure III-4.2 DOE Water Quality Monitoring Stations in the Langat River Basin

The following is the findings in the water quality fluctuation during the period of 2005 to 2009:

4.2 Water Quality Fluctuation in the Flowing Direction of the Langat River

- The BOD_5 concentration at the monitoring station of 1L07 is in the range of 1.8 mg/L to 2.3 mg/L every year. Since the almost present population lives in the downstream of this monitoring station, it shows the concentration by natural load without artificial pollution. The monitoring station of 1L16 is also placed in the less affected area by artificial pollution and its trend of water quality is similar to those at 1L07.



Source: Prepared by the Study Team based on ASMA data

Figure III-4.3 Water Quality Fluctuation in the Flowing Direction of the Langat River (2005-2009)

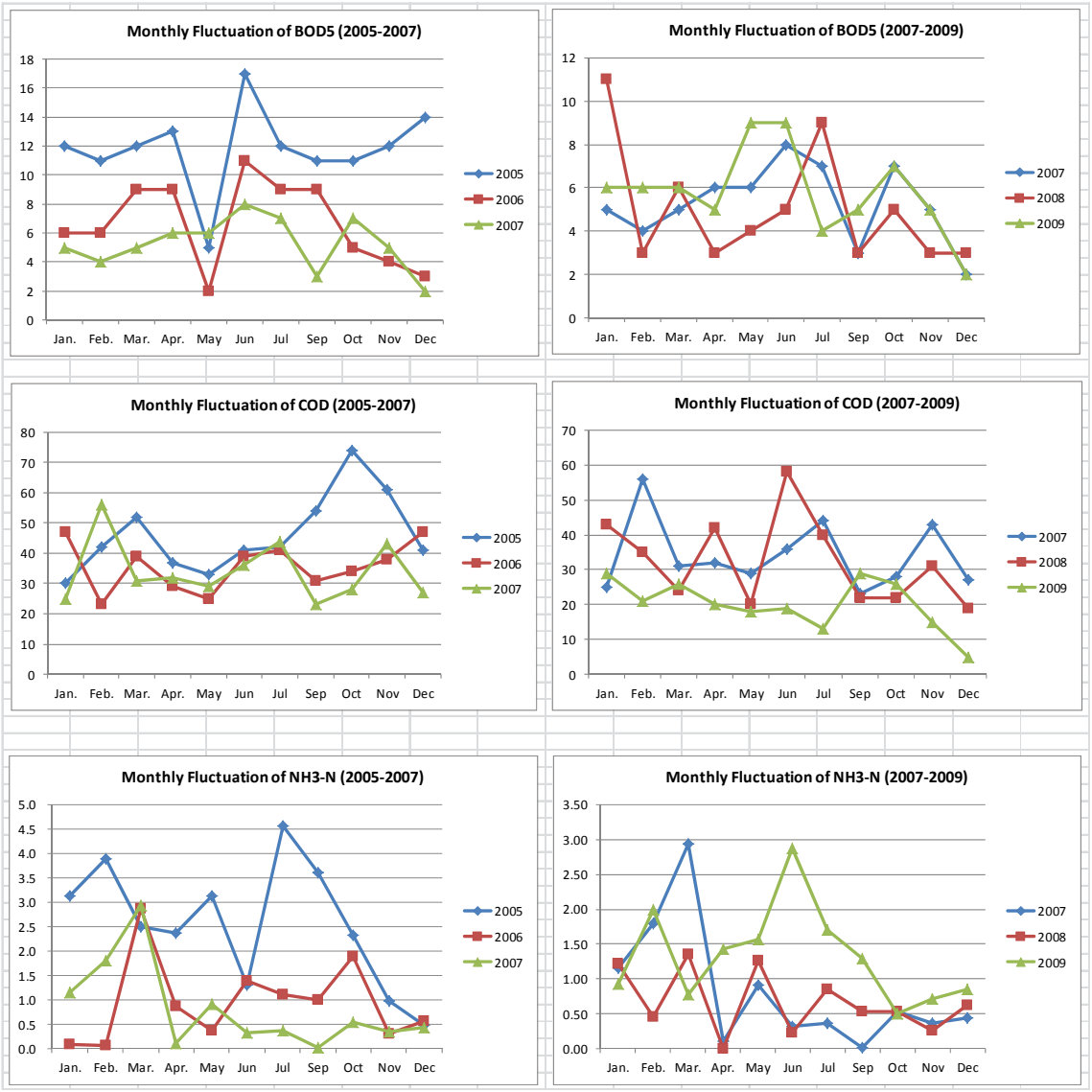
- At 1L15 100 m downstream of WIP Cheras Batu 11, water quality is rapidly deteriorated by the inflow of sewage effluent from existing STPs, untreated sewage, sullage, industrial wastewater, etc. and at 1L05 upstream of the confluence with Sg. Jeloh or 1L04 upstream of the confluence with Sg. Ramal, the concentrations of BOD_5, COD and AMN reach to their peak. Especially in 2009, all peaks are concentrated at 1L05.
- For the period of 2005 to 2007, the improvement trend is found in water quality of the Langat River, however in the subsequent period of 2007 to 2009, water quality has deteriorated again and such trend is outstanding especially in BOD5 and AMN showing an organic pollution derived from mainly domestic sewage
- The section from the confluence with the Semenyih to the estuary, water quality is improved by the dilution and self-purification action due to no big

urban area/.

4.3 Water Quality Fluctuation at the Monitoring Station of 1L05 of the Langat River

The monitoring station of 1L05 upstream of the confluence with Sg. Jeloh is directly affected by the inflow of sewage effluent from existing STPs, untreated sewage, sullage, industrial wastewater, etc. from Langat, Cheras Batu 11, Cheras Jaya , Cheras East, Kajang 1 and Kajang 3, therefore, water quality is worst in the monitoring stations in the Langat River Basin.

- There was an improvement trend in monthly water quality fluctuation during a period of 2005 to 2007, but adversely a deterioration trend during a period of 2007 to 2009.
- The monthly water quality fluctuation is so hard that it is difficult to identify the seasonal characteristics but has the peak in September during a period of 2007 to 2009.
- Pollution status based on Water Quality Index (WQI) is polluted (P) nine times in 2005, two times in 2006, four times in 2007, four times in 2008 and two times in 2009 and slightly polluted (SP) in all other months.
- In terms of water quality class, Class IV is three times in 2005, two times in 2008 and one time in 2009 and Class III in all other months.
- According to the National Water Quality Standards for Malaysia, Class II requires conventional treatment or ordinary coagulation-sedimentation and rapid sand filtration for water supply use, and Class III requires extensive treatment by any additional treatment process but in case of Class IV, water supply use is not supposed. At Cheras Batu 11 WIP, water intake has been forced to be closed more than 50 times since 1998 due to high concentration of AMN, O&G, diesel oil and chemical substances and the improvement and stabilisation of water quality in the Langat River becomes the urgent issue in the metropolitan area.



Source: Prepared by the Study Team based on ASMA data

Figure III-4.4 Water Quality Monthly Fluctuation at 1L05 the Langat River

5 Sewerage Strategy

5.1 Service Area by Sewerage

Based on the discussion with KeTTHA, the sewerage service area shall be the subcatchments of Cheras Batu 11, Cheras Jaya, Kajang 1and Kajang 3 proposed in the Antara Report which shows rapid population growth. The southern area of Kajang 3 subcatchment moved to the service area of Kajang 2 CSTP are excluded.

5.2 Design Population

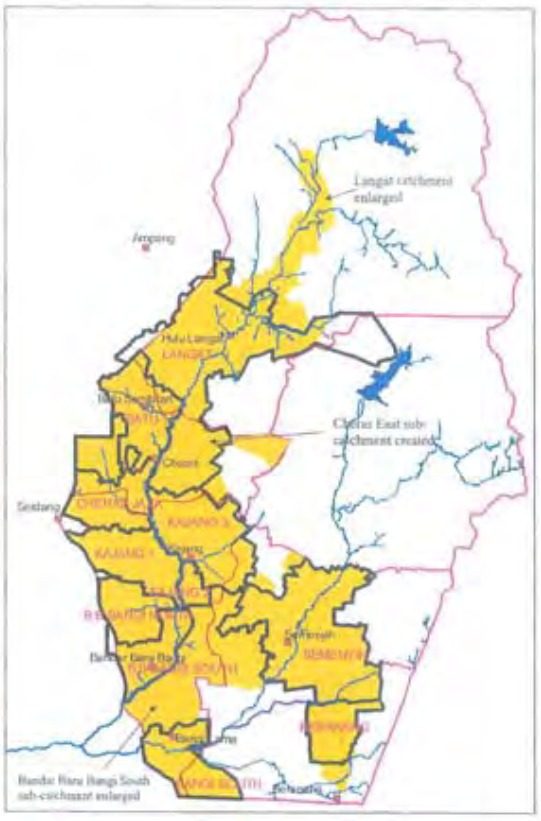
The Antara Report gives **Table III-5.1** showing the population projection by 2035 based on 2005 Census Progarmme. While, the latest Census 2010 is now available on the district basis and 2010 population projection in the Antara Report was verified using such data.

According to Census 2010, the population is 298,500 in Kajang District, 261,200 in Cheras District, and 559,700 in total. The boundaries of Districts used in Census are different from those used in sewerage catchment/subcatchment. **Figure III-5.1** shows such relationship between them, in which, Cheras District involves sewerage subcatchments of Cheras Batu 11, Cheras Jaya, Cheras East and Kajang 3 partly or fully, while Kajang District is concerned with a part or whole of sewerage subcatchments of Cheras Jaya, Kajang 1, Kajang 2, Kajang 3, BBB North, BBB South, Bangi South and Semenyih.

Table III-5.1 Population Projection

Catchment	Population						
	2005	2010	2015	2020	2025	2030	2035
Langat	58,100	65,944	73,857	82,350	91,409	101,007	111,107
Cheras							
Cheras Bt 11	76,024	91,989	110,847	133,016	158,289	186,781	218,534
Cheras Jaya	69,461	84,048	101,277	121,533	144,624	170,656	199,668
Cheras East	57,605	69,702	83,990	100,789	119,938	141,527	165,587
Sub-Total	203,090	245,739	296,114	355,338	422,851	498,964	583,789
Kajang							
Kajang 1	62,775	69,366	75,956	82,792	89,829	97,016	104,292
Kajang 2	31,125	34,393	37,661	41,050	44,539	48,102	51,710
Kajang 3	79,199	87,515	95,829	104,453	113,332	122,398	131,578
Sub-Total	173,099	191,274	209,446	228,295	247,700	267,516	287,580
Bandar Baru Bangi							
BBB North	92,677	99,628	106,104	111,940	117,537	122,826	127,739
BBB South	126,307	135,781	144,606	152,560	160,188	167,396	174,092
Sub-Total	218,984	235,409	250,710	264,500	277,725	290,222	301,831
Semenyih	66,400	83,996	103,735	127,075	154,397	186,820	225,118
Beranang	15,800	16,274	16,762	17,265	17,783	18,317	18,866
Bangi South	46,527	50,017	53,268	56,198	59,008	61,663	64,129
Total (Report)	**782,000**	**888,651**	**1,003,891**	**1,131,020**	**1,270,872**	**1,424,509**	**1,592,420**

Source: Antara Report



Source: Antara Report

Figure III-5.1 Relationship between Census Districts and Sewerage Catchment

Here, assuming that the population density is almost even in each subcatchment, the population in the Antara Repport is allocated to Census District based on the rough areal proportion involved in respective Census Districts as shown in **Table III-5.2**, from which the following are pointed out.

- 2010 projected population for Cheras and Kajang Census Districts is 656,500 in Antara Report which exceeds about 97,000 over Census 2010.
- The Antara population allocation to Cheras and Kajang Census Districts is lack of appropriateness. Namely, Antara population is about 66,000 below Census in Cheras District and about 163,000 over in Kajang District.

The difference between 2010 population in the Antara Report and Census 2010 is not so small that the adjustment of Antara population is proposed so as to meet the actual population by Census.

Table III-5.2 Relationship between Population Projection in Antara Report and Census 2010

Catchment	Population by Antara	Population Distribution in Census District				
		Ulu Langat	Cheras	Kajang	Semenyih	Beranag
Langat	65,944	100% 65,944				
Cheras						
Cheras Bt 11	91,989	10% 9,199	90% 82,790			
Cheras Jaya	84,048		40% 33,619	60% 50,429		
Cheras East	69,702		100% 69,702			
Sub-Total	245,739	9,199	186,111	50,429	0	0
Kajang						
Kajang 1	69,366			100% 69,366		
Kajang 2	34,393			100% 34,393		
Kajang 3	87,515		10% 8,752	80% 70,012	10% 8,752	
Sub-Total	191,274	0	8,752	173,771	8,752	0
Bandar Baru Bangi						
BBB North	99,628			100% 99,628		
BBB South	135,781			80% 108,625	20% 27,156	
Sub-Total	235,409	0	0	208,253	27,156	0
Semenyih	83,996			5% 4,200	95% 79,796	
Beranang	16,274					100% 16,274
Bangi South	50,017			50% 25,009		50% 25,009
Total	888,653	75,143	194,863	461,662	115,704	41,283
Census 2010 Population	**707,800**	**64,300**	**261,200**	**298,500**	**68,000**	**15,800**
Difference	**180,853**	**10,843**	**-66,337**	**163,162**	**47,704**	**25,483**
Cheras + Kajang			656,525			

Source: Prepared by the Study Team

The population projection in the Antara Report is adjusted as shown in **Table III-5.3** with the following method.

1) Future population is projected by Census District using the past Census data.
2) Under the assumption that population percentage in sewerage catchment/subcatchment is unchanged from those in the Antara Report in Census District, projected population is allocated to respective Census Districts.

Table III-5.3 Adjusted Population Projection

Catchment	Adjusted Antara Population Projection						Antara
	2010	2015	2020	2025	2030	2035	2035
Langat	56,500	63,500	70,400	78,700	86,400	93,100	111,107
Cheras	290,000	328,000	381,000	420,100	466,000	521,600	583,789
Cheras Bt 11	118,800	132,900	152,700	170,500	189,200	209,400	218,534
Cheras Jaya	77,700	91,400	109,100	116,300	128,600	148,300	199,668
Cheras East	93,500	103,700	119,200	133,300	148,200	163,900	165,587
Kajang	129,300	147,600	164,800	185,600	204,600	221,300	287,580
Kajang 1	44,800	52,100	58,700	65,400	72,000	78,700	104,292
Kajang 2	22,100	25,900	29,200	32,500	35,800	39,100	51,710
Kajang 3	62,400	69,600	76,900	87,700	96,800	103,500	131,578
Bandar Baru Bangi	150,600	167,800	182,000	210,400	231,700	243,800	301,831
BBB North	64,500	72,400	79,300	90,900	100,200	106,300	127,739
BBB South	86,100	95,400	102,700	119,500	131,500	137,500	174,092
Semenyih	49,600	59,100	69,600	73,600	80,900	92,400	225,118
Beranang	6,200	6,400	6,700	7,100	7,400	7,700	18,866
Bangi South	25,700	28,600	30,600	34,200	37,200	39,000	64,129
Total	**707,900**	**801,000**	**905,100**	**1,009,700**	**1,114,200**	**1,218,900**	**1,592,420**
Total (CB, CJ, K1, K3)	**303,700**	**346,000**	**397,400**	**439,900**	**486,600**	**539,900**	**654,072**

Source: Prepared by the Study Team

5.3 Design Population Equivalent (PE)

In the Antara Report, design PE is estimated using three methods, or 1) Census data, 2) Submission data and 3) Land use data as shown in **Table III-5.4** and PE estimated by Land use data is recommended due to the minimum value among them.

Table III-5.4 Design PE Estimation

	2005	2010	2015	2020	2025	2030	2035
Census Data	931,711	1,456,264	1,865,574	2,213,280	2,503,362	2,773,593	2,996,749
Submission Data	782,000	1,283,942	1,735,689	2,137,243	2,488,602	2,789,767	3,040,738
Landuse Data (Recommended)	906,448	1,249,549	1,592,651	1,935,753	2,278,854	2,621,956	2,965,058

Source: Antara Report

However, there is a miscalculation in the Antara Report in the course to convert population to PE by multiplying population by a conversion factor of 0.919 to 1.250. According to the explanation in the Antara Report, the design PE should be almost equal to a design population of 1,595,420 at the target year of 2035, but it gives a population of 2,996,749 resulting in the use of a conversion factor of 1.878 on average.

The increase in commercial facilities such as schools, hospitals, restaurants, etc. is generally admitted corresponding to the city development caused by population increase. It is not correct that PE will be approximate to population in future as the Antara Report says, but a conversion factor will keep high percentage to residential PE in the rapidly developing area like Cheras and Kajang. Therefore, a conversion factor of 1.50 is proposed to apply to subcatchments of Cheras Batu 11, Chera Jaya, Kajang 1 and Kajang 3 as shown in **Table III-5.5**.

Table III-5.5 Adjusted Design Population Equivalent (PE)

Catchment	Modified Population Equivalent						Antara 2035
	2010	2015	2020	2025	2030	2035	
Cheras Bt 11	178,200	199,400	229,100	255,800	283,800	314,100	285,147
Cheras Jaya	116,600	137,100	163,700	174,500	192,900	222,500	247,375
Kajang 1	67,200	78,200	88,100	98,100	108,000	118,100	190,358
Kajang 3	93,600	104,400	115,400	131,600	145,200	155,300	187,373
Total	455,600	519,100	596,300	660,000	729,900	810,000	910,253

Source: Prepared by the Study Team

The adjusted design PE in **Table III-5.5** was modified based on the discussions with Planning Section of IWK Central Region Office on July 26 and August 4.

1) Although the development of Kajang 1 has been delayed, its design PE should be increased more than estimated.
2) The design PE of existing public and private STPs shows the relative reliable potential of future development as well as that of ISTs to be connected to a sewerage system in future. Therefore, the design PE of Kajang 3 in 2035 should be more than or equivalent to a total design PE of existing STPs and ISTs or 196,900 PE calculated from **Table III-2.1**.
3) A total design PE of four subcatchments shall be 835,000 PE.

The modification of design PE was done with the following steps:

Step 1: Design PE of Cheras Batu 11 and Cheras Jaya in **Table III-5.5** shall be unchanged.
Step 2: Some southeastern area of Kajang 3 is shifted to the Kajang 2 service area, of which the CSTP the construction work has just commenced. For this reason, 71,200 PE can be deducted from a design PE of 196,900 PE for Kajang 3, resulting in 125,800 PE.
Step 3: This 125,800 PE shall be a design PE of Kajang 3 for the year of 2035.
Step 4: The design PE of Kajang 1 is then set so that the total design PE of Cheras Batu 11, Cheras Jaya, Kajang 1and Kajang 3 for the year of 2035 is 835,000 PE.
Step 5: The design PE of Kajang 1 and Kajang 3 for the intermittent years shall be fixed by the proportional allotment method.

Table III-5.6. shows the final design PE after above modifications.

Table III-5.6 Final Design Population Equivalent (PE)

Catchment	Final Population Equivalent						DPE of Existing STPs & ISTs
	2010	2015	2020	2025	2030	2035	
Cheras Bt 11	178,200	199,400	229,100	255,800	283,800	314,100	293,811
Cheras Jaya	116,600	137,100	163,700	174,500	192,900	222,500	146,928
Kajang 1	74,500	119,900	114,300	133,700	153,100	172,600	102,476
Kajang 3	93,600	62,700	103,600	113,900	121,600	125,800	125,754
Total	462,900	519,100	610,700	677,900	751,400	835,000	668,969
Incl. ground water infiltration	510,000	570,000	670,000	750,000	830,000	920,000	

Source: Prepared by the Study Team

5.4 Design Sewage Flow

(1) Per Capita Sewage Flow

Per capita sewage flow is 225 l/PE•day according to the Malaysia Guidelines. While in Selangor actual per capita water consumption is 232～239 L/capita•day in 2007 to 2010 almost equivalent to the above per capita sewage flow. Therefore, 225 L/PE•day is considered to be reasonable.

(2) Infiltration

It is natural to lay sewers so as not to allow the infiltration of groundwater, but actually difficult to make infiltration zero. In accordance with the Malaysia Guidelines, extraneous inflow shall be estimated at 10% of average sewage flow.

(3) Peak Wet Weather Flow (PWWF)

Peak wet weather flow used for designing of sewers and pumping stations shall be calculated by multiplying the daily average sewage flow by the following peak flow factor in accordance with the Malaysia Guidelines

Peak Flow factor (PFF) = 4.7 / [PE / 1000] $^{0.11}$

(4) Design Sewage Flow

Table III-5.7 shows the design sewage flow of Kajang 3 CSTP covering subcatchments of Cheras Batu 11, Chera Jaya, Kajang 1 and Kajang 3.

Table III-5.7 Design sewage Flow for Kajang 3 CSTP

(Unit: m^3/day)

	2010	2015	2020	2025	2030	2035
Daily average sewage flow	115,000	128,000	151,000	169,000	187,000	207,000

Source: Prepared by the Study Team

5.5 Design Criteria for Sewerage Facilities

The design criteria for sewerage planning shall comply with the following as provided in "Malaysian Sewerage Industry Guidelines Volume III – Sewer Network & Pump Stations (3rd edition)".

(1) Sewer system

Table III-5.8 Recommended Pipe Material and Specifications

Pipe material	Applicable diameter（mm）	Specifications
Vitrified Clay (VC)	100~450	MS1061、BS EN295-3
Reinforced concrete (RC)	450~2,400	MS881、BS5911
Ductile iron (DI)	100~700	BS EN598
Steel	3,000 以下	BS534

Source: Malaysian Sewerage Industry Guidelines Volume III: Sewer Networks & Pump Stations

Table III-5.9 Recommended Pipe Material and Restrictions

Sewage category and pipe material	Applicable diameter（mm）	Lining, restrictions
Gravity sewers		
Vitrified Clay (VC)	All available sizes	
Reinforced concrete (RC)	600 mm and above	Lining required
Ductile iron (DI)	All available sizes	Lining and coating required Polyethylene sleeve for buried sections Use when high strength required
Force main		
Ductile iron (DI)	All available sizes	Lining and coating required Polyethylene sleeve for buried sections
Steel	700 mm and above SSD approval required	Lining and coating required

Source: Malaysian Sewerage Industry Guidelines Volume III: Sewer Networks & Pump Stations

1) Gravity sewer

Minimum size	225 mm
	150 mm（domestic connections）
Minimum design velocity	0.8 m/sec (at full bore)～4.0 m/sec (at peak flow)
Minimum cover	1.2 m

Velocity formula Manning equation

$V = (R^{2/3} S^{1/2}) / n$

V = Sewer velocity
S = Hydraulic gradient
R = Hydraulic radius
n = Manning's roughness coefficient（**Table III-5.10**）

Table III-5.10 Manning's Roughness Coefficient, n

Pipe material	Manning's roughness coefficient, n	
	Good condition	Bad condition
Uncoated cast iron pipe	0.012	0.015
Coated cast iron pipe	0.011	0.013
Ductile iron pipe	0.012	0.015
Vitrified clay pipe	0.010	0.017
Concrete pipe	0.012	0.016

Source: Malaysian Sewerage Industry Guidelines Volume III: Sewer Networks & Pump Stations

2) Force main

Minimum size 100 mm
Sewer velocity 0.8～3.0 m/sec
Retention time in force main 2 hours
Velocity formula (2) Hazen-williams equation

$h_f = 6.82 (V / C)^{1.85} (L / D^{1.167})$

h_f = Friction loss
C = Hazen-Williams coefficient（**Table III-5.11**）
V = Velocity in the pipe
D = Equivalent diameter of the pipe
L = Pipe length

Table III-5.11 Hazen-Williams Coefficient

Pipe material	Hazen-Williams coefficient, C
Top quality pipe, straight and smooth	130～140
Smooth masonry	120
Vitrified clay	110
Old cat iron	100
Old cast iron in bad condition	60~80

Source: Malaysian Sewerage Industry Guidelines Volume III: Sewer Networks & Pump Stations

3) Manhole

Manhole diameter based on **Table III-5.12**

Table III-5.12 Minimum Manhole Diameter

Depth to soffit from cover level (m)	DN largest pipe in manhole (mm)	Minimum internal dimensions (mm)
<1.5	<150	1,000
	225～300	1,200
	375~450	1,350
	525～710	1,500
	820～900	1,800
	>900	Subject to designer's requirement based on site condition
≥1.5	≤300	1,200
	375~450	1,350
	525～710	1,500
	820～900	1,800
	>900	Subject to designer's requirement based on site condition

Source: Malaysian Sewerage Industry Guidelines Volume III: Sewer Networks & Pump Stations

Manhole spacing　　Not more than 100 m (sewers less than 1.0 m in diameter)
Not more 150 m (sewers larger than 1.0 m in diameter)

(2) Pumping Stations

Malaysian guidelines for schemes serving more than 5000 PE recommend that separate wet and dry well pump stations be adopted, although submersible non-clog impeller type pumps are permitted for sewer network pumping facilities serving a PH up to 5000.

The guidelines for the larger stations (greater than 20,000 PE) specify a pump design flow of 25% hourly maximum flow, with six pump sets each comprising four duty and two assist of equal capacity, thereby achieving a 50% standby (for a PE up to 10,000 the design is based on 100% peak flow with a standby capacity of 100%) **(see Table III-5.13)**.

Table III-5.13 Recommended Design Parameter for Pump Stations

Parameter	Unit	5,000<PE<20,000	PE>20,000
Type of station		Wet-well / dry-well up to 10,000 PE	Wet-well and dry-well
Number of pumps		4 (2 sets) (1 duty / 1assist) 100% standby	6 (2 sets) (2 duty / 1assist) 50% standby
Pump design flow		50% peak flow	25% peak flow
Minimum retention time at Q_{ave}	min	30 at average flow	30 at average flow
Minimum pass through opening	mm	75	75
Minimum suction/ discharge openings	mm	100	100
Pumping cycle	start/h	6 to 15	6 to 15

Source: Malaysian Sewerage Industry Guidelines Volume III: Sewer Networks & Pump Stations

5.6 Conditions of CSTP Candidate Sites

Originally an individual CSTP was planned to be constructed for each subcatchment of Cheras Batu 11, Cheras Jaya, Kajang 1, Kajang 2 and Kajang 3 as well as sewage sludge treatment facilities in the Antara Report as shown in **Table III-3.1** and **Table III-3.2**. However, Kajang 2 CSTP construction work is now under bid evaluation process and the Kajang 1 CSTP site is no longer

available due to the future use of a retention pond by DID. For this reason, the Malaysian site has the idea to integrate the Kajang 1 service area with the Kajang 3 service area and to construct three CSTPs for subcatchment of Cheras Batu 11, Cheras Jaya and Kajang 1and Kajang 3.

The above three subcatchments are located neighbouring along the Rangat River in order of Cheras Batu 11, Cheras Jaya and Kajang 1+3 from the upstream. Thus, if the proper STP site can be acquired in the downstream, it is possible to integrate these three subcatchment into one catchment and construct only one CSTP as one alternative. The possible candidate sites for this integrated STP are the opriginally proposed centralised sewage treatment plant sites for four subcatchments as shown in **Figure III-5.2**. The conditions of each site are summarised in **Table III-5.14**.

When considering the possibility to integrate the above subcatchments, the following are pointed out from the conditions of CSTP candidate sites.

1) Kajang 1 site has been already gazetted for retention ponds by the Department of Irrigation and Drainage (DID) and is not available.
2) Cheras Jaya site has an area of 2.44 ha which is too small for the integrated CSTP site. Although there is a land on the eastern side beyond the road, it is also gazetted for retention pond by DID and no more available. Therefore, this site is dropped from the list.
3) Cheras Batu 11 site adjoining to the existing STP HLT235 has been already gazetted for CSTP site by JPP but has a disadvantage in its location upstreammost of Sg. Langat among subcatchments of Cheras Batu 11, Chera Jaya, Kajang 1 and Kajang 3, since almost sewage generated downstream of the site has to be pumped up to the CSTP. The site is also located upstream of WIP Cheras Batu 11 and the approximately 2 km long extension of CSTP discharge pipe is required to the downstream of WIP to solve this issue. It should be noted that the gazetted land includes the low-lying area about 10 m lower than the ground elevation of existing STP, which may require the land reclamation.

Source: Google Map

Figure III-5.2 Location of Centralised Sewage Treatment Plant Candidate Sites

4) Kajang 3 site cannot approach Cheras Batu 11 site in a land area, or 7.33 ha against 8.19 ha plus 1.92 ha of existing STP site, but barely keep an area to accommodate the required treatment facilities. As being located approximately 6 km downstream of Cheras Batu 11 site, CSTP has an advantage to reduce the flow and head in pumping sewage to CSTP.

As stated earlier, the possible site of integrated CSTP for subcatchments of Cheras Batu 11, Chera Jaya, Kajang 1 and Kajang 3 is either Cheras Batu 11 or Kajang 3.

Table III-5.14 Condition of Centralised Sewage Treatment Plant Candidate Sites

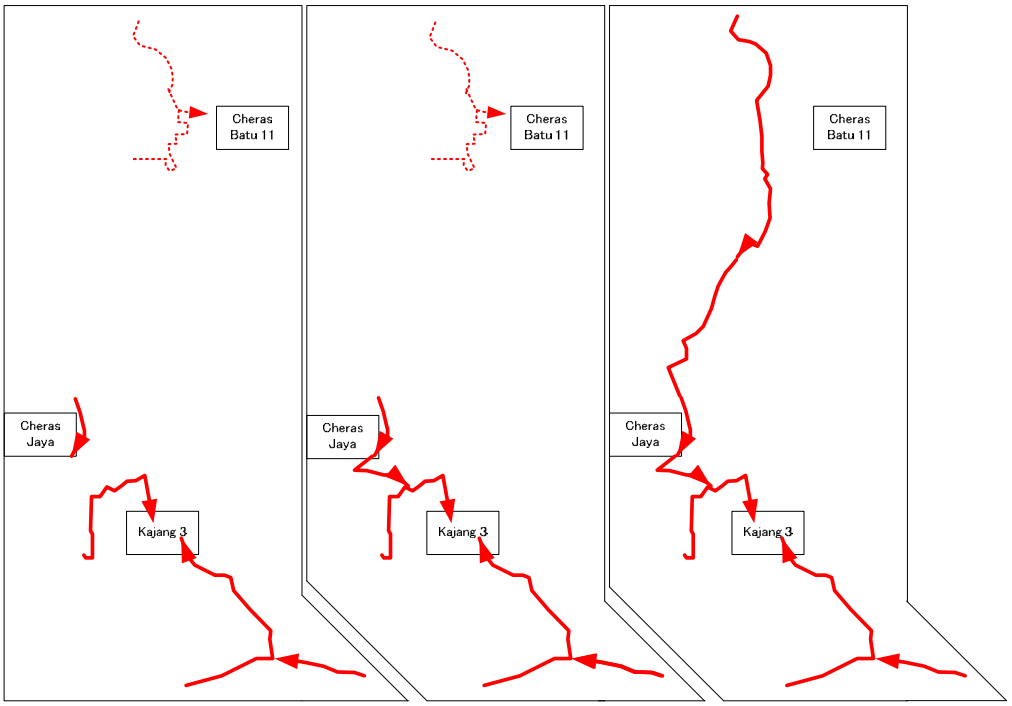
	Cheras Batu 11	Cheras Jaya	Kajang 1	Kajang 3
Existing STP	HLT235 IDEA DPE=45,000 PE CPE=25,944 PE	HLT165 SBR DPE=35,000 PE CPE=21,254 PE	None	None
Area	1.9309 ha	2.4395 ha		
Land Acquisition	Adjoining area is gazetted for CSTP site. Lot 614=1.9818 ha Lot 615=1.8307 ha Lot 616=4.3757 ha		Not available due to gazetted site for retention pond by DID.	A land of 4.4 ha is already acquired An adjoining land of 2.8 ha is under processing for acquirement.

	Total=8.1882 ha			
Conditions	● Along Sg. Langat ● Located upstream of WIP Cheras Batu 11 and upstreammost in the study area. ● Gazetted surrounding area includes the low-lying area	● Along Hulu Sg. Balok (tributary of Sg. Langat) ● Surrounding area is residential and industrial except for gazetted site for retention pond on the opposite.		● About 165m away from Sg. Langat. ● There are religious school and dormitory in the adjoining area but others are almost agricultural land.

Source: Prepared by the Study Team

5.7 Sewer System

Since IWK itself has already abandoned the Kajang 1 Centralised Sewage Treatment Plant site due to the use as a retention pond by the Department of Irrigation and Drainage (DID), Kajang 1 area is integrated into Kajang 3 area. Then, as shown in **Figure III-5.3**, three alternatives, or (1) three STPs (individual treatment)、(2) two STPs and (3) only one STP (integrated treatment) are developed.



(1) Three STPs (individual) (2) Two STPs (3) Only one STP (integrated)

Source: Prepared by the Study Team

Figure III-5.3 Three Alternatives for Sewer System(s)

The results of comparative study among these three alternatives are summarised in **Table III-5.15**.

Table III-5.15 Conditions of CSTP Proposed Sites

	Alternative I (3 CSTPs)	Alternative II (2 CSTPs)	Alternative III (1 CSTP)
Degine PE	Cheras Batu 11 315,000 PE Cheras Jaya 220,000 PE Kajang 1+3 300,000 PE Total 835,000 PE (920,000 PE)	Cheras Batu 11 315,000 PE Kajang 1+3 520,000 PE Total 835,000 PE (920,000 PE)	835,000 PE (920,000 PE)
Design sewage flow	Cheras Batu 11 78,000 m3/d Cheras Jaya 55,000 m3/d Kajang 1+3 74,000 m3/d Total 207,000 m3/d	Cheras Batu 11 78,000 m3/d Kajang 1+3 128,700m3/d Total 207,000 m3/d	207,000 m3/d
Sewer (Trunk)	Cheras Batu 11 - Cheras Jaya - Kajang 1+3 9,.530 m Total 9,530 m	Cheras Batu 11 - Cheras Jaya 1,100 m - Kajang 1+3 9,.530 m Total 10,630 m	Total 16,510 k m
Sewer (Branch)	Cheras Batu 11 35,590 m Cheras Jaya 22,370 m Kajang 1+3 37,045 m Total 95,005 m	Cheras Batu 11 35,590 m Cheras Jaya 21,270m Kajang 1+3 37,045 m Total 93,905 m	Cheras Batu 11 31,300 m Cheras Jaya 21,270 m Kajang 1+3 37,045 m Total 89,615 m
Advantages	● Construction works can start in parallel.		● CSTP can be constructed by phase so as to meet the actual sewage inflow. ● Staff requirement can be minimised.
Disadvantages	● The outfall pipes from Cheras Batu 11 have to extend about 1.8 km long by the downstream of WIP. ● The expansion site of Cheras Batu 11 may require the land reclamation due to the depressed area. ● The treatment process is different by CSTP site, if existing process remains as it is.		
Construction cost (CSTP)	Cheras Batu 11 RM 276.0 M Cheras Jaya RM 213.0 M Kajang 1+3 RM 266.4 M Total RM 755.3 M	Cheras Batu 11 RM 276.0 M Cheras Jaya + Kajang 1+3 RM 444.3 M Total RM 720.3 M	RM 514.4 M
(Sewer)	Trunk sewer RM 66.0 M Branch sewer RM 304.8 M Manhole RM 4.5 M Pumping sta. RM 109.1 M Total RM 484.5 M	Trunk sewer RM 73.7 M Branch sewer RM 301.3 M Manhole RM 4.5 M Pumping sta. RM 109.1 M Total RM 488.6 M	Trunk sewer RM 114.4 M Branch sewer RM 287.5 M Manhole RM 4.6 M Pumping sta. RM 109.1 M Total RM 515.6 M.
Grand total	**RM 1,239.8 M**	**RM 1,208.8 M**	**RM 1,030.0 M**

Source: Prepared by the Study Team

From the study mentioned-above, in terms of extent of STP site, there is no problem in both Cheras Batu 11 and Kajang 3, however Cheras Batu 11 site has a crucial defect in its location at the uppermost stream of the Langat River which requires pumping almost sewage generated in the downstream area, while in this regard, Kajang 3 site has an advantage to minimise sewage-pumping.

According to the comparative study among three alternatives, integrated alternative has an advantage in both construction cost and operation and maintenance costs to three STPs and two STPs

alternatives. Through the integration to only one sewage treatment plant, sewage treatment and sludge management can be done efficiently and utilization of sewage effluent and biosolids can be done effectively. Therefore, the integrated sewage treatment at Kajang 3 is strongly recommended.

The proposed sewer system under the only one integrated sewage treatment plant is shown in **Figure III-5.4**.

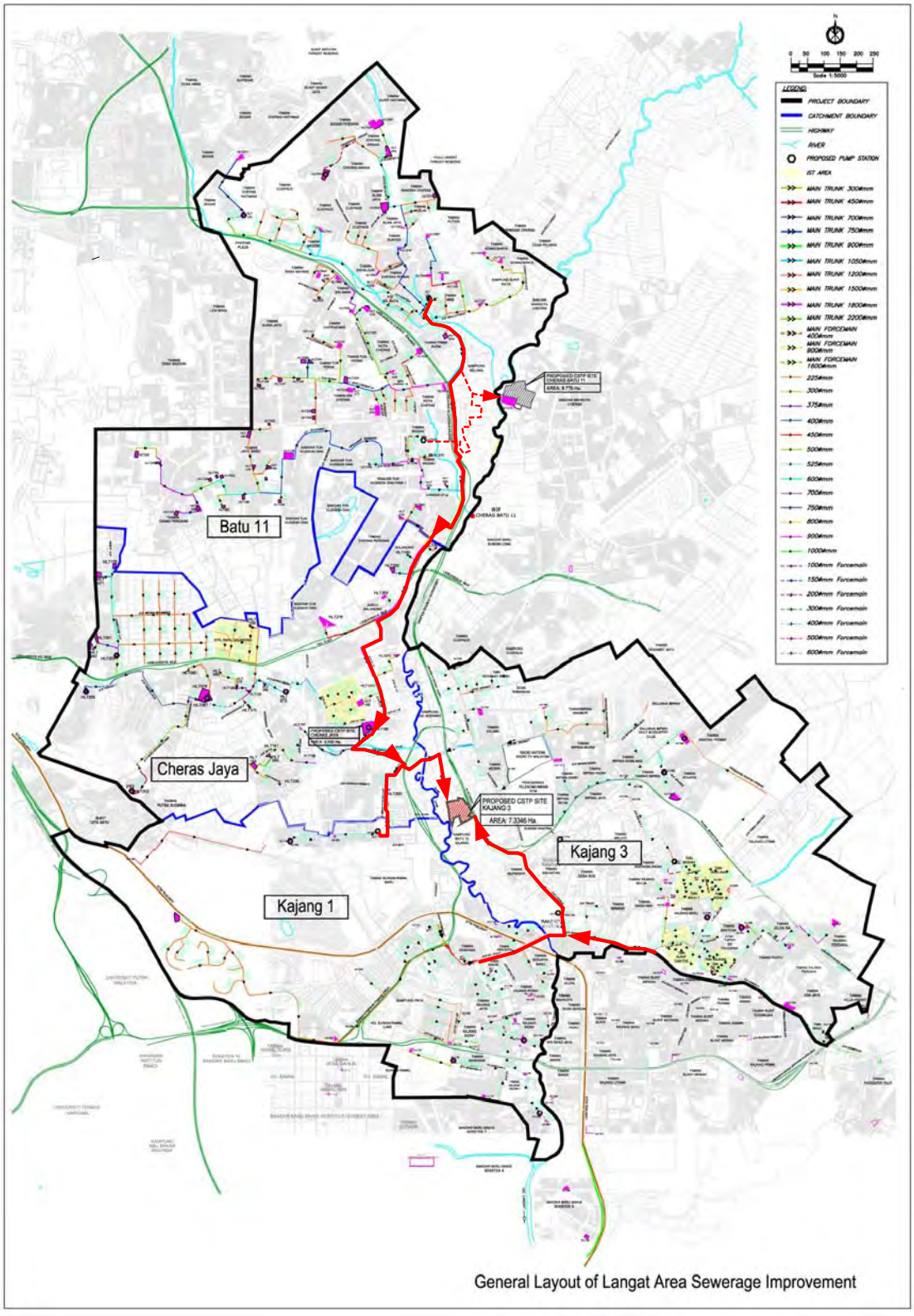
In the study area, the Langat River flows from the north to the south, which several tributaries joins from both sides. As a whole, topography slopes down southwards.

Out of four sewerage subcatchments, Cheras Batu 11, Cheras Jaya and Kajang 1 line from the north along the right bank of the Langat River and Kajang 3 is situated on the left bank facing Cheras Jaya and Kajang 1.

The proposed Kajang 3 CSTP is located on the left bank near the crossing point of three subcatchment boundaries, or CherasJaya , Kajang 1 and Kajang 3, which is approximately 160 m away from the Langat River a slightly south of the centre of the study area. For the proposed CSTP site, Cheras batu 11 and Cheras Jaya are located on the north, Kajang 1 on the south and Kajang 3 extends north and south.

In the subcatchments of Cheras Batu 11 and Cheras Jaya, three tributaries of Sg. Raja、Sg. Cheras and Hulu Sg. Balak flow from the northwest to the southeast and join the Langat River. For this reasom, small hills and valleys are formed alternately and the above tributaries flow down such valleys towards the Langat River. The northern trunk sewer starting from Cheras Batu 11 takes the route on the road near the Langat River to reach the proposed CSTP via Cheras Jaya. The subtrunk sewer collecting sewage in the northen part of Kajang 1 subcatchment is connected to the above northern trunk sewer through a pumping station.

The trunk sewer covering the southern part of Kajang 1 subcatchment runs on Jalan Sg. Chua to westwards across the Langat River, joins the trunk sewer covering the southern Kajang 3 subcatchment and then takes the route on Jalan Cheras northwards and unpaved road along the Express Highway (E7) to the proposed CSTP site, which require the pumping station due to the adverse slope, although there is no prominent undulation



Source: Prepared by the Study Team

Figure III-5.4 Proposed Sewer System for the Integrated Sewage Treatment Plant

5.8 Proposed Kajang 3 CSTP

(1) Design Sewage Flow

Table III-5.16 shows the summary of design sewage flow. The per capita sewage flow is 225 L plus 10% groundwater infiltration.

Table III-5.16 Design Sewage Flow – Ultimate (2035)

	PE	Sewage flow （Daily average)
Total	920,000	207,000 m^3/day

Source: Prepared by the Study Team

(2) Design Sewage Water Quality

The influent quality is calculated by per capita pollution load and STP inflow. **Table III-5.17** shows the design sewage quality of influent and effluent.

Table III-5.17 Design Influent Value

	g/capita/day	Influent Quality			
		Pollution load (kg./day)	Sewage inflow (m3/day)	Influent Quality (mg/l)	
BOD	56	46,760	206,663	226.3	≒230
SS	68	56,780	206,663	274.7	≒270
COD	113	94,355	206,663	456.6	≒457
AMN	7	5,845	206,663	28.3	≒28
TN*	11	9,185	206,663	44.4	≒44
O&G	11	9,185	206,663	44.4	≒44

Source: Prepared by the Study Team

(3) Treatment Level and Target Quality of Sewage Effluent

The discharge point is located upstream of the water intake point and regulated as Standard “A” according to the “Malaysian Sewerage Industry Guidelines Volume IV for Sewage treatment”.

The purpose of design requirements is to ensure that the effluent standards can be met under the normal operations of a sewage treatment plant. The quality of effluent from a sewage treatment plant is expected to vary due to the natural variability in the flows and loads to the plant. Therefore, the design effluent parameter shall be less than the required effluent standards to ensure that, when the plant is under normal operation, any grab sample of effluent will comply with the consent EQA effluent standards.

Table III-5.18 Design Effluent Value of Standard A

	Effluent Quality	
	Absolute (mg/L)	Design (mg/L)
BOD_5	20	10
SS	50	20
COD	120	60
AMN	10	5
NO_3-N	20	10
Oil and Grease (O&G)	5	2

Source: Malaysian Sewerage Industry Guidelines Volume IV: SewageTreatment Plants

*: Design influent value is for TN but effluent standard is for Nitrate Nitrogen (NO_3-N).

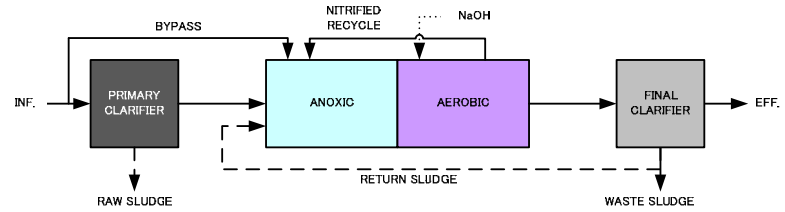
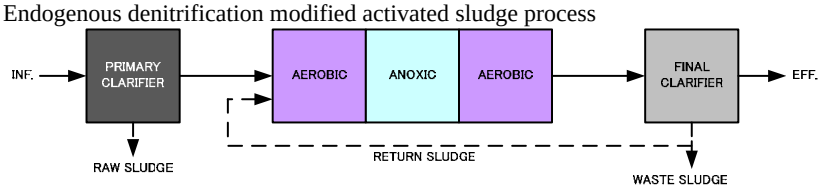
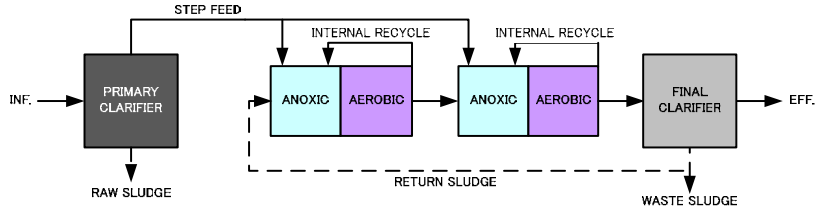
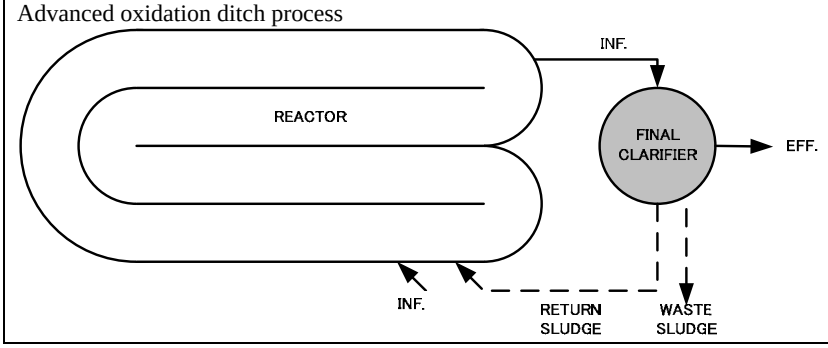
(4) Sewage Treatment Facilities

1) Treatment Method

Generally a biological treatment process is applied to sewage treatment. Stabilization ponds or aerated lagoons may be adopted to small-scale plants, however, activated sludge process including its modified methods is adopted to medium- and large-scale plants by site condition and/or effluent standards.

For this project, to comply with the design Effluent Standard for TN of less than or equal to 10 mg/l, modified activated sludge processes with biological denitrification as shown in **Table III-5.19** are necessary,. Endogenous denitrification or advanced oxidation ditch processes are applied to small scale sewage treatment plants, while recirculation denitrification or step feed multi-staged denitrification processes are applied to larger scale plants. Among these processes, the step feed two-staged denitrification process with internal recycle is adopted for the proposed centralised sewage treatment plant.

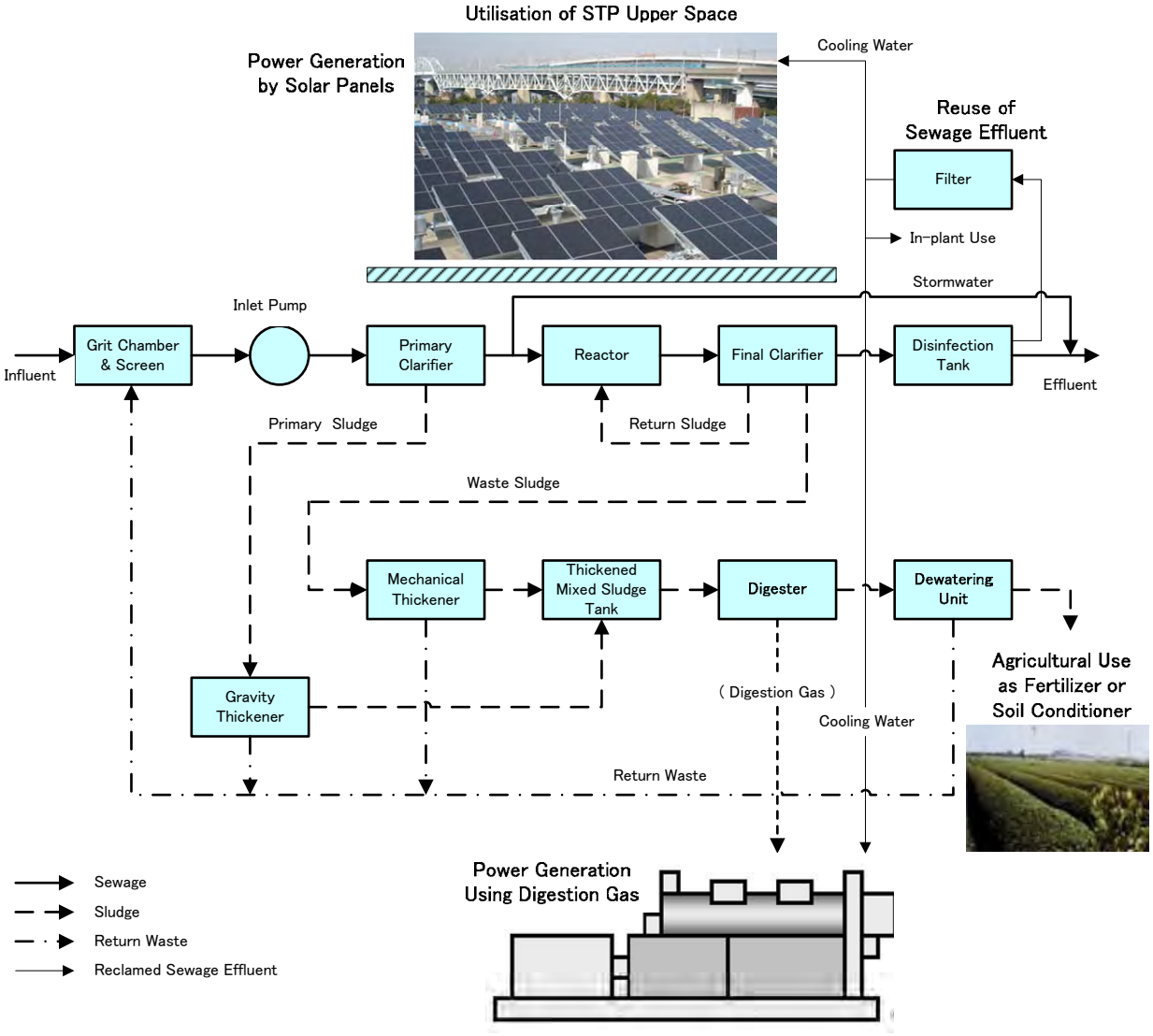
Table III-5.19 Typical Biological Denitrification Process

Process	Nitrogen Removal Rate (%)	Application
Recirculation denitrification modified activated sludge process 	60~70%	Large scale plants
Endogenous denitrification modified activated sludge process 	75~85%	Large scale plants **(Recommend)**
Step feed two-staged denitrification modified activated sludge process 	70~90%	Small scale plants
Advanced oxidation ditch process 	More than 85%	Small scale plants

Source : "Sewerage System Planning and Design Guidelines", Japan Sewage Works Association, 2001

2) Process Flow Diagram

The treatment process flow diagram of this treatment plant is presented in **Figure III-5.5**. The details of a reactor follow the recommended process as shown in **Table III-5.19**.



Source: Prepared by the Study Team

Figure III-5.5 Process Flow Diagram of Sewage and Sludge Treatment

(a) Pretreatment

Incoming sewage to sewage treatment plant is pumped up at the inlet pumping station to pretreatment facilities to remove floating material, grit and O&G (oil and grease) at screens, grit chamber and O&G removal tank, respectively.

(b) Primary treatment

Then, sewage enters into the primary clarifiers to separate settleable solids and other matters attached thereto from sewage which is called primary sludge.

The expected removal efficiencies in primary treatment are 30% to 50 % in BOD_5, 40% to 60% in SS and 30% to 50 % in COD, respectively.

(c) Secondary treatment

Biological nitrogen removal systems achieve nitrification and de nitrification along with BOD reduction in reactors followed by final clarifiers. The step feed two-staged biological denitrification process with internal recycle as shown in **Table III-5.19** splits the influent flow and directs its portion to each of two anoxic zones. To give allowance in facility layout, a deep aeration system with an effective water depth of 6 to 10m developed by

TMG is adopted in the reactors. Some activated sludge is returned to reactors as return sludge and the remaining is withdrawn from final clarifiers to sewage treatment facilities as waste sludge.

Through secondary treatment in reactors and final clarifiers, the removal efficiencies are 90% to 95 % in BOD_5, 90% to 95% in SS, 75% to 85 % in COD, and 75% to 85% in TN, respectively, for the influent quality to STP so that the sewage effluent quality complies with the effluent standard.

(d) Disinfection

For disinfection, there are three methods, or (a) chlorine, (b) UV (Ultra Violet) and (3) ozone. Ozone disinfection is generally used with expectation of secondary effects like decolourisation and deodourisation, but the cost is most expensive in both initial and O&M costs. Although UV system is recently popular in small- and middle-scale sewage treatment plant, the cost, especially the initial cost is rather expensive in comparison with chlorine disinfection. While, chlorine disinfection has disadvantages in no expectation of inactivation of protozoa and some viruses in sewage effluent and bad effect on receiving water bodies by byproduct such as trihalomethane, etc., but they can be minimised through firm dosing rate control, and has an advantage of residual disinfection effect. Therefore, chlorine disinfection is adopted in the proposed CSTP.

(e) Discharge

The CSTP site is located approximately 160 m away from the Langat River, but there is one existing stream from the CSTP site to the Langat River, which is used as a discharge channel of sewage effluent.

(f) Deep Aeration System

Until 1960's, Tokyo's sewerage had not been fully developed. Faced with the economic growth, the rapid urbanization and the population congestion in the urban area, the TMG had to develop sewerage infrastructure with large-scale capacity with very limited space. In other words, TMG had to develop highly efficient sewerage infrastructure which could serve the maximum population with the least amount of land.

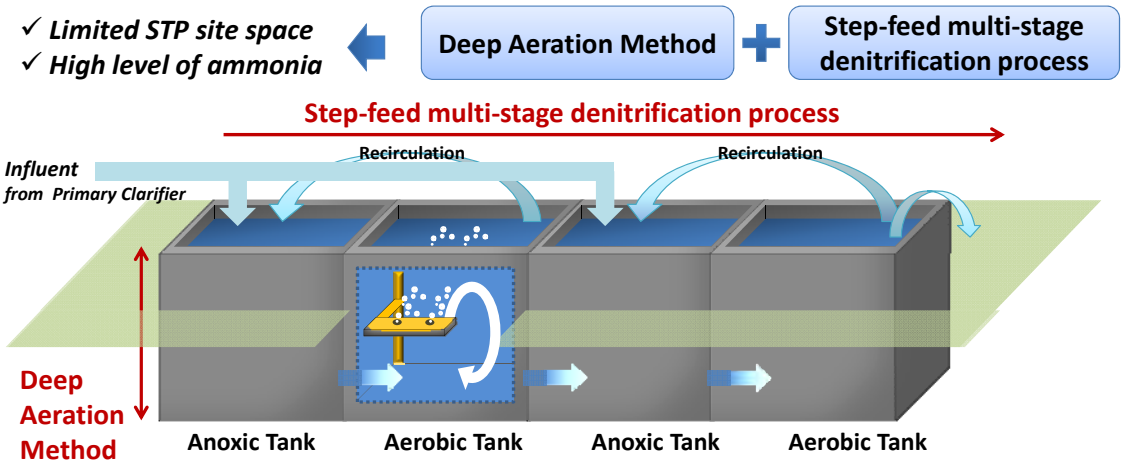
Under the circumstance of the land limitation, the TMG developed the efficient STP design and some good examples are the followings:

- two-storied sedimentation tank
- utilization of the STP's roof top
- deep aeration method

Deep aeration method aims to make best use of land by designing an aeration tank with 10m depth and half size lot area, compared with a conventional aeration tank (5m depth). Generally, the deeper tank causes more sedimentation of sludge and shorter circuit flow inside the tank, and increases the dead spot of air. TMG's design characteristics come from the position of the baffle plate and the aeration blower installed inside the tank to solve these problems.

In accordance with "Malaysian Sewerage Industry Guidelines" published by SPAN, it would require about 9.36 ha to cover 450,000PE and thus 920,000PE would require huge space, if a conventional aeration tank is adopted. Since the size of Kajang 3 site is about 7.3 ha and not enough to accommodate the STP of 920,000 PE in case of the conventional aeration tank, we propose the deep aeration method.

The diagram below outlines the deep aeration method which will operate alongside the step feed multistage denitrification process, which will address the current challenges faced the Langat catchment areas:



Source: Prepared by the Study Team

Figure III-5.6 Step Feed Multistage Denitrification Process by Deep Aeration System

3) Sludge Treatment Facilities

(a) Sludge Thickening

Separate thickening approach is applied to primary sludge and waste sludge, respectively, due to the difference in sludge characteristics, that is to say, gravity thickening for primary sludge from primary clarifiers and mechanical thickening for waste sludge from final clarifiers.

The moisture contents are reduced from 99% to 96% for primary sludge and 99.2 % to 96% for waste sludge, resulting in the volume reduction of 1/4 and 1/5, respectively, through sludge thickening.

(b) Sludge Digester

An anaerobic medium-temperature digestion process without heating is applied to reduce sludge volume and to stabilize sludge. Sludge temperature put into the tanks is in the range of 24 to 35 degree C. This digestion process has a digestion period of thirty days. Although the change in sludge volume is a slight in the anaerobic digestion process, the solids in sludge are decreased due to the progress of decomposition of organic matters in sludge which stabilise the sludge and generate methane-rich digestion gas usable for gas power generation as green gas.

(c) Sludge Dewatering Facility

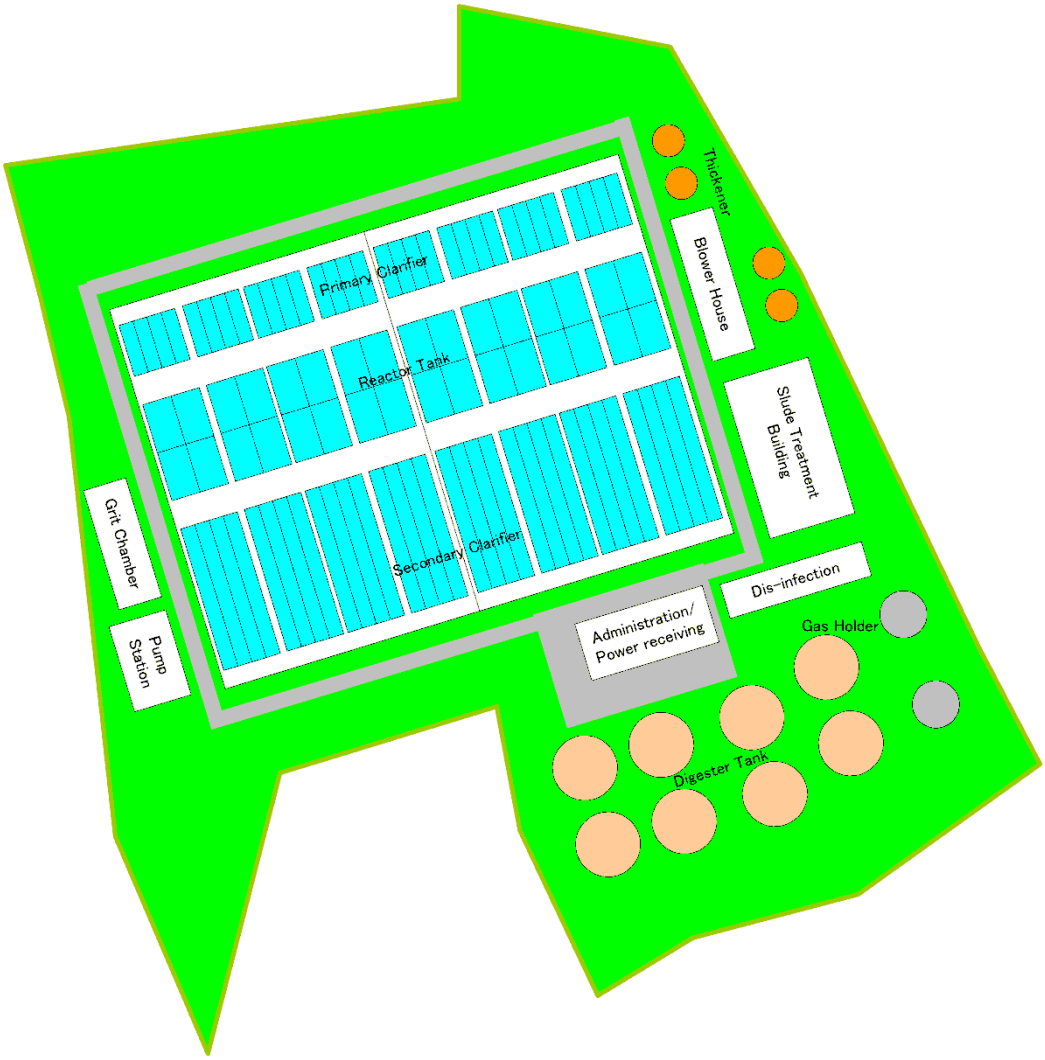
By sludge dewatering, moisture content of digested sludge is reduced to 80%and sludge volume is further reduced to 1/4 to 1/10. When moisture contents downs below 80%, sludge changes from liquid condition to so called cake condition which facilitates sludge handling without adhesion in contact.

(d) Sludge Disposal

The dewatered sludge contains Nitrogen (N) and Phosphorus (P). P and N in the sludge are the main elements that can be converted to organic fertilizer for rubber plantation, landscaping, gardening etc. Sludge (containing P and N) can be taken over by fertilizer companies, hence resulting in minimal sludge disposal costs. If the sludge from the proposed STP would be taken over by fertilizer company, the sludge will not be dumped at the landfill sites, so the serious environmental problem within Greater KL is resolved.

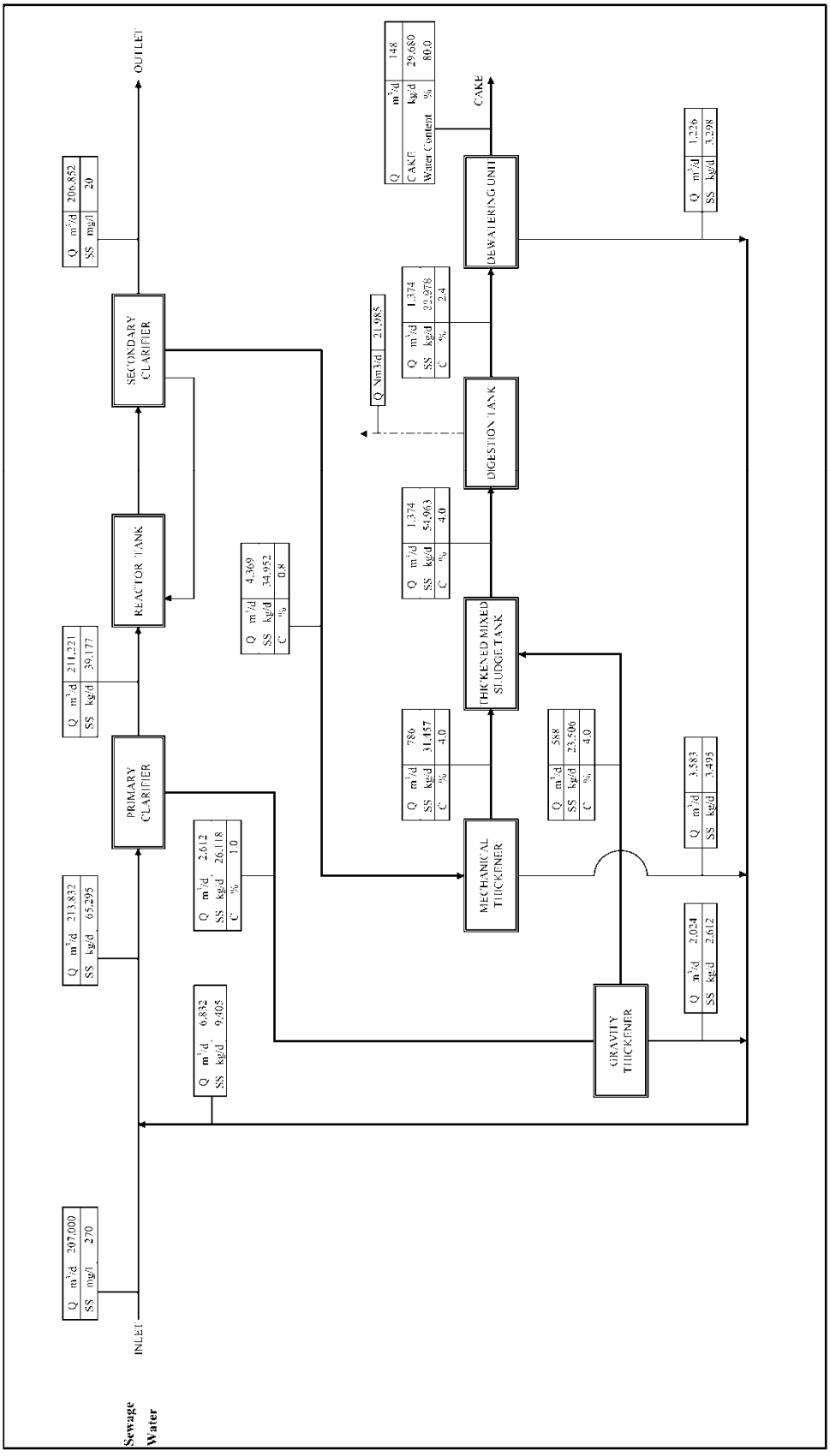
(5) Layout of Sewage Treatment Facilities

Layout and material balance of the proposed Kajang 3 CSTP are shown in **Figure III-5.7** and **Figure III-5.8**, respectively.



Source: Prepared by the Study Team

Figure III-5.7 Layout of Kajang 3 Centralised Sewage Treatment Plant



Source: Prepared by the Study Team

Figure III-5.8 Mass Balance of Kajang 3 Centralised Sewage Treatment Plant

The dimensions/specifications of major facility/equipment is summarized in **Table III-5.20**.

Table III-5.20 List of Major Facility/Equipment

Category	Facility/ Equipment	Dimensions/Specifications	Phase I (104,000 m^3/day)	Phase II* (207,000 m^3/day)
Preliminary Treatment	Inlet pump	Type: Vertical Installed Centrifugal Pump Ø400 mm x 29 m^3/minQ x 20 mH x 130 kW Ø600 mm x 54 m^3/minQ x 20 mH x 250 kW	2 units 3 units (one as standby)	- 3 units
	Pumping station	59 m x 30 m x 33 mH (12 m + 21 m BF)	1 bldg.	-
	Grit chamber	1.8 mW x 24.0 mL x 5.0 mD	3 channels	3 channels
	Screen	Type: automatic screen 70,200 m^3/dayQ x Opening 20 mm x 3.7 kW	3 units	3 units
	Odour control facility	Type: Biological scrubber 100 m^3/min	1 unit	
Primary Treatment	Primary clarifier	5.0 mW x 18.5 mL x 3.0 mD	16 tanks	16 tanks
	Sludge collector	Type: Chain flight 5.0 mW x 18.5 mL x 3.0 mD x 2 trains x 0.75 kW	8 units	8 units
Secondary Treatment	Reactor	Type: Step-feed 2-stage denitrification process 10.0 mW x 74.0mL x 10.0mH	4 tanks	4 tanks
	Reactor facility 1st mixer 1st air diffuser 2nd mixer 2nd air diffuser Recirculation pump	 Submersible mixer: Approx. 8.0 kW Super fine membrane Submersible mixer: Approx. 6.0 kW Super fine membrane Centrifugal pump	 4 sets 4 tanks 8 sets 4 tanks 16 units	 4 sets 4 tanks 8 sets 4 tanks 16 units
	Blower	Type: Turbo Blower 92 m^3/min x 70 kPa x 150 kW	4 units (one as standby)	3 units
	Blower house	1F: 15 m x 50 m, 2F: 15 m x 25 m	1 bldg.	-
	Secondary clarifier	5.0 mW x 52.0 mL x 4.0 mD	16 tanks	16 tanks
	Sludge collector	Type: Chain flight 5.0 mW x 52.0 mL x 4.0 mD x 2 trains x 2.2 kW	8 units	8 units
Disinfection	Disinfection tank	12.0 mW x 50.0 mL x 3.5 mD	One tank	-
Advanced Treatment	Utility water facility	Ø1,000 mm x 5.5 kW	2 units	0 unit
Sludge Thickening	Sludge thickener for primary sludge	Type: Gravity thickener Dia.11.0 m x 4.0 mD	2 tanks	2 tanks
	Sludge collector	Dia.11.0 m x 4.0 mD x 0.4 kW	2 units	2 units
	Sludge thickener for waste sludge	Type: Gravity-belt thickener 50 m^3/hr x 6 kW	3 units	3 units
Sludge Digestion	Sludge digester	Dia.22.0 m x 9 mWall	4 tanks	4 tanks
	Digestion facility Mixer Gas holder Desulfuriser Gas combustion Unit	 2,500 m^3/hr x 22 kW 2,500 m^3/hr 420 m^3/hr 420 m^3/hr	 4 units 1 units 1 units 1 units	 4 units 1 units 1 units 1 units
Sludge Dewatering	Dewatering facility	Type: Screw press Ø900 mm x 450 kg/hr x (3.7 + 1.5)kW	4 units (one as standby)	3 units
	Sludge treatment bldg.	55 m x 31 m 21 mH (underground 7m)	1 bldg.	

Electrical Facilities	Power Supply	11 kV Switchgears, 3000jVA x2 Transformer, 2000kVA x2 Standby Diesel Generator	1 unit	1 unit
	Substation and Generator bldg.		1 bldg.	
Common	Administration bldg.		1 bldg.	

*The number of facility/equipment in Phase II shows the additional number to Phase I.

	Civil		Building		Equipment

Source: Prepared by the Study Team

(6) Green Technology at the Proposed Kajang 3 CSTP

In this day of environmental awareness regarding the effects of climate change and global warming, the necessity of incorporating green technology into every aspect of life is crucial. They say that we are in "the century of the environment". Therefore, the pursuit of environmental sustainability is the responsibility of all nations, communities, or any other organization, or even individuals on our Earth.

In the planning of sewerage infrastructure, the reasonable level of capital expenditure and the environmental sustainability are important, but those two factors conflict each other sometimes. Therefore, an ideal balance between economical reasonableness and environmental contribution must be achieved by the sewerage infrastructure planning.

Based on TMG's experience, the proposed technologies as stated below bring great advantages in terms of cost and environmental contribution.

1) Gas Generation Facility

Methane gas produced during digestion (the biological decomposition of organic materials in anaerobic condition) in the sludge treatment process can be used as fuel of power generation. The power generation using methane gas produced from sewage sludge is known as the carbon neutral method. Through this method, produced CO_2 circulates in life cycles and the levels of CO_2 in our atmosphere will not be increased. Thus, this facility contributes to the reduction of CO_2 gas emissions, one of the greenhouse gases that cause global warming.

In case of the proposed STP with the ultimate capacity of 207,000m3/day, the generated power is about 3,758,000 kWh/year as per the following calculation:

	Tokyo Example	Proposed Project
Thickened Mixed Sludge injected into Digester	100.3 DSt/day	54.69 DSt/day
Generated Power	52,200 kw/day	28,000 kw/day

- Generated Power considering the difference of heating temperature between Tokyo's case and Langat Model Project's case: 28,000 kw/day x 40% = 11,440 kw/day
- Generated Power considering some buffer (reliability factor):
  11,440 kw/day x 90% = 10,296 kw/day
- 10,296 kw/day x 365 days = 3,758,040 kWh/year
- 3,758,040 kWh/year x RM0.377/kWh = RM 1,416,781

It takes two to three months that the gas suitable for power generation is produced. Then, it takes a month to adjust the system to generate the power from the gas. Therefore, it takes 4 months to generate the power after the commissioning of the sludge gas generation system.

Gas Generation Facility contributes to electricity cost saving as well as the reduction of CO_2 Gas emission. Methane gas has 21 times as much greenhouse effect as CO_2. Therefore, this facility has a great advantage environmentally.

Source: Provided by the Tokyo Metropolitan Government

Figure III-5.9 Biosolids Gas Power Generation System at Morigasaki Wastewater Reclamation Centre, Tokyo

2) Sludge Recycle for Fertilizer Use

Treated sludge contains phosphorus and nitrogen, which are major chemical constituents for fertilizer. Our proposed dewatering facility will reduce water content of sludge up to 80%. Sludge which has undergone the dewatering process contains 5.3% of phosphorus and 4.72% of nitrogen. Although in general, chemical fertilizers are used for agriculture, the sewage sludge can be utilized as the main components of organic fertilizer for some cases, e.g., rubber plantation, landscaping, palm oil plantation, etc.

3) Photovoltaic Power Generation

To enhance public awareness of sewerage infrastructure and make the best use of limited area, TMG found many methods of utilizing the roof top areas of STP, such as park, playground, tennis court, etc. Solar Panel is one of those various utilization methods, and can be considered as a potential solution of the proposed STP in future. Photovoltaic power generation can contribute to the electricity cost saving as well as to the reduction of CO2 gas emission. Also, tangible symbol of solar panel would enhance public awareness of environment consciousness. Photovoltaic power generation in Tokyo is illustrated in the figure below:

:

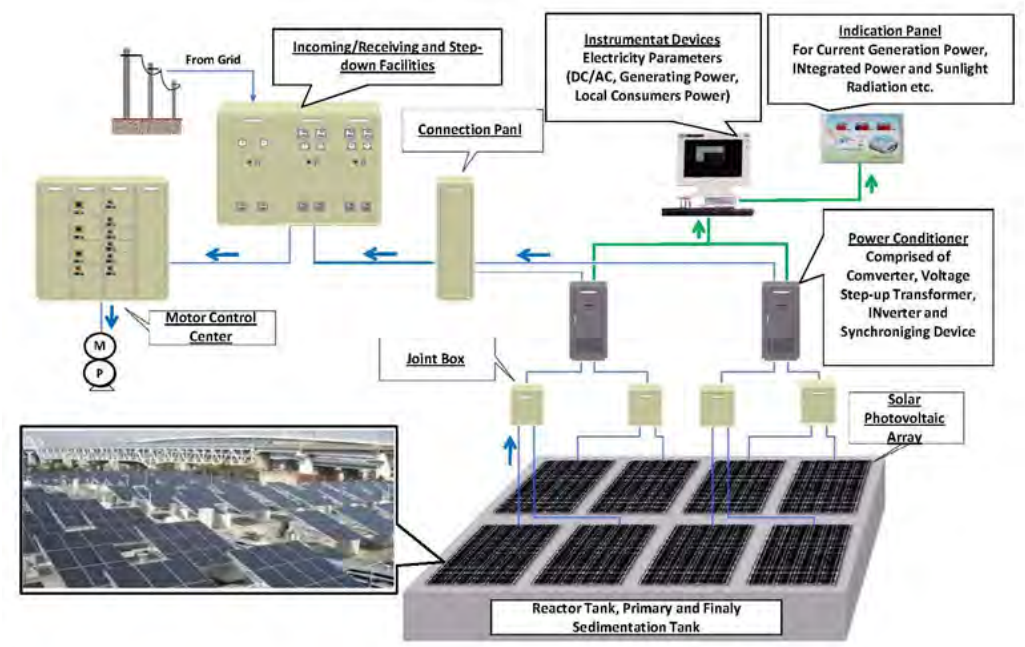
The specification of photovoltaic power generation is stated below.

- Scale : about 1MW
- Expected generated electrical power : about 570,000 kwh per year
- Expected Reduction of carbon-dioxide emissions : about 180 ton per year

Source: Provided by the Tokyo Metropolitan Government

Figure III-5.10 Photovoltaic Power Generation at Kasai Wastewater Reclamation Centre,

Tokyo



Source: Provided by the Tokyo Metropolitan Government

Figure III-5.11 Schematic Diagram for Solar PV Generation System (on grid)

An issue of concern is that power generation efficiency might decline due to high temperature in Langat area. Thus, one of the potential solutions to be considered in future is the photovoltaic power generation system fitted with sprinklers by utilizing reclaimed water as its source to cool down the temperature of the surface of solar panels.

4) Reclaimed Water

Ideal water cycle and water use saving can be achieved through effective utilization of reclaimed water. The TMG has more than 20 years experiences to develop methods of introducing reclaimed water. For example, reclaimed water from Ochiai STP in Tokyo is utilized for toilet flushing including all toilets in the buildings of Tokyo Metropolitan Government. The water for road cooling at the area of Parliament Building in the centre of Tokyo is the reclaimed water from Shibaura STP in Tokyo. The reclaimed water from Ariake STP is utilized for washing of Sky Train Vehicle. By adopting the advanced treatment technology, the effluent can be treated to the level of drinking water, and some amount of reclaimed water from Ochiai STP is for drinking (though it is demonstration purpose). Please find some examples of reclaimed water usage in Tokyo as follows:

2009 Result

STPs	Usage	Volume (m3/y)
Shibaura	•Flushing / District Cooling	1,415,527
	•Gardening/Fountain	54,639
	•Road Cooling at the area of Parliament Building	1,863
Ariake	•Washing of Sky Train Vehicle	800,597
	•Road Cooling	2,114
Ochiai	•Toilet Flushing in TMG Bldg.	1,100,691
	•Pond Playing	29,238,950
	•Gardening	23
Morigasaki	•Industrial Use	243,460
	•Road Cooling	13,613
Kosuge etc.	•Road Cooling	1,634,240
	•Gardening	87
	Total	**34,505,804**

Source: Provided by the Tokyo Metropolitan Government

Figure III-5.12 Examples of the use of Reclaimed water in Tokyo

Population increase in Cheras and Kajang area is estimated as per the following table:

Table III-5.21 Estimated Population Increase in Cheras

Sewerage Sub-Catchment	2010	2020	2030	2035
Cheras Batu 11	118,800	152,700	189,200	209,400
Cheras Jaya	77,700	109,100	128,600	148,300
Kajang 1	44,800	58,700	72,000	78,700
Kajang 3	62,400	76,900	96,800	103,500
Total	303,700	397,400	486,600	539,900

Source: From Table III-5.3

Since these areas will be expanded as housing and commercial area, it is indispensable to achieve the sustainability of water. Therefore, the water reuse in these areas (for industrial use, toilet flushing, landscaping, sprinkling in town, etc.) will contribute to the sustainability of water in these areas and has good potentiality for the near future.

(7) Mechanical Equipment Plan

1) General

Mechanical design for process and facilities for the STP have been conducted in terms of economy and easy maintenance. Further, design shall be improved and upgraded in consideration of some experiences of Pantai STP, etc. Some considerable terms of Mechanical Equipment are shown in below,

- Inlet gate type in Pump Station – Emergency shut off. Gate is requested.
- Type of Sewage lift pump in Pump Station – Current Mixed Flow Type is poor repair condition and difficult maintenance. Shaft and impeller of pump are broken. Dry Well Centrifugal Type is recommendable.
- Blower type –Much noise and vibration occur because of large capacity and no existence of cover, which are sometimes broken. Turbo type is requested.
- Aeration type – Super fine membrane diffusers with the latest technology are recommendable due to reduction of electrical charge cost.
- Mechanical thickener type - Belt gravity type with the latest technology is recommendable.
- Dewatering unit type - Screw press type is recommendable, which is same as Pantai.
- Installation of odor control system – Biological scrubber method is adopted.

The issues described hereunder shall be reviewed due consideration in preparation of the detailed design.

2) Design condition of STP Facility

Design condition of each facility related to mechanical equipment is shown in **Table III-5.22.**

Table III-5.22 Design condition of each Facility related to mechanical equipment

Facility Name	Design condition (Phase Ⅰ + Phase Ⅱ)	Reference
Pump Station	459,000 m^3/day	(Hourly maximum)
Grit chamber Facility	459,000 m^3/day	(Hourly maximum)
Primary Clarifier Facility	Proposed 207,000 m^3/day	(Daily average)
Aeration Tank Facility	Proposed 207,000 m^3/day HRT Approx. 6.5 hr MLSS Ave. 2,400 mg/ l Temperature of water 28℃ Water depth 10 m	(Daily average)
Secondary Clarifier Facility	Proposed 207,000 m^3/day	(Daily average)
Gravity Thickener	Inlet Sludge Solids Content 1.0 %	

	Thickened Solids Content 4.0 %	
Mechanical Thickener	Inlet Sludge Solids Content 0.8 % Thickened Solids Content 4.0 %	
Digester Facility	Non- heating type Digestion period 30 days	
Sludge dewatering Unit	Inlet Sludge Solids Content 2.4 % Sludge Water content Approx. 80%	

Source: Prepared by the Study Team

List of major mechanical equipment is shown in **Table III-5.20.**

3) Pleliminary Treatment Facility

Pleliminary Treatment Facility is composed of Grit Chamber and Pump Station. Both facility have very important role, which make treatment process reliable and effective.

(a) Grit Chamber

Grit chamber is designed before sewage lift pump facility, which is composed of ultimate six channels. The first unit operation encountered in grit chamber is gates, coarse screenings, and medium screenings. Regarding inlet gate, emergency shut-off gates are installed by request of IWK. Material of gate body should be ductile iron.

The principle role of screenings is to remove coarse and medium materials from the flow stream, such as leaves, paper, rags. These materials are lifted up by screen automatically, which are transferred to screenings hopper by screenings conveyor.

Sand is sedimented by gravity at grit chamber, because grit, consisting of sand, or other heavy solid materials that have specific gravities greater than organic solids. Sedimented sand is collected at bottom of sand pit by grit collector, and transferred to grit separator by grit pump.

(b) Pump Station

Pump Station is composed of two wet wells and one dry well of sewage lift pumps. Effluent flow is transferred to Primary Clarifier by sewage lift pump.

Vertical Centrifugal Pumps are recommendable according to the following reasons.

- Reasonable pump cost
- Pump efficiency is almost same as mixed flow type.
- Easy operation and maintenance because the pumps are installed in a dry well, and operators have thus easy access to monitor pumps.
- In case of PE > 20,000, dry well pumps are recommendable according to SPAN of Malaysian Sewerage Industry Guidelines.

4) Primary Treatment Facility

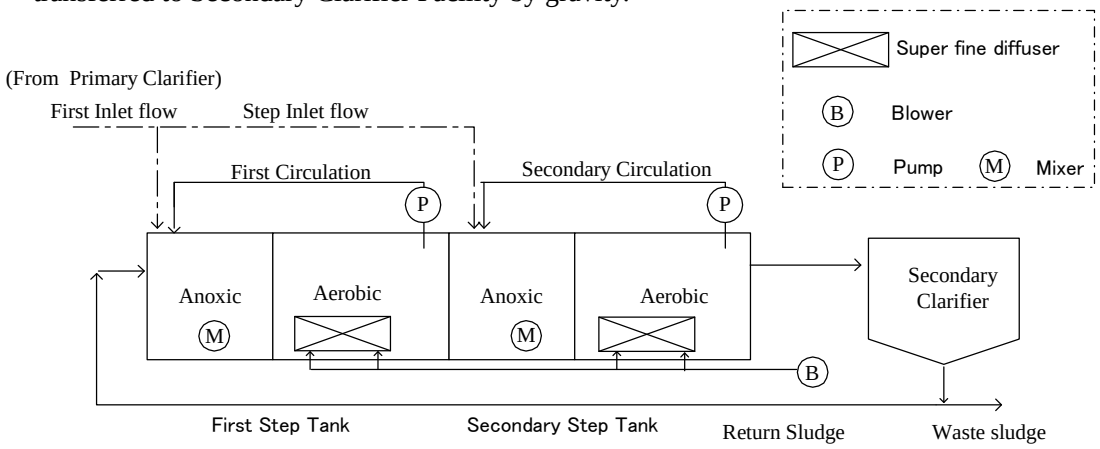
Solid-liquid separation occurs in clarifier by gravity, and settled solids (primary sludge) are collected to sludge pit by sludge collector and transferred to the Gravity Sludge Thickener by primary sludge pumps. Chain flight type is recommendable as primary sludge collector, which is same type as Pantai. Floating scum is removed from inlet sewage by scum skimmer, and are transferred to scum screen by pump.

5) Secondary Treatment Facility

(a) Aeration Tank

Inlet flow of Aeration Tank is transferred from Primary Treatment Facility by gravity, which is distributed to first and secondary Anoxic Tank for denitrification by each inlet step gate. Effluent flow of each anoxic tank is transferred to next each Aerobic Tank for nitrification. Each effluent flow of Aerobic Tank is circulated to Anoxic Tank. Treatment water is

transferred to Secondary Clarifier Facility by gravity.



Source: Prepared by the Study Team

Figure III-5.13 System Flow of Secondary Treatment Facility

Regarding major mechanical components of aeration, mixers in Anoxic Tank are same type as Pantai. Super fine membrane diffusers and turbo blower with the latest technology are recommendable from the reasons below;

- Reasonable construction cost
- Much reasonable electrical charge cost, reduction ratio is approx.25 % (Aeration system in Pantai is different type, which is mechanical aerator type.)
- Packaged turbo blower with latest technology is recommendable, which is easy maintenance, low noise, and low vibration.

Aeration is carried out by combination of blowers and air diffusers. Air for microorganism is supplied from blower to membrane diffuser, and oxygen is soluble into the wastewater. Super fine bubbles of dia. 1mm generate with membrane. Submersible mixers are 24 hours working, and blower and diffusers are controlled by combination of VFD and DO control efficiently.

(b) Secondary Clarifier

Solid-liquid separation occurs in clarifier by gravity. Return sludge from Secondary Clarifier is circulated to first Anoxic Tank for keeping MLSS concentration by return sludge pumps continuously. Waste sludge from Secondary Clarifier is transferred to Sludge Holding Tank by waste sludge pumps, which operate intermittently by a timer control.

Generated scum is removed in clarifier, and transferred from clarifier to scum pit by gravity. Scum is transferred to scum screen in Grit chamber by scum pump. In scum pit, since the FRP sealing plate prevent odor from spreading into air surrounding effectively, odor are transferred to odor control system by deodorization fan.

(6) Disinfection and Advanced Treatment Facility

Hypochlorite solution is injected to all the effluent flow from the secondary clarifiers by chemical pumps.

Treated water before disinfection is used as de-foaming water of Aeration Tank. Treated water after disinfection is used as washing water for each equipment and piping, and sprinkler stop cocks, etc.

(7) Sludge Treatment Facility

(a) Sludge Thickening Facility

Primary sludge is thickened by Gravity Thickener. Waste sludge is thickened by Mechanical Thickener. Mechanical thickened sludge and primary thickened sludge are transferred to Thickened Sludge Holding Tank for Digester by pump. Belt gravity type with the latest

technology is recommendable as mechanical thickener, which is easy maintenance and high performance.

(b) Sludge Digestion Facility

Thickened sludge from Thickened Sludge Holding Tank is transferred to Digester Tank by thickened pump. After digested, digester sludge is transferred to Digested Sludge Holding Tank by digested pump. In case of adoption of a digestion gas power generation system, exhausted gas is used to heat digestion tanks for more stable digestion.

(c) Sludge Dewatering Facility

Digested sludge is transferred to dewatering unit by sludge pump. Screw press type is applied for its compactness, low-speed rotation, low energy consumption, and easy operation. Further, polymer solution work is needed for dewatering every day. Drainage water from dewatering unit is transferred to Waste Water Tank by gravity, and waste water is transferred to Grit chamber by waste water pump.

(8) Electrical Equipment and Instrumentation

1) Power Supply

An incoming power supply from TNB will be applied for main power supply at 11kV 50Hz. All of the received power is stepped down to 420V from 11kV to meet motor voltage. The maximum demand of the treatment plant is estimated to be 1900kW in Phase1, which equates to 2600kVA, therefore one set of 3000kVA transformer will be provided with some surplus capacity. A transformer will be connected to 11kV incoming line through 11kV switchgear. The transformer is outdoor, oil immersed, and natural cooling type, and 11kV switchgear is composed of VCB (Vacuum Circuit Breaker), protection devices and metering devices.

2) Emergency Power Supply

A standby power generator will be provided to supply electrical power in case of power failure. The capacity of generator will be 2000kVA and capable of covering sewage pumps, blowers and emergency facilities. The type of generators is 3phase 420V, diesel engine, radiator cooling, and battery starter. The fuel tank capacity will be for 24 hours running. The silencers will be adopted to reduce noise level to less than 75dB at one meter away from the generator building. Between commercial power line and generator power line has an interlocking system at the ACBs to protect from short circuit.

3) Electrical Room

Four electrical rooms will be planned in the treatment plant which is at Sub-station, Pump Station, Blower Building and Sludge Treatment Building.

Incoming power will be received at 11kV and stepped down to 420V-240V in Sub-station and LV power will be distributed to other electrical rooms. Standby generator will be installed in Sub-station.

As main equipment, the following components will be applied.

Table III-5.23 Main equipment

Equipment	Feature
11kV Switchgear	VCB
420V Switchgear	ACB, MCCB
MCC (Motor Control Center)	420V Form 3b
Capacitor bank	PF > 95%
UPS	240V 60 minutes backup for SCADA and instrumentation
PLC/RTU	Open protocol (Profibus)

Source: Prepared by the Study Team

4) Operation and Control

As a basic idea, automatic control is executed by PLC (Programmable Logic Controller) and manual control is done by hard relays. PLCs have higher flexibility for a programming of control and hard relays have higher reliability. Even in the case of PLC failure, manual operation by hard relays is possible.

There are three possible locations for the equipment control: equipment side, electrical room side and SCADA side. From the viewpoint of safety, operation from equipment side has the highest priority using change-over switches (Local-Remote) and operation from SCADA side has the least priority. An emergency stop button will be applied beside each pump.

VFD (Variable Frequency Drive) will be applied for sewage pumps and blowers. VFD is useful for control flexibility and energy saving.

Pump number and pump speed control by pump pit level will be applied for automatic control method of sewage pumps and constant DO control will be applied for blowers.

5) Instrumentation

Instrumentations, which are necessaries for automatic control, operation and maintenance and data logging, will be provided. The recommended instrumentations and their types are shown below.

Table III-5.24 Instrumentation

Measuring Items	Types
Sewage pump well level	Submersible water level meter
Inlet sewage flow	Electromagnetic or Ultrasonic flow meter
Aeration tank pH	Glass Electrode
Aeration tank temperature	Resistance Thermometer
Aeration tank DO	Polarographic oxygen electrod
Aeration tank MLSS	Penetration Light Type
Blower air flow	Orifice flow meter
Return sludge flow	Electromagnetic flow meter
Waste sludge flow	Electromagnetic flow meter
Effluent flow	Electromagnetic or Ultrasonic flow meter
Sludge holding tank level	Pressure gauge
Mechanical thickener sludge flow	Electromagnetic flow meter
Gravity thickener sludge flow	Electromagnetic flow meter
Digester pressure	Ultrasonic / Differential Pressure Type
Digester level	Differential Pressure Type
Digester sludge temperature	Resistance Thermometer
Dewatering sludge flow	Electromagnetic flow meter

Source: Prepared by the Study Team

6) SCADA System

The SCADA system (Supervisory Control and Data Acquisition) is designed to facilitate monitoring and control of the treatment plant. All items such as alarms, status, and measuring can be monitored and recorded comprehensively from the SCADA.

The master computers which are installed in the control room located at Administration Building will be connected with all PLCs by LAN and will communicate with each other by Ethernet protocol. The master computers are a human-machine interface (HMI) which will monitor and control the plant through a graphical display.

Furthermore, the processed data in the computer are accumulated into the data server, which is connected to the logging and the alarm processing printers.

Telemetry-telecontrol system will be applied to intermediate pump stations to be automated. Data communication method will be public radio network or private optical fiber network.

7) Distribution and Cabling

All cablings which will be adopted are multi-core PVC/SWA/PVC/Cu or XLPE/SWA/PVC/Cu cables. Cables will be generally laid underground, together with concrete cable tiles and warning tape, or, where necessary, in concrete trenches and UPVC cable ducts. Concrete draw pits are provided as necessary.

Cables are fixed to cable trays in buildings. Cable trays are heavy duty, galvanized, return flange type and fixed to concrete walls. All cables are fully protected from UV degradation.

(9) Staged Construction

The current sewage inflow to existing sewage treatment plants is estimated below to prepare the staged construction plan as basic information.

As stated in **2.4 (2) 1), Part I**, the average population per household was declined from 5.22 in 1980 to 4.31 in 2010 in the country and from 5.33 to 3.93, respectively, in Selangor, which is sharper than the national average. Although the average population per household by administrative district in Census 2010 has not yet open, the Department of Statistics has declared the estimation of population, number of households and average population per household by administrative district annually apart from Census. **Table III-5.25** shows the estimated average population by household by administrative district in 2010 in Selangor.

Table III-5.25 Estimated Average Population by Household by Administrative District in Selangor (2010)

State / District	Population ('000)	Household ('000)	Average Population Per Household
Selangor State	5,102.6	1,374.1	3.7
Gombak	681.3	179.8	3.8
Klang	832.6	208.2	4.0
Kuala Langat	242.1	54.3	4.5
Kuala Selangor	202.0	45.9	4.4
Petaling	1,508.9	438.0	3.4
Sabak Bernam	138.2	30.9	4.5
Sepang	151.7	40.1	3.8
Ulu Langat	1,149.6	325.1	3.5
Ulu Selangor	196.1	51.8	3.8

Source: Prepared by the Study Team

Based on **Table III-5.25** the average population by household of Ulu Langat where Cheras and Kajang belong to is 3.5 persons or the second lowest following 3.4 persons of Petaling Jaya in Selangor. In Malaysia, the lowest is 3.2 persons in Benton, Pahang and Ulu Langat is ranked as the fourth.

It is no longer the time explicitly that one connection equals to 5 Population Equivalent (PE), which is different depending on administrative district and state. This is supported by the fact that the state population calculated by 5 PE/connection exceeds the present population largely, as shown in **Table III-2.5**. Therefore, an actual sewage inflow to the sewage treatment plants is expected to be 20% to 30% less than that calculated using the connected PE and per capita daily average sewage flow, as stated below.

In Malaysia, the per PE daily average sewage flow of 225 litres is used as a standard. The per capita daily average water consumption in Selangor varies in the range of 212 litres to 239 litres during the period of 2006 to 2010, which is almost equivalent to the above per PE daily average sewage flow. As there is no other reliable data on this matter, 225 litres shall be used as a standard in this Study.

The comparison of sewage flows between the actual and estimated ones is shown in **Table III-5.26**. From **Table III-5.26**, the actual flows at HLT235 and HLT165 are roughly equal to the calculated flows using 3.5 PE/connection, but that of HLT217 largely exceeds the calculated flow. It is unknown whether the measured flow shows the daily average or the momentary value at the measuring time. It should be noted that in case of the latter, it does not show the daily average.

Table III-5.26 Comparison between Calculated and Actual Flows

HLT CD		Connected PE (PE)	Estimated Flow		Measured Flow (m3/day)	Process
			5 PE/Conn. (m3/day)	3.5 PE/Conn. (m3/day)		
HLT235	Bandar Mahkota Cheras	25,944*[1]	5,837	**4,086**	**4,079*[1]**	IDEA
HLT165	CherasJaya	21,254*[1]	4,782	**3,348**	**2,500*[1]**	SBR
HLT217	Bandar Baru Bangi Sek 9	51,005*[2]	11,476	**8,033**	**14,777*[1]**	EA

Source: *[1] *IWK Data*
*[2] *Antara Report*

The proposed Kajang 3 Centralised Sewage Treatment Plant has a full design capacity of 920,000 PE including ground water infiltration, while the present total connected PE of Cheras Batu 11, Cheras Jaya, Kajang 1 and Kajang 3 is aprroximately 463,000 PE according to **Table III-2.4**, almost equivalent to half of a full design capacity. Even in case that the proposed plant will be constructed with a half size of a full design capacity in Phase 1, it is expected that the actual inflow will be 20% to 30% less than a design capacity and there will be no fear that the plant will be fully operated immediately.

In addition to this, all the existing small sewage treatment plants will not be connected to the new centralised sewage treatment plant in Phase 1, but will be connected during Phase 1 and Phase 2 separately. Hence, the plant will have an adequate capacity, even if being constructed with a half size of a full design capacity for a while.

There are three options for construction of sewage treatment plant as follows:

- Option 1: All facilities will be constructed at once with a full design capacity.
- Option 2: All the civil structures and buildings will be constructed at a full design capacity, while mechanical and electrical equipment will be installed by stage.
- Option 3: All the buildings including the administrative building will be constructed at a

full design capacity, while sewage and sludge treatment facilities and mechanical and electrical equipment will be installed by stage.

The comparative study is shown in **Table III-5.27**.

Based on the comparative study in **Table III-5.27**, option 3 is adopted for the Project from the viewpoint to protect the facilities from leaving unused as much as possible and alleviate a financial burden by initial investment. The sewage treatment plant is composed of two modules for a full design capacity and will be constructed by phase as required by an actual sewage flow incoming to a sewage treatment plant.

Table III-5.27 Comparative Study of Options

	Option 1	Option 2	Option 3
Financial burden	Initial investment is largest. In case of a loan, repayment is required for the construction cost for unused facilities.	Initial investment can be somewhat alleviated	Initial investment can be minimized.
Utilization of facilities	Many facilities will be left unused with much waste. Actual period of operation will be shorter.	For civil facilities, equivalent to Option 1	Waste is least.
Flexibility to change of structures or specifications	The change of type and system will be difficult.	As the civil structures will be constructed on the assumption that an initial plan will be unchanged in future, the flexibility to change the type or system of equipment in the next stage will be less.	Based on the actual status of O&M of existing facilities, the change of type and system of equipment will be possible. State-of-the-art technology will be adoptable.
Effect on O&M works	When a great accident will occur in the facilities in operation, other facilities will be usable as a stand-by. Even unused facilities, regular operational adjustment is required resulting in an extra work.	Even if a great accident will occur in the facilities in operation, other facilities will be unavailable due to no provision of mechanical and electrical equipment.	When a great accident will occur in the facilities in operation, sewage may be discharged into public water bodies without treatment.

Source: Prepared by the Study Team

6 Construction, Operation and Maintenance Cost

6.1 Project Component

This section presents project implementation plan and schedule for The Preparation Study on PPP Project of Water Sector in Malaysia. Components of the Project are shown in **Table III-6.1**.

Table III-6.1 Project Components

No.	Item	Phase 1	Phase 2	Remarks
1	Sewage Treatment Plant	104,000 m^3/day	103,000 m^3/day	Total 207,000 m^3/day
2	Trunk Sewer Pipe Pump Station	00～2,000 mm L=16.5 km 2 nos		
3	Branch Sewer Pipe Pump Station	100～1,050 mm L=89.7 km 24 nos		
4	IST Area Work	L=89.0 km 12,000 nos		

Source: Prepared by the Study Team

6.2 Construction Plan and Schedule

6.2.1 Sewage Treatment Facility

Sewage treatment plant will be constructed in Phase 1 and Phase 2. Facility with capacity of 104,000m^3/day for Phase 1 and with capacity of 103,000m^3/day will be constructed in Kajang 3.

- Construction Period: 3 years for Phase 1 and Phase 2 each
- Capacity: Phase 1 104,000 m^3/day
  Phase 2 103,000 m^3/day,
  Total 207,000 m^3/day
- Proposed Area: 7.33 ha
- Location: Kajang 3 CSTP site along Kajang-Semenyih By-Pass
- Facility: Wastewater Treatment Facility
  Grit Chamber/ Pump Station, Primary Clarifier/ Aeration Tank/ Secondary Clarifier, Disinfection Tank
  Sludge Treatment Facility
  Gravity Thickener, Mechanical Thickener, Dewatering Equipment, Digestion Tank, Gas Holder

6.2.2 Trunk Sewer

Total length of 16.5 km trunk sewer which connects branch sewer to proposed STP will be constructed in Phase 1.

- Construction Period: 3 years for Phase 1
- Diameter: Dia 300 mm to 2,000 mm
- Material: VCP, RCP, DIP (for force main)
- Total Pipe Length: 16.5 km
- Pump Station: 2 nos

6.2.3 Branch Sewer

Total length of 89.7 km branch sewer which connects existing STP to trunk sewer will be constructed.

- Construction Period: 6 years: (3years each for Phase 1 and Phase 2)
- Diameter: Dia 100mm to 1,050 mm
- Material: VCP, RCP, DIP (for force main)
- Total Pipe Length: 89.7 km
- Pump Station: 24 nos

6.2.4 IST Area Work

Total connection of 12,000 ISTs will be connected to sewerage system. The branch sewer construction which connects each house in IST area to branch sewer and house connection work is planned.

- Construction Period: 3 years for Branch Sewer for Phase 1 and Phase 2 each
  3 years for House Connection for mainly Phase 2 each
- Diameter: Dia 225 mm
- Material: VCP
- Total Pipe Length: 69.0 km
- House Connection: 12,000 ISTs

6.3 Construction Cost

The construction cost is estimated by the following approach. The contractor's site expenses, overhead and profit have been included into the respective cost items stipulated below.

6.3.1 Civil Works

The construction costs for civil works are estimated by unit cost basis. The unit construction costs of respective work items are presented in **Appendix III-6.1**. These were determined by referring to contracts recently estimated cost by other sewerage project, and other data that were collected, examined and analyzed. Each unit cost includes 1) labor cost, 2) construction material price, 3) construction equipment cost, 4) contractor's overhead/profit and 5) tax.

6.3.2 Trunk and Branch Sewer Installation Works

Unit price for pipe installation is estimated by past construction price.

Unit prices for excavation, backfilling, pipe base work and asphalt pavement are estimated by quantity survey. Cost of CCTV camera inspection and connection/ demolition of existing STP s are included.

6.3.3 Mechanical and Electrical Works

Major equipment is decided by quotation basis. The other cost of mechanical and electrical equipment is adopted assessed value by past construction price in other sewerage project.

6.3.4 Building Works

The cost for building works is estimated by unit cost basis of building area.

Construction cost is tabulated in **Table III-6.2**. Breakdown of construction cost is shown in **Appendices III-6.1** to **III-6.3**

Table III-6.2 Construction Cost

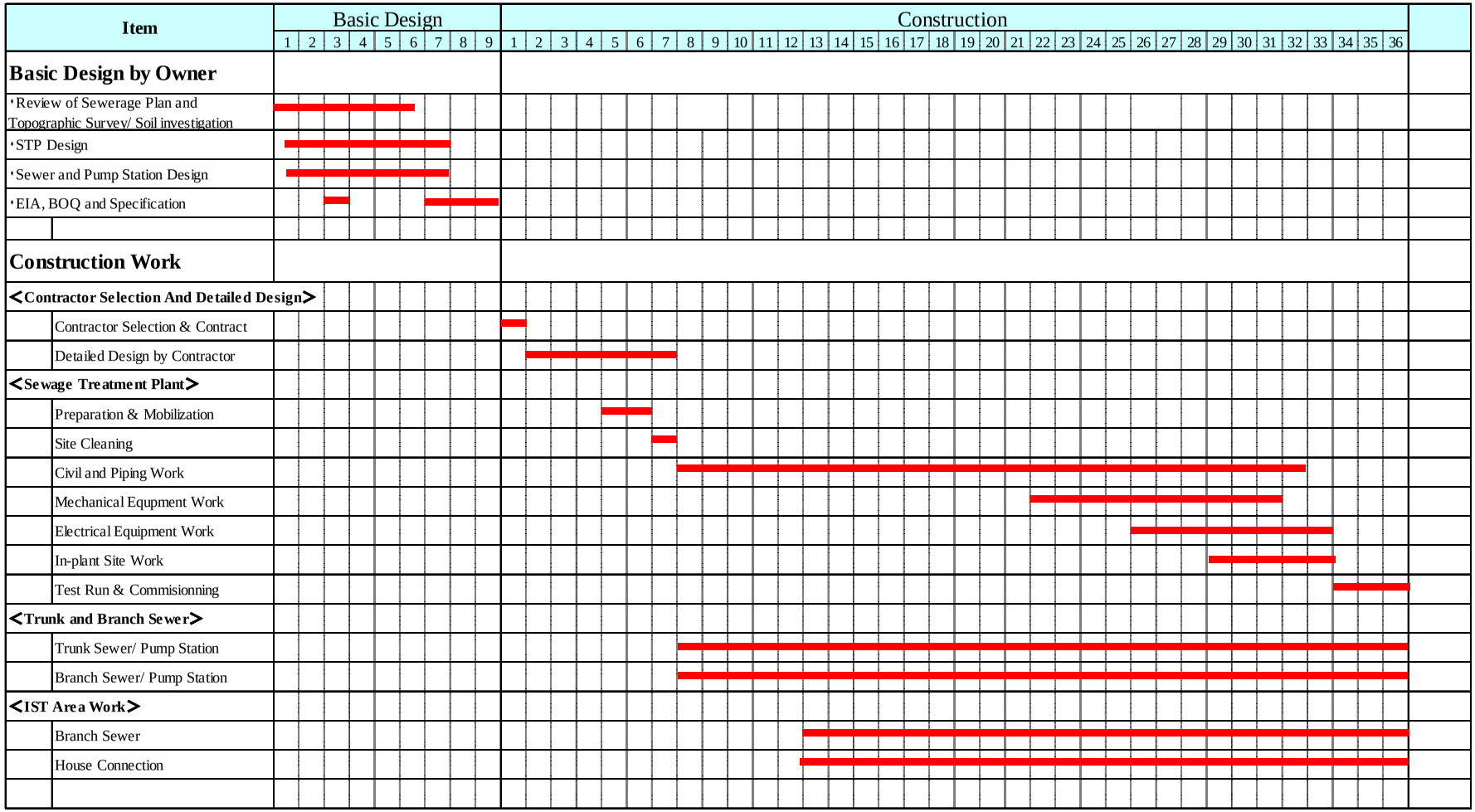
(Unit: RM)

No.	Facility Name	Outline	Work Item	Phase 1	Phase 2	Total
1	Sewage Treatment Plant (STP)	Wastewater Treatment Facility, Sludge Treatment Facility	Civil/Building Work	146,278,000	84,240,000	230,518,000
			Mechanical Equipment	97,733,235	80,581,875	178,315,110
			Electrical Equipment	62,837,112	42,745,408	105,582,520
			STP Sub-Total	**306,848,347**	**207,567,283**	**514,415,630**
2	Trunk Sewer	φ300～2000mm, L=16.5km, 2PS	Pipe	115,112,520		115,112,520
			Pump Station	38,553,130		38,553,130
			TS Sub-Total	**153,665,650**		**153,665,650**
3	Branch Sewer	φ100～1050mm, L=89.7km, 24 PS	Pipe			291,419,620
			Pump Station			70,556,350
			Sub-Total			**361,975,970**
4	IST Area Work	φ225mm, L=69.0km, 12,000 Houses	Branch Sewer			33,915,342
			House Connection			71,946,000
			Sub-Total			**105,861,342**
Total			Rm			1,135,918,592
			Round Rm			**1,135,919,000**
			Round Yen			**29,893 mil.Yen**

Source: Prepared by the Study Team

6.4 Construction Schedule

Construction work will be started after basic design conducted by the owner. Total period for detailed design and construction work is estimate 36 months. Detailed design which conducted before construction work by contractor is estimated about 6 month included preparation work & mobilization and site clearance. Construction work period is estimated about 30 months for STP and pump station construction and trunk sewer and branch sewer installation. House connection work for IST area is estimated 60 months. Construction schedule is shown in **Figure III-6.1**.



Source: Prepared by the Study Team

Figure III-6.1 Construction Schedule

6.5 O&M Costs

These O&M costs will be represented anticipated yearly expenditures for Manpower, Chorine Polymer, Electricity, Repair Cost, Contingency and Others. The maintenance work for sewer pipe will be conducted by outsourcing.

Annual operation and maintenance cost is estimated 20,970 thousand Rm for STP, 6,400 thousand RM for pump station and 192,000 RM for sewer pipe. Breakdown of O&M cost is shown in **Table III-6.3, 7.4 and 6.5** respectively. Breakdown of O&M cost is shown in **Appendix III-6.5**

Table III-6.3 Breakdown of Annual O&M Costs for STP

	O&M Cost Items	O&M Cost (RM/year)
1	Manpower	1,926,000
2	Chlorine	2,115,540
3	Polymer	3,704,896
4	Electricity	8,288,004
5	Sludge Disposal	-
6	Repair Cost	1,295,925
7	Others	1,733,037
8	Contingency (10%)	1,906,340
	Total	**20,969,742**

Source: Prepared by the Study Team

Table III-6.4 Breakdown of Annual O&M Costs for Pump Station

	O&M Cost Items	O&M Cost (RM/year)
1	Electricity	5,713,000
2	Screening	96,000
3	Repair Cost	286,000
4	Others	305,000
	Total	**6,400,000**

Source: Prepared by the Study Team

Table III-6.5 Annual Maintenance Costs for Sewer Pipe

	O&M Cost Items	O&M Cost (RM/year)
1	Cleaning of Pipe for Outsource	**192,000**

Source: Prepared by the Study Team

7 Relevance to "Sewage Treatment Plant Project (II) in Malaysia"

As mentioned in **3.1**, in the report of "Sewerage Catchment Planning and Sludge Management Strategy Study for Upper Langat River Basin" prepared by JPP in November 2009, the sewerage catchments of Cheras and Kajang in Selangor are sub-divided into five sewerage sub-catchments or Cheras Batu 11, Cheras Jaya, Kajang 1, Kajang 2 and Kajang 3, respectively, and an individual centralized sewage treatment plant is proposed for each.

While in the report of "The Preparatory Survey for Sewage Treatment Plant Project (II)" by JICA in September 2009, seventeen (17) sewage treatment plant construction projects are selected as priority projects for prioritization. Out of them, Batu 11, Kajang 3, Kajang 1 and Cheras Jaya in Selangor are highly ranked as third, fourth, seventh and seventh, respectively, as shown in **Table III-7.1**, which are the same sub-catchments as mentioned in the above JPP's report (For the remaining Kajang 2 sub-catchment, JPP has already selected the contractors for construction of the Kajang 2 centralized sewage treatment plant and a sewer system, respectively, as of January 31, 2012.).

The PPP scheme proposed in this Study is to integrate above four sub-catchments and construct only one centralized sewage treatment plant in the proposed site for Kajang 3 CSTP as well as the construction of an integrated sewer system

Table III-7.1 Priority Projects for National Sewage Treatment Projects Phase II

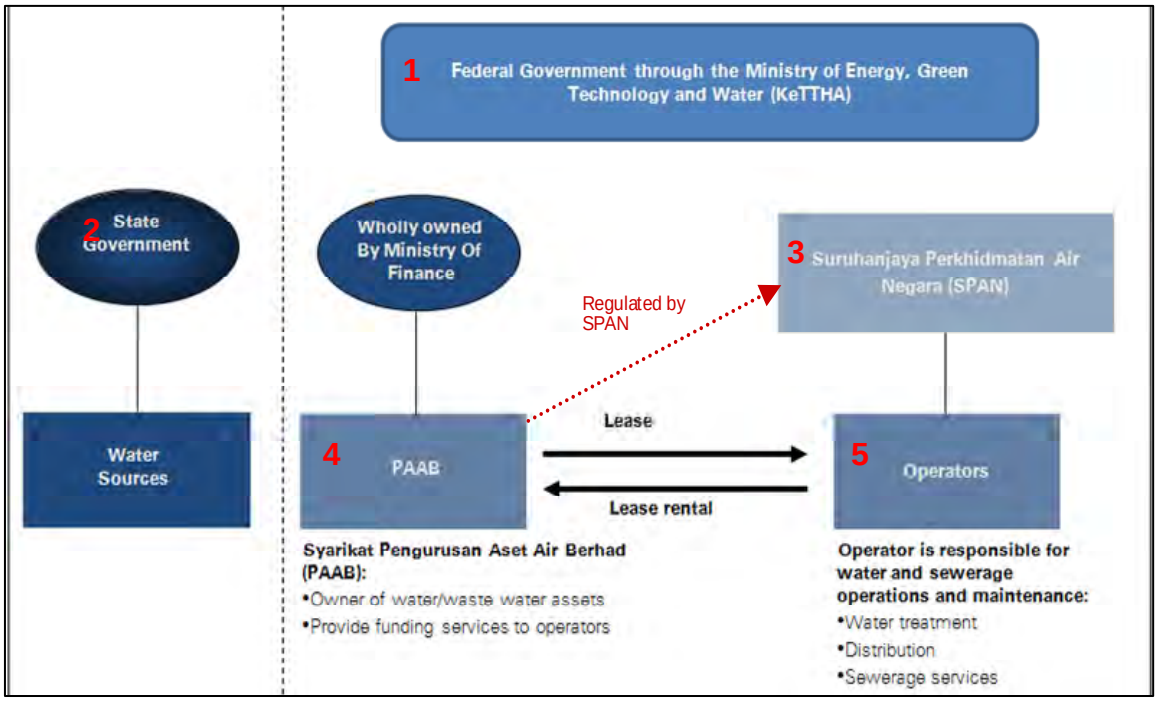
State	Location	Assessment Result	Land Status	Priority
W.P.K.L.	Pantai	40	Completed	1
W.P.K.L.	Jinjang Kepong	39	Under process	2
Selangor	Batu 11	36	Completed	3
Sabah	Kota Kinabalu	34	Completed	4
Selangor	Kajang 3	34	Under process	4
Perak	Papan	33	Completed	6
P. Pinang	Batu Feringghi	32	Completed	7
Selangor	Kajang 1	32	Under process	7
Selangor	Cheras Java	32	Completed	7
Johor	Johor Baru City	29	Under process	10
Sarawak	Miri	29	Under process	10
Pahang	Bandar Kuantan	27	Completed	12
Terengganu	Kuala Terengganu Selantan	26	Under process	13
Johor	Taman Kota Kulai & Taman Puteri Kulai	26	Completed	13
Pahang	Bandar Bentong	22	Under process	15
Kedah	Kota Setar	21	Completed	16
Perak	Kuala Kangsar	21	Under process	16

Source: "Preparatory Survey for Sewage Treatment Plant Project (II)",JICA, September 2009

8 Project Structure

8.1 Proposed PPP Framework

The Federal Government began the water services industry (consisting of water and sewerage sector) restructuring in 2004. A new operating model was introduced to reform the water services industry. There are five (5) key stakeholders which comprises of the Federal Government, State Government, the water regulator, the water asset management company and the water operators who operate the whole value chain. The new operating model is depicted in **Figure III-8.1**.



Source: The Water Tablet: Malaysian Water Reforms, 2008

Figure III-8.1 New Operating Model of the Malaysian Water Services Industry

The instrument to restructure or to enable the new operating model in the water and sewerage sector was based on the promulgation of the National Water Services Commission 2006 and the Water Services Industry Act 2006.

8.1.1 The Water Industry Reforms – after the enactment of WSIA 2006

- Institutional reforms: This resulted with the industry adopting a licensing regime and regulated by Suruhanjaya Perkhidmatan Air Negara ("SPAN") or the "Water Regulator".
- Financial reforms: This resulted in the industry being moved into an "Asset-light" operating environment for water operators where the funding of new capital development for industry is facilitated by Pengurusan Aset Air Berhad ("PAAB" or "Water Asset Management Company").

In the new operating model, a water asset management company was set-up under the Ministry of Finance (MOF), which is now known as Pengurusan Aset Air Berhad (PAAB). Under the new operating model, the financing of infrastructure assets in the water services industry for water operators are alleviated through PAAB. The water operators operate as "Asset-Light" entities which focus on O&M only. The principal role of PAAB is to raise funding to acquire existing and fund new infrastructure assets in the water services industry. PAAB is also tasked to the following objectives[4]:

[4] "*Inside PAAB*" - http://www.paab.my/inside-paab

a) to construct, refurbish, improve, upgrade, maintain and repair water infrastructure and all other assets in relation to the water systems;
b) to source and obtain competitive financing for the development of the nation's water assets and lease such assets to the water operators licensed by SPAN for operations and maintenance; and
c) to assist SPAN to restructure the nation's water services industry towards achieving the Government's vision for efficient and quality water services.

More importantly, PAAB is established as a means of funding CAPEX for as long as the industry has not reached a full-cost recovery.

It is understood that WSIA concept intends to realise "Asset-light" model to alleviate financial burden of water operators where PAAB raise funds and lease to water operators. In view of massive investment required to improve water services industry both water and sewerage infrastructure, PAAB may face funding constraint to complete migration of water assets and construction of new assets.

The LMP proposes to introduce PPP scheme to relax the burden borne by the Public sector (PAAB or JPP/IWK) to construct new sewerage infrastructure (Sewage Treatment Plants / Sewer Networks) as if public sector plays a same role as PAAB in water sector.

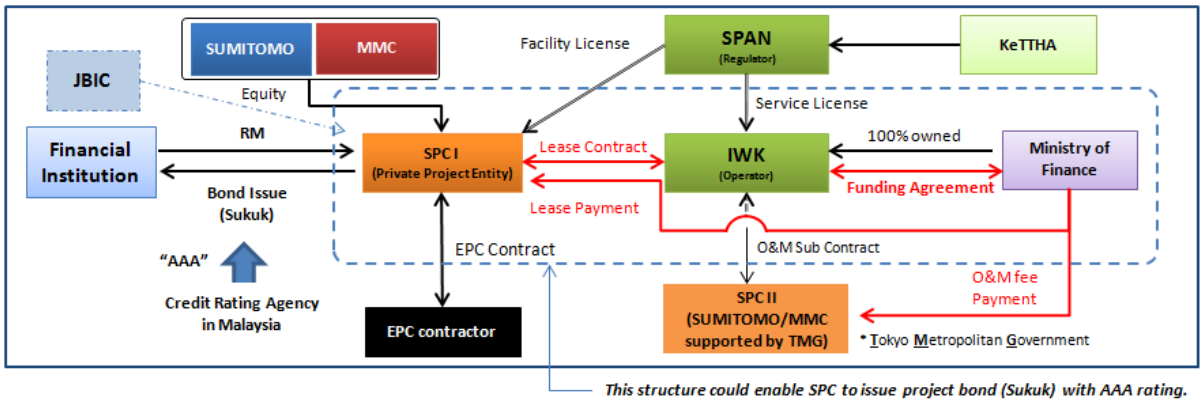
In this respect, concept of the LMP could facilitate the sewerage sector reform to catch up with ongoing water sector reform. By introducing PPP scheme in sewerage infrastructure development, PAAB can focus on solely water sector reform.

Once the sewerage sector is rationalized, driven by the PPP in terms of operational efficiency and financial soundness, it could help in the integration of sewerage and water sector operators.

8.2 Investment Structure

Shareholder's funds provided by private companies will finance the equity portion of the LMP. **Two Special Purpose Companies ("SPC")** will be established by MMC and Sumitomo:

- **SPC I** will be responsible for **development, design, engineering, procurement, construction and financing.** A lease contract will be arranged among SPC I, IWK and MOF. Upon obtaining a facility license from SPAN, SPC I is to be a facility owner of the project. Lease payments will be paid by MOF.
- **SPC II** will be responsible for **O&M** of the plant. The O&M sub-contract will be arranged among SPC II, IWK and MOF where O&M fee is to be paid by MOF. The service license will be owned by IWK and is sub-contracted to SPC II.



Source: Prepared by the Study Team

Figure III-8.2 Proposed PPP Scheme to Rationalise the Malaysian Sewerage Industry

8.3 Financing Structure

The debt portion of the project will be financed locally through the bond issuance in Malaysian Ringgit under the project finance scheme arranged by the private companies with the properly designed contractual framework to attract long term investors. Details are discussed in section 6.

8.4 Contractual Structure

With respect to the current licensing regime set in WSIA, we plan to adopt a leasing scheme where the lease agreement is a core agreement in the model project structure. Following project documents, but not limited to, are to be considered and discussed later stage.

- **Lease agreement** between **SPC I, MOF** and **IWK**
- **EPC agreement** between **SPC I** and **EPC contractor**
- **O&M agreement** between **SPC II, MOF** and **IWK**

Under this model, provided that the Federal Government and IWK waive the exclusive rights under the Concession Agreement, SPC I can obtain a facility license to own the project plant as provided under WSIA.

SPC I, as the owner conferred by the facility license, will lease the project plant to IWK to provide sewerage services as the services licensee.

In relation to the O&M sub contracting, we wish to highlight the following:
Section 12 of WSIA stipulates that:

> *"(1) The grant of an individual licence under Section 9 shall be personal to the individual licensee and the individual licence shall not be assigned, sub-licensed or transferred to any other person except with the prior written approval of the Minister.*
>
> *(2) An individual licensee who assigns, sub-licenses or transfers its individual licence to any other person without the prior written approval of the Minister commits an offence and shall, on conviction, be liable to a fine not exceeding three hundred thousand ringgit or to imprisonment for a term not exceeding three years or to both."*

Pursuant to the above, it may be gleaned that the assignment or sub-contracting of the individual license is subject to the written approval of the Minister. As has been mentioned earlier, since IWK has a subsisting concession agreement, we believe that reference must therefore be made first to the said agreement to ascertain whether or not the license provided to IWK may be sub-contracted. At this juncture, we are not made privy to the said agreement and thus cannot confirm on the same.

MMC and Sumitomo as project sponsors of SPC I will be responsible for the design and construction of the plant and sewer networks where SPC I will employ capable and reliable EPC contractor. However, since IWK has a subsisting Concession Agreement with the Government, reference has to be made to clause (c) that confers IWK exclusive rights to:

Clause (c) to plan, design, construct and commission new public sewerage systems;

Therefore, we would like to seek the approval from IWK and the Federal Government by virtue of the exclusive rights conferred to IWK to build new sewerage systems.

This model is in line with the envisaged WSIA model. Under WSIA, although it is not specifically provided, it is envisaged that the facilities licensee and the service licensee both be separate i.e. one party should not be both entities. This was one of the ideas that were put forth when formulating WSIA in order to ensure a better and more efficient service.

9 Financing Plan

9.1 Proposed Financing Plan

The proposed financing plan for the LMP is largely premised on our key underlying beliefs to the Malaysian government as below, that it is advisable to consider the following:

- To introduce **private finance** for sewerage projects to reduce the Public sector's funding obligation and construction management responsibility. As explained before, private financing initiative under PPP structure will be recommended as an effective way to pass through funding obligations as well as responsibility of project construction and management to the private sector. However, the challenge lies in the strict bond market. One typical feature of the profile of investors in the Malaysian bond market is their risk adverse attitude towards investment. Therefore, only AAA-rated bonds are qualified to be major targets of institutional investors such as the insurance companies, pension fund like the Employee's Provident Fund (EPF).
- To attract risk adverse institutional investors in meeting the funding needs of **long-term sewerage infrastructure developments,** optimal balance in risk sharing arrangement between the public sector and the private sector is one of critical factors**.**
- To utilise **Islamic finance** given Malaysia's position as one of the largest Islamic finance markets in the world in terms of transaction volume, providing the LMP access to a larger investor base.

Based on the above, we would like to propose that the LMP is financed via **Islamic Bonds issued by the SPC secured by lease payment agreement with MOF.**

9.1.1 Islamic Bonds issued by SPC secured by lease payment agreement with MOF

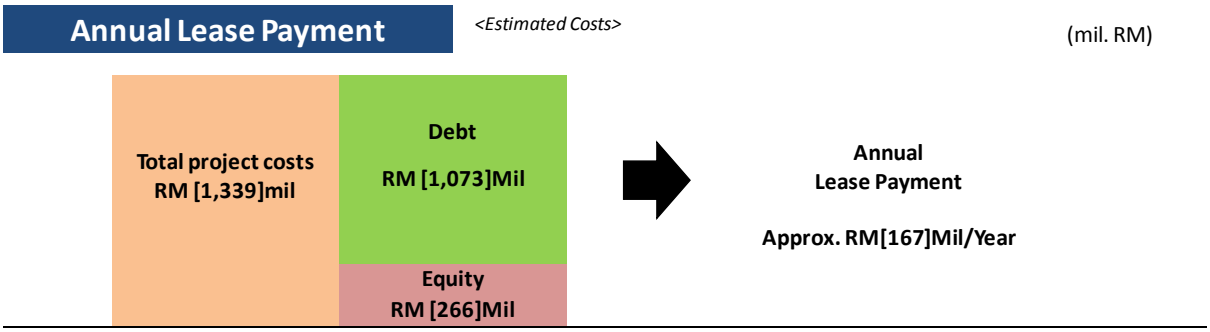
(1) Overview (Refer to **Figure III-8.2**)
In line with our key underlying beliefs, this proposed financing plan utilises private finance in the form of Islamic bonds (sukuk) issued by the SPC (held by private sector shareholders), and is secured with a lease payment agreement with MOF to support the funding of the LMP.

(2) Financing Details
Under the structure, SPC is going to pay coupon to bond holders. Our finance cost projection for SPC Islamic Bonds secured by lease payment agreement with MOF will be the following;
(1) Reference Rate: 20year - 5.24%

- Referred to the yield of Malaysian government bond as at 24th of October, 2011 plus premium.
- The premium range is presumed circa 1.13% (AAA corporate guarantee level).
- The yield of the 20-year Malaysian Government Bond is 4.11%.

9.1.2 Annual Lease Payments for CAPEX

The total estimated project cost up to RM1,339 million is planned to be financed with a 80:20 debt to equity ratio; i.e. RM1,073 million in debt and RM266 million in equity. Annual lease payments from MOF will only commence after the commercial operation date in 2016 for 20 years. This translates into and annual lease payment of RM167 million, and is illustrated in **Figure III-9.1**.



Source: Prepared by the Study Team

Figure III-9.1 Estimated Annual Lease Payment from MOF to SPC I

The benefits of this arrangement to the GOM are two-fold:

- The CAPEX to fund the construction of the LMP will be fully financed by private sector funds at highly competitive rates.
- The annual lease payments will only commence after the construction of the LMP is complete, relieving the government of the heavy front-loaded CAPEX financial burden.

The key assumption which we are making here is that MOF is agreeable to fund the annual lease payments upon the completion of the LMP's construction.

9.1.3 Annual OPEX Payments

To facilitate the provision of O&M services to the LMP, an O&M subcontracting company will be established by MMC/Sumitomo. The company will provide O&M service to the LMP for 20 years after the commercial operation date in 2016.

The average annual estimated OPEX is approximately RM31 million, including the sludge disposal cost. There will be additional estimated average savings of OPEX by RM6.2 million per year, should the treated sludge be taken by fertilizer companies.

Benefits of Proposed Financing Plan

It is noted that, due to the guarantee fee, the projected financing rates for the proposed financing plan is 1.5% to 2.5% higher than PAAB's estimated financing rates. However this project will be funded by private sector finance instead of government funds, therefore **alleviating the government's financial burden.**

As the SPC's income stream will be secured by an annual lease payment with MOF, it is highly likely that the SPC Islamic bonds would be rated as **AAA**, and would attract investors which require low-risk and strong credibility.

Furthermore, the utilisation of long term Islamic bonds will be in line with the government's agenda, expanding the Malaysian financing market as a **global Islamic finance hub**.

9.2 International Financing Programs – Potential Utilization of Financing from the Japanese Government

Currently, the Japanese Government prepares a variety of financing programs to support the development of international infrastructure projects that Japanese private companies are involved in (i.e. "Japanese Finance"). Subject to credit assessment, Japanese Finance can provide long-term loans that could reach up to 20 years, which can bring about economic benefits to the host countries of the projects in question, which in the LMP's case would be Malaysia.

Although the proposed financing plan for the LMP was assumed that the Islamic bonds in Malaysia Ringgit issued by the SPC undertaking the LMP's development, JBIC is also in the process of

studying if a more attractive financing scheme for the LMP could be introduced.

Apart from that, JBIC has signed a MOU with Bank Negara Malaysia in 2007 to cooperate each other in relation to the promotion of Islamic finance to contribute for development of Asian region. JBIC has been studying Islamic finance and keen on expanding its global network in relation to Islamic finance.

It is envisioned that the LMP's potential utilisation Japanese Finance will enhance the government-to-government (G2G) relationship between Japan and Malaysia, which is extremely important for long term infrastructure projects. In fact that Japanese government through JICA provided several technical support programs where IWK engineers were dispatched to Japan and got training, and JICA experts conducted the OJT for IWK engineers in Malaysia, since Japanese Government was willing to contribute to the improvement of the sewerage sector providing not only the loan for the construction of infrastructure but also support operational improvement once they committed financing in the sector. We foresee that the LMP, if executed successfully, will be replicated for future STP projects, paving the way for the long-term sustainability of the Malaysian sewerage industry (explained further in Section 8). This would require substantial amount of long term financing, of which Japanese Finance can be of great assistance.

10 Financial and Economic Analysis

10.1 General Overview

It goes without saying that the Government must plan and execute an efficient and effective public investment to create demand and stimulate the future economy. However, the question of its efficiency and effectiveness of the plan may be raised and scrutinised by the public. It has become increasingly complicated and difficult especially for developed countries to select the best investment plan within their limited resources without compromising public support.
In terms of macro economics, GDP can be increased directly by Government's expenditure. However, not thoroughly considering the efficiency and effectiveness of such public investments it could cause a huge budget deficit, placing heavy burden on the future generations. These are the historical facts that many developed countries have experienced or are still experiencing.

To assess the efficiency and effectiveness of an investment, cost-benefit analysis (CBA) is usually applied. In this method, factors are quantified as "benefits" and are compared with "costs". It started out of a need to quantitatively assess whether a business or society at large would experience a net benefit from a given project. The methodology entails the systematic estimation of all benefits and all costs of a contemplated course of action in comparison with alternative courses of action. CBA considers gains and losses to all members of the community who are affected by the project being considered. The analysis should not concentrate solely on the financial implications of a project but other tangible and intangible externalities must be assessed.

In this section, with reference to this method, we attempt to quantify the factors of the LMP and make a comparison to prove that the LMP is advantageous both quantitatively and qualitatively.

As mentioned in **5.7**, it is an underlying belief of the LMP that the existing scattered small-scale STPs in Langat area should be demolished and integrated into one centralized STP, which will be constructed in Kajang 3 and incorporate the technical knowledge from TMG. On the other hand, there is the JPP Project which plans to construct 3 STPs in Cheras Batu 11, Cheras Jaya, and Kajang 3. As the JPP Project has not been decided in details, we have made reasonable assumptions for it and use the value for comparison with the LMP.

10.2 Key Assumptions of the Financial and Economic Analyses

10.2.1 Structure

(1) Langat Model Project Proposal

As mentioned in **8.2**, our proposed structure is to take care of EPC, O&M and Funding by SPC I and SPC II established by MMC and Sumitomo. The Private Sector's deep and long term involvement is the key of this proposed structure.

(2) JPP Project

We assume that the plan to construct 3 STPs in the area would be executed in the conventional implementation process where JPP will call tenders and select contractors in EPC basis. The Private Sector's involvement in O&M and Funding is not considered.

10.2.2 CAPEX

(1) Langat Model Project Proposal

Capital expenditures are divided into two stages based on the actual required capacity (PE) projection. Both stages include the costs of sewerage treatment plant, sewer network, and green technologies as mentioned in **6.3**. Although our proposed STP covers all sewage from 4 sub-catchments (Cheras Batu 11, Cheras Jaya, Kajang-1 and Kajang-3) within the limited land space using deep aeration method which requires more excavation civil work, our CAPEX is estimated to be within JPP project budget.

(2) JPP Project

Capital expenditures are divided into two stages as well to be matched with our proposal. As 3 STPs are constructed in separate locations, the CAPEX is expected to be higher than our proposal due to less scale merit.

10.2.3 OPEX

(1) Langat Model Project Proposal

The LMP's OPEX consists of operation & maintenance costs in the STP such as chlorine, polymer, electricity, labour, repair, and operation & maintenance costs in the pump station & sewer network such as electricity, screenings, and repair. Sludge disposal costs are assumed though, if treated sludge will be taken over by selected fertilizer companies for fertilizer use which can be result in minimizing the cost in our proposal. In addition, electricity costs can be saved by bio gas generation from the sludge digestion.

(2) JPP Project

JPP Project's OPEX includes the same operation & maintenance costs as our proposal, and sludge disposal costs are also included. JPP Project's OPEX is assumed much higher than our proposal because operating 3 separated STPs in different locations will lead to less efficient operations and require extra consumables stock and extra human resources.

10.2.4 Finance

(1) Langat Model Project Proposal

The LMP's funding consists of 20% of equity and 80% of debt. The debt funding comes from the Sukuk issued by the SPC. The details are shown below;

Table III-10.1 LMP Financing Assumptions

Funding source	Equity	SPC Sukuk
Share	20%	80%
Tenor	-	23 years including construction period
Assumed Rate	-	5.24%

Source: Prepared by the Study Team

The above tenure and rate would require further study and is subject to change.

(2) JPP Project

For the JPP Project, there is no applicable interest rate for the financing as it has been approved and allotted in the Government budget. However, this would aggravate the financial sustainability of the Government if it plans to continue increasing expenditure and widening its deficit. It is assumed as if PPP and private funding be utilized to address the situation. For the purpose of this analysis, the following interest rate is assumed.

Table III-10.2 JPP Project Financing Assumptions

Funding Source	Commercial Bank
Share	100%
Tenor	23 years including construction period
Assumed Rate	5.24%

Source: Prepared by the Study Team

10.2.5 Revenues

In both the LMP and JPP Project, same assumptions are used on the revenue projection, which means projected population equivalent multiplied with average tariffs.

10.2.6 Economic Benefits

The likely economic benefits for LMP and JPP are further elaborated in detail as follows. Limited by measurement problems, the aim of this analysis is not to include all the benefits, but to capture the most tangible and measurable one which is Land Re-Development. This approach was adopted not only because of the difficulties of measuring some types of economic benefit due to environmental changes, but also because the selected benefits were most likely to occur in all settings. In addition to the Land Re-Development, potential economic benefits have also been indicated

(1) Langat Model Project Proposal

(a) Land Re-development

The construction of a centralised STP will result in the shutdowns of existing STPs. The land where the STPs are located can be utilized for other development purposes. In addition, the land sites at Cheras Batu 11 and Cheras Jaya which are to be used for the construction of STPs under JPP can then be developed for other purposes. The estimated land price of these available sites will be included in the CBA.

(b) Electricity cost savings

With the installations of a bio gas generation facility, the plant can partially self-sustain itself by generating its own electricity. The expected power generation from the bio gas generation facility is approximately 3,500,000kWh per year.

(c) Reduced carbon dioxide emission

At the Copenhagen Climate Change Summit, Prime Minister Datuk Seri Najib Tun Razak made a pledge to reduce carbon dioxide emissions to 40% by 2020 compared to the levels in 2005[5]. This is equivalent to 42.2 million tonnes of carbon dioxide[6]. Recycling gas generated from sludge into fuel generation will vastly reduce carbon dioxide emissions as methane produces 21 times more greenhouse effect than carbon dioxide.

(d) Future of Renewable Energy (RE)

As part of Malaysia's key strategies to achieve a high-income economy and be a developed nation, holistic and sustainable development as laid out in Budget 2010 will be the foundation for the development of the new economic model and the formulation of the 10th Malaysian Plan. The budget also stressed the participation of the private sector in driving the economy to bring about this transformation. In line with the new economic model, the government is promoting green technology and various initiatives towards sustainable development.

Under the Renewable Energy Act, the four renewable energy (RE) resources eligible for feed-in-tariff (FiT) are biogas, biomass, small hydropower and solar photovoltaic. Currently, the electricity generated will be used to power the plant. Moving forward, the plant can expand and double as a power generation facility. This will entitle the plant to be eligible to apply for FiT. This will help reduce the nation's dependency on coal and gas for power generation.

(e) Reduced Contamination at Langat River

The Langat River is contaminated with high level of ammonia. Other factors that contribute to the densely polluted river are factory effluents, illegal waste disposal, contaminated water leaking from landfill, gray water, and environmental change of river source. This is deeply worsened by the fact that effluent nearby STPs has caused the shutdown of Cheras Batu 11

[5] *Najib Returns from Copenhagen*, The Star Online, 20 December 2009
[6] *Enter a New Era of Green Energy, The Star BizWeek, 3 December 2011*

Water Treatment Plant. With the new centralised plant, STPs located upstream can be shut down, thus reducing effluents from the sewages. The step-feed multi-stage denitrification process which will be used in the plant will also greatly reduce the levels of ammonia produced through high levels of denitrification.

(f) Technical transfer

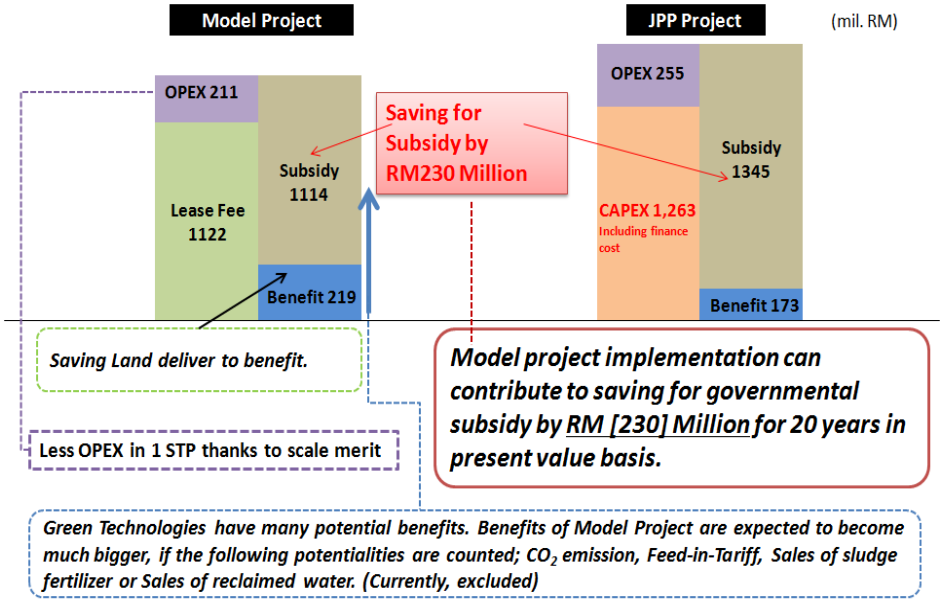
Technical transfer by TMG is also proposed as stated in Section 4. It is much more difficult to quantify the effect by technical transfer to sewerage sector, but it can cater additional value to improve operational efficiency though the LMP.

(2) JPP Project

In JPP Project, the existing STPs will be demolished, just as the LMP, and thus the estimate land price of these existing STPs will included as an economic benefit. This however will be lesser than the sum of land prices for LMP as it will not include the land price for Cheras Batu 11 and Cheras Jaya.

10.3 Evaluation of the Financial and Economic Analyses

Based on the key assumptions as stated in sub sections above, an analysis of the financial and economic aspects of both the LMP and JPP Project was conducted, and the present value basis comparison of the analysis is illustrated as below:



Source: Prepared by the Study Team

Figure III-10.1 Present Value Basis Comparison between the LMP and JPP Project

Based on the analysis, the key financial and economic benefits are detailed as below:

- **Lower Capital and Operating Expenditure (CAPEX and OPEX)** – The LMP's single and centralised STP is projected to cost a total CAPEX of up to RM1,122 million and OPEX of up to RM211 million over the period of 20 years. Taking into account the benefits derived from the savings on land use, it will result in savings in subsidy by RM230 million if compared to the estimated costs of the JPP Project for 3 separate STPs, with CAPEX estimated at RM1,263 million, OPEX of RM225 million and benefits estimated at RM173 million over the same period.
- **Private Financing at Favourable Financing Rates** – The LMP would be financed entirely by private funds with a debt to equity ratio of 80:20. The average cost of debt from the various sources of debt is 5.24% for 80% of the debt; compared to an estimated the same interest rate for 100% of the debt financing for the JPP Project.

- **Economic Benefits** – The LMP will bring about several economic benefits, primarily through the value derived from the utilisation of land in Cheras Batu 11 and Cheras Jaya for development which would bring positive economic impact. Apart from that, other economic benefits include reduction in operating costs and CO2 emissions. Through utilizing green technology, it also would address the Langat River pollution. Besides, the technical transfer advisory fee arising from the technical support from TMG to the LMP would also be an added economic benefit.

11 Operation and Effect Indicators

To check the progress status and effect of the proposed Project, the operation and effect indicators are defined as shown in **Table III-11.1** and **Table III-11.2**.

11.1 Operation Indicators

The operation indicators are set to show how efficiently the sewerage services is operated to achieve the targets

Although a number of existing small sewage treatment plants are currently in service, the baseline is set as zero to show the operation status of the newly-constructed centralized sewage treatment plant.

- Sewage treatment population and sewage flow will increase as the sewage collected by existing sewage treatment plants and in the present IST areas will be re-connected to the newly-constructed sewer system to the centralized sewage treatment plant. Sewage treatment population is calculated by a number of domestic connections by the per household average population, but the per household average population should be based on the results of census for population and housing declared by the Department of Statistics Malaysia but not use of 1 connection = 5 persons
- Facility utilisation rate is set for identifying the necessity for expansion, but has a tendency that the value will be dropped after facility completion.
- One of the proposed Project is to integrate a number of existing small sewage treatment plants to only one centralised sewage treatment plant and this indicator shows the progress status of sewerage service.
- If IST areas will be connected to a public sewerage system under the public burden, this indicator shows the progress status of connection works at IST areas.
- Trunk sewers coverage rate shows the progress status of trunk sewer construction works in the spans defined as trunk sewers beforehand.
- BOD_5 removal efficiency is to check whether the newly-constructed centralize sewage treatment plant will work out as planned.
- Sludge reuse rate is to check how extent sewage sludge generated from newly-constructed centralize sewage treatment plant will be utilized for other purposes than reclaimed land disposal. In this context, the use of digestion gas power generation and/or fertilizer is supposed.

11.2 Effect Indicators

The effect indicators are set to show how extent the life of the people will be comfortable and water environment will be conserved by the implementation of the Project

- The improvement status of water quality of the Langat River as a receiving water body will be checked using the annual average BOD_5 concentration at the DOE monitoring station of 1L04 which is located at the upstream of the confluence of the Jeloh River.
- The population coverage by sewerage is to show the acceptance of sewerage by the people. The population in the study area shall be reviewed at the time of census.
- The compliance status with the sewage effluent discharge standard will be checked with BOD_5 as a typical organic pollution index, T-N to show the denitrification performance of the sewage treatment process adopted, and O&G which is a parameter that most existing sewage treatment plants cannot comply to.
- Power reduction rate is used to measure the green technology impact that may be adopted at the proposed sewage treatment plant.

Table III-11.1 Operation Indicators for Sewerage

Category	Name of indicators	Calculation equation of indicators	Target				Purpose
			Present	2016	2020	2025	
Base	Served population by sewerage	= (No. of domestic conn.) × (Per household average population)	0	0	570,000	670,00	Evaluate what extent the people use a public sewerage system
Base	Sewage flow to be treated	Same as the name	0	0	128,000 m3/day	151,000 m3/day	Evaluate the integration progress of exiting STPs
Base	Facility utilization rate	= (Daily average sewage flow) / (treatment capacity)	0	0	62%	73%	Evaluate what extent a treatment capacity is utilized.
Assist	Integration rate of existing STPs	= (No. of STPs connected) / (No. of existing STPs)	0	0	30%	100%	Evaluate the integration progress of exiting STPs
Assist	Connection rate of ISTs	= (No. of ISTs connected) / (No. of existing ISTs)	0	0			(Option) Evaluate the connection progress of exiting ISTs
Assist	Trunk sewer coverage rate	= (Pipe length installed) / (Pipe length planned)	0	0	100%	100%	Evaluate the sewerage development is properly implemented
Assist	BOD_5 removal efficiency	= (Inf..BOD_5－Eff. BOD_5) / Inf. BOD_5 × 100	0	0	95.6%	95.6%	Evaluate what extent the sewage treatment work out
Assist	T-N removal efficiency	= (Inf. T-N－Eff. T-N) / Inf. T-N × 100	0	0	66%	66%	Evaluate what extent the sewage treatment work out
Assist	Reuse rate of sewage sludge	= (Sludge amount reused) / (sludge amount generated)	0				(Option) Evaluate what extent sludge is reused other than dumping disposal at a reclaimed disposal site
Assist	Digestion gas power generation	Same as the name	0				(Option) Evaluate what extent sludge reuse is carried out.

Source: Prepared by the Study Team

Note: inf.: influent, eff.: effluent, std.: standard, STP: Sewage Treatment Plant, IST: Individual septic Tank, T-N: Total Nitrogen, O&G: Oil & grease

Table III-11.2 Effect Indicators for Sewerage

Category	Name of indicators	Calculation equation of indicators	Target				Purpose
			Present	2016	2020	2025	
Base	Improvement of river water quality	Annual average BOD_5 of 24 samplings					Evaluate what extent sewage treatment is contributed to river water quality improvement
Base	Population coverage by sewerage	= (Served population by sewerage) / (population in the service area)					Evaluate what extent a sewerage system is used by the people
Assist	Compliance rate of eff. std, (BOD_5)	= (no. of samples below eff. std.) / (No. of total samples) Analysis frequency: weekly	-	100%	100%	100%	Evaluate the compliance status with effluent standard using the typical organic pollution index
Assist	Compliance rate of eff. std, (T-N)	= (no. of samples below eff. std.) / (No. of total samples) Analysis frequency: weekly	-	100%	100%	100%	Evaluate the compliance status with effluent standard using T-N for which sewage treatment process is selected.
Assist	Compliance rate of eff. std, (O&G)	= (no. of samples below eff. std.) / (No. of total samples) Analysis frequency: weekly	-	100%	100%	100%	Evaluate the compliance status with effluent standard using O&G which almost existing STPs cannot meet..
Assist	Reduction rate of power consumption	= [(digestion gas power generation) + (photovoltaic power generation] / (total power consumption)					(Option) Evaluate the energy-saving impact by alternative energy

Source: Prepared by the Study Team

Note: inf.: influent, eff.: effluent, std.: standard, STP: Sewage Treatment Plant, IST: Individual septic Tank, T-N: Total Nitrogen, O&G: Oil & grease

PART IV

ENVIRONMENTAL AND SOCIAL CONSIDERATION

1 Environment and Social Consideration

1.1 Legal Framework on Environment and Social Consideration and its organization

1.1.1 Laws and regulations on Environment and Social Considerations

Laws and regulations related to environment and social consideration are shown in **Table IV-1.1**.

Table IV-1.1 Laws and Regulations Related to Environment and Social Consideration

Environmental Laws	Contents
Environmental Quality Act 1974, amendment 1985,	The Act regulates EIA procedures, prescribed activities which EIA is necessary and public participation.
Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987; Amendment 1995	Environmental order on environmental impact assessment.
Environmental Quality (Sewage and industrial effluent) Regulation 1979; Amendment 1997; Amendment 2000	The regulations regulate environmental control on sewage and industrial effluent with standard values.
Environmental Quality (Sewage) Regulations 2009	The regulations regulate water quality of effluent to discharge into inland waters for new STP (constructed after 2009) and existing STP (constructed before 2009).
Environmental Quality (Industrial effluent) Regulations 2009	The regulations regulate environmental control on industrial effluent with standard values.
Environmental Quality (Clean Air) Regulations, 1978; Amendment 2000	The Regulations regulate environmental control to protect air pollution.
Environmental Quality (Scheduled Waste) Regulations, 2005	The regulations regulate hazardous waste to environment as scheduled waste, order scheduled premises for their disposal; manage transportation and dumping of waste by manifest system, notification to DOE and permission rules.
Environmental Quality (Control of Pollution for Solid Waste Transfer Station and Landfill) Regulation 2009	This regulation regulates pollution control for solid waste transfer station and landfill.
Guideline for Erosion and Sediment Control in Malaysia, Department of Irrigation and Drainage, 2010	To protect soil erosion from construction sites and soil sedimentation in channels and streams, standards of turbidity and TSS in drained water are set up, together with referred countermeasure facilities.
Factories and Machinery (Noise Exposure) Regulation 1989, and Occupational Health and Safety Act 514, 1994	This regulation regulates noise control for factories and machinery.
Planning Guidelines for Environmental Noise Limits and Control, DOE, 2004	This guideline regulates noise limits in the environment, procedures on environmental noise measurements and impact assessment. This guideline supersedes noise limits set in "Guidelines for Sitting and Zoning of Industries", and "Guidelines an Application for Permission to Install Generator Sets".
Guidelines for Noise Labeling and Emission Limits of Outdoor Sources, DOE, 2004	This guideline regulates noise emission levels and noise labeling requirements and procedures for measurement and labeling of noise emission of outdoor noise sources. This guideline and "Planning Guidelines for Environmental Noise Limits and Control supersede noise limit set in "Guideline an Application for Permission to Install

	Generator Sets".
Planning Guidelines for Vibration Limits and Control, DOE, 2004	This guideline specifies vibration limits in the environment and procedures for environmental vibration measurements and impact assessment. However, the vibration limits specified are provided as only guidance ones.
Social Consideration Laws	Contents
Land Acquisition Act 1960 (Act 486); Amendment 1992	This Act regulates land acquisition procedures and necessary form for public purpose.
National Heritage Act 2005	This act regulates the organization and procedures to preserve national heritage, the rule of heritage fund, conservation management plan.
Factories and Machinery Act, 1967 (Revised 1974)	To keep safety of employees, factories must be always clean and its structures are to be sturdily constructed so as to endure load, to prohibit the operation of machineries by non-qualified person, and to have to take safety countermeasures to deal with hazardous substances which may give damage to employees' health, etc. This act regulates the rules to safely manage factories and operate machineries.
Occupational Safety and Health Act,1994	To secure safety of works, health, and welfare for employees, employers are requested to take every responsibility. This act regulates to set up council, safety and health officer, to maintain safety working system and equipment of plants, and supervising responsibilities.

Source: Prepared by the Study Team

1.1.2 Relating agencies and its organization on Environmental and Social Consideration

Environmental issues are handled in each level of federal, state, and local authorities. The main leading organization in federal level is the Department of Environment (DOE) of the Ministry of Natural Resources and Environment. Each state government becomes deeply involved in environmental issues which generate from economical development by the reason why each state government has a responsibility on ownership and management of all the land and economical development in each state.

The Ministry of Natural Resources and Environment was established on March 2004. In this organization, important offices are belonged on environmental impact assessment. The outline of the organization is shown in **Table IV-1.2**. Under the Minister, there are deputy minister and secretary general, and under the umbrella of these top organizations, there are a deputy secretary general who handles the field of natural resources, and an another deputy secretary general who charges the field of environmental management, and a undersecretary for administration. Of these management organizations, the following functions are set up,

Table IV-1.2 Organizations of the Ministry of Natural Resources and Environment

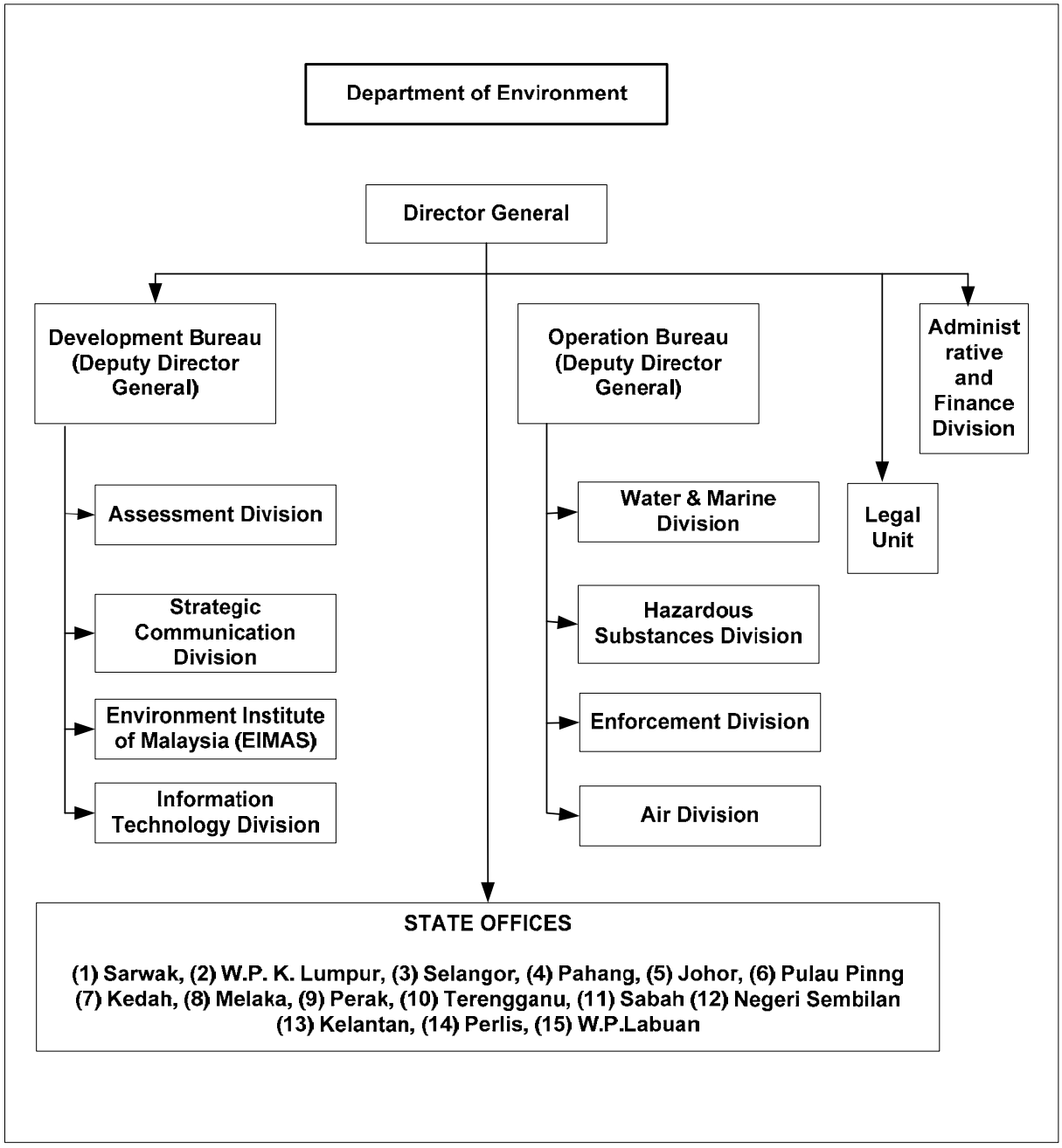
No.	Department and Institute Name
1.	Forestry Department Peninsular Malaysia (JPSM*)
2.	Forest Research Institute Malaysia (FRIM*)
3.	Minerals and Geosciences Department Malaysia (JMG*)
4.	Department of Environment (JAS*: DOE**)
5.	Department of Wildlife & National Parks Peninsular Malaysia (PERHILTAN*)
6.	Department of Irrigation and Drainage (JPS*: DID*)
7.	National Hydraulic Research Institute of Malaysia (NAHRIM*)
8.	Department of Director General of Lands and Mines (JKPTG)
9.	Department of Survey & Mapping Malaysia (JUPEM)
10.	National Institute of Land and Survey (INSTUN)

Source：Ministry of Natural Resources and Environment

Note：*Abbreviation name by Malay、**Abbreviation name by English

Of these organizations, DOE is a leading authority for EIA and Environmental Management Plan (EMP), and the Department of Irrigation and Drainage also has important function for giving permission on soil erosion and sedimentation control in construction works.

The DOE is managed based on the Environmental Quality Act, 1974. The organization chart is shown in **Figure IV-1.1**. Organization of DOE is classified into two main bureaus of 1) development and 2) operation under a director general.



Source: Department of Environment, Ministry of Natural Resources and Environment

Figure IV-1.1 Organization Chart of Department of Environment

1.1.3 Regulation Procedures of IEE/EIA on Environmental and Social Consideration

(1) Necessity of EIA

Environmental Quality Act (EQA), 1974 and amendment 1985 regulates that proponents for prescribed activities have to submit the EIA report to Director General of DOE. In the Environmental Quality Order 1987 under the EQA 1974, construction of municipal sewerage treatment plant (STP) is scheduled as one of the prescribed activities that need to submit the EIA report. Thus, implementation of this project needs the EIA report because it has the project objective to construct centralized STP for some sub-catchment areas in Kajang Municipal Council of Selangor State.

(2) EIA Procedures

1) Preliminary Assessment and Formulation of Preliminary EIA report

In early time of project implementation, preliminary assessment has to conduct by the registered Consultant (registered to DOE.

In the implementation process of preliminary assessment, public participation is conducted in the following manners: Public opinion sampling, Public meetings or workshop, Regular meeting with a citizen committee. These public participation manners have the following characteristics.

Table IV-1.3 Public Participation Manners in Preliminary EIA Procedures

Public Participation Manners	Characteristics
① Public opinion sampling	This manner is used for surveying huge variety of community. However, it may be suitable to deal with complicated survey contents. This survey must be managed and carefully planned to get valuable results.
② Public meetings or workshop	This survey is used to obtain public opinion on various issues.
③ Regular meeting with a citizen committee	This manner is useful during planning and development stages in large scale's project. The citizen committee should be formed by real representative of the community.

Source: "A Handbook of Environmental Impact Assessment Guidelines" by DOE (October 2009)

Registered consultant to conduct the Preliminary Assessment has to select the most suitable manners for public participation under consideration of community size, urban/rural areas, and population density etc.

In the Preliminary Assessment, the assessor must review technical and economical feasibility including Site option, Design option of plant, Significant environmental impacts and mitigation measures which are predicted by the outlined plan of project.

Assessment results are compiled to Preliminary EIA report and its EIA report is submitted to Director General of DOE for approval and review.

2) Review Process and Time Frame

After submission of Preliminary EIA report to DOE, the report review is carried out by state office of DOE. Approval procedures are led by the Director of Assessment Division with assistance of Environmental Control Officers. The Director of Assessment Division asks to review the Preliminary EIA report to EIA technical committee (in-house committee of DOE) which can recommend on acceptable of the EIA report. The Director of Assessment Division determines to approve or reject the Preliminary EIA report.

To review the Preliminary EIA report, it will be necessary about 5 weeks as shown in **Table IV-1.4**. However, if DOE decides to request more information on the Preliminary EIA and rejects to approve it, the proponent (Consultant) must submit the necessary information and modify the Preliminary EIA report. For that process, EIA laws request to repeat again the same procedures and its review period will become 10 weeks in total.

Thus, EIA procedures will generally become 10 weeks (70 days). In addition, as this period does not include time frame for additional survey and the modification of the EIA report, to complete the review process by DOE will need longer period.

Table IV-1.4 Review Activities of Preliminary EIA by DOE and Time Frame

Review Activities	Period
(1) Submission of Preliminary EIA report to DOE • DOE call the Consultant for presentation of the EIA (Technical review meeting by DOE)	2 weeks
(2) One Stop Agency Meeting (Related agencies: Local authority, Irrigation dept., Sewerage service dept. and others) (Comment by related agencies, request of extra information by DOE)	2 weeks
(3) Decision of Approve/ reject by DOE	1 week

Source: "A Handbook of Environmental Impact Assessment Guidelines" by DOE (October 2009)

Note: The above steps are in case of smooth proceeding. If DOE request more information and does not approve, the same steps will be repeated.

3) Detailed Environment Assessment

After the review of the Preliminary EIA report by the Director General of DOE, if the proposed project is anticipated to have significant impact against environment, DOE may require detailed environment assessment. In this case, the proponent must submit the TOR for the detailed assessment. The TOR is reviewed by the Review Panel to secure that the project contents do not conflict to the Government's policy and decisions. The Review Panel is composed of university specialists and NGO staff, and members of related fields belonging to several authorities and its chairman is the Director General of DOE.

Detailed EIA report is publicly browsed for public comment at the places of DOE offices, state offices, public libraries, and related local authority office with public notification through homepage of DOE and newspapers. Public comments are received within the period of 45 days from the first public notification day by newspapers. Review period for detailed EIA report is anticipated to be 12 weeks (84 days).

Table IV-1.5 Review Activities of Detailed EIA by DOE and Time Frame

Review Activities	Period
(1) Formulation of TOR for detailed EIA report (TOR is formulated by discussion with the proponent and Review Panel), Review panel was composed of University, NGO, related authorities' specialist, and its chairman is Director General of Environmental Quality.	1 month
(2) Review of EIA report Including public browse of EIA report for 4 weeks and collecting public comment (within 45 days from first notification of public browse to newspaper), holding review meeting.	12 weeks (84 days)
(3) Decision of Approve/ Reject by DOE	

Source: "A Handbook of Environmental Impact Assessment Guidelines" by DOE (October 2009)

If DOE decides to request more information for the detailed EIA and rejects to approve it, the proponent (or Consultant) must submit the necessary information and modify the detailed EIA report. For that process, EIA laws request to repeat again the same procedures and its review period will become 24 weeks in total.

The flow chart of EIA procedures shall be shown in **Figure IV-1.2**.

(3) EIA Approval and Imposed Conditions

Imposed conditions with EIA approval generally were attached. In these conditions, its outlines on similar construction project of STP for reference are shown:

In the imposed conditions, 1) confirmation items on project concept, 2) requirement items on Environmental Management Plan (EMP), a) environmental protection items for earthworks and construction in the earthworks and construction stage, b) environmental protection items in operation stage, 3) reporting and submission of various reports to DOE, 4) requirement items for environmental audit, 5) reporting items at completion stage, 6) requirement on administration, 7) other items on EIA approval conditions by Department of Irrigation and Drainage (DID) as imposed conditions by relating authority.

Imposed conditions for EIA approval count to 65 items, together with 3 comments from DID. The key factors are summarized as follows,

1) Confirmation items on project concept
   - Any changes to the project concept are not allowed prior to obtaining permission from the Director General of DOE.
   - DOE reserves the right to stop any development activities in the project site if there is any violation to the Environment Quality Act 1974 and its regulations or occurrence of pollution and disturbance to the surrounding area.
2) Requirement items on Environmental Management Plan (EMP)
   a) Environmental protection items for earthworks and construction in the earthworks and construction stage
      - Interested parties to construction works must give great attention to soil erosion and soil sedimentation which occurs by earthworks. “Erosion and sediment control plan (ESCP)” shall be prepared as prescribed in “the Guideline for Erosion and Sediment Control in Malaysia, (2010)” published by DID and the ESCP is included in the EMP report.
      - Any design and changes of the river and drainage system must be referred to the DID to obtain approval prior to earthwork activities.
      - Vehicle and machinery wheels must be washed before entering public road and high-pressure water sprinkler facilities have to be prepared.
      - Excess earth material from earthwork activities should be disposed at the legal dumpsite, approved by local Authority.
      - Access route for vehicle transporting construction materials and soils must be obtained from local authority in advance.
   b) Erosion control
      - Exposed area, which earthwork activities are completed, should be covered within 14 days from the earthwork completion date.
   c) Surface water runoff control
      - Any discharge of surface water runoff from the project site should flow through the silt trap or detention pond. Water quality of discharge water should be less than 250 mg/L in turbidity and 50 mg/L or less in TSS.
   d) Sedimentation control
   e) Water quality control and monitoring
      - Any potential soil erosion and surface water runoff occurrence during earthwork activities must be monitored continuously. The total suspended solid (TSS) in discharged water during earthwork activities must not exceeded 50 mg/L. Water quality monitoring for TSS must be conducted monthly from the beginning of earthworks until construction completed.
   f) Air quality control and monitoring
      - Installation of fuel combustion equipment such as boiler and standby generator should be obtained written approval from DOE as indicated in the Environmental Regulations (Clean Air) 1978.
      - Air monitoring for PM_{10} must be done monthly from earthwork commencement to construction completion.
   g) Noise monitoring and control
      - Noise monitoring and analysis must be done monthly, in the period of

commencement of earthworks to construction completion. The location and frequency of the monitoring must be referred and agreed by DOE.

3) Operating stage after STP facilities completed
   - In the similar way to those in construction stage, imposed conditions with EIA approval such as water quality monitoring and protection, air quality monitoring and protection, noise monitoring and protection, solid waste management are shown.

4) Reporting to DOE
   a) Reporting on earthworks
      - Brief report on earthwork and construction progress must be submitted within 90 days form the date of EIA approval by the prescribed format. These details must be submitted every three months once until the earthworks and construction complete.
      - EIA approval condition compliance report must be submitted every three months once from commencement of earthworks to the end of the project.

   b) Reporting on monitoring

From commencement of earthworks to completion of construction works
   - Monitoring reports of noise/water quality (TSS)/air quality must be monthly submitted.

Operation stage
   - Monitoring reports of air quality/noise must be submitted every three monthly once.

5) Environmental Audit
   - Environmental audit of the project should be carried out by third party which is DOE registered auditor.
   - The audit should be carried out once in four months during earthworks.
   - The audit should be conducted yearly once during construction and operation stages.
   - Audit report must be submitted to DOE every year.

6) Requirement on administration
   - Environmental officer (EO) should be appointed to be fully responsible on matters pertaining environmental management and implementation of all the mitigation measures. The information of EO should be submitted to DOE within 14 days prior to commencement of land cleaning activities.

As shown in the above, imposed conditions with EIA approval describe compliance items during construction works, precaution statements, monitoring and frequencies, reporting to DOE and submission frequencies of reports in detail. Concrete countermeasures to the imposed conditions for EIA approval is shown in Environmental Management Plan report.

1.1.4 Environmental Management Plan (EMP) Report

Environmental Management Plan, after EIA approval and before commencement of construction works at project site, is prepared by consultant who is commissioned by the proponent. The EMP translates EIA approval conditions into practicable action. The EMP includes the following contents at minimum (It depends on "Guidance Documents for Preparation and Submission of Environmental Management Plan, 2010, DOE)".

(1) Introduction: Project outline approved by development order by local authority
(2) Policy: Corporate policy statement on environmental management and protection
(3) Implementation organization: Environmental officer, technical consultant, contractor, site supervisor, etc.
(4) Environmental requirement: Imposed conditions for EIA approval and mitigation countermeasures; concrete implementation plans to protect soil erosion and sedimentation, water pollution, air pollution, and noise.
(5) Materials and waste management

(6) Emergency response plan (ERP)

The proponent is required to carry out surely the EMP in commencement of construction works by proponents and to ensure it, also, to submit the declaration letter, with EMP report to DOE.

1.1.5 Environmental Audit Report

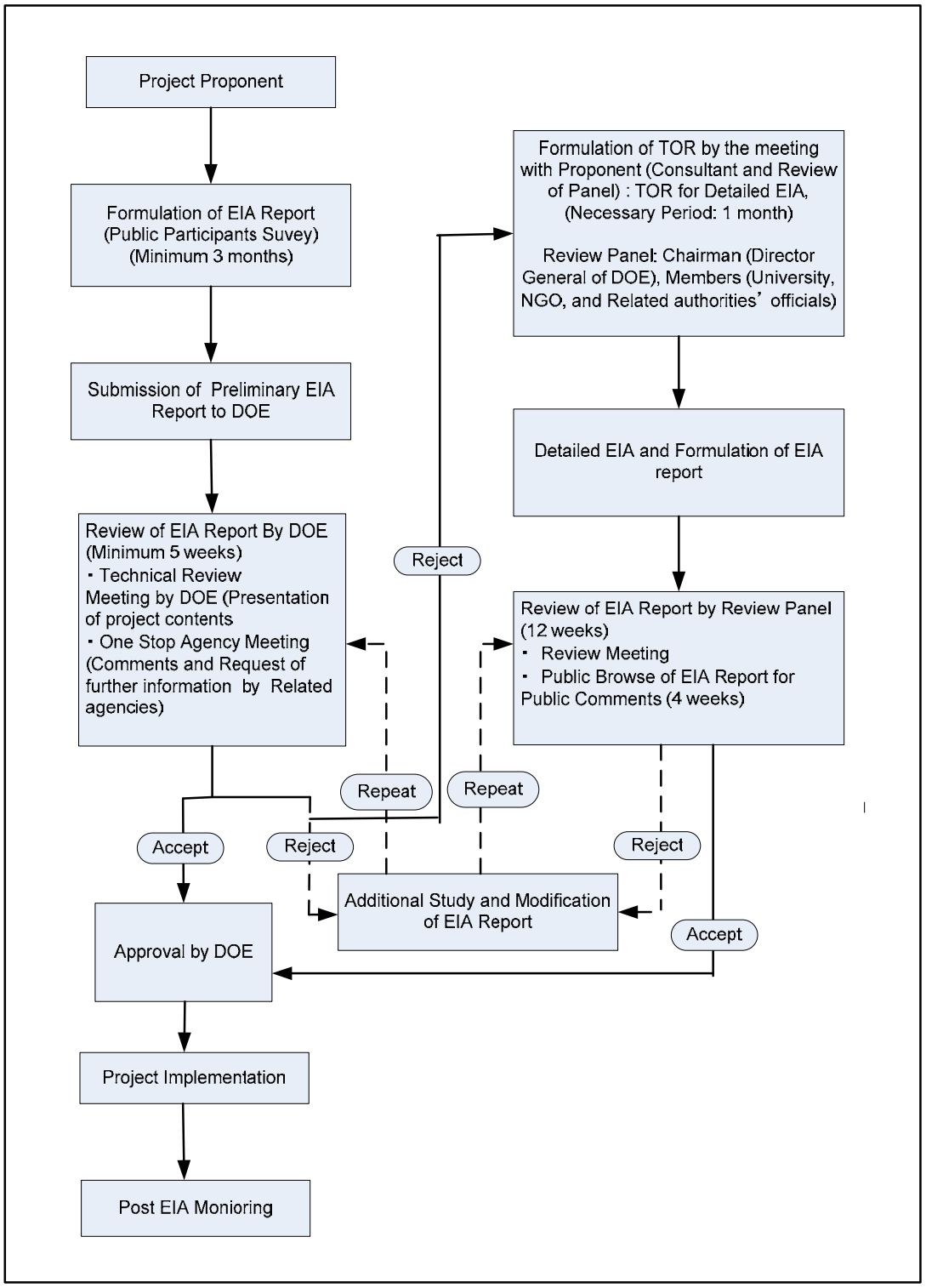
Environmental audit is carried out as EIA approval conditions or DOE's instruction at the construction and operation stages to confirm whether the project implementation organizations comply with the rules for environmental protection which Environmental Quality Act (1974) and relating registrations regulates and if non-compliance, DOE shall request to correct them. Environmental audit is conducted by third parties that registered to DOE.

Environmental audit officials, firstly as preparation step for environmental audit, shall finalize the audit scope and obtain preliminary information from the organization, (2) the audit plan, (3) checklists for the site audit.

Secondary, the audit officials carry out the site audit in the following process, (1) open meeting with the organization, (2) Examination of construction documents and monitoring records, (3) observation of construction activities and operating conditions, (4) collecting environmental samples (it generally constrains to have doubt to monitoring data, etc.), (5) confirmation of audit items, (6) closing meeting to inform the organization of the audit results.

Finally, the audit officials finalize the environmental audit report including the audit confirmation items and recommendations and submit it to DOE. On the other hand, the organization to be audited must submit Corrective Action Report against the audit results that the environmental audit requested to correct and after completion of corrective action plan, it has to submit the completion report to DOE.

As described in the above, environmental audit confirms whether construction works and operation of completed facilities are conducted under constrains required by environmental laws and regulations and it is a system to implement in compliance with the laws and regulations. Environmental audit fees shall be shouldered by the proponents and the project implementation organizations.



Source: "A Handbook of Environmental Impact Assessment Guidelines" by DOE (October 2009)

Note: If the EIA report is not approved by DOE or Review Panel, the same review processes will be repeated. If DOE determines to need the detailed EIA in the final preliminary stage, TOR for the detailed EIA must be firstly formulated.

Figure IV-1.2 Flow of EIA Approval Process

1.2 Scoping

After the first reconnaissance survey including field survey from September to October, 2011, scoping list was reviewed on the consideration of laws and regulations, collected information, and present status of STP site on Environment and Social Consideration. Results of scoping are shown in **Table IV-1.6** Scoping List.

Table IV-1.6 Scoping List

Category	No	Impact Items	Evaluation		Evaluation Reasons
			P-Const* U-Const*	Operating*	
Mitigation Measure	1	Air Pollution	B-	D	U-Const: Degradation of air quality is supposed on the temporary basis by operation of construction machines and vehicles. Operating: Degradation of air quality will not be caused because pumps, blowers, and motors are always operated by commercialized electric power. Digester gas power generation is planned. In the collecting stage of a little sewage, the gas amount may be very little. Methane gas which largely affects to greenhouse warming is burned and it is exhausted as CO_2. Thus, air pollution may happen in some degree.
	2	Water Pollution	B-	B+	U-Const: water pollution may be caused by discharged water derived from construction site, construction machines and vehicles and workers' camp. High turbidity water may be discharged to the Langat River through existing artificial canal from construction site and by the construction works for the outlet with discharge pipes. Operating: Water quality of effluent from the STP is planned to apply "Standard A" of "Sewage Industrial guidelines in Malaysia" (to be applied for discharge of effluent in the river where an intake point for water supply is located in the upstream). Heretofore, effluent from simple sewage treatment system and septic tanks were directly discharged to the river. The proposed STP will discharge comparatively clean effluent less than standard A by sewage treatment. Thus, water pollution will be improved.
	3	Waste	B-	B-	U-Const: Construction waste soils and scrap woods will be produced. Operating: general waste will be produced by workers at a completed STP. All the sludge is planned to sell to fertilizer company as fertilizer. If it is not bought into reality, the sludge shall be dumped in dumping site.
	4	Soil Contamination	B-	D	U-Const: soil pollution which may be caused by oil spill of construction machines is supposed. Operating: adverse impact to environment is not supposed.
	5	Noise and Vibration	B-	D	U-Const: noise and vibration caused by construction works, operation of construction machines and vehicles are supposed. Operating: adverse impact to environment is not supposed.
	6	Land	D	D	Construction works which may cause land subsidence is not supposed.

		Subsidence			
	7	Bad Odor	D	D	In the boundary area between proposed STP and private houses, buffer zone is planned to be set up. In addition, the STP is of covered system with deodorization treatment equipment. Thus, adverse impact with bad odor will not generate.
	8	Bottom Sediment	D	D	Construction works which may provide adverse impact is not supposed.
Natural Environment	9	Protected Area	D	D	In the STP site and its periphery area, there are no national parks and sanctuaries.
	10	Ecosystem	D	D	Since project site is in an artificial forest and a banana plantation, there are no rare species of fauna and flora. Thus, adverse impact to ecosystem will not be almost supposed.
	11	Hydrology	D	D	U-Const: the proposed STP will not directly discharge the effluent to the river. The discharge is conducted through existing artificial canal. Thus, any impacts which may change the river bed and the stream flow of the river will not be supposed. Operating: the same to the above.
	12	Topography/ Geology	D	D	The project plans to construct STP facilities by use of natural flat land and it does not include a large scale of land cutting and earth filling. Thus, impacts to topography and geology will not be almost supposed.
Social Environment	13	Resettlement	D	D	The proposed STP and pumping facilities are established in the public lands, and sewer main is constructed along public roads. Thus, resettlement does not generate.
	14	Poverty Group	D	D	In the project site and its periphery area, there are no poverty groups.
	15	Ethnic Minorities and Indigenous Peoples	D	D	In the project site and its periphery area, there are no ethnic minorities and indigenous peoples.
	16	Local Economy of Employment & Livelihood	D	D	The project objective is to construct STP. It will not affect to living conditions and livelihood of residents with local economical conditions.
	17	Land use and utilization of local resources	D	D	The project objective is to construct STP. It will not almost affect to land use, utilization of water resources, and local economy.
	18	Water Use	B-	D	In the downstream of about 15 km from planned effluent outlet of proposed STP in the Langat River, there is water intake facility for water supply. Thus, the effluent is planned to meet water quality of Standard A (Discharge standard of effluent from STP in case that water intake point for water supply is located in the downstream) because of continuous water intake operation.
	19	Existing Social Infra and Social Service	B-	B+	U-Const: traffic congestion at the local roads in the periphery of proposed STP site is supposed. Operation: As vehicles for transportation of sludge and aggregating agent only a few times pass through roads, adverse impact for traffic will not almost happen. Since treated effluent with better quality is discharged into the Langat River through existing artificial canal by the proposed STP, fluvial environment will be improved and residents' life will be good sanitary condition. Thus, it will become the upgrading of social service.

	20	Social Organization such as Social Capitals and Local Authority	D	D	Sewerage system forms a part of social infrastructures. Planned STP is operated and managed by relating authority. STP facility comes close to full operation in response of the upgrading of social infrastructures in the area.
	21	Bias Distribution of Damage and Benefit	D	D	Bad odor is concentrated in the STP site because sewage of the area is collected in one place and residents in the periphery area are annoyed. But bad odor will not generate from the STP due to its closed facilities and deodorizing equipments.
	22	Conflict of Interest in the Project area	D	D	In the selection of the proposed STP site, conflict on land use may generally happen. But, as relating agencies for this Project are arranged, conflict of interest in the project area will not generate.
	23	Cultural Heritage	D	D	In the project site and its periphery area, there are no cultural heritages.
	24	Landscape	D	D	The project objective is to construct new STP. There are only few houses with artificial forests in the periphery area of the project site where was bordered by express high-way in east side and by the Langat River in west side. As it has not recreation land, there will not affect any impacts to landscape.
	25	Gender	D	D	The project aims at constructing centralized STP and it does not have any impact to gender.
	26	Children's Right	D	D	The project aims at constructing centralized STP and it does not have any impact to children's right.
	27	Infectious Diseases of HIV/AIDS	D	D	Affection on infectious diseases of HIV/AIDS by construction works will not generate.
	28	Work Environment (Including Safety Control)	B-	D	U-Const: It is necessary to make an arrangement for work environment (including safety control) of construction workers.
Others	29	Accidents	B-	B-	U-Const: It is necessary to make an arrangement on construction accidents and handling accidents of construction machines and vehicles. Falling-down of workers from height must be protected Operation: It is necessary to make an arrangement on handling accidents of operating equipment. In the maintenance works of sewers, oxygen deficiency and generation of hydrogen sulfate must pay attention for workers life's protection. Falling-down of workers from height must be protected
	30	Trans-boundary Impact and Climate Change	D	B+	The project is to construct centralized STP. It will not almost affect trans-boundary impact. To somewhat cope with global heating, solar panels on the top of the proposed STP are set up and it is planned to generate about 1 Giga Watt. Furthermore, digester gas–power generation (about 400 KW) is planned. The generated power will cover a part of electric requirements of proposed STP.

Source: Prepared by the Study Team

Note: P-Const*: Pre-construction stage, U-Const*: Under construction stage, Operating*: Operating stage; STP: Sewage Treatment Plant.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive /negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses.)
D: No impact is expected.

1.3 TOR for Environment and Social Consideration Survey

Based on the scoping results for survey on environment and social consideration, TOR for environment and social consideration survey was finalized. The TOR is shown in **Table IV-1.7**.

Table IV-1.7 TOR for Environment and Social Consideration Survey

Environmental Item	Survey Item	Survey Method
Air Pollution	① Confirmation of environmental standards ② Field survey Survey items：TPS (Total suspended particulate),、PM_{10}、SO_2, NO_2	① Collection and review of existing information ② Measurement of base line data in the field Proposed measuring point (Near south boundary between the proposed STP site and residential area） Measuring duration hours: TPS, $PM_{10,}$ SO_2 (24 hours), NO_2 (1 hour), (Measuring duration hours depend on "Recommended Malaysian Air Quality Guideline & Standard").
Water Pollution	① Confirmation of environmental standards ② Field survey Analysis items：27 items（Water temperature, pH, DO, EC, Turbidity、TSS, NH_4-N, BOD、COD, Oil & Grease, Fe, Zn, Cu, Ni, Hg, Cd, Cr^{6+},Cr^{3+}, Mn, Pb, CN, Sn, S, Phenol, B, Total Coliform, Fecal Coliform ③ Present status of effluent of existing STPs to the Langat River	① Collection and review of existing information ② Measurement of base line data in the field Planned sampling points (2 points in the upper stream of about 500 m and 1,000 m from the outlet of effluent through existing artificial canal in the Langat River and 2 points in the downstream of about 500 m and 1,000 m from the outlet in the River.) (Analysis items of water quality depends on National Interim Water Quality Standards for Malaysia (NIWQSM）. ③ Existing information and hearing from relating authorities
Waste	① Disposal manners of construction waste ② Handling of sewage sludge	① Hearing from relating authorities, and similar case study ② Dumping sludge quality standards, information on location, owner, and space of dumping site, dumping fee, dumping permission, etc.
Soil Contamination	① Protection manners survey of oil spills during construction stage	① Description of works, construction methods, construction period, sort of construction machineries, confirmation of locations for operating and storage
Noise and Vibration	① Confirmation of environmental standards ② Field survey Measurement of Equivalent continuous noise level, Maximum/Minimum noise level ③ Construction method	① Review of Existing Information ② Measurement of base line data in the field Planned measuring point (Near south boundary between the proposed STP site and residential area） Planned measuring hours: two times during daytime and night time ③ Review of pilling construction works
Bad Odor	① Deodorizing	① Review of deodorizing manners
Existing Social Infrastructure and Social Service	① Traffic control method survey	① Permission relating to pipe laying works on roads, and its procedures, relating agency to traffic control, and similar case study.
Labor Environment	① Survey on work safety conditions and	① Control agencies on work safety, and regulations,

(Including work safety)	regulations	etc. and similar case study.
Accidents	① Survey on work safety conditions and regulations during construction and operation stages	① Work safety law and safety regulations at factories and on machineries, and its control agency, etc.
Impacts to Trans-boundary and Climate Change	① Digestion gas power generation survey	① Review of generation amount of digestion gas from sludge, power generation amount

Source: Prepared by the Study Team
Note: STP: Sewage Treatment Plant

1.4 Present Status of Proposed STP Site

1.4.1 Proposed STP Site

Proposed project site (Kajang 3 STP site) is located in Kajang Municipal Council of Hulu Langat District in the east of the Selangor State. The area of the target site is 7.3 ha and is bordered in the east side by Cheras Kajang Express Highway (E7) running in the N-S direction and in the west side by the Langat River.

An access road runs with about 17 m width (Main road: 14.3 m in width; Side ditches in each side: 1.2 m in width) along the west boundary of the project site. This access road is divided into two small roads passing small river near southwest side of the proposed STP site. One road runs in the east direction around an Islamic school and housing area and bends in the south direction. This road is in unpaved condition and its road width is about 4 m. Another one is also unpaved road and extends to the south direction in the forests.

In the outer skirt of the northwest boundary, housing area beyond an artificial forest is distributed. In the space between the access road and the Langat River, the land is almost covered by scattered trees and some places of the space are used for solid waste dumping sites. In the south half of the proposed premise for the project, the land is presently used as banana plantation.

According to inhabitants, small stream running in the southwest side of the proposed site is old Langat river and the Langat river running in the west side of the project site is an artificial channel which was newly constructed. In this report, this new artificial channel is called as the Langat River and small stream running in the southwest side of the proposed STP site is named as old Langat River. Old Langat River has the width of about 4 m and runs in the southwest direction and connects to the Langat River.

The landform of the project site is almost flat and in the west side of the access road, the landform becomes smooth slope with a very little dip. Several private houses are only distributed near the north and south boundaries in the west side of the access road. The outline of proposed site is shown in **Figure IV-1.3**.

Source: Prepared by the Study Team Using Google Map

Figure IV-1.3 Outline of the Proposed Project Site

1.4.2 Local Authority

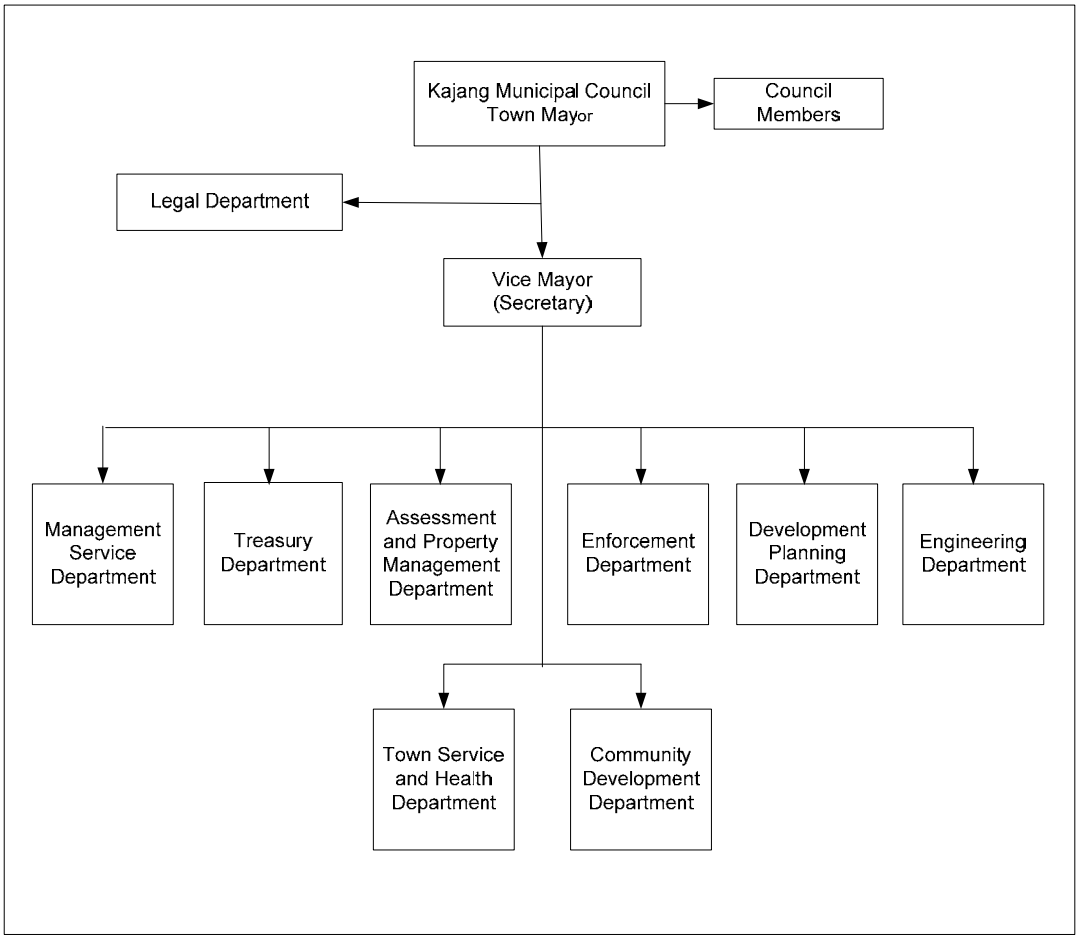
The Project Area is located at Kajang Municipality Council (KMC) of Hulu Langat District in Selangor State. As local authority, the KMC is a independent organization and it has equal functions to Hulu Langat District office. Thus, high order organization of the KMC is Selangor State office.

The KMC has jurisdiction area of 78,761 hectares (787.61 km2) and consists of 6 sub-districts of Kajang, Cheras, Semenyih, Beranang, Hulu Langat, Julu Semenih as shown **Figure IV-1.4**.

Source: http://www.mpkj.gov.my/home

Figure IV-1.4
Jurisdiction Area of Kajang Municipality Council

Administration organization of the KMC is shown in **Figure IV-1.5**. The administrative organization of the KMC composed of 8 departments under president and conduct town services in every field of the KMC.



Source: http://www.mpkj.gov.my/home

Figure IV-1.5 Administrative Organization of Kajang Municipality Council

Administration functions of main departments are as follows:

- Assessment and Property Management Department)
  (Revenue collection of all properties, maintaining council's property in good conditions)
- Community Development Department
  (Organizing social and community development activities)
- Development Planning Department
  (Ensuring uniform land use planning based on the local planning, policy, and implementation guideline, and processing applications for planning permission based on the provision of Town and Country Planning Act 1976)
- Engineering Department
  (Maintaining infrastructure and public facilities)
- Management Services Department
  (General administration, Human resources management, and Information system management, etc.)
- Town Service and Health Department
  (Environmental and general health control, and food quality control)
- (Treasury Department)

1.5 Alternative Plan (Zero Option)

As alternative plan (Zero Option), present status of sewage treatment with its issues is described below and necessity (namely, advantage) of establishment of centralized STP is explained.

(1) Present Status of Sewage Treatment

Sewage collecting area of proposed STP is composed of 4 sub-collecting areas: Cheras batu 11, Cheras jaya, Kajang 1, and Kajang 3. Of these sub-collecting areas, there are 169 existing public STPs and after treatment of sewage, effluents are discharged to the Langat River. These are pubic STPs which are operated and managed by IWK and in addition, other many private STPs are operated. **Table IV-1.8** indicates number of existing public STPs, its treated population, and sewage flow in sewage collecting area of the proposed STP.

Table IV-1.8 Number of Existing Public STPs, Population Equivalent and Sewage Flow in the Study Area

No.	Subcatchment	Number of Existing Public STPs	Sewage Treatment Population (PE)	Sewage Flow (m^3/day)
1	Cheras batu 11	64	188,189	42,343
2	Cheras jaya	30	10,8259	24,358
3	Kajang 1	32	69,425	15,621
4	Kajang 3	43	110,810	24,932
Total		169	476,683	107,254

Source: Prepared by the Study Team based on the data from IWK

Scale sizes of existing STPs are shown in **Table IV-1.9**. The scale sizes of the existing STPs are generally very small and its maximum treatment capacity is less than 20,000 PE. Further, according to scale size categories, the STPs of less than 2,000 PE are counted to 91 ones and it corresponds to 54 % of total ones and those of less than 5,000 PE in secondary category are 47 ones and it occupies to 28% of totals. Sum of both categories come to 82 %. The existing public STPs will be obviously formed by very small size of

Table IV-1.9 Number of Existing Public STPs by Size in the Study Area

No.	Subcatchment	Sewage Treatment Population Equivalent (PE)			
		≦2,000	≦5,000	≦10,000	≦20,000
1	Cheras batu 11	33	19	9	3
2	Cheras jaya	11	11	7	1
3	Kajang 1	21	7	4	0
4	Kajang 3	26	10	5	2
Total		91	47	25	6
%		54	28	15	3

Source: Prepared by the Study Team based on the data from IWK

Treatment systems of the existing public STPs distributed in sewage collecting areas are operated by Extended aeration process (EA), Intermediated decanting extended aeration process (IDEA), Oxidation ditch process (OD), Sequencing batch reactor (SBR), Actil Bio process (AB), Hi kleen process (HK), Solar air treatment system (SATS) of activated sludge processes. Of these processes, EA process occupies 54 % of total treatment processes.

(2) Issues in Existing STP and Improvement Points by Establishment of Proposed Centralized STP

Adaptation situations by water quality treated at the existing STPs to Malaysian effluent standards

"Environmental Quality (Sewage) Regulations 2009" (BOD5、COD、NH4-N、SS、Oil and Grease) are shown in **Table IV-1.10**.

Table IV-1.10 Compliance with Effluent Standards after Sewage Treatment

(Unit: %)

No.	Subcatchment	Water Quality Standards for Treated Effluent					Sum of whole*
		BOD	COD	NH_4-N	Oil & Geese	SS	
1	Cheras batu 11	67.2	90.6	39.7	14.1	85.9	7.9
2	Cheras jaya	70.0	83.3	50.0	6.7	80.0	0.0
3	Kajang 1	76..0	87.5	21.9	28.1	87.5	9.4
4	Kajang 3	72.1	83.7	34.0	81.4	81.4	4.7
Total		70.4	87.0	36.0	84.0	84.0	6.0

Source: Prepared by the Study Team based on the data from IWK

Note: Sum of whole* means 6.0 % in the sum that adapted in all of 5 chemical items of standards. If one item of analyzed values exceeds standards, it is judged to be non-adapted.

Comparing each measured water quality with standards, them of BOD, COD, and SS values shows fairly high adequateness but in degree of overall coincide, only water quality of 10 STPs (6 %) in 169 of total STPs accorded. This indicates that sewage treatment is not appropriately operated and river water discharged from those existing STPs may be polluted.

The project aims at abolishing these many existing STPs and establishing a centralized STP and treating in a lump sum sewage collected from wide drainage areas. The implementation of the Project will attribute the following advantages.

- By establishing a centralized STP, treated water quality will become less than discharge standards for effluent from STP and intake facility for public water supply located at about 15 km downstream of the Langat River will be able to intake raw water with stable water quality of less than standards. This also results in improvement of river environment.
- To integrate many existing STPs to one centralized STP, man powers of operators and other employments will be saved and its surplus man power can allot them to other sections which man powers are shortage

1.6 Work Environment (Occupational Safety Law)

Government agency which executes jurisdiction on occupational safety is "the Department of Occupational Safety and Health (DOSH)" under "the Ministry of Human Resources". Proponent must apply to conduct registration on "Work Safety Control" to its state office one month ago for commencement of construction works for the Project. This concrete instruction is provided by imposed conditions for EIA approval because DOE requests comments to relating agencies including the DOSH at the time of reviewing preliminary EIA report and the proponent must cope with its conditions.

Important laws on occupational safety are "Factories and Machinery Act 1967 (Revised 1974)" and "Occupational Safety and Health Act 1994". Outlines of these laws are shown below,

(1) "Factories and Machinery Act 1967 (Revised 1974)"

Inspector specified by this Act has strong power such as entry to any factory, taking samples of discharge materials from factories, sealing against dangerous machineries not to comply to this Act and putting in inoperative conditions.

Factories must be constructed in well-build conditions so as to bear fairy heavy load in foundations, roofs, and upstairs. Opening mouth of floor has to set up fences to protect falling of workers. In

addition, suitable lightning and ventilation system, and passage without obstruction and effective fire extinguish equipment at factories must be prepared.

In case of treating with explosion and hazardous substances at factories, employer takes countermeasures to remove its risks. Further, dangerous parts of machineries shall be set up by fences for employees' safety and if safety for employees cannot be secured, its parts must be operated by automatic system. To keep safety of employees, they must wear goggles, gloves, safety caps, and work clothes, if necessary. The Act regulates penal rules against offence.

(2) "Occupational Safety and Health Act 1994"
Since this Act is applied to every sectors such as manufacturing, mining and quarrying, construction, agriculture and forestry, fishing, and utilities (electricity, gas, water, and sanitary services), transport and storage and communication, the Project for constructing centralized STP is included in these categories.

Objective of this Act is to ensure safety, health, and welfare for laborers and to promote so as to keep favorite occupational environment.

To secure safety and health of employees at work places, council consisting of employer and employees and relating agency's officials is set up, and occupier at work places has to employ a safety and health officer to propel its objectives at work place. Safety and health officer has strong power such as enforced entry at work places; investigation of plant, substances, and articles; sealing for in-operation at factories for safety and health of employees. Employer must notice neighboring Occupational Safety and Health Office of accidents occurred at work places, dangerous occurrences, and occupational diseases. The Act regulates occupational safety and health for employees by these rules.

1.7 Stakeholder Meeting

The project is in the preliminary stage and the implementation agency for the project is not still fixed. Project design is also under processing.

Under this situation, to hold stakeholder meeting with residents around the proposed STP site is in premature stage because it may cause surprised happening. Thus, the stakeholder meeting shall be conducted through the implementation agency after the implementation agency and the project design are fixed in the design stage.

2 Land Acquisition and Resettlement

2.1 Land Ownership System in Malaysia

In Malaysia, land administrative power principally belongs to state government. The jurisdiction of state government is derived from national recognition of "Malaysian Federal Constitution (1957)" that lands are under jurisdiction of state government. This is also stated in National Land Code (1965). The ownership of the lands is recognized through land registration. Thus, any person who occupies the state lands without authorization is deeded as squatters.

2.2 Legal Framework on Land Acquisition and Resettlement, and Implementation Agency

Government agency for land acquisition is State General of Land and Mines in Selangor State. According to Malaysian Laws Act 486, Land Acquisition Act (1960), "State Director of Land and Mines "of state government has strong power on land acquisition and "Land Administrator" under the umbrella of state director actually engages into land acquisition procedures.

To acquire project land by land acquisition, the following conditions shall need to be satisfied.

- Project for land acquisition has for public objective.
- State government considers that project is effective for economic development in Malaysia and is useful for public.

The land acquisition procedures are carried out by the following process. Flow of land acquisition procedures are shown in Figure 2.1.

1) Application for land acquisition to state land administrator.
2) Review of application quality for land acquisition by state land administrator.
3) Of application documents, land administrator sends "Land acquisition plan and Summary plan of the project" to State Economic Planning Unit (SEPU) and the SEPU reviews the land acquisition purpose and decides to approve or refuse "development approval".
4) The SEPU directs to negotiate for acquiring planned project land between land owners and applicants within fixed period. If the negotiation for land purchasing ends in failure, the SEPU shall recommend proceeding on land acquisition process.
5) In the reference of the SEPU's recommendation, state government decides the approval or the refuse of land acquisition application.
6) Preliminary notice: if state government considers that land acquisition application has reasonability, it shall notice in the gazette.
7) State director of land and mines gives permission relating personnel to enter land acquisition lands for survey and land affirmation.
8) State land administrator finalizes land acquisition plan and lists of the lands.
9) If state government decides that the project fits to public purpose, the government notices its declaration to the gazette.
10) State land administrator draws the boundary line of the lands and registers the lands.
11) To estimate compensate fees for land acquisition, state land administrator requires necessary information to the Director of Town and Country Planning (DTCP). The DTCP must provide the information to him within 4 weeks.
12) State land administrator commences for land acquisition process.
    - The administrator holds public meeting on compensation fees for land acquisition with interested persons who relate to acquired lands. For this purpose, the administrator sends the notice all the stakeholders.
    - In the public meeting, the administrator collects information on land prices for land acquisition from interested persons and inquiries to them, and evaluates land prices and decides compensation fees.
    - The administrator prepares award on compensation fees for land acquisition and

decides it. The award becomes final certificated

13) Finalization of land acquisition procedures

2.3 Progress of Land Acquisition

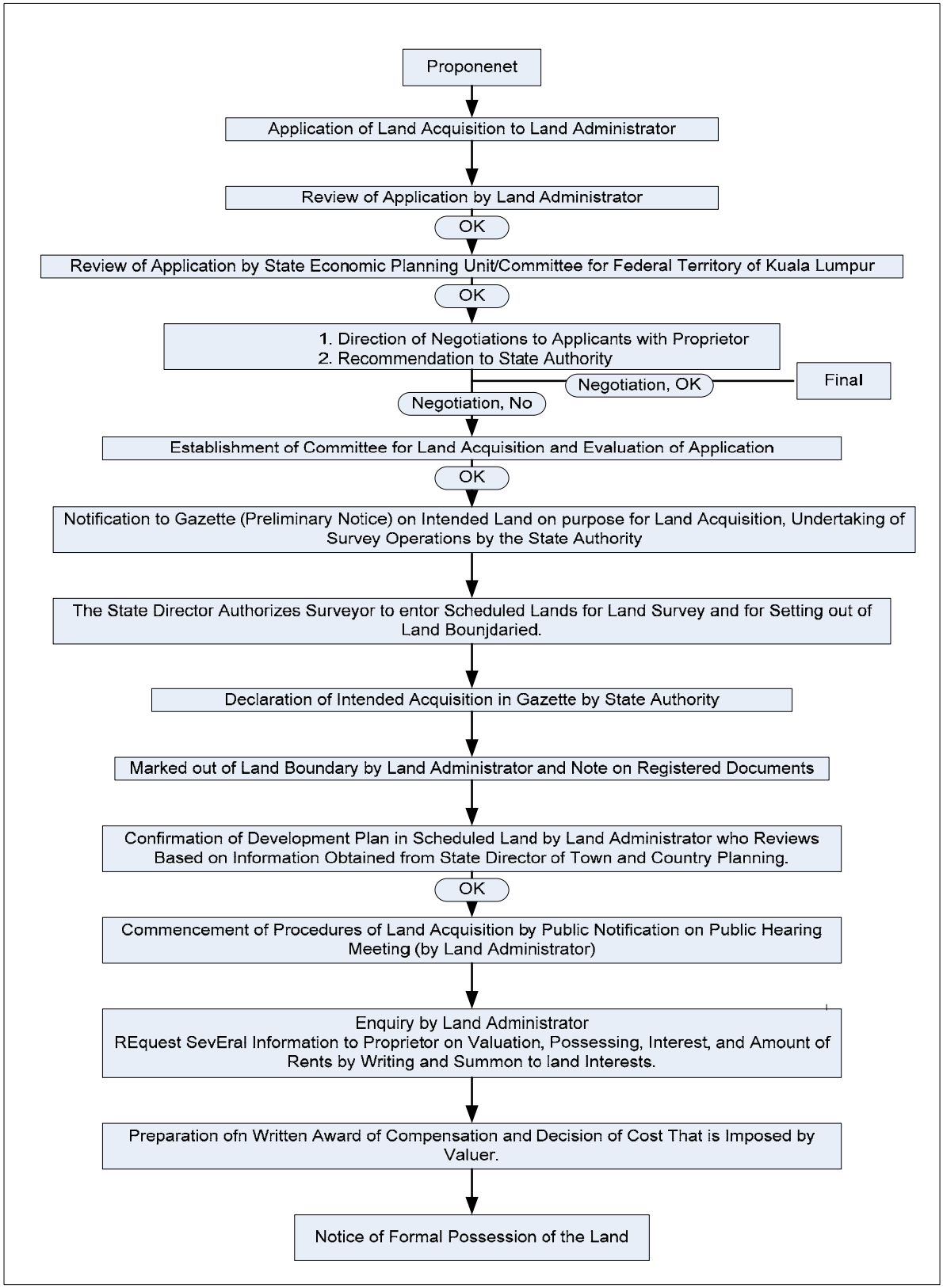
Present situation (As of December 2011) on land acquisition of construction site for the proposed STP is described in this section. Acquisition of the proposed STP land is carried out based on land acquisition law (1960). Land acquisition process was started from April 2011. At present, half lands (red color part on **Figure IV-2.2**) in the northern part are under negotiation with land owners and another half lands (purple color part on the Figure 2.2) in the southern part are already acquired and it is converted to state land. In this point, the state land means to be acquired for the proposed STP site. Figure 2.2 shows lot number map for the proposed STP site and **Table IV-2.1** present status of land acquisition.

Purchasing procedures for land acquisition are conducted by "the Sewage and Sewerage Department (JPP)" under the Ministry of Energy, Green Technology, and Water" by using national government fund.

2.4 Necessity of Land Acquisition and Resettlement

There are no squatters excluding 5 houses at lot number 347 in land acquisition. According to IWK, these 5 houses originally are rented to other people as commercial business with house building by land owner. It is his free if how kinds of business are carried out by land owner. If buying and selling are agreed between government and land owners, tenants shall transfer to another lands based on the discussion with land owners. But it will generally need notification from land owners to tenants one – two months ago.

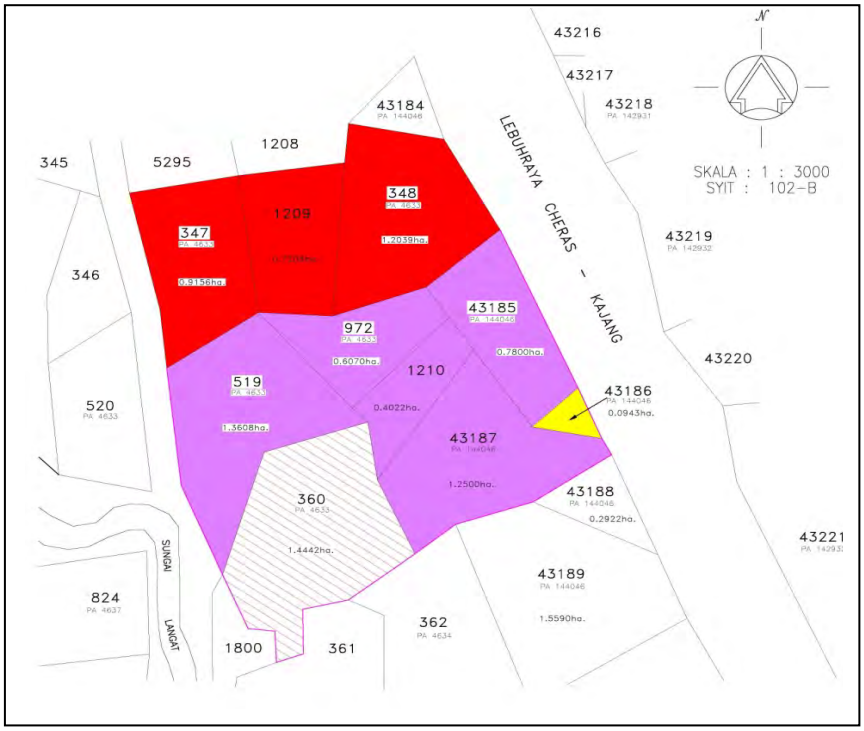
Acquisition of the necessary land for the proposed STP is conducted based on Land Acquisition Act and in addition, there are no squatters in the area. Thus, it is judged that there are no issues on necessary of the resettlement by squatters. .



Source: Valuation and Property Services Department, Ministry of Finance

Note: State Authority means state council; State Director means state director of lands & mines; Development approval is granted by Local Authority.

Figure IV-2.1 Procedures of Land Acquisition



Source: IWK

Figure 2.2 Lot number of the Proposed STP Site.

Table IV-2.1 Land Acquisition Situation of the Proposed STP Site

No.	Lot Number of Proposed STP Site	Land Acquisition Situation	Commencement Day of Land Acquisition	Completion /Scheduled Completion Date of Land Acquisition
1	347	Final stage of land acquisition process, soon payment of land price	April 2011	Schedule: February 2012
2	1209	Final stage of land acquisition process, completion of negotiation for land purchasing.	-ditto-	-ditto-
3	247	Final stage of land acquisition process, under negotiation on payment of land price.	-ditto-	-ditto-
4	519, 972, 43185, 1210, 43186	Completion of land acquisition process. all lots belong to state.	March 2011	Completion of the process on September 6, 2011
5	43186	JKR land, Director of JKR agreed to transfer land ownership to JPP on April 2011.	As department of JKK agreed to transfer the land ownership to JPP on April 2011, JPP can use it as the proposed land at any time.	

Source: IWK

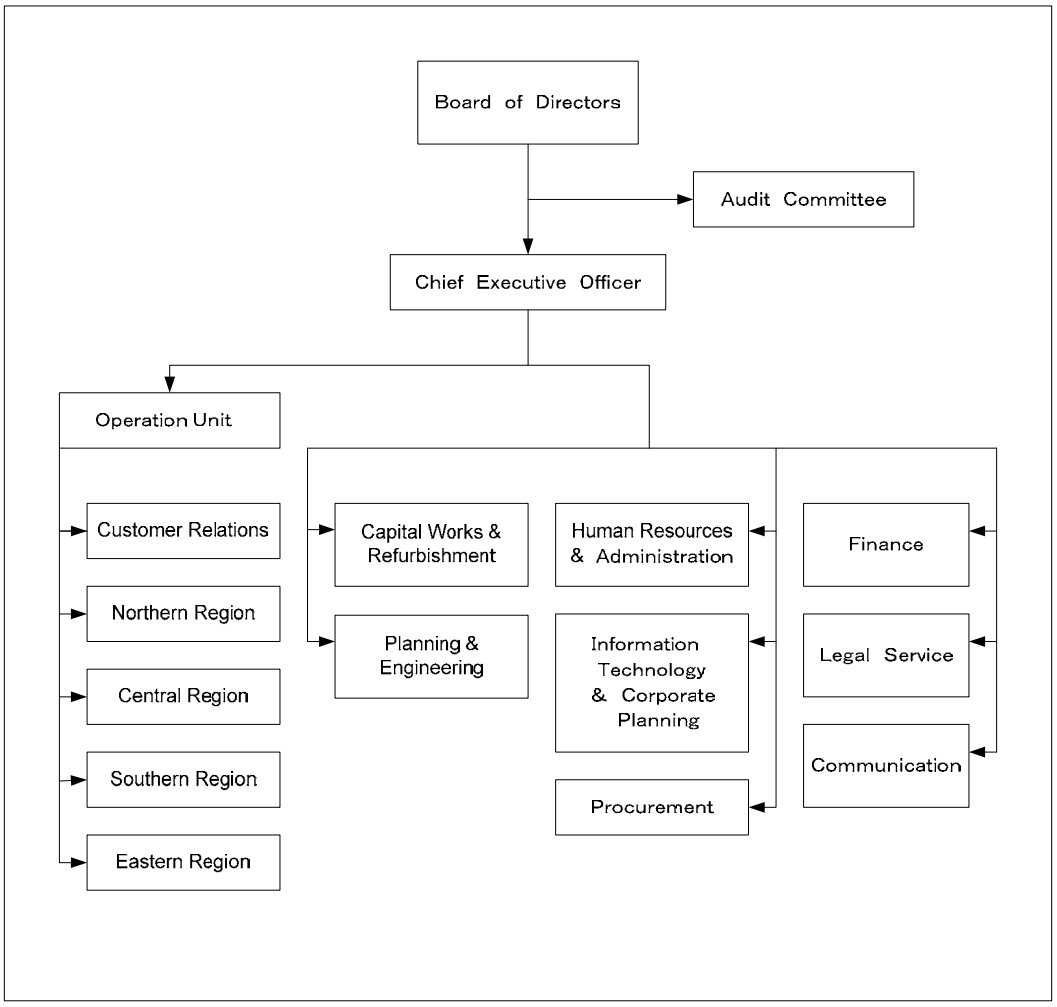
2.5 Claim Adjustment Mechanism

The claim adjustment mechanism with land acquisition is include in Land Acquisition Act (1960) and in land acquisition, state land administrator designated under state land law holds the land compensation meetings to decide its compensation fees and collects all the interested persons relating to the land acquisition and reviews their statements and arranges their concerns. The state land administrator holds the same power as the Court in the land compensation meetings.

In the land compensation meetings, if the administrator could not collect all the interested persons, their meetings become invalidity.

On the other hand, the land administrator provides award for compensation fees on consideration of estimations of the fees by public valuers belonging to "the Valuation and Property Services Department, the Ministry of Finance" and private valuers designated by land owners.

According to IWK, there no issues on claim adjustment for land acquisition in the proposed STP site. However, complaints on noise and bad odor will cope with by "Operation Unit of IWK". **Figure IV-2.3** shows IWK organization chart.



Source: IWK

Figure IV-2.3 IWK Organization Chart

2.6 Cost and Financial Resources for Resettlement

In the land compensation meetings which are held on the basis of Land Acquisition Act (1960). The land administrator must provide the notice for holding land compensation meetings to all the interested persons such as the occupiers, registered land owners, registered interested persons, and possible persons who shall have the land interests, and inquires land values and relating interests to all persons who require compensation fees. The land administrator decides compensation fees by these meetings.

If squatters and renters are living in the project land for land acquisition, the compensation fees are included in the land acquisition fees and the applicants for land acquisition must pay land purchasing cost including their compensation fees to the land owners. However, in the proposed STP site, squatters do not dwell in and resettlement of inhabitants does not need. Thus, budget preparation for resettlement is not necessary.

3 Survey Items Relating to EIA Checklist

3.1 Permits and Explanation

(1) Development Approval

Aside from approval of preliminary EIA report, development approval for the proposed STP site as a necessary approval for commencement of construction works is needed. According to the officer of the "Valuation and Property Department of Kajang Municipality Council (Majlis Perbandaran Kajang)", after acquisition of ownership of the development land by land acquisition or negotiation with land owners and before the start of construction works, development plan assessment shall be submitted with scheduled forms to the KMC by the proponent. To obtain the preliminary EIA approval from DOE prior to acquire development approval in order to be included in a part of evaluation for development approval is hoped. The committee for development approval is held at two times and it is approved with or without conditions. Time framework for procedures for development approval is generally one to three months. Development approval procedures are shown in Figure 1.

(2) Road Works Permission

The Road Department of the Ministry of Public Works (JKR) controls main roads excluding local roads. JKR Hulu Langat office exercises jurisdiction over 7 sub-districts of Ampang, Cheras, Kajang, Semenyih, Beranang, Langat, Bandar Baru Bangi including the project area. Proponent must get "Road Works Permission" by surmising "Professional Traffic Management Plan" to JKR Hulu Langat office. Review period of submitted documents for permission is about 2 weeks.

As JKR issues "Guideline on the Estimation Procedures for Traffic Management during Construction" and "Manual on Traffic Control Devise" and others, the Contractor should establish traffic control plan during construction works for pipe laying by referring them.

(3) Construction Work Permission for Earthworks on Soil Erosion and Sedimentation

Before the start of earthworks, the design for drainage surface water from STP site has to be submitted to the Department of Irrigation and Drainage, the Ministry of Natural Resources and Environment for approval. To protect soil erosion and sedimentation in drained canal and stream, the Contractor must set up sedimentation pond and silt trap in proposed STP site and drain its supernatant water.

(4) Work Safety Management Registration

One month ago, prior to start of construction works, the Contractor must register work safety management manners to the state office of the Department of Occupational Safety and Health, the Ministry of Human Resources.

3.2 Pollution control

(1) Noise generation caused by pumps, blowers, and generators for emergency which are set up in proposed STP

In the proposed STP, the following noise generation equipment is planned to be set up. (Note: noise generation sound levels show their levels in noise generation sources.)

1) Pump, 6 units：250 KW/unit, noise generation sound level 85 dB/unit
2) Blower, 6 units：150 KW/unit, noise generation sound level 100 dB/unit
3) Generator for emergency, 2 units：2,000 KVA/unit, noise generation sound level 85 dB/unit

Positional relationships among installation positions of noise generation equipment at the proposed STP and neighboring residential area and school are shown in **Figure IV-3.1**. In the outside of southwest boundary of the proposed STP site, there are Islamic school and residential area, and in the northwest side along access road, there are some housing areas.

Source: Prepared by the Study Team

Note: Yellow square Houses used for noise measure checking

Red square Installing points of noise-generation equipment

Figure IV-3.1 Positional Relationship between Noise-Generation Equipment and Surrounding Houses at the Proposed Site

"Planning Guideline for Environmental Noise Limits and Control (2004)" regulates the maximum permissible noise levels as shown in **Table IV-3.1**. The maximum noise limits are ones which are measured in the premises boundary. On the other hand, since "WHO's Recommended Noise Exposure Limits" were almost the same ones as the Malaysian Environmental Noise Limits, the Malaysian noise limits were adapted.

Table IV-3.1 Maximum Permissible Sound Level for Planning and New Development

Category	Day Time (7:00 am – 10:00 pm)	Night Time (10:00 pm – 7:00 am)
Noise Sensitive Area Low Density Residential, Institutional (School, Hospital), Workshop Areas	50 dB	40 dB
Suburban Residential (Medium Density) Areas, Public Species, Parks, Recreational Areas	55 dB	45 dB

Source: Schedule 1 of "Planning Guideline for Environmental Noise Limits and Control (2004)"

Noise level at Islamic school and residential area in the outer of southwest boundary of proposed STP site

Located area of Islamic school corresponds to noise sensitive area by the above guideline. However, the role on noise sensitive area due to no students in night time is applied only in day time and that in day time is 50 dB. In night time, as the noise limit of suburban residential area is

applied, that in night time is 45 dB.

The direct distance from blowers to the southwest boundary of the STP site is about 260 m, the distance from pumps to the southwest boundary is about 350 m, and the distance from generators to the southwest boundary is about 340 m. In case that the blowers, pumps, and generators are operated at the same time, combination noise level in the southwest boundary becomes 59.6 dB. This noise level exceeds the noise limit (50 dB) in day time at noise sensitive area and that one (45 dB) in night time at suburban residential area.

Thus, the noise level (100 dB) of blowers which has the largest sound level is needed to reduce 15 dB and down to 85 dB at sound source by use of silencer, that level (85 dB) of pumps to reduce 10 dB and down to 75 dB at sound source, and that level (85 dB) of generator also to reduce 10 dB and down to 75 dB at sound source by use of silencers. In this case, when those equipment are operated at the same time, the combination noise level in southwest premises boundary becomes 44.8 dB and it fulfills a criteria of the noise sensitive area's limit (50 dB) in day time and suburban residential area' s limit (45 dB) in night time.

As a result, it is necessary to reduce sound level of 15 dB in blowers and them of 10 dB in pumps and generators by use of silencers to meet noise standards.

Noise level at residential area in the northwest side of proposed STP site

At residential area in northwest side of the proposed STP site, noise limits in suburban residential area are applied based on the above guideline, and those are 55 dB in day time with 45 dB in night time.

As shown in the above, in case that blowers, pumps, and generators were simultaneously operated, combination noise level at Islamic school and residential area were calculated. To fulfill criteria, it became clear to be necessary to reduce noise level of 15 dB in a blower, that level of 10 dB in a pump and a generator by use of silencers, respectively.

Thus, in the same condition, combination noise level in northwest residential area is calculated and it is reviewed whether its noise level meets with noise standards or not.

The direct distance from blowers to residential area in the northwest boundary of the STP site is about 385 m, the distance from pumps to the boundary of the residential area is about 305 m, and the distance from generators to the boundary of the residential area is about 315 m. In case that the blowers, pumps, and generators are operated at the same time, combination noise level in the northwest boundary becomes 41.9 dB. This noise level meets with the noise limit (55 dB) in day time and that one (45 dB) in night time at suburban residential area.

Noise level at neighboring residential area along access road in the northwest of proposed STP site

In the similar way as the above, in case that blowers, pumps, and generators were simultaneously operated and noise level of 15 dB of a blower and those levels of 10 dB of a pump and a generator were reduced, combination noise level at Islamic school and residential area were calculated.

The direct distance from blowers to neighboring residential area in the northwest boundary of the STP site is about 320 m, the distance from pumps to the boundary of the residential area is about 150 m, and the distance from generators to the boundary of the residential area is about 130 m. In case that the blowers, pumps, and generators are operated at the same time, combination noise level neighboring residential area in the northwest boundary becomes 44.8 dB. This noise level meets with the noise limit (55 dB) in day time and that one (45 dB) in night time at suburban residential area.

According to review results in the above, if noise level of 15 dB of a blower with those of 10 dB

of a pump and a generator are reduced and at the same time their equipment are operated, combination noise levels at Islamic school and residential area in southwest premises boundary, in northwest residential area, and at neighboring residential area along access road in the northwest of proposed STP site meet with Malaysian noise standards. Thus, it is necessary that noise level of 15 dB of a blower and those of 10 dB of a pump and a generator are reduced.

Noise calculation equations used for reviewing these noise levels are shown below.

Noise Calculation Equation

Noise calculation equation:

$L2 = L1 - 20 \log_{10}(d2/d1)$

L2: Noise level in prediction distance (dB)
L1: Noise level in standard distance (dB)
d2: Prediction distance
d1: Standard distance near point sound level

Combination sound levels in case of overlapping sounds:

$L\ (dB) = 10 \log_{10} (10^{L1/10} + 10^{L2/10} + \text{----------})$

L (dB): Combination noise level
Li (dB): Noise level by each sound source

(2) Noise Generation Caused during Construction Works

According to "Planning Guideline for Environmental Noise Limits and Control (2004)", noise standards during construction works is shown in Schedule 6. Outline of noise standards is shown in **Table IV-3.2**. Maximum permissible sound levels of construction works by receiving land use are divided into 3 time periods such as Day time (7:00 am - 7:00 pm), Evening (7:00 pm - 10:00 pm), and Night time (10:00 pm – 7:00 am). In the day time, fairy large sound levels are permissible but in the evening, its permissible sound levels become a little bit lower and in the night time, it is almost the same levels as those of residential areas. Thus, construction works generated large sound levels are hoped to be carried out in the day time (7:00 am – 7:00 pm). If the construction schedule is hurried up, the construction works shall finish until the evening (7:00 pm-10:00 pm) under constrains by use of machineries with small sound levels, and especially, near schools and hospitals, shall shorten construction period by ingenious attempt of construction schedules.

Table IV-3.2 Maximum Permissible Sound Levels of Construction Works by Receiving Land Use

Receiving Land Use Category	Noise Parameter	Day Time 7:00 am – 7:00 pm	Evening 7:00 am – 10:00 pm	Night Time 10:00 pm – 7:00 am
Residential	L90	60 dB	55 dB	50-55* dB
	L10	75 dB	70 dB	50-55* dB
	LMax	90 dB	85 dB	50-55* dB

Source: Schedule 6 of "Planning Guideline for Environmental Noise Limits and Control (2004),"

Note: Maximum permissible sound levels in the night time are based on Schedule 1 by its regulation. Small limit (50 dB) is applied to schools and hospitals' neighboring areas and large limit (55 dB) in residential areas.

(3) Bad Odor's Generation

In the Malaysian environmental laws, there are no regulations to prevent bad odor.

In the preliminary construction plan, closed system for sludge treatment facilities etc. at the proposed STP is planned. To trap bad odor, grit chamber, primary sedimentation tank, reactor, tank related to sludge facility, scum pit, and machineries are covered. Its air is deodorized by deodorized equipment.

Deodorization is conducted by packed column type of biological odor control method. This is a method that discomposes odor component by filling materials with several kinds of micro-organisms in biological odor control column, breeding them, and supplying air with bad odor.
As advantage points of this method, easy operation and maintenance, cheaper operation cost for only electrical fee to blowers, small type of facility are pointed out.

3.3 Natural Environment

(1) Environmental Protection Area
There are no protection areas of environmental protection and conservation areas regulated by government laws and international treaties in the neighboring areas of proposed STP site and also, in the river mouth of the Langat River which STP's effluent water is discharged.

(2) Ecosystem
Proposed STP site is covered by artificial forest (Mango and Dorian trees) and banana plantation and its area is not significant in ecosystem.

3.4 Social Environment

3.4.1 Ethnic Minorities and Indigenous Peoples

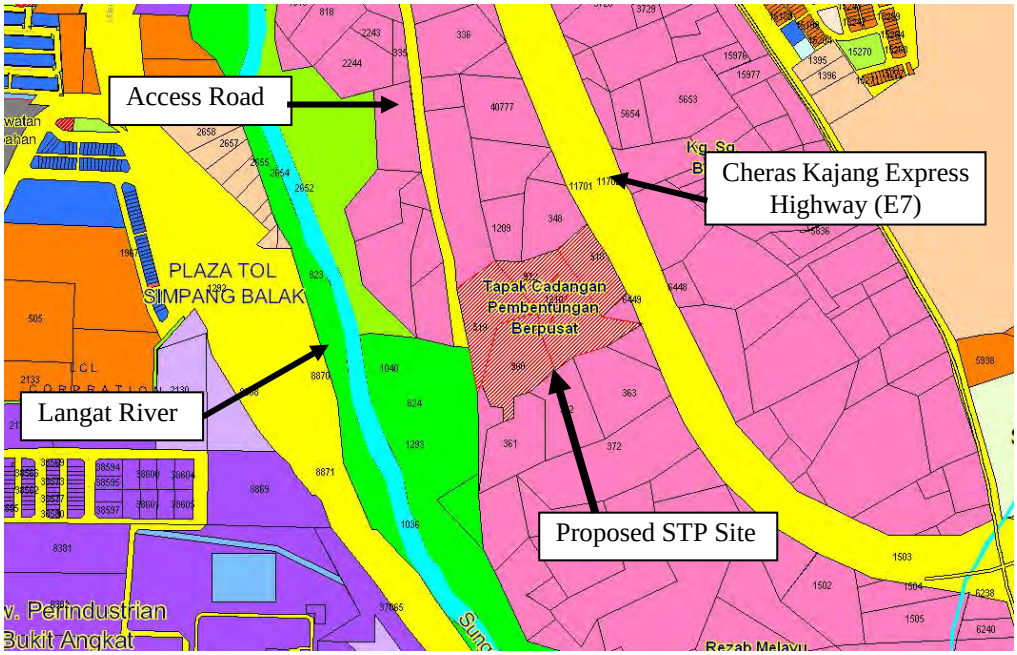
(1) Ethnic Minorities
In Malaysia, ethnic composition of about 28.31 million national populations (2009) is Malay (65 %), Chinese (26 %), and Indian people (8 %) and others (1%). Of these people, Chinese and Indian people are categorized as ethnic minorities. In Malaysia, living level standards of those peoples are generally high and they have economic power. Thus, the implementation of the Project will not give adverse impact to their livelihood and the improvement of sewerage system will adversely provide positive impact to them.

(2) Indigenous People
In Peninsular Malaysia, Indian people who are called "Orang Asli" are living. There are 18 orang asli tribes, categorized under three main groups according to their different languages and custom: Semang (or Negrito), generally confined to the northern portion of the peninsula, Senoi, residing in the central region, Proto-Malay (or Aboriginal Malay) living in the southern region.

In the jungle of the Selangor State, Senoi indigenous are living. However, in Kajang Municipal Council which the proposed project STP site is located, they are not living. Thus, the implementation of the Project will not affect their livelihood.

3.4.2 Historical and Cultural Heritage

According to KMC Planning Development Department, its land development of the proposed STP site has no problems because there are no historical and cultural heritages. In addition, the development planning map of KMC (**Figure IV-3.2**) shows that the proposed STP site is already approved by state government with agreement of relative agencies. The STP site is shown as development area for STP construction on the map.



Source : Kajang Municipal Council

Figure IV-3.2 KMC Development Planning Map

3.5 Adverse Impact and Mitigation Measures at Construction and Operation Stages

3.5.1 Adverse Impact and Mitigation Measures at Construction Stage

Adverse impact and mitigation measures against environment at construction stage are shown in **Table IV-3.3**.

Table IV-3.3 Adverse Impact and Mitigation Measures at Construction Stage

No	Adverse Impact	Mitigation Measures	Relating Regulation and Organizations
1	Soil erosion from cut and fill, and temporary sedimentation of natural waterways	To plan careful construction schedule. To maintain stable slope of filled surface. To avoid unnecessary exposure of soils. To protect drainage channel by embankment. To conduct adequate compaction of filled slope surface. To conduct vegetation (grass) on erodible surface (especially filled areas) as soon as possible.	Environmental quality (prescribed activities) (environmental impact assessment) order 1987; amendment 1995, DOE
2	Adverse impacts on surface hydrology	To avoid discharge of surface water with high turbidity to streams by earthwork activities during construction stage, it is once drained to sedimentation pond, and after sedimentation of soils, supernatant water is discharged to streams. In case of high turbidity in supernatant water, silt trap device to reduce its concentration is used.	Guideline for erosion and sediment control in Malaysia, 2010; DID. Design of drainage facility to streams prior to earthworks must be approved by DID
3	Ground and surface water contamination by oil, grease and fuel	To avoid setting up of construction equipment near drainage channel and artificial reservoir. Safe disposal and storage of grease etc.	Environmental quality (prescribed activities) (environmental

		To Clean labor camp and storage sites of construction equipment, and to avoid environmental pollution by spill of fuel and oil.	impact assessment) order 1987; amendment 1995, DOE
4	Creation of stagnant water bodies in dumping site of surplus excavation soils, borrow pits, and quarries, etc. suited for mosquito and other vectors to breed, impairing aesthetics or posing danger to humans/animals	To make earth fill or to keep clean drainage to avoid creating aquatic habitats. To keep original landscaping after use.	-Ditto-
5	Dumping of surplus excavation soils caused by pipe laying	Dumping to general waste dumping sites	
6	Noise and vibration pollution at the time of pipe laying and construction of treatment plant	Near schools, hospitals which are designated as sensitive area by Planning Guidelines for Environmental Noise Limits and Control (2004), the Contractor should complete the construction works in short time by proper arrangement of work schedule. In addition, by using small scale of back hoe etc and equipment with silencer etc, the Contractor should make an arrangement so as not to cause large noise and vibration.	Planning Guidelines for Environmental Noise Limits and Control (2004); DOE
7	Fog and dust during construction works	To avoid fog and dust caused by construction works and by water spray before or during construction works.	Environmental quality (prescribed activities) (environmental impact assessment) order 1987; amendment 1995, DOE
8	Traffic accidents and disturbance during pipe laying works in roads	In case that pipe laying works are conducted at main roads with heavy traffic condition, the Contractor must need to get JKR permission from JKR Hulu Langat office before start of construction works, by submission of "Traffic Management Plan" on pipe laying works in the roads. In addition, the Contractor conducts pipe laying works in each single lane, and puts construction sign and post with color taping for temporary fences, and put watchmen. In addition, at night time, the Contractor must put electric lightning signal equipment indicating construction site for safety traffic control. The Contractor must conduct safety traffic control so as not to cause traffic disturbance of passers and bicycles and have to safely lead them by watchmen. As JKR's main office issues "Guidelines on the Estimation Procedures for Traffic Management During Construction" and "Manual on Traffic Control Devises" etc., the Contractor should refer to them.	In advance to start of pipe laying works, the Contractor needs to get JKR permission by submission of "Traffic Management Plan" of pipe laying works in the roads, including schedules, safety traffic control plan to JKR Hulu Langat office.
9	Accidents by entrance and exit of	In the entrances and exits of construction sites	Environmental quality

	construction vehicles at construction site	such as STP and pumping stations, the Contractor must all the time and safely control construction vehicles by standing plural watchmen. In addition, the Contractor must teach thoroughly to drivers on safety traffic control for no traffic accidents. The Contractor should ban intrusiveness of the public and fence and put sign board of no trespassing.	(prescribed activities) (environmental impact assessment) order 1987; amendment 1995, DOE
10	Dirtied road by adhering tires of wetted soils and fallen objects by vehicles for transportation of equipment and materials and surplus excavation soils	In case that transportation vehicles for construction works drop fallen object, the Contractor must build organization system to be able to pick up them. The Contractor should confirm drops of any hazard materials which may disturb traffic by going around roads at least three times per day. Further, the Contractor should make clean the tires of transportation vehicles so as not to dirt roads by dirty tires with wetted soils and conduct cleaning of dirty parts of roads.	-Ditto-
11	Discharge of muddy water by construction works	Muddy water caused by construction works has to drain to vacant area, trench, and pond. If in neighboring places of construction sites, proper drain ones are not found, the Contractor should lay temporary drain pipes and build provisional trenches not to provide nuisance to residential houses.	-Ditto-
12	Wastewater and solid waste caused by construction sites and camps	In the neighboring area of construction sites and workers camp, environment must be always kept in clean condition. Waste must be properly dumped by bins and cans segregating oils, general rubbish, and hazard materials etc. In the neighboring area of construction sites and laborer's camp, portable toilets and temporary water supply system for cleaning and hand wash should be set up for cleanliness.	-Ditto-
13	Safety control of construction workers	Any worker and personnel who enter into construction sites have to bear safety shoes and hats for construction works. Site manager of the Contractor must conduct morning assembly every day by collecting all the laborers and give instructions to them on safety control of construction site and thoroughly conduct safety management of the site. In the construction site where heavy machines for construction are operated, intrusiveness except concerned parties should be banned.	Occupational Safety and Health Act (1994); DOSH
14	Safety control and management on installation of machineries and equipment at STP	Installation and initial run of machineries and equipment so as not to cause any accidents to labors must be supervised by experienced licensed persons who well know about their handling.	Factories and Machinery Act (1967), Revised (1974); DOSH

Source: Prepared by the Study Team

3.5.2 Adverse Impact and Mitigation Measure at Operation Stage

Adverse impact and mitigation measures at operation stage are shown in **Table IV-3.4**.

Table IV-3.4 Adverse Impact and Mitigation Measures at Operation Stage

No	Adverse Impact	Mitigation Measures (Environmental Management Plan)	Relating Regulations and Organizations
1	Disposal of sludge generated by sewage treatment from STP. In the target year of 2035, sludge of 130 kg/day (25,971 kg/day) with water content of 80 % is generated.	As sewage treated at STP is derived of domestic wastewater, it will not include heavy metals and hazardous substances. Thus, sludge is disposed to landfills for general wastes	Environmental Quality (Scheduled Waste) Regulations, 2005; IWK
2	Noise pollution caused by blowers and main pumps booster pumps of intake facility and treatment plant, and generator	To decrease noise level, silencers to blowers and main pumps and generators which are set up in proposed STP shall be arranged. Distance from blowers to Islamic school in the southwest boundary is about 350 m, distance from blowers to residential area in the northwest boundary is about 380 m and distance from blowers to housing area along access road in northwest boundary is about 320 m. To reduce noise levels by attaching silencers 15 dB in blowers, 10 dB in pumps and generators, their combination noise will become less than standards of noise protection laws (day time: 50 dB and nigh time 45 dB).	Planning Guidelines for Environmental Noise Limits and Control 2004; DOE
3	Bad odor generated by STP	To avoid bad odor from STP, sludge treatment system is designed as completely closed one and the exhaust air from ventilator in sludge treatment system deodorizes by deodorizing facilities. In addition, buffer zone around STP is set up.	

Source: Prepared by the Study Team

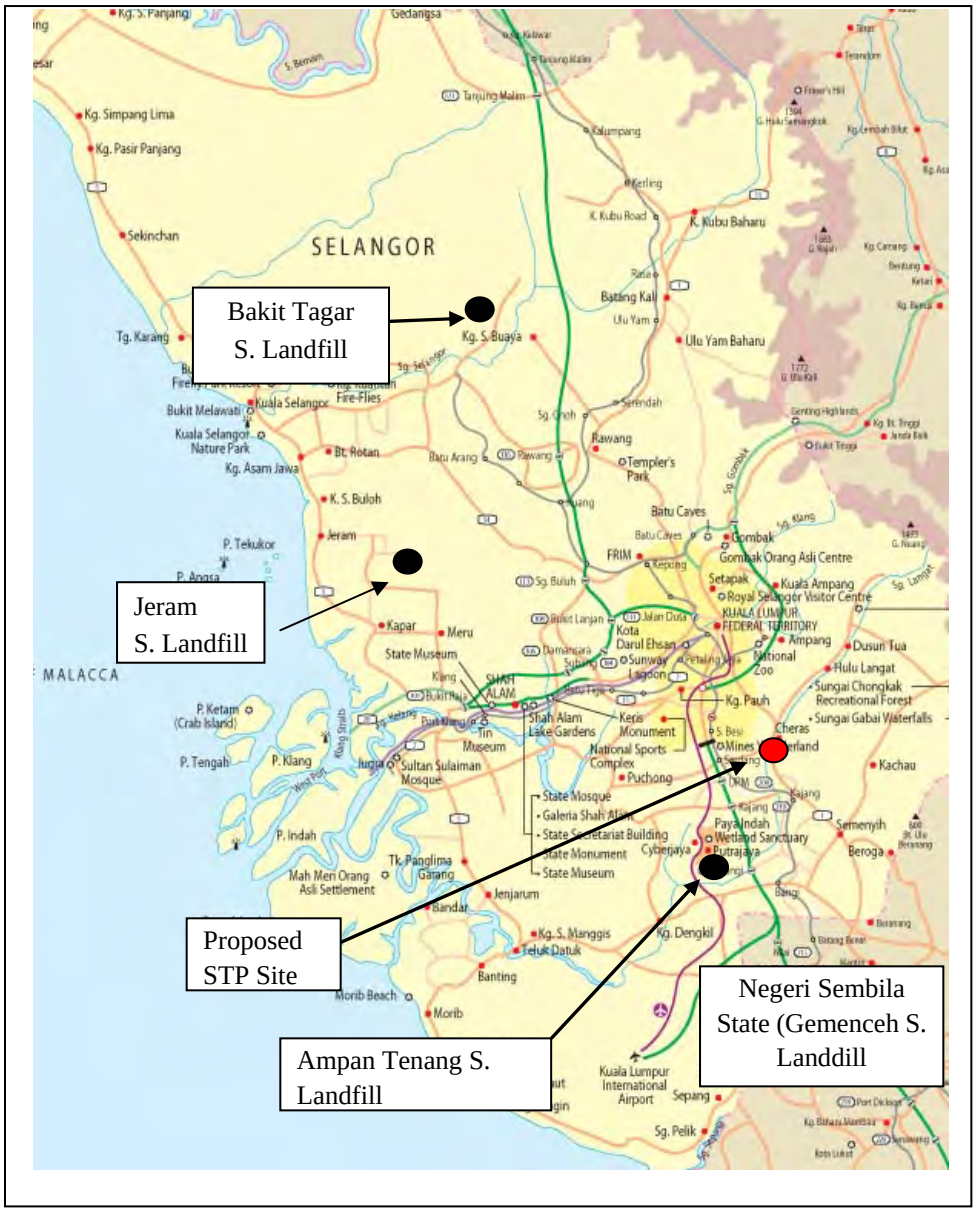
(1) Sludge Disposal Generated from STP

According to environmental laws in Malaysia, effluent from industries must be treated under their responsibilities and after treatment, the effluent with permissible water quality less than standards must directly discharge to public water body (rivers and lake and sea). Thus, sewage to be treated at STP is limited to domestic wastewater. "Environmental Quality (Scheduled Waste) Regulations, (2005)" regulates that sludge generated from STP does not falls into prescribed waste. If it applied to schedule waste, it must be disposed to special dumping sites where are regulated by these Regulations and pay special attention to its handling.

Thus, sludge from STP is dumped as general wastes to general waste dumping sites.
In the target year of 2035, total of sewage treatment amount attains to 207,000 m3/day and its sludge amount is 130 m3/day (25,971 kg/day) with water content of 80 %. As a result of interview to KMC's Town Service and Health Department, they have not responsibility to the issues. Sludge disposal generated from STP is under jurisdiction of Indah Water Consortium (IWK).

In Selangor State, there are 4 general waste sanitary landfills that IWK is used for sludge disposal and

they are also authorized by DOE. These landfills are managed by private sectors. IWK disposes sludge by agreement with private sectors. Locations of these landfills are shown in **Figure IV-3.3** with the outline in **Table IV-3.5**.



Source: Prepared by the Study Team

Figure 3.3 Locations of Sludge Disposal Sites to be Used by IWK

(Gemenceh sanitary landfill is located at the outside of the map. Location is not indicated.)

Table IV-3.5 Outline of General Waste Dumping Sites for Sludge Disposal Used by IWK

No.	Landfill Name	Location	Managing Organization	Outline
1	Ampan Tenang Sanitary Landfill	Selangor State	Alam Flora Co. Ltd.	Closedown: February 2010、 Lifespan：12 years Dumping fee: Public waste RM 600/m^3
2	Jeram Sanitary Landfill	Selangor State	Worldwide Landfills Co. Ltd.	Land area：160 acres, Operation start: January 2007、 Lifespan 処理場寿命：16 年間 Present dumping volume：2,000 m^3/day Dumping fee： Public waste RM 36/m^3 Special RM 141.66/m^3
3	Bukit Tagar Sanitary Landfill	Selangor State	Kub-Berjaya Enviro. Co., Ltd.	Land area：700 acres, Lifespan：40 years Dumping fee:：Public waste RM 36/m^3 Special RM 141.66/m^3
4	Gemenceh Sanitary Landfill	Negeri Sembilan State		

Source: IWK Website

(2) Noise Generation by Blowers (6 Units), Pumps (6 Units), and Generators (2 Units) at STP

Noise generation by blowers, pumps, and generators at STP is explained in Chapter 3, 3.2 Pollution Control, (1) Noise generation caused by pumps, blowers, and generators for emergency which are set up in proposed STP.

(3) Control of Bad Odor

Control of bad odor is described in Chapter 3, 3.2 Pollution Control, (2) Bad Odor's Generation.

(4) Buffer Zone

DOE recommend setting up buffer zone as environmental requirement by "Buffer Guidelines for the Siting and Zoning of Industries". The Buffer Guideline classifies the concept of the STP into 5 categories: (1) Open treatment plant (TP) near residential(R)/commercial (C) plot, (2) Enclosed TP near R/C plot, (3) Buried/covered TP near R/C plot, (4) Enclosed TP near R plot/high rise building, (5) Small scale of open TP (with PE less than 150) near industrial plot. The guideline regulates size and scale of buffer zones in the above categories as follows:

Table IV-3.6 Size and Scale of Buffer Zone and STP Categories

No.	STP Categories	Size and Scale of Buzzer Zone
(1)	Open TP near R/C plot	• Minimum distance of 30 m from the fence of the STP to the nearest building property line of residential/commercial area. • Minimum distance of 20 m from the fence of the STP to the nearest building property line of industrial area.
(2)	Enclosed TP near R/C plot	• Minimum distance of 10 m from the fence of the STP to the nearest property line of residential/commercial area.
(3)	Buried/covered TP near R/C plot	• Minimum distance of 10 m from the fence of the STP to the nearest building property line of residential/commercial area.
(4)	Enclosed TP near R plot/high rise building	• Minimum distance of 30 m from the fence of the STP to the nearest building property line of residential/high rise building.
(5)	Small scale of open TP near industrial plot	• Minimum distance of 20 m from the fence of the STP to the nearest building property line of industrial area.

Source: "Malaysian Sewerage Industry Guidelines – Volume 4: Sewage Treatment Plants" by SPAN (January 2009)

Table IV-3.7 Other Buffer Constrain for every STP

No.	STP Category	Other Buffer Constrain
(1)	Every type of STP	Minimum distance 5 m inside from fence of STP shall be kept for access and screening, beautification by planting,.

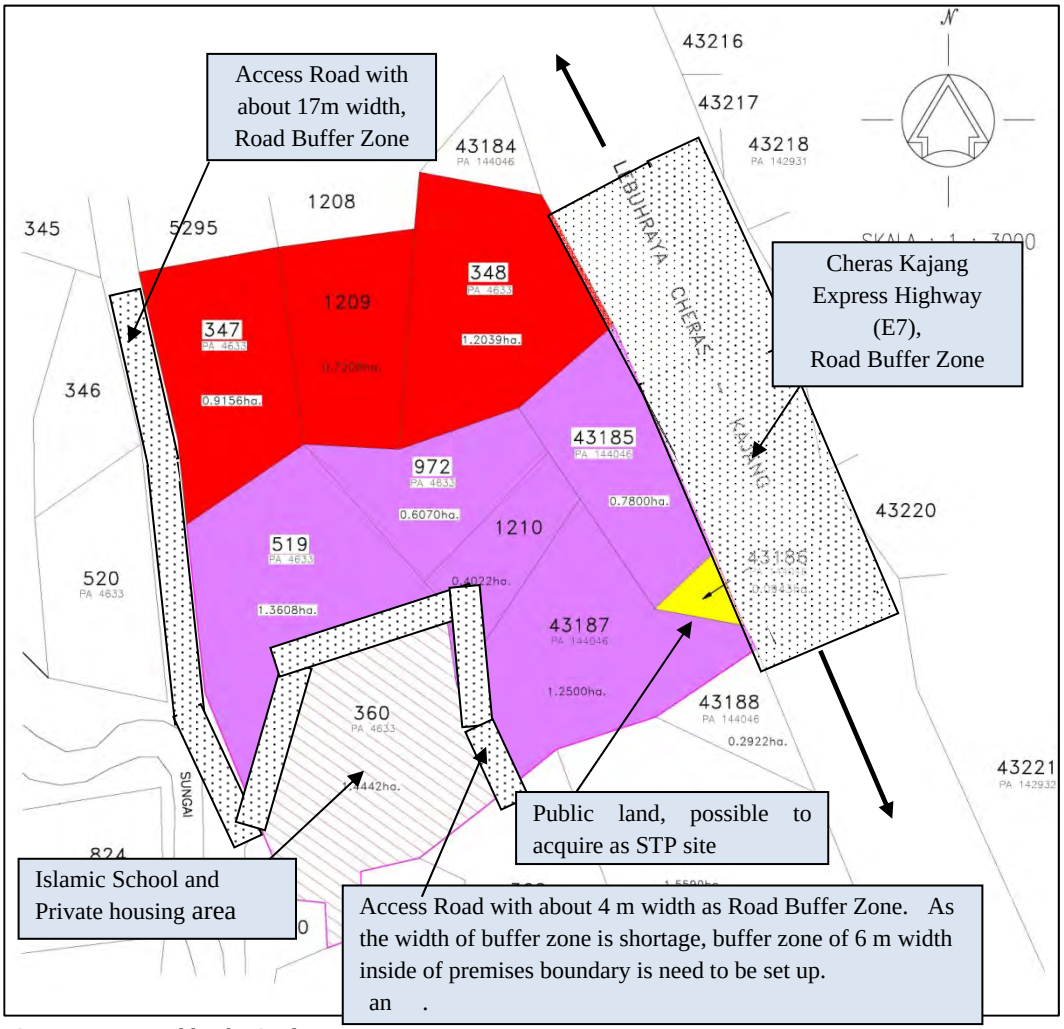
Source: "Malaysian Sewerage Industry Guidelines – Volume 4: Sewage Treatment Plants" by SPAN (January 2009)

In addition to the above categories, "the Buffer Guidelines" regulate that the buffer zone can be applied to drainage reserve, road, highway reserve, transmission reserve, utility reserve, and park.

In the above categories, enclosed/covered facilities as a preliminary plan of this STP will be designed. Around the project site, there are no high rise building and industrial areas. Thus, size and scale of buffer zone for the Project will become 10 m width from the real premise boundary.

On the other hand, the project area is enclosed by Cheras Kajang Express Highway (E7) running to NS direction in the east side and by access road with width of about 17 m along the Langat River flowing in the NS direction in the west side. These roads are applied as buffer zone. In the southwest boundary, there is a housing area consisting of an Islamic school and some houses with a local road of 4 m width running around the boundary. Thus, in the southwest boundary, this local road is used for a part of buffer zone but its width is shortage. To set up buffer zone with 10 m width, buffer zone must be set up 6 m inner side from the premise boundary of the proposed STP site. In the northwest boundary, there are artificial forests.

Furthermore, "Buffer Guideline" requires other buffer constrain as shown in **Table IV-3.7**. Thus, the STP facilities must be constructed with width of 5 m inside from the boundary of the buffer zones. This buffer area must be planting for beautification. Outline of buffer zone is shown in **Figure IV-3.4**.



Source: Prepared by the Study Team

Note: Not scale in the width of access road and express highway
In addition to buffer zone, land space for beautification must be prepared with 5 m width. The land space for beautification is omitted in the above Figure.

Figure IV-3.4 Outline of Buffer Zone

3.6 Monitoring Plan

3.6.1 Monitoring System by Implementation Organization

DOE evaluates and surveillances monitoring results. Imposed conditions with EIA approval include detailed instructions on monitoring items and frequency and submission of reports by DOE. The monitoring is actually carried out at the sites by proprietors and Contractors at construction stage and by management utility at operation stage. Monitoring fees are shouldered by these interested parties. Analysis of water and air quality is limited in only accreted and/or registered laboratories by DOE.

By reference of imposed conditions on monitoring by DOE in the similar STP project, monitoring draft plan is established.

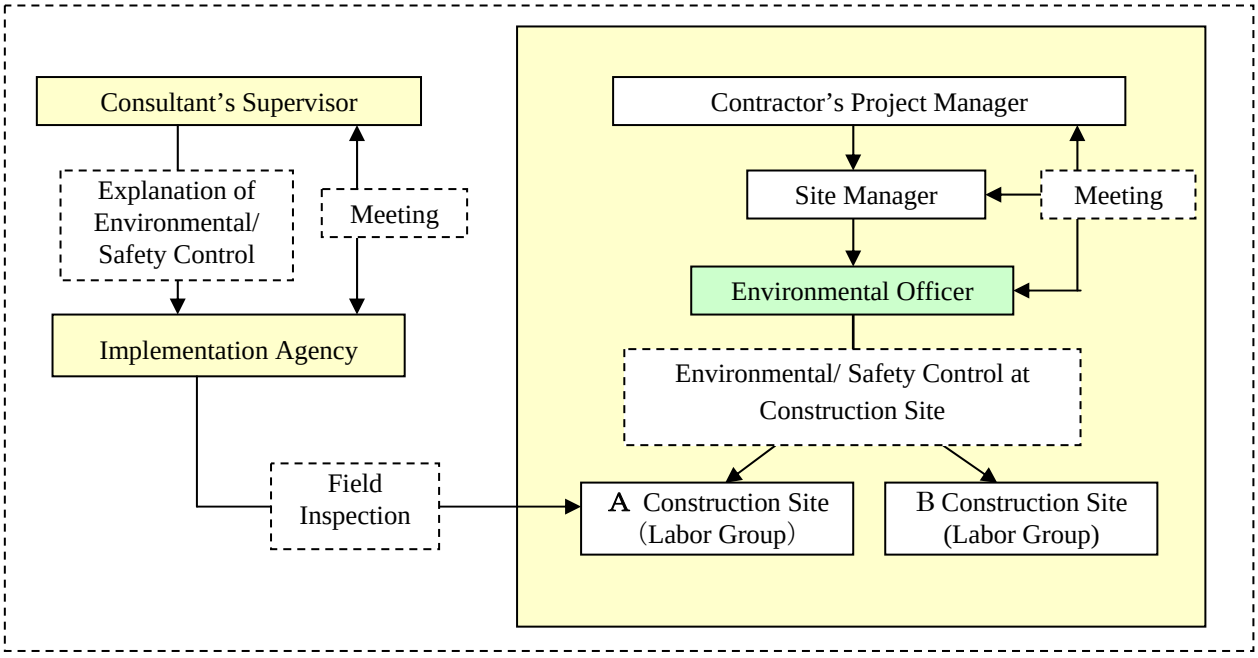
According to instruction of DOE, a full-time environmental officer must be employed by the Proponent/Contractor side.

(1) Monitoring system at Construction Stage

The aim of safety management (safety traffic control and laborers' safety working) in site is, to avoid injuries arising from construction activities, produce a healthy working environment, and create fewer disturbances to the public. Environmental Management Program shall be implemented in order to protect all personnel at site/the public and minimize the risk of accidents and incidents and ensure the health of the working personnel and vicinities and the public of the area and ensure the minimum damage to the environment. The safety measures shall be continuously implemented throughout the duration of the construction works.

Environmental Management shall include the site, work areas outside the site, such as equipment and material storage sites and construction sites. Special care shall be paid for the traffic control during the time of construction.

Project manager of the Contractor who controls construction works must select and arrange Safety Environmental Supervisor under Site Manager. He shall select an enlightened and experienced engineer as the "Environmental Officer" from engineering staff and must engage in safety environmental management for whole construction works. The Safety Environmental Supervisor has to plan a safety environmental management by checking site environment of construction sites, establishing necessary plan, discussing Project Manager and Site Manager, and notifying necessary safety environmental management countermeasures to all the workers. **Figure IV-3.5** shows implementation management system in construction site. The Consultant Supervisor must safely implement the construction works by adequately discussing Contractor's Project Manager and implementation agency.



Source: Prepared by the Study Team

Figure IV-3.5 Environmental Management Systems in Construction Site

3.6.2 Monitoring Plan

Adverse impacts and mitigation measures at construction and operation stages and monitoring plan for environmental protection are shown in **Table IV-3.8**. Monitoring results should be recorded and stored by format papers.

Table IV-3.8 Monitoring Plan for Environmental Protection in Construction and Operation Stages

No.	Adverse Impact and Countermeasures	Monitoring Parameters	Monitoring Locations	Monitoring Manners	Frequency	Responsibility of Monitoring
Construction Stage						
1.	Erosion from cut and fill and temporary sedimentation of natural waterways	Soil erosion and turbidity of surface water	Outlet to stream from sedimentation pond at STP site	Measure of Turbidity and TSS in drain water	During construction Once a day	Environmental officer, Consultant Supervisor, Implementation Agency
2.	Adverse impacts on surface hydrology and mitigation countermeasures	Disturbance to discharge channel of surface water	Outlet periphery discharged to stream from STP site	Physical observation	During construction Once a day	-Ditto-
3.	Ground and surface water contamination by oil, grease and fuel	Ground and surface water contamination by oil, grease, and fuel	Outlet periphery discharged to stream from STP site	Physical observation	During construction Once a day	-Ditto-
4.	Creation of stagnant water bodies in dumping site of surplus excavation soils, borrow pits, quarries, and construction site, etc.	Keeping of no stagnant water bodies in environment	Dumping site of surplus excavation soils, borrow pits, quarries, and construction site, etc.	Physical observation	During construction Once/week	-Ditto-
5.	Dumping of surplus excavation soils caused by pipe laying	Keeping safety and sanitary dumping site	Dumping site (Public general dumping site)	Physical observation	During construction Once/week	-Ditto-
6.	Protection of noise and vibration pollution at the time of pipe laying and construction of STP and pumping stations	Noise and vibration	All Construction site	Complain by people	During construction	-Ditto-
7.	Protection of fog and dust during construction works	Fog and dust	All Construction site	Complain by people	During construction	-Ditto-
8.	Protection of Traffic accidents and disturbance during pipe laying works in roads	Adequate safety traffic control manners	All pipe laying work sites	Physical observation	During construction Twice/week	Environmental officer, Consultant supervisor, Implementation agency, JKR
9.	Protection of	Adequate safety	Entrance and	Physical	During	-Ditto-

	accidents by entrance and exit of construction vehicles at construction sites	traffic control manners	exit for construction of STP and pumping stations	observation	construction Twice/week	
10.	Protection of dirtied road by adhering tires of wetted soils and fallen objects by vehicles for transportation of equipment and materials and surplus excavation soils	Dirty grade of roads	Passage roads of vehicle for transportation of equipment, materials and surplus excavation soils	Physical observation	During construction Twice/week	-Ditto-
11.	Discharge of wastewater by construction works and its countermeasures	Confirmation of adequate discharge countermeasures of wastewater	All construction sites	Physical observation	During construction Once/week	Environmental officer, Consultant supervisor, Implementation agency
12.	Wastewater and solid waste caused by construction sites and camps and its countermeasures	Adequate treatment of wastewater and solid waste	All construction sites, laborers camp and its neighbouring area	Physical observation	During construction Once/week	-Ditto-
13.	Safety control of construction workers	Wear of safety shoes and hats and safety control manners at construction sites	All construction sites	Physical observation	During construction Once/week	Environmental officer, Consultant supervisor, Implementation agency, DOSH
Operating Stage						
1.	Dumping of sludge generated by sewage treatment	Proper dumping of sludge to public dumping site	STP	Physical observation	Every month	Implementation agency
2.	Noise pollution caused by blowers (6 units), pumps (6 units), and generators for emergency (2 units) installed at STP	Noise	STP	Complain by people	During operation time	-Ditto-
3	Bad odor from STP	Bad odor	STP	Complain by people	During operation time	-Ditto-

Source: Prepared by the Study Team

4 Others

4.1 Power Generation Using Digestion Gas

(1) Outline of Power Generation using Digestion Gas

To reduce electric power cost and greenhouse effect gas, the Project plans power generation using digestion gas which generates from proposed STP.

Its treatment system conducts power generation by combusting digestion gas with gas engine/gas turbine and by rotating engine after removal of trace impure substance (Siloxane), by use of activated carbon, which gives damage to engines. On the other hand, heat waste from exhaust gas and cooling water is collected by forms of steam or hot water and it is utilized for heating and cooling system and supply of hot water.

Power generation efficiency attains to generally 25 – 35 %, heat waste efficiency to 40 -45 % and their combined efficiency becomes about 80 – 90 %. This is fairly high efficiency.

(2) Ration of Power generation Using Digestion Gas to All Consumed Power

In the proposed STP, two generators (400 KW/unit) are operated based on maker's standard capacity. Its total of power generation becomes 800 KWh/two unit. This electric power is utilized for blowers (150 KW/unit) with higher demand in STP. In this case, maximum possible operation numbers become 4 units. However, as inflow amount of sewage during night- time (22:00-6:00) to STP is comparatively a little, only two blowers are supposedly operated and electric consumption by blowers becomes 12,000 KWh.

On the other hand, average electric demand of whole STP is supposed to be 2,710 KWh and the total amount by 24 hours becomes 65,040 KWh (2,710 KWh×24 hours = 65,040 KWh). In this case, the ratio of power generation using digestion gas to total electric consumption becomes 18 % (12,000/65,040 = 0.18). About 18.5 % of electric demand at the STP will be able to cover by power generation using digestion gas.

Yearly power generation cost by using digestion gas becomes RM 1,651,260 by rough calculation (12,000 KWh×0.377 RM/KWh×365 days = RM 1,651,260 (¥40,620,996: ¥24.6/RM in the money exchange rate of December 2011).

4.2 Mitigation Measures Cost (Approximate Estimate) against Environmental Effect at Construction and Operation Stages

Mitigation measures cost against environmental effect at construction and operation stages will be approximately estimated as follows:

(1) To engage into environmental countermeasures at construction stage, full-time environmental officer is needed to be employed. Construction period is roughly estimated to be three years.
(2) To reduce noise level, silencers for blowers (6 units), pump (6 units), and generator (2 units) are attached.
(3) To protect bad odor, deodorization facility is equipped. 、
(4) Power generation equipment using digestion gas is installed

These mitigation countermeasures cost roughly estimated is shown in Table 4.1.

Table 4-1 Mitigation Measures Cost against Environmental Effect at Construction and Operation Stages (Approximate Estimate)

No.	Mitigation Countermeasure	Cost Estimate	Cost
1	Employment Fee for Full-time Environmental Officer for Three Years	Envir. officer：RM 8,000 /M RM8,000 /M × 3 years	RM: 576,000
2	Anti-noise Silencer	Blower (6 units) Pump (6 units) Generator (2 units)	RM: 40,000 RM: 40,000 RM: 200,000
3	Deodorization Equipment	Lump sum	RM: 15,000,000
4	Power Generation Equipment using Digestion Gas	Lump sum	RM: 22,000,000
Total			RM: 37,856,000 ¥: 932,000,000

Source: Prepared by the Study Team

Note: Exchange rate: RM= ¥24.62 (JICA Exchange Rate, December, 2011)

4.3 Monitoring Form

The latest results of the below monitoring items shall be submitted to the lenders as part of Quatenary Progress Report throughout the construction phase

Construction Phase

1. Imposed conditions for EIA approval and countermeasures

No.	EIA Approval Number	Approval Conditions	Countermeasures
Control Measures for Earthworks and Construction			
1	EIA Approval Condition 1		
2	EIA Approval Condition 2		
Erosion Control			
3	EIA Approval Condition 3		
4	EIA Approval Condition 4		
	-Continues-		

2. Pollution

Water Quality of effluent discharge to river

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country Standards	Standards For Contract	Measured Point	Frequency
BOD_5	mg/L			20			Quarterly
SS	mg/L			50			ditto
COD	mg/L			120			ditto
NH_4-N	mg/L			10			ditto
NO_3-N	mg/L			20			ditto
Oil & Grease	mg/L			5			ditto

Note: Country standards: Environmental Quality (Sewage) Regulations 2009

Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country Standards	Standards For Contract	Measured Point	Frequency
TPS	$\mu g/m^3$			260			Quarterly
PM_{10}	$\mu g/m^3$			105			ditto
SO_2	$\mu g/m^3$			105			ditto
NO_2	$\mu g/m^3$			320			ditto

Note: Country standards: Recommended Malaysian Air Quality Guidelines (Ambient standards)

Noise (Construction site)

Noise Level (L_{Aeq})	Unit	Measured Value (Mean)	Measured Value (Max)	Country Standards	Standards For Contract	Measured Point	Frequency
Day time 7:00 am-7:00 pm	dB			L_{90} 60 dB L_{10} 75 dB L_{Max} 90 dB			Quarterly
Evening 7:00 pm-10:00 pm	dB			L_{90} 55 dB L_{10} 70 dB L_{Max} 85 dB			
Night time 10:00 pm-7:00 am	dB			50-55* dB			ditto

Note: Country standards: Planning guidelines for environmental noise level and control 2004. In noise level of the night time, smaller noise level (50dB) is applied at school and hospital, and larger noise level (55 dB) at residential areas.

Turbidity of Discharge Water-

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country Standards	Standards For Contract	Measured Point	Frequency

Turbidity	NTU			250			Quarterly
SS	mg/L			50			ditto

Note: Country standards: Guideline for erosion and sediment control in Malaysia (2010)

The latest results of the below monitoring items shall be submitted to the lenders as part of Quarterly Progress Report throughout the construction phase

Operation Phase

1. Imposed conditions for EIA approval and countermeasures

No.	EIA Approval Number	Approval Conditions	Countermeasures
Water Quality Monitoring and Control			
1	EIA Approval Condition 1		
2	EIA Approval Condition 2		
Noise Monitoring and Control			
3	EIA Approval Condition 3		
4	EIA Approval Condition 4		
Solid Waste Management			
5	EIA Approval Condition 6		
6	EIA Approval Condition 7		
	-Continues-		

2. Pollution

-Water Quality of effluent discharged to river

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country Standards	Standards For Contract	Measured Point	Frequency
BOD_5	mg/L			20			Annually
SS	mg/L			50			Ditto
COD	mg/L			120			Ditto
NH_4-N	mg/L			10			Ditto

NO_3-N	mg/L			20			Ditto
Oil & Grease	mg/L			5			Ditto

(Note) Country standards: Environmental Quality (Sewage) Regulations 2009

1. Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country Standards	Standards For Contract	Measured Point	Frequency
TPS	$\mu g/m^3$			260			Annually
PM_{10}	$\mu g/m^3$			105			Ditto
SO_2	$\mu g/m^3$			105			Ditto
NO_2	$\mu g/m^3$			320			Ditto

(Note) Country standards: Recommended Malaysian Air Quality Guidelines (Ambient standards)

2. Noise- (Operation of equipment at STP)

Noise Level (L_{Aeq})	Unit	Measured Value (Mean)	Measured Value (Max)	Country Standards	Standards For Contract	Measured Point	Frequency
Day time 7:00 am-10:00 pm	dB			50 dB			Annually
Night time 10:00 pm-7:00 am	dB			45 dB			Ditto

(Note) Country standards: Planning guidelines for environmental noise level and control 2004

3. Complaint from inhabitants living in the neighboring areas

Monitoring Item	Numbers and contents of formal comments conducted by the public	Frequency
Noise		Annually
Bad Odor		ditto

4.4 Environmental Check List

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA report, does the conditions satisfied? (d) Aside from the above EIA report, does the project acquire necessary approvals and licenses on the environment from local supervisory authority?	(a) N (b) N '(c) NA (d) NA	(a) Principally, there are two kinds of EIA reports such as preliminary and detailed EIA reports. If the DOE approves preliminary EIA report, the environmental impact assessment is approved. Presently, preliminary EIA report is prepared and finally, it will complete after implementation agency and project design and project cost are fixed. (b) Preliminary EIA report is in preparation stage. Thus, it is not approved by Malaysian government. (c) it is not applicable due to non-approval of preliminary EIA report. (d) (1) Development approval is not approved by Kajang Municipality Council. Its application shall be submitted after EIA approval and before start of the construction. (2) Construction work permission for soil erosion and sedimentation must be obtained from DID, prior to start of earthworks. (3) One month ago, prior to start of construction works, the Contractor must register on work safety management manners to the Department of Occupational Safety and Health.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from residents reflected to project contents?	(a) NA (b) NA	(a) In the preparation process of preliminary and detailed EIA report, the EIA law requests to conduct adequate explanation and to receive their opinions from local stakeholders. Presently, preliminary EIA report is in the preparation stage. Implementation agency, project design, and project cost is not still fixed. Thus, it is not presently in the stage which we explain them to local stakeholders. (b) Iit is not applicable due to the above reasons.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) NA	(a) Proposed STP land is decided in the one place from the very beginning and it is only one project plan and there are no other alternative plans.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
2 Pollution Control	(1) Water Quality	(a) Do chemical items, such as SS, BOD, COD, and pH contained in effluents discharged by the facility operations comply with the country's effluent standards? (b) does heavy metals contain in untreated sewage water?	(a) Y (b) N	(a) Based on acceptable conditions of sewage discharge (Standard A: constrain limits in case that intake facility for water supply is located in the downstream of discharge point of sewage treated water) of "Environmental Quality (Sewage) Regulations, 2009", the treatment method of planned sewage system is decided and its effluent meets with sewage discharge standards. (b) In Malaysia, STP collects only domestic sewage water and its sewage water does not generally include heavy metals. Industrial effluent is regulated with another regulation, "Environmental Quality (Industrial Effluents) Regulations 2009". Industrial water is regulated to directly discharge the effluent with water quality of less than standards to the rivers after treatment.
	(2) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations?	(a) Y	(a) Only domestic sewage is discharged to STP. Sludge is treated and disposed by Malaysian standards.
	(3) Soil Contamination	(a) In the case that sludge may contain heavy metals, do countermeasures to protect soil contamination and groundwater pollution by leachate of seepage water from sludge in landfill?	(a) NA	(a) Sewage that is treated at STP is derived from domestic houses. Thus, it does not include heavy metals. Sludge is dumped to sanitary landfills that are authorized by DOE. Thus, leachate of seepage water from sludge in landfill does not cause soil contamination and groundwater pollution.
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a) Y	(a) 6 pumps (250 KW, 85 dB/unit), 6 blowers (150 KW, 100 dB/unit), and 2 generators (2,000 KVA,85 dB/unit) are installed in STP. Those equipment will be operated with silencer to meet with "Planning Guidelines for Environmental Noise Limits and Control (2004)", namely, noise sensitive area (school, hospital) 50 dB in day time (7:00 a.m.-10:00 pm), suburban residential area 55 dB in day time, and 45 dB in night time (10:00 pm-7:00 am). Vibration by operation of those equipment is not generally generated by vibration protection parts of the equipment.
	(5) Bad Odor	(a) Does the project take the countermeasures to protect bad odor which may generate from sludge treatment facilities.etc?	(a) Y	(a) Sludge treatment system is designed as completely closed system and deodorizing equipment is installed to remove bad odor.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Condition	(1) Protected Areas	(a) Do the project site or discharge area of effluent locate in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) In the proposed STP site, neighboring area, and discharge area of effluent from the STP, there are no protected areas which were regulated by Malaysian laws and international convention. Thus, implementation of the project does not affect adverse to protected areas.
	(2) Ecosystem	(a) Does the project site and discharge area of effluent encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species of which protection and conservation are need by Malaysian laws and international treaties? (c) In the case that significant adverse impacts to ecosystem are apprehend, does the project conduct the countermeasure to reduce the adverse impacts to ecosystem? (d) Does the implementation of the project affect aquatic environment in rivers etc? Does the countermeasure to reduce adverse impacts to aquatic organisms etc?	(a) N (b) N (c) N (d) N	(a) Project site and discharge area of effluent from STP do not include primeval forests, tropical rain forests, ecological valuable habitats such as coral reefs, mangroves, or tidal flats. (b) Project site does not include the protected habitats of endangered species of which protection and conservation are need by Malaysian laws and international treaties. (c) Proposed STP site is presently used for artificial forest and banana plantation. It will not provide significant adverse impact to ecosystem. (d) Sewage treatment system will be designed so as to fit water quality of category A which is applied in case of intake of raw water for water supply at the downstream of the Langat River. Thus, river water quality will be improved compared present condition. The project will not affect aquatic environment in the Langat River.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance for rebuilding the livelihood of involuntary resettlement' residents given in advance? (c) Are resettlement plans including recovery of livelihood base after resettlement, compensation by reacquisition price of lands and houses established with the survey for resettlement? (d) Does the payment of compensation fee conducted prior to resettlement? (e) Are the compensation principals shown in written document? (f) Of involuntary resettlement residents, does the resettlement plans properly consider vulnerable groups, especially, females, children, elderly people, poverty groups, ethnic minorities, and indigenous people etc.? (g) Does the agreement by resettlement people prior to resettlement concluded? (h) Is the implementation system to properly carry out residents' resettlement arranged together with implementation budget and budget measures? (i) Is the monitoring plan for resettlement impact established? (j) Does the complaint handling countermeasures established?	(a) NA (b) NA (c) NA (d) NA (e) NA (f) NA (g) NA (h) NA (i) NA (j) NA	(a) There are no squatters in the proposed STP site. Thus, implementation of the project does not cause involuntary resettlement. (b) It is not applicable due to the above reasons. (c) It is not applicable due to the above reasons. (d) It is not applicable due to the above reasons. (e) It is not applicable due to the above reasons. (f) It is not applicable due to the above reasons. (g) It is not applicable due to the above reasons. (h) It is not applicable due to the above reasons. (i) It is not applicable due to the above reasons. (j) It is not applicable due to the above reasons.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(2) Living and Livelihood	(a) Does project implementation affect adverse impact to living condition of inhabitants by change of land use and of utilization of water bodies? (b) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	(a) N (b) N	(a) Proposed STP site is located in aritificial forest and banana plantation in in flat land. Thus, large scale of cut earth and earth fill will be not conducted. As the STP discharges comparatively clean treated water to the River, it will not affect the liveing conditions of inhabitants by change of land use and of utilization of water bodies.. (b) Periphery area of STP site is of forests with fairly few houses. Thus, implementation of the project will not affect the living conditons olf inhabitants.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country’s laws?	(a) N	(a) Proposed STP site and periphery area does not have the local archeological, historical, cultural, and religious heritage. In additon, pumping stations are planned to be constructed in public lands of existing STP sites, there are no important heritages, and its construction activities will not provide any damages.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) As proposed STP site and pumping stations are not located at specially landscape area, the project will not affect local landscape.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) NA (b) NA	(a) In Malaysia, Chinese and Indian of minorities has stronger economic power than that of Malaysian people. Thus, concept minorities' rights are not applied. In addition, though Orang Asli of indigenous peoples are living in Selangor State, their living areas are limited in inland areas and they do not live in the project site. Thus, social consideration on the culture and lifestyle of indigenous people is not applied. (b) It is not applied due to the above reasons.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in hardware side for individuals relating to the project such as the installation of safety equipment fo protect labor accidents and the management of toxic substances involved? (c) Are soft side countermeasures such as tangible safety education for labors and the formulation of safety sanitary plans (including traffic control and public health) to interested persons to the project planned and conducted? (d) Are proper countermeasures taken not so as to threaten the safety of inhabitants peoples and interested persons of the project by guardmen for the project?	(a) Y (b) Y (c) Y (d) Y	(a) Project is carried out by compliance of Malaysian occupational safety and health act (1994). (b) Project is planed under the consideration on installation of safety equipment to protect labor accidents, the management of toxic substances. (c) In the construction stage, safety sanitary plans (including traffic control and public health to interested persons to the project will be conducted. (d) Project will take enough education not so as to be threatened to safety of inhabitants and interested people by Guardman for the project.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(1) Impacts during Construction	(a) Are adequate mitigation countermeasures considered to reduce adverse impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) Does construction activities adversely affect the natural environment (ecosystem)? In that case, are adequate mitigation countermeasures prepared? (c) Does construction activities adversely affect to social environment? In that case, are adequate mitigatin countermeasures prepared? (d) Does construction activities cause traffic congestion? Are mitigation countermeasures prepared?	(a) Y (b) N (c) N (d) Y	(a) Mitigation countermeasures against environmental pollution (noise, vibration, turbidity water, and waste, etc.) will be prepared. Concrete mitigation countermeasures are described in Chapter 3. Survey Items Relating to EIA Checklist. (b) As construction site of proposed STP is used for artificial forest and banana plantation, that construction activities will not affect the natural environment (ecosystem). (c) Construction of STP does not affect social environment. (d) As pipe laying of sewage main is anticipated to cause traffic congestion because it is conducted on heavily-trafficked roads.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program planned? (c) Can the proponent establish an adequate monitoring system (organization, personnel, equipment, and budget and their continuity)? (d) Does reporting manners and its frequencies from proponent to concerned agency regulate?	(a) Y (b) Y (c) Y (d) N	(a) Proponent should conduct monitoring plan which is described in the report, chapter 3, 3.6.Monitoring Plan. (b) Monitoring parameters, manners, and frequency are based on work experiences of the STP construction project at Panama and the sewage improvement project in Bangladesh and advices by sewerage engineers. (c) many STPs in Malaysia are managed by JPP/IWK. Monitoring system shall be established because existing STP systems are monitored with adequate monitoring system by those organizations. (d) reporting manners and its frequencies from proponent to DOE do not regulate by regulations. But DOE generally regulates them by imposed conditions for EIA approval.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
6 Note	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans-boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans-boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) Y	(a) As countermeasures for global warming, power generation (12,000 KWh) using digestion gas at the proposed STP is planned. This generation will produce about 18.5% of total electric demand of the STP. Electric save cost per year by this power generation is supposed to be RM 1,650,000/year (¥40,620,000/year).

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards,
appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

APPENDICES

Appendix I-2.1

JADUAL 3: PURATA SAIZ ISI RUMAH MENGIKUT NEGERI, 1980-2010
TABLE 3: AVERAGE HOUSEHOLD SIZE BY STATE, 1980-2010

Negeri *State*	**Purata saiz isi rumah** *Average household size*			
	1980	1991	2000	2010
MALAYSIA	**5.22**	**4.92**	**4.62**	**4.31**
Johor	5.50	4.89	4.51	4.17
Kedah	5.00	4.80	4.60	4.29
Kelantan	4.83	5.10	5.03	4.86
Melaka	5.51	4.96	4.48	4.05
Negeri Sembilan	5.24	4.80	4.47	4.20
Pahang	5.08	4.96	4.52	4.59
Perak	5.23	4.71	4.35	4.04
Perlis	4.52	4.60	4.42	4.26
Pulau Pinang	5.48	5.00	4.38	3.94
Sabah	5.37	5.15	5.16	5.88
Sarawak	5.45	4.98	4.76	4.47
Selangor	5.33	4.93	4.59	3.93
Terengganu	4.89	5.30	5.06	4.78
W.P. Kuala Lumpur	4.87	4.69	4.24	3.72
W.P. Labuan	5.54	5.03	4.94	4.72
W.P. Putrajaya	(b)	5.61	5.34	3.45

Appendix III-2.1

BOD5 Discharge Load by Treatment Process

Subcatchment	EA (PE)	IDEA (PE)	OD (PE)	SBR (PE)	AB (PE)	HK (PE)	SATS (PE)	AL (PE)	BF (PE)	BS (PE)	IT (PE)	OP (PE)	RBC (PE)	Total (PE)
Langat														
Cheras Batu 11	444,889	4,881	-	44,025	2,850	3,420	-	64,282	48,923	30,656	6,258	101,738	-	751,922
Cheras East														
Cheras Jaya	172,190	-	31,106	11,536	-	9,868	-	93,163	119,405	-	-	11,897	-	449,165
Kajang 1	107,465	17,379	34,719	-	3,267	1,808	-	-	18,420	1,902	4,950	64,713	5,830	260,453
Kajang 2														
Kajang 3	149,461	20,134	9,683	49,264	2,628	1,882	1,008	-	52,192	-	48,911	73,369	-	408,532
Total	874,005	42,394	75,508	104,825	8,745	16,978	1,008	157,445	238,940	32,558	60,119	251,717	5,830	1,870,072
							1,123,463							

BOD5 Discharge Load by Treatment Process (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	59.2	0.6	-	5.9	0.4	0.5	-	8.5	6.5	4.1	0.8	13.5	-	100
Cheras East														
Cheras Jaya	38.3	-	6.9	2.6	-	2.2	-	20.7	26.6	-	-	2.6	-	100
Kajang 1	41.3	6.7	13.3	-	1.3	0.7	-	-	7.1	0.7	1.9	24.8	2.2	100
Kajang 2														
Kajang 3	36.6	4.9	2.4	12.1	0.6	0.5	0.2	-	12.8	-	12.0	18.0	-	100
Total	46.7	2.3	4.0	5.6	0.5	0.9	0.1	8.4	12.8	1.7	3.2	13.5	0.3	100
							60.1							

Number of STPs

Subcatchment	EA (Unit)	IDEA (Unit)	OD (Unit)	SBR (Unit)	AB (Unit)	HK (Unit)	SATS (Unit)	AL (Unit)	BF (Unit)	BS (Unit)	IT (Unit)	OP (Unit)	RBC (Unit)	Total (Unit)
Langat														
Cheras Batu 11	39	1	0	2	2	2	0	3	4	3	2	6	0	64
Cheras East														
Cheras Jaya	19	0	1	1	0	2	0	3	3	0	0	1	0	30
Kajang 1	16	1	3	0	3	2	0	0	1	1	1	3	1	32
Kajang 2														
Kajang 3	18	2	1	2	1	3	1	0	5	0	5	5	0	43
Total	92	4	5	5	6	9	1	6	13	4	8	15	1	169

Number of STPs (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	60.9	1.6	0.0	3.1	3.1	3.1	0.0	4.7	6.3	4.7	3.1	9.4	0.0	100
Cheras East														
Cheras Jaya	63.3	0.0	3.3	3.3	0.0	6.7	0.0	10.0	10.0	0.0	0.0	3.3	0.0	100
Kajang 1	50.0	3.1	9.4	0.0	9.4	6.3	0.0	0.0	3.1	3.1	3.1	9.4	3.1	100
Kajang 2														
Kajang 3	41.9	4.7	2.3	4.7	2.3	7.0	2.3	0.0	11.6	0.0	11.6	11.6	0.0	100
Total	54.4	2.4	3.0	3.0	3.6	5.3	0.6	3.6	7.7	2.4	4.7	8.9	0.6	100

Average Sewage Effluent BOD5

	EA	IDEA	OD	SBR	AB	HK	SATS	AL	BF	BS	IT	OP	RBC	
Ave. Eff. BOD	14.1	9.9	20.5	15.0	12.6	8.5	12.8	20.9	37.2	13.4	39.7	27.6	11.8	17.4
Ranking	7	2	9	8	4	1	5	10	12	6	13	11	3	

COD Discharge Load by Treatment Process

Subcatchment	EA (PE)	IDEA (PE)	OD (PE)	SBR (PE)	AB (PE)	HK (PE)	SATS (PE)	AL (PE)	BF (PE)	BS (PE)	IT (PE)	OP (PE)	RBC (PE)	Total (PE)
Langat														
Cheras Batu 11	1,919,141	39,917	-	149,626	13,244	26,058	-	252,619	135,793	111,880	17,035	335,351	-	3,000,664
Cheras East														
Cheras Jaya	801,616	-	105,368	56,979	-	46,682	-	376,704	381,500	-	-	47,461	-	1,816,310
Kajang 1	538,562	81,079	112,565	-	21,112	6,970	-	-	55,905	10,555	17,910	204,866	35,773	1,085,297
Kajang 2														
Kajang 3	725,340	88,076	48,805	207,765	9,009	10,460	3,465	-	194,831	-	141,579	323,259	-	1,752,589
Total	3,984,659	209,072	266,738	414,370	43,365	90,170	3,465	629,323	768,029	122,435	176,524	910,937	35,773	7,654,860
							5,011,839							

COD Discharge Load by Treatment Process (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	255.2	5.3	-	19.9	1.8	3.5	-	33.6	18.1	14.9	2.3	44.6	-	399
Cheras East														
Cheras Jaya	178.5	-	23.5	12.7	-	10.4	-	83.9	84.9	-	-	10.6	-	404
Kajang 1	206.8	31.1	43.2	-	8.1	2.7	-	-	21.5	4.1	6.9	78.7	13.7	417
Kajang 2														
Kajang 3	177.5	21.6	11.9	50.9	2.2	2.6	0.8	-	47.7	-	34.7	79.1	-	429
Total	213.1	11.2	14.3	22.2	2.3	4.8	0.2	33.7	41.1	6.5	9.4	48.7	1.9	409
							268.1							

Number of STPs

Subcatchment	EA (Unit)	IDEA (Unit)	OD (Unit)	SBR (Unit)	AB (Unit)	HK (Unit)	SATS (Unit)	AL (Unit)	BF (Unit)	BS (Unit)	IT (Unit)	OP (Unit)	RBC (Unit)	Total (Unit)
Langat														
Cheras Batu 11	39	1	0	2	2	2	0	3	4	3	2	6	0	64
Cheras East														
Cheras Jaya	19	0	1	1	0	2	0	3	3	0	0	1	0	30
Kajang 1	16	1	3	0	3	2	0	0	1	1	1	3	1	32
Kajang 2														
Kajang 3	18	2	1	2	1	3	1	0	5	0	5	5	0	43
Total	92	4	5	5	6	9	1	6	13	4	8	15	1	169

Number of STPs (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	60.9	1.6	0.0	3.1	3.1	3.1	0.0	4.7	6.3	4.7	3.1	9.4	0.0	100
Cheras East														
Cheras Jaya	63.3	0.0	3.3	3.3	0.0	6.7	0.0	10.0	10.0	0.0	0.0	3.3	0.0	100
Kajang 1	50.0	3.1	9.4	0.0	9.4	6.3	0.0	0.0	3.1	3.1	3.1	9.4	3.1	100
Kajang 2														
Kajang 3	41.9	4.7	2.3	4.7	2.3	7.0	2.3	0.0	11.6	0.0	11.6	11.6	0.0	100
Total	54.4	2.4	3.0	3.0	3.6	5.3	0.6	3.6	7.7	2.4	4.7	8.9	0.6	100

Average Sewage Effluent COD

	EA	IDEA	OD	SBR	AB	HK	SATS	AL	BF	BS	IT	OP	RBC	
Ave. Eff. BOD	64.3	48.9	72.3	59.3	62.5	45.1	44.0	83.6	119.5	50.3	116.7	99.9	72.4	71.4
Ranking	7	3	8	5	6	2	1	10	13	4	12	11	9	

AMN Discharge Load by Treatment Process

Subcatchment	EA (PE)	IDEA (PE)	OD (PE)	SBR (PE)	AB (PE)	HK (PE)	SATS (PE)	AL (PE)	BF (PE)	BS (PE)	IT (PE)	OP (PE)	RBC (PE)	Total (PE)
Langat														
Cheras Batu 11	361,114	2,495	-	37,559	4,255	5,570	-	75,304	25,510	23,771	2,546	52,392	-	590,516
Cheras East														
Cheras Jaya	131,922	-	25,538	4,798	-	16,802	-	86,580	80,697	-	-	8,606	-	354,943
Kajang 1	132,980	14,944	26,630	-	4,341	2,248	-	-	16,874	4,439	7,200	30,050	12,550	252,256
Kajang 2														
Kajang 3	164,543	29,752	13,978	32,880	1,822	2,605	551	-	49,269	-	32,677	30,964	-	359,041
Total	790,559	47,191	66,146	75,237	10,418	27,225	551	161,884	172,350	28,210	42,423	122,012	12,550	1,556,756
							1,017,327							

AMN Discharge Load by Treatment Process (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	48.0	0.3	-	5.0	0.6	0.7	-	10.0	3.4	3.2	0.3	7.0	-	79
Cheras East														
Cheras Jaya	29.4	-	5.7	1.1	-	3.7	-	19.3	18.0	-	-	1.9	-	79
Kajang 1	51.1	5.7	10.2	-	1.7	0.9	-	-	6.5	1.7	2.8	11.5	4.8	97
Kajang 2														
Kajang 3	40.3	7.3	3.4	8.0	0.4	0.6	0.1	-	12.1	-	8.0	7.6	-	88
Total	42.3	2.5	3.5	4.0	0.6	1.5	-	8.7	9.2	1.5	2.3	6.5	0.7	83
							54.4							

Number of STPs

Subcatchment	EA (Unit)	IDEA (Unit)	OD (Unit)	SBR (Unit)	AB (Unit)	HK (Unit)	SATS (Unit)	AL (Unit)	BF (Unit)	BS (Unit)	IT (Unit)	OP (Unit)	RBC (Unit)	Total (Unit)
Langat														
Cheras Batu 11	39	1	0	2	2	2	0	3	4	3	2	6	0	64
Cheras East														
Cheras Jaya	19	0	1	1	0	2	0	3	3	0	0	1	0	30
Kajang 1	16	1	3	0	3	2	0	0	1	1	1	3	1	32
Kajang 2														
Kajang 3	18	2	1	2	1	3	1	0	5	0	5	5	0	43
Total	92	4	5	5	6	9	1	6	13	4	8	15	1	169

Number of STPs (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	60.9	1.6	0.0	3.1	3.1	3.1	0.0	4.7	6.3	4.7	3.1	9.4	0.0	100
Cheras East														
Cheras Jaya	63.3	0.0	3.3	3.3	0.0	6.7	0.0	10.0	10.0	0.0	0.0	3.3	0.0	100
Kajang 1	50.0	3.1	9.4	0.0	9.4	6.3	0.0	0.0	3.1	3.1	3.1	9.4	3.1	100
Kajang 2														
Kajang 3	41.9	4.7	2.3	4.7	2.3	7.0	2.3	0.0	11.6	0.0	11.6	11.6	0.0	100
Total	54.4	2.4	3.0	3.0	3.6	5.3	0.6	3.6	7.7	2.4	4.7	8.9	0.6	100

Average Sewage Effluent AMN

	EA	IDEA	OD	SBR	AB	HK	SATS	AL	BF	BS	IT	OP	RBC	
Ave. Eff. BOD	12.8	11.0	17.9	10.8	15.0	13.6	7.0	21.5	26.8	11.6	28.0	13.4	25.4	14.5
Ranking	5	3	9	2	8	7	1	10	12	4	13	6	11	

O&G Discharge Load by Treatment Process

Subcatchment	EA (PE)	IDEA (PE)	OD (PE)	SBR (PE)	AB (PE)	HK (PE)	SATS (PE)	AL (PE)	BF (PE)	BS (PE)	IT (PE)	OP (PE)	RBC (PE)	Total (PE)
Langat														
Cheras Batu 11	236,005	5,071	-	15,013	2,723	2,677	-	20,787	11,804	19,225	2,561	20,303	-	336,169
Cheras East														
Cheras Jaya	149,368	-	10,631	8,798	-	8,072	-	34,338	34,454	-	-	2,025	-	247,686
Kajang 1	75,197	19,881	9,659	-	3,308	638	-	-	5,153	225	1,215	16,592	2,223	134,091
Kajang 2														
Kajang 3	104,349	10,856	12,744	25,462	410	2,688	1,155	-	21,011	-	15,471	24,728	-	218,874
Total	564,919	35,808	33,034	49,273	6,441	14,075	1,155	55,125	72,422	19,450	19,247	63,648	2,223	936,820
							704,705							

O&G Discharge Load by Treatment Process (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	31.4	0.7	-	2.0	0.4	0.4	-	2.8	1.6	2.6	0.3	2.7	-	45
Cheras East														
Cheras Jaya	33.3	-	2.4	2.0	-	1.8	-	7.6	7.7	-	-	0.5	-	55
Kajang 1	28.9	7.6	3.7	-	1.3	0.2	-	-	2.0	0.1	0.5	6.4	0.9	52
Kajang 2														
Kajang 3	25.5	2.7	3.1	6.2	0.1	0.7	0.3	-	5.1	-	3.8	6.1	-	54
Total	30.2	1.9	1.8	2.6	0.3	0.8	0.1	2.9	3.9	1.0	1.0	3.4	0.1	50
							37.7							

Number of STPs

Subcatchment	EA (Unit)	IDEA (Unit)	OD (Unit)	SBR (Unit)	AB (Unit)	HK (Unit)	SATS (Unit)	AL (Unit)	BF (Unit)	BS (Unit)	IT (Unit)	OP (Unit)	RBC (Unit)	Total (Unit)
Langat														
Cheras Batu 11	39	1	0	2	2	2	0	3	4	3	2	6	0	64
Cheras East														
Cheras Jaya	19	0	1	1	0	2	0	3	3	0	0	1	0	30
Kajang 1	16	1	3	0	3	2	0	0	1	1	1	3	1	32
Kajang 2														
Kajang 3	18	2	1	2	1	3	1	0	5	0	5	5	0	43
Total	92	4	5	5	6	9	1	6	13	4	8	15	1	169

Number of STPs (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	60.9	1.6	0.0	3.1	3.1	3.1	0.0	4.7	6.3	4.7	3.1	9.4	0.0	100
Cheras East														
Cheras Jaya	63.3	0.0	3.3	3.3	0.0	6.7	0.0	10.0	10.0	0.0	0.0	3.3	0.0	100
Kajang 1	50.0	3.1	9.4	0.0	9.4	6.3	0.0	0.0	3.1	3.1	3.1	9.4	3.1	100
Kajang 2														
Kajang 3	41.9	4.7	2.3	4.7	2.3	7.0	2.3	0.0	11.6	0.0	11.6	11.6	0.0	100
Total	54.4	2.4	3.0	3.0	3.6	5.3	0.6	3.6	7.7	2.4	4.7	8.9	0.6	100

Average Sewage Effluent O&G

	EA	IDEA	OD	SBR	AB	HK	SATS	AL	BF	BS	IT	OP	RBC	
Ave. Eff. BOD	9.1	8.4	9.0	7.0	9.3	7.0	14.7	7.3	11.3	8.0	12.7	7.0	4.5	8.7
Ranking	9	7	8	2	10	2	13	5	11	6	12	2	1	

SS Discharge Load by Treatment Process

Subcatchment	EA (PE)	IDEA (PE)	OD (PE)	SBR (PE)	AB (PE)	HK (PE)	SATS (PE)	AL (PE)	BF (PE)	BS (PE)	IT (PE)	OP (PE)	RBC (PE)	Total (PE)
Langat														
Cheras Batu 11	903,237	17,247	-	54,051	4,929	11,110	-	86,346	64,380	38,537	4,299	162,006	-	1,346,142
Cheras East														
Cheras Jaya	338,027	-	41,738	19,891	-	23,790	-	146,176	186,802	-	-	15,947	-	772,371
Kajang 1	229,737	25,764	45,919	-	9,339	1,240	-	-	26,664	4,909	3,600	90,033	14,131	451,336
Kajang 2														
Kajang 3	280,652	33,891	23,739	85,373	3,634	3,543	441	-	87,494	-	33,409	151,263	-	703,439
Total	1,751,653	76,902	111,396	159,315	17,902	39,683	441	232,522	365,340	43,446	41,308	419,249	14,131	3,273,288
							2,157,292							

SS Discharge Load by Treatment Process (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	120.1	2.3	-	7.2	0.7	1.5	-	11.5	8.6	5.1	0.6	21.5	-	179
Cheras East														
Cheras Jaya	75.3	-	9.3	4.4	-	5.3	-	32.5	41.6	-	-	3.6	-	172
Kajang 1	88.2	9.9	17.6	-	3.6	0.5	-	-	10.2	1.9	1.4	34.6	5.4	173
Kajang 2														
Kajang 3	68.7	8.3	5.8	20.9	0.9	0.9	0.1	-	21.4	-	8.2	37.0	-	172
Total	93.7	4.1	6.0	8.5	1.0	2.1	-	12.4	19.5	2.3	2.2	22.4	0.8	175
							115.4							

Number of STPs

Subcatchment	EA (Unit)	IDEA (Unit)	OD (Unit)	SBR (Unit)	AB (Unit)	HK (Unit)	SATS (Unit)	AL (Unit)	BF (Unit)	BS (Unit)	IT (Unit)	OP (Unit)	RBC (Unit)	Total (Unit)
Langat														
Cheras Batu 11	39	1	0	2	2	2	0	3	4	3	2	6	0	64
Cheras East														
Cheras Jaya	19	0	1	1	0	2	0	3	3	0	0	1	0	30
Kajang 1	16	1	3	0	3	2	0	0	1	1	1	3	1	32
Kajang 2														
Kajang 3	18	2	1	2	1	3	1	0	5	0	5	5	0	43
Total	92	4	5	5	6	9	1	6	13	4	8	15	1	169

Number of STPs (%)

Subcatchment	EA (%)	IDEA (%)	OD (%)	SBR (%)	AB (%)	HK (%)	SATS (%)	AL (%)	BF (%)	BS (%)	IT (%)	OP (%)	RBC (%)	Total (%)
Langat														
Cheras Batu 11	60.9	1.6	0.0	3.1	3.1	3.1	0.0	4.7	6.3	4.7	3.1	9.4	0.0	100
Cheras East														
Cheras Jaya	63.3	0.0	3.3	3.3	0.0	6.7	0.0	10.0	10.0	0.0	0.0	3.3	0.0	100
Kajang 1	50.0	3.1	9.4	0.0	9.4	6.3	0.0	0.0	3.1	3.1	3.1	9.4	3.1	100
Kajang 2														
Kajang 3	41.9	4.7	2.3	4.7	2.3	7.0	2.3	0.0	11.6	0.0	11.6	11.6	0.0	100
Total	54.4	2.4	3.0	3.0	3.6	5.3	0.6	3.6	7.7	2.4	4.7	8.9	0.6	100

Average Sewage Effluent SS

	EA	IDEA	OD	SBR	AB	HK	SATS	AL	BF	BS	IT	OP	RBC	
Ave. Eff. BOD	28.3	18.0	30.2	22.8	25.8	19.8	5.6	30.9	56.8	17.9	27.3	46.0	28.6	30.5
Ranking	8	3	10	5	6	4	1	11	13	2	7	12	9	

Compliance to Standard

Parameter	BOD	COD	AMN	O&G	SS	All	All (Excl. AMN)	All (Excl. OG)
Langat								
Cheras Batu 11	42	58	25	9	55	5	7	22
Cheras East								
Cheras Jaya	21	25	15	2	24	-	1	13
Kajang 1	24	28	7	9	28	3	9	7
Kajang 2								
Kajang 3	31	36	15	5	35	2	4	14
Total	118	147	62	25	142	10	21	56

Parameter	BOD	COD	AMN	O&G	SS	All	All (Excl. AMN)	All (Excl. OG)
Langat								
Cheras Batu 11	-	-	-	-	-	-	-	-
Cheras East								
Cheras Jaya	-	-	-	-	-	-	-	-
Kajang 1	-	-	-	-	-	-	-	-
Kajang 2								
Kajang 3	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-

Non-Compliance to Standard

Parameter	BOD	COD	AMN	O&G	SS	All	All (Excl. AMN)	All (Excl. OG)
Langat								
Cheras Batu 11	22	6	38	55	9	58	56	41
Cheras East								
Cheras Jaya	9	5	15	28	6	30	29	17
Kajang 1	8	4	25	23	4	29	23	25
Kajang 2								
Kajang 3	12	7	28	38	8	41	39	29
Total	51	22	106	144	27	158	147	112

Compliance Rate to Standard

Parameter	BOD	COD	AMN	O&G	SS	All	All (Excl. AMN)	All (Excl. OG)
Langat								
Cheras Batu 11	65.6	90.6	39.7	14.1	85.9	7.9	11.1	34.9
Cheras East								
Cheras Jaya	70.0	83.3	50.0	6.7	80.0	0.0	3.3	43.3
Kajang 1	75.0	87.5	21.9	28.1	87.5	9.4	28.1	21.9
Kajang 2								
Kajang 3	72.1	83.7	34.9	11.6	81.4	4.7	9.3	32.6
Total	69.8	87.0	36.9	14.8	84.0	6.0	12.5	33.3

Appendix III-6.1 Breakdown of Civil/Building Cost for STP

0.038 Rm/Yen

Items	Specification	Unit	Unit Price (Rm)	Q'ty (Basic)	Phase-1		Phase-2		Total (Rm) (Phase-1+Phase-2)	Reference
					Q'ty	Amount (Rm)	Q'ty	Amount (Rm)		
Land Preparation		m^2	80	73,346	73,346	5,867,680	0	0	5,867,680	7.3346ha×10,000m2/ha
			(Q'ty: for whole)							
Sub Total (Land Preparation)						**5,867,680**		**0**	**5,867,680**	
Round						**5,868,000**		**0**	**5,868,000**	
						154,421,000 yen		0 yen	154,421,000 yen	
Pump Station/Grit Chamber			*(Q'ty: for whole)*							
Sheet Pile Driving/Removing	Type V_L	pcs	5,200	436	436	2,267,200	0	0	2,267,200	
Sheet Pile Lease	Ditto	t	850	1,098	1,098	933,300	0	0	933,300	
Support Installation/ Removing	H-400×400	t	850	1,084	1,084	921,400	0	0	921,400	
Support Lease	Ditto	t	620	1,084	1,084	672,080	0	0	672,080	
Center Support Pile Driving	H-350×350	pcs	1,600	103	103	164,800	0	0	164,800	
Center Support Pile	Ditto	t	4,200	71	71	298,200	0	0	298,200	
Dewatering						525,698		0	525,698	10% of above Work
Excavation	Soil	m^3	25	22,896	22,896	572,400	0	0	572,400	
Backfilling	BH	m^3	8	4,530	4,530	36,240	0	0	36,240	
Surplus Soil Transport		m^3	25	18,366	18,366	459,150	0	0	459,150	
Foundation Piles	400×400, L=20m	pcs	4,400	521	521	2,292,400	0	0	2,292,400	
Gravel		m^3	120	306	306	36,720	0	0	36,720	
Lean Concrete		m^3	300	153	153	45,900	0	0	45,900	
Concrete		m^3	300	266	266	79,800	0	0	79,800	
Reinforced Concrete		m^3	350	6,903	6,903	2,416,050	0	0	2,416,050	
Formwork		m^2	40	16,668	16,668	666,720	0	0	666,720	
Reinforcement Bar		t	3,800	966	966	3,672,396	0	0	3,672,396	
Building Work		m^2	2,000	907	907	1,814,000	0	0	1,814,000	
Other Work						2,418,355		0	2,418,355	20% of above Work
Sub Total (Pump Station)						**20,292,809**		**0**	**20,292,809**	
Round						**20,293,000**		**0**	**20,293,000**	
						534,026,000 yen		0 yen	534,026,000 yen	

Items	Specification	Unit	Unit Price (Rm)	Q'ty (Basic)	Phase-1		Phase-2		Total (Rm) (Phase-1+Phase-2)	Reference
					Q'ty	Amount (Rm)	Q'ty	Amount (Rm)		
Primary Clarifier/ Reactor Tank/ Secondary Clarifier			*(Q'ty: for 4/8 trains)*							
Excavation	Soil	m^3	13	211,058	211,058	2,743,759	211,058	2,743,759	5,487,518	
Backfilling	BH	m^3	8	129,590	129,590	1,036,720	129,590	1,036,720	2,073,440	
Surplus Soil Transport		m^3	25	89,615	89,615	2,240,381	89,615	2,240,381	4,480,762	
Foundation Piles	400×400, L=20m	pcs	4,400	2,879	2,879	12,667,490	2,879	12,667,490	25,334,980	
Gravel		m^3	120	2,464	2,464	295,680	2,464	295,680	591,360	
Lean Concrete		m^3	300	1,232	1,232	369,600	1,232	369,600	739,200	
Reinforced Concrete		m^3	350	23,746	23,746	8,311,100	23,746	8,311,100	16,622,200	
Formwork		m^2	40	55,242	55,242	2,209,680	55,242	2,209,680	4,419,360	
Reinforcement Bar		t	3,800	3,324	3,324	12,632,872	3,324	12,632,872	25,265,744	
Other Work						10,626,821		10,626,821	21,253,641	25% of above Work
Sub Total (CAS)						**53,134,103**		**53,134,103**	**106,268,206**	
Round						**53,134,000**		**53,134,000**	**106,268,000**	
						1,398,263,000 yen		1,398,260,000 yen	2,796,526,000 yen	
Gravity Thickener	2 / 4 Tanks		*(Q'ty: for 2/4 tanks)*							
Excavation	Soil	m^3	13	4,774	4,774	62,062	4,774	62,062	124,124	
Backfilling	BH	m^3	8	3,646	3,646	29,168	3,646	29,168	58,336	
Surplus Soil Transport		m^3	25	1,241	1,241	31,025	1,241	31,025	62,050	
Foundation Piles (Gravity Thickener)	400×400, L=20m	pcs	4,400	41	41	180,400	41	180,400	360,800	
Foundation Piles (Holding Tank)	400×400, L=20m	pcs	4,400	71	71	312,400	71	312,400	624,800	
Gravel		m^3	120	118	118	14,160	118	14,160	28,320	
Lean Concrete		m^3	300	59	59	17,700	59	17,700	35,400	
Reinforced Concrete (Gravity Thickener)		m^3	350	319	319	111,650	319	111,650	223,300	
Reinforced Concrete (Holding Tank)		m^3	350	575	575	201,250	575	201,250	402,500	
Formwork (Gravity Thickener)		m^2	40	1,149	1,149	45,960	1,149	45,960	91,920	
Formwork (Holding Tank)		m^2	40	1,567	1,567	62,680	1,567	62,680	125,360	
Reinforcement Bar (Gravity Thickener)		t	3,800	45	45	169,708	45	169,708	339,416	
Reinforcement Bar (Holding Tank)		t	3,800	81	81	305,900	81	305,900	611,800	
Building (Pump Room)		m^2	2,000	211	211	422,000	211	422,000	844,000	
Other Work						393,213		393,213	786,425	20% of above Work
Sub Total (Gravity Thickener)						**2,359,276**		**2,359,276**	**4,718,551**	
Round						**2,359,000**		**2,359,000**	**4,718,000**	
						62,079,000 yen		62,080,000 yen	124,158,000 yen	

Items	Specification	Unit	Unit Price (Rm)	Q'ty (Basic)	Phase-1		Phase-2		Total (Rm) (Phase-1+Phase-2)	Reference
					Q'ty	Amount (Rm)	Q'ty	Amount (Rm)		
Digestion Tank	2 / 8 Tanks		*(Q'ty: for 2/8 tanks)*							
Excavation	Soil	m^3	13	28,596	57,192	743,496	57,192	743,496	1,486,992	
Backfilling	BH	m^3	8	25,919	51,838	414,704	51,838	414,704	829,408	
Surplus Soil Transport		m^3	25	2,945	5,890	147,250	5,890	147,250	294,500	
Foundation Piles	400×400, L=20m	pcs	4,400	326	652	2,868,800	652	2,868,800	5,737,600	
Gravel		m^3	120	182	364	43,680	364	43,680	87,360	
Lean Concrete		m^3	300	91	182	54,600	182	54,600	109,200	
Reinforced Concrete		m^3	350	2,771	5,542	1,939,700	5,542	1,939,700	3,879,400	
Formwork		m^2	40	4,520	9,040	361,600	9,040	361,600	723,200	
Reinforcement Bar		t	3,800	388	776	2,948,344	776	2,948,344	5,896,688	
Building		m^2	2,000	111	222	444,000	222	444,000	888,000	
Other Work						1,993,235		1,993,235	3,986,470	20% of above Work
Sub Total (Digester)						**11,959,409**		**11,959,409**	**23,918,818**	
Round						**11,959,000**		**11,959,000**	**23,918,000**	
						314,711,000 yen		314,710,000 yen	629,421,000 yen	
Gas Holder	1 / 2 unit		*(Q'ty: for 1/2 tanks)*							
Excavation	Soil	m^3	13	3,407	3,407	44,291	3,407	44,291	88,582	
Backfilling	BH	m^3	8	2,386	2,386	19,088	2,386	19,088	38,176	
Surplus Soil Transport		m^3	25	1,123	1,123	28,075	1,123	28,075	56,150	
Foundation Piles	400×400, L=20m	pcs	4,400	78	78	343,200	78	343,200	686,400	
Gravel		m^3	120	45	45	5,400	45	5,400	10,800	
Lean Concrete		m^3	300	23	23	6,900	23	6,900	13,800	
Reinforced Concrete		m^3	350	1,230	1,230	430,500	1,230	430,500	861,000	
Formwork		m^2	40	1,935	1,935	77,400	1,935	77,400	154,800	
Reinforcement Bar		t	3,800	172	172	653,600	172	653,600	1,307,200	
Other Work						160,845		160,845	321,691	10% of above Work
Sub Total (Gas Holder)						**1,769,299**		**1,769,299**	**3,538,599**	
Round						**1,769,000**		**1,769,000**	**3,538,000**	
						46,553,000 yen		46,550,000 yen	93,105,000 yen	
Disinfection Tank			*(Q'ty: for whole)*		*for 70%*		*for 30%*			
Excavation	Soil	m^3	13	12,201	8,541	111,029	3,660	47,584	158,613	
Backfilling	BH	m^3	8	7,522	5,265	42,123	2,257	18,053	60,176	
Surplus Soil Transport		m^3	25	5,147	3,603	90,073	1,544	38,603	128,675	
Foundation Piles	400×400, L=20m	pcs	4,400	150	105	462,000	45	198,000	660,000	
Gravel		m^3	120	174	122	14,616	52	6,264	20,880	
Concrete		m^3	300	87	61	18,270	26	7,830	26,100	
Reinforced Concrete		m^3	350	1,272	890	311,640	382	133,560	445,200	
Formwork		m^2	40	4,114	2,880	115,192	1,234	49,368	164,560	
Reinforcement Bar		t	3,800	178	125	473,693	53	203,011	676,704	
Building (Pump Room)		m^2	2,000	190	133	266,000	57	114,000	380,000	
Other Work						380,927		163,254	544,182	20% of above Work
Sub Total (Disinfection Tank)						**2,285,563**		**979,527**	**3,265,090**	
Round						**2,286,000**		**980,000**	**3,266,000**	
						60,158,000 yen		25,790,000 yen	85,947,000 yen	

Items	Specification	Unit	Unit Price (Rm)	Q'ty (Basic)	Phase-1		Phase-2		Total (Rm) (Phase-1+Phase-2)	Reference
					Q'ty	Amount (Rm)	Q'ty	Amount (Rm)		
Sludge Treatment Building			*(Q'ty: for whole)*							
Building Work		m^2	2,000	4,950	4,950	9,900,000	0	0	9,900,000	
Foundation Piles	400×400, L=20m	pcs	4,400	454	454	1,996,500	0	0	1,996,500	
Sub Total (Sludge Treatment Building)						**11,896,500**		**0**	**11,896,500**	
Round						**11,897,000**		**0**	**11,897,000**	
						313,079,000 yen		0 yen	313,079,000 yen	
Administration / Power receiving Building			*(Q'ty: for whole)*							
Building Work		m^2	2,000	1,800	1,800	3,600,000	0	0	3,600,000	
Foundation Piles	400×400, L=20m	pcs	4,400	206	206	907,500	0	0	907,500	
Sub Total (Administration / Power receiving Building)						**4,507,500**		**0**	**4,507,500**	
Round						**4,508,000**		**0**	**4,508,000**	
						118,632,000 yen		0 yen	118,632,000 yen	
Blower House			*(Q'ty: for whole)*							
Building Work		m^2	2,000	1,125	1,125	2,250,000	0	0	2,250,000	
Foundation Piles	400×400, L=20m	pcs	4,400	129	129	567,188	0	0	567,188	
Sub Total (Blower House)						**2,817,188**		**0**	**2,817,188**	
Round						**2,817,000**		**0**	**2,817,000**	
						74,132,000 yen		0 yen	74,132,000 yen	
Discharge Pipe			*(Q'ty: for whole)*							
Excavation	Soil	m^3	13	35,438	35,438	460,694	0	0	460,694	
Backfilling	BH	m^3	8	27,488	27,488	219,904	0	0	219,904	
Surplus Soil Transport		m^3	25	8,745	8,745	218,625	0	0	218,625	
Foundation Piles	400×400, L=20m	pcs	4,400	276	276	1,214,400	0	0	1,214,400	
Gravel		m^3	120	300	300	36,000	0	0	36,000	
Lean Concrete		m^3	300	150	150	45,000	0	0	45,000	
Reinforced Concrete		m^3	350	2,700	2,700	945,000	0	0	945,000	
Formwork		m^2	40	10,800	10,800	432,000	0	0	432,000	
Reinforcement Bar		t	3,800	378	378	1,436,400	0	0	1,436,400	
Sub Total (Disinfection Tank)						**5,008,023**		**0**	**5,008,023**	
Round						**5,008,000**		**0**	**5,008,000**	
						131,789,000 yen		0 yen	131,789,000 yen	
Yard Work/ Yard Pipe							20% of above			
				20% of above		**24,379,600**		**14,039,400**	**38,419,000**	
Round						**24,380,000**		**14,039,000**	**38,419,000**	
						641,579,000 yen		369,450,000 yen	1,011,026,000 yen	
Total Cost (Civil & Architecture)						**146,278,000**		**84,240,000**	**230,518,000**	
						3,849,421,000 yen		2,216,842,000 yen	6,066,263,000 yen	

Appendix III-6.2 Mechanical & Electrical Equipment Cost for STP

Langat Model Project CAPEX (Mechanical & Electrical)

No.	Category	Facility/Major Equipment	Dimensions/Specifications	Phase I (Quantity)	Phase I (Price)	Phase II (Quantity)	Phase II (Price)	Total (Quantity)	Total (Price)
(Mechanical)									
1	**Preliminary Treatment**								
1-1		**Grit Chamber**							
		Inlet gate	Ductile iron gate (emergency shut down type) 1.5m x 1.5m x 2.2kW	3		3		6	
		Grit collector	Jet spray nozzzle type(pressure Approx. 5kgf/cm2)	3lots		3lots		6lots	
		Grit lift pump	Submersible sludge pump 2m3/min x 15kW	3duty+1stock		3duty+1stock		6duty+2stock	
		Girt pump for grit collector	Single stage volute type 2m3/min x 30kW	1duty + 1standby		0		1duty + 1standby	
		Storage Tank for grit collector	FRP 20m3	1		0		1	
		Grit separator	Screw conveyor type equipped with tank 3.7kW,	1		0		1	
		Grit hopper	15m3 x 3.0kW	1		0		1	
		Outlet gate	Ductile iron gate (manually) 1.5m x 1.5m	3		3		6	
		Piping & Steel works		1lot		1lot		2lots	
1-2		**Screen**							
		Automatic Coarse Screen	1.5mW x 5.0mH x Opening 100mm x 3.7kW (Intermittent rake type, rope type)	3		3		6	
		Automatic Medium Screen	1.5mW x 5.0mH x Opening 20mm x 3.7kW (Intermittent rake type, pinion rack type)	3		3		6	
		No.1Conveyor	Belt type 600mmWx16mx1.5kW	1		0		1	
		No.2Conveyor	Belt type 600mmWx10mx1.5kW	1		0		1	
		No.3Conveyor	Belt type 600mmWx16mx1.5kW	1		0		1	
		Screening conveyor	Skip hoist type 0.5m3 x 15mH x 3.7kW	1		0		1	
		Grit hopper	15m3 x 3.0kW	1		0		1	
		Biological Scrubber	Necessary capacity (Grit chamber & Screen facility & Pump well & Primary Treatment facility)	1		0		1	
		Fan	Necessary capacity	2		0		2	
		Piping & Steel works		1lot		1lot		2lots	
1-3		**Pump Facility**							
		Inlet Pump	Vertical Installed Centrifugal Pump						
			Ø400 mm x 27 m^3/minQ x 20 mH x 130 kW	2		0		2	
			Ø600 mm x 54 m^3/minQ x 20 mH x 250 kW	3		3		6	one as standby
		Discharge valve	Motorized butterfly valve Ø500mm x 0.4kW	2		0		2	
		Discharge valve	Motorized butterfly valve Ø700mm x 0.4kW	3		3		6	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**12,980,530**		**10,756,384**		**12,980,530**

No.	Category	Facility/Major Equipment	Dimensions/Specifications	Phase I (Quantity)	Phase I (Price)	Phase II (Quantity)	Phase II (Price)	Total (Quantity)	Total (Price)
2	**Primary Treatment**	**Primary Clarifier**							
		Sludge Collector	Chain flight (Notch type)						
			W5.0mxL18.5mxD3.0mx2trains/unitx0.75kW	8		8		16	
		Primary Sludge Pump	Centrifugal non-clog type Ø100 mm x 0.8m3/min x 10m x 5.5kW	3		3		6	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**6,146,636**		**6,146,637**		**12,293,273**
3-1	**Secondary Treatment**								
3-1		**Reactor Tank**							
		Step Gate	1000mmW x 600s.t.	8		8		16	
		1st mixer	Submersible mixer Approx. 8.0kW (2units mixer /set)	4sets		4sets		8sets	
		1st air diffuser	Super fine menbrane(Swirling flow, SOR 3,521kgO2/day/tank x Water depth 10m x Oxygen transfer efficiency not less than 27%, membrane installation level is 5m water depth)	4tanks		4tanks		8tanks	
		2nd mixer	Submersible mixer Approx.6.0kW (2units mixer/set)	8sets		8sets		16sets	
		2nd air diffuser	Super fine menbrane(Swirling flow, SOR 3,429kgO2/day/tank x Water depth 10m x Oxygen transfer efficiency not less than 27%, membrane installation level is 5m water depth))	4tanks		4tanks		8tanks	
		Recirculation Pump	Centrifugal non-clog pump 11m3/min x 7mH x 22kW	16		16		32	
		Blower	Turbo blower 92m3/min x 70kPa x 150kW (Multi-stage type equipped with individual oil circulation system and cooling water system, or electromagnetic foil bearing type)	3duty + 1 standby		3duty		6duty + 1 standby	
		Biological Scrubber	Necessary capacity	1		0		1	
		Fan	Necessary capacity	2		0		2	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**25,948,500**		**23,615,930**		**49,564,430**
3-2		**Final Clarifier**							
		Sludge Collector	Chain flight (Notch type)						
			W5.0mxL52mxD4.0mx2trains/unitx2.2kW	8		8		16	
		Return Sludge Pump	Centrifugal non-clog type Ø300 mm x 9m3/min x 7m x 22kW	8		8		16	
		Waste Sludge Pump	Centrifugal non-clog type Ø100 mm x 1.1m3/min x 10m x 5.5kW	3		3		6	
		Cost (RM)			**9,611,023**		**9,611,024**		**19,222,047**

No.	Category	Facility/Major Equipment	Dimensions/Specifications	Phase I (Quantity)	Phase I (Price)	Phase II (Quantity)	Phase II (Price)	Total (Quantity)	Total (Price)
4	**Advanced Treatment**	**Utility Water Facility**							
		Utility Water Facility	Filter (Fiber type) Dia.1.0m x 5.5kW	2		0		2	
		Filter Feed Pump	Submersible Sewage Pump Ø80 mm x 0.3m3/min x 20m x 3.7kW	2		0		2	
		De-foaming pump	Submersible Sewage Pump Ø200 mm x 2.6m3/min x 30m x 30kW	2		2		4	
		Filter Water Transfer Pump	Submersible Sewage Pump Ø80 mm x 0.4m3/min x 15m x 3.7kW	2		0		2	
		Backwashing Drainage Pump	Submersible Sewage Pump Ø80 mm x 0.4m3/min x 15m x 3.7kW	2		0		2	
		Desulfuriser Scrubbing Pump	Submersible Sewage Pump Ø250 mm x 5.5m3/min x 20m x 37kW	2		0		2	
		Autostrainer for utility water	Automatic backwashing type Ø80 mm x 0.4kW	2		0		2	
		Autostrainer for de-foaming	Automatic backwashing type Ø50 mm x 0.4kW	2		0		2	
		Autostrainer for Filter	Automatic backwashing type Ø80 mm x 0.4kW	2		0		2	
		Autostrainer for Desulfuriser	Automatic backwashing type Ø250 mm x 0.4kW	2		0		2	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**3,356,536**		**351,258**		**3,707,794**
5	**Sludge Thickening**	**Sludge Thickner**							
		Gravity Thickner for primary sludge	Sludge collector Dia.11mx4mDx0.4kW	2		2		4	
		Primary Thickened Sludge Pump	Centrifugal non-clog type Ø100 mm x 0.6m3/min x 8m x 3.7kW	3		3		6	
		Mechanical Thickner for waste slu	Belt type Thickener 50m3/hrx6kW	3		3		6	
		Sludge Feed Pump for Thickener	Progress Cavity Pump Ø150 mm x 25-75m3/hr x 15m x 22kW	3		3		6	
		Thickened Mixed Sludge Pump	Centrifugal non-clog type Ø150 mm x 0.9m3/min x 25m x 5.5kW	3		3		6	
		Polymer Dissolving Tank	Cylindrical Steel Tank 6m3 x 7.5kW	2		2		4	
		Polymer Feeder	0.4kW	2		2		4	
		Polymer Feed Pump	Progress Cavity Pump Ø32 mm x 0.4- 1.2m3/hr x 15m x 0.75kW	3		3		6	
		Waste Sludge Mixer	Submersible Propeller Mixer 3kW	2		2		4	
		Thickened Sludge Mixer	Vertical type Propeller Mixer 30kW	2		2		4	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**6,319,227**		**6,319,226**		**12,638,453**
6	**Sludge Digestion**	**Digestion Facility**							
		Mixer	Mechanical mixing type equipped with draft tube	4		4		8	
		Gas Holder	2,500m3	1		1		2	
		Desulfuriser	420m3/hr	1		1		2	
		Gas Combuster	420m3/hr(15kW + 11kW)	1		1		2	
		Digested Sludge Pump	Centrifugal non-clog type Ø100 mm x 0.8m3/min x 10m x 7.5kW	2		2		4	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**12,272,017**		**12,272,017**		**24,544,034**

No.	Category	Facility/Major Equipment	Dimensions/Specifications	Phase I (Quantity)	Phase I (Price)	Phase II (Quantity)	Phase II (Price)	Total (Quantity)	Total (Price)
7	**Sludge Dewatering**	**Dewatering Facility**							
		Dewatering press	Screw press Dia900mmx450kg/hr						
			(3.7+1.5)kW	4		3		7	
		Digested Sludge Mixer	Vertical type Propeller Mixer 11kW	2		2		4	
		Polymer Dissolving Tank	Cylindrical Steel Tank 20m3x15kW	2		1		3	
		Polymer Feeder	0.4kW	2		1		3	
		Coagulant Storage Tank	PE, 18m3	2		0		2	
		Sludge Feed Pump for Dewateriing	Progress Cavity Pump Ø125 mm x 11-33m3/hr x 30m x 11kW	4		3		7	
		Polymer Feed Pump	Progress Cavity Pump Ø65 mm x 2-6 m3/hr x 30m x 2.2kW	4		3		7	
		Coagulant Feed Pump	Progress Cavity Pump Ø25 mm x 44-132 L/hr x 30m x 0.4kW	2		0		2	
		Sludge Cake Hopper	13m3 x 3.0kW	2		0		2	
		Waste Water Tank Mixer	Submersible Propeller Mixer 3kW	2		0		2	
		Waste Water Pump	Centrifugal non-clog type Ø200 mm x 3.7m3/min x 20m x 22kW	2		0		2	
		Auto Feed Water Supply Unit	Pressure Tank Type (Two Centrifugal pumps) Ø125 mm x 2.5m3/min x 50m x 44kW	1lot		0		1lot	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**12,987,681**		**9,740,761**		**22,728,442**
8	**Odor Control**	**Odour Control Facility**							
		Biological Scrubber	120m3/min (Sludge Treatment Facility)	1		0		1	
		Fan	120m3/min	2		0		2	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**6,322,659**		**0**		**6,322,659**
9		**General Requirement for Mechanical Works**							
		Cost (RM)		1lot	**588,885**	1lot	**588,885**	2lots	**1,177,770**
10		**Miscellaneous Facility**							
		Cost (RM)		1lot	**724,389**	1lot	**724,390**	2lots	**1,448,779**
11	**Disinfection**	**Chlorine Distribution Facility**							
		Chlorine Storage Tank	PE, 10m3	2		2		4	
		Chlorine Pump	Progress Cavity Pump Ø50 mm x 20m x 0.75kW	3		3		6	
		Piping & Steel works		1lot		1lot		2lots	
		Cost (RM)			**475,152**		**455,362**		**930,514**
		Sub-Total Cost (RM) - Mechanical			**97,733,235**		**80,581,875**		**178,315,110**

No.	Category	Facility/Major Equipment	Dimensions/Specifications	Phase I (Quantity)	Phase I (Price)	Phase II (Quantity)	Phase II (Price)	Total (Quantity)	Total (Price)
(Electrical)									
1	**Electrical Major Equipment**								
		Sub-station		1lot	**18,992,400**	1lot	**18,399,600**	2lots	**37,392,000**
		Pump Station		1lot	**5,149,000**	1lot	**3,857,000**	2lots	**9,006,000**
		Clarifier & Aeration Tank		1lot	**7,220,000**	1lot	**6,422,000**	2lots	**13,642,000**
		Blower		1lot	**4,276,900**	1lot	**3,349,700**	2lots	**7,626,600**
		Sludge Treatment		1lot	**8,859,700**	1lot	**5,967,900**	2lots	**14,827,600**
		SCADA		1lot	**5,327,600**	1lot	**4,115,400**	2lots	**9,443,000**
		Telemetary System		30lots	**11,400,000**	0lot	**0**	30lots	**11,400,000**
		General Requirement for Electrical Works		1lot	**611,512**	1lot	**233,808**	2lots	**845,320**
		Miscellaneous		1lot	**1,000,000**	1lot	**400,000**	2lots	**1,400,000**
		Sub-Total Cost (RM) - Electrical			**62,837,112**		**42,745,408**		**105,582,520**
(Mechanical & Electrical)									
		TOTAL Cost (RM) - M & E			**160,570,347**		**123,327,283**		**283,897,630**

Appendix III-6.3 Construstion cost for Sewer

Summary for Sewers, Pump Stations and Manholes (Excluding IST Areas)

Catchment	Network (RM)	Pump Station (RM)	MH (RM)	Jacking Pit (RM)	Total (RM)
Trunk Sewer	96,390,870	50,168,630	735,000	10,290,000	157,584,500
Cheras Batu 11	82,112,699	10,529,400	1,299,541	19,320,000	113,261,640
Cheras Jaya	52,080,498	20,219,500	1,041,976	15,960,000	89,301,974
Kajang 1	29,684,724	10,025,750	656,812	10,360,000	50,727,286
Kajang 3	44,510,505	18,166,200	907,965	14,000,000	77,584,670
Total	**304,779,297**	**109,109,480**	**4,641,293**	**69,930,000**	**488,460,070**

Description	Unit	Quantity	Unit Rate	Cost (RM)
Testing and Commisioning of Sewers and CCTV inspection	m	106,135	RM 30/m	3,184,050.00
Resurfacing of road pavement (milling and 50mm asphaltic concrete)	m^2	34,250	RM70/m^2	2,397,500.00
Relocation of Utilities	-	-	Lump Sump	20,000,000.00
Connecting of STPs	no.	160	10,000	1,600,000
TOTAL				**27,181,550.00**

GRAND TOTAL **RM 515,641,620**

Breakdown of construction cost for trunk sewer and manholes

TRUNK SEWER CONSTRUCTION COST

Diameter	Length (m)	Unit Rate (RM/m)	Cost (RM)
300mm	263	1,700.00	447,100.00
450mm	515	2,700.00	1,390,500.00
Sub-total	**778**		**1,837,600.00**
750mm	620	3,461.00	2,145,820.00
900mm	1,730	4,300.00	7,439,000.00
1050mm	2,450	4,620.00	11,319,000.00
1200mm	2,761	5,000.00	13,805,000.00
1500mm	944	6,000.00	5,664,000.00
1650mm	2,614	6,500.00	16,991,000.00
2000mm	1,872	8,500.00	15,912,000.00
400mm (DI)	545	3,500.00	1,907,500.00
900mm (DI)	1,721	7,950.00	13,681,950.00
1800mm (DI)	474	12,000.00	5,688,000.00
Sub-total	**15,731**		**94,553,270.00**
TOTAL	**16,509**		**96,390,870.00**

TRUNK SEWER MANHOLES COST

Diameter	Length (m)	No. of MH	MH Unit Rate (RM/MH)	Cost (RM)
300mm	263	5	5,000.00	25,000.00
450mm	515	7		35,000.00
750mm	620	8		40,000.00
900mm	1,730	18		90,000.00
1050mm	2,450	25		125,000.00
1200mm	2,761	28		140,000.00
1500mm	944	10		50,000.00
1650mm	2,614	27		135,000.00
2000mm	1,872	19		95,000.00
400mm (DI)	545	N/A		
900mm (DI)	1,721			
1800mm (DI)	474			
	16,509	**147**	**5,000**	**735,000**

CHERAS BATU 11 SUB-CATCHMENT

Diameter	Length (m)	Unit Rate (RM/m)	Cost (RM)
225mm	7,152	1,545	11,049,840
300mm	2,931	1,648	4,830,288
375mm	2,201	1,751	3,853,951
400mm	1,668	2,266	3,779,688
450mm	472	2,575	1,215,400
500mm	3,504	2,781	9,744,624
525mm	0	2,900	0
600mm	4,123	3,090	12,740,070
700mm	0	3,296	0
750mm	4,898	3,461	16,950,998
900mm	1,758	4,120	7,242,960
1050mm	519	4,620	2,397,780
100mm (DI)	0	1,350	0
150mm (DI)	0	1,800	0
200mm (DI)	1,219	2,100	2,559,900
300mm (DI)	0	2,750	0
400mm (DI)	250	3,400	850,000
500mm (DI)	0	4,010	0
600mm (DI)	0	4,620	0
900mm (DI)	616	7,950	4,897,200
	31,311		**82,112,699**

CHERAS JAYA SUB-CATCHMENT

Diameter	Length (m)	Unit Rate (RM/m)	Cost (RM)
225mm	7,859	1,545	12,142,155
300mm	2,594	1,648	4,274,912
375mm	701	1,751	1,227,451
400mm	325	2,266	736,450
450mm	752	2,575	1,936,400
500mm	698	2,781	1,941,138
525mm	0	2,900	0
600mm	1,399	3,090	4,322,910
700mm	2,341	3,296	7,715,936
750mm	620	3,461	2,145,696
900mm	211	4,120	869,320
1050mm	1,674	4,620	7,733,880
100mm (DI)	0	1,350	0
150mm (DI)	466	1,800	838,800
200mm (DI)	471	2,100	989,100
300mm (DI)	0	2,750	0
400mm (DI)	0	3,400	0
500mm (DI)	243	4,010	974,430
600mm (DI)	916	4,620	4,231,920
800mm (DI)	0	7,000	0
900mm (DI)	0	7,950	0
	21,270		**52,080,498**

KAJANG 1 SUB-CATCHMENT

Diameter	Length (m)	Unit Rate (RM/m)	Cost (RM)
225mm	6,069	1,545	9,376,605
300mm	1,460	1,648	2,406,080
375mm	485	1,751	849,235
400mm	0	2,266	0
450mm	2,245	2,575	5,780,875
500mm	382	2,781	1,062,342
525mm	935	2,900	2,711,500
600mm	0	3,090	0
700mm	244	3,296	804,224
750mm	779	3,461	2,695,963
900mm	0	4,120	0
100mm (DI)	116	1,350	156,600
150mm (DI)	0	1,800	0
200mm (DI)	0	2,100	0
300mm (DI)	634	2,750	1,743,500
400mm (DI)	617	3,400	2,097,800
500mm (DI)	0	4,010	0
600mm (DI)	0	4,620	0
800mm (DI)	0	7,000	0
	13,966		**29,684,724**

KAJANG 3 SUB-CATCHMENT

Diameter	Length (m)	Unit Rate (RM/m)	Cost (RM)
225mm	12,700	1,545	19,621,500
300mm	2,581	1,648	4,253,488
375mm	1,475	1,751	2,582,725
400mm	0	2,266	0
450mm	65	2,575	167,375
500mm	909	2,781	2,527,929
525mm	0	2,900	0
600mm	232	3,090	716,880
700mm	507	3,296	1,671,072
750mm	1,533	3,461	5,305,406
900mm	119	4,120	490,280
100mm (DI)	1,280	1,350	1,728,000
150mm (DI)	0	1,800	0
200mm (DI)	0	2,100	0
300mm (DI)	399	2,750	1,097,250
400mm (DI)	1,279	3,400	4,348,600
500mm (DI)	0	4,010	0
600mm (DI)	0	4,620	0
800mm (DI)	0	7,000	0
900mm (DI)	0	7,950	0
	23,079		**44,510,505**

Breakdown of construction cost for manholes by catchment

CHERAS BATU 11 SUB-CATCHMENT

Diameter	Length (m)	No. of MH	MH Size	MH Unit Rate (RM/MH)	Excavation (RM)	Cost (RM)
225mm	7,152	85	1,200	3,244	130	286,756
300mm	2,931	35	1,200	3,244	130	118,076
375mm	2,201	25	1,500	3,650	203	96,313
400mm	1,668	20	1,500	3,650	203	77,050
450mm	472	10	1,500	3,650	203	38,525
500mm	3,504	40	1,500	3,650	203	154,100
525mm	0	0	1,500	3,650	0	0
600mm	4,123	40	1,800	3,759	292	162,024
700mm	0	0	1,800	3,759	292	0
750mm	4,898	55	1,800	3,759	292	222,783
900mm	1,758	25	1,800	3,759	292	101,265
1050mm	519	10	2,100	3,868	397	42,649
100mm (DI)	0	N/A				
150mm (DI)	0					
200mm (DI)	1,219					
300mm (DI)	0					
400mm (DI)	250					
500mm (DI)	0					
600mm (DI)	0					
900mm (DI)	616					
	31,311	**345**				**1,299,541**

CHERAS JAYA SUB-CATCHMENT

Diameter	Length (m)	No. of MH	MH Size	MH Unit Rate (RM/MH)	Excavation (RM)	Cost (RM)
225mm	7,859	100	1,200	3,244	130	337,360
300mm	2,594	50	1,200	3,244	130	168,680
375mm	701	10	1,500	3,650	203	38,525
400mm	325	10	1,500	3,650	203	38,525
450mm	752	20	1,500	3,650	203	77,050
500mm	698	15	1,500	3,650	203	57,788
525mm	0	0	1,500	3,650	0	0
600mm	1,399	20	1,800	3,759	292	81,012
700mm	2,341	40	1,800	3,759	292	162,024
750mm	620	10	1,800	3,759	292	40,506
900mm	211	10	1,800	3,759	292	40,506
1050mm	1,674	0	2,100	3,868	397	0
100mm (DI)	0	N/A				
150mm (DI)	466					
200mm (DI)	471					
300mm (DI)	0					
400mm (DI)	0					
500mm (DI)	243					
600mm (DI)	916					
800mm (DI)	0					
900mm (DI)	0					
	21,270	**285**				**1,041,976**

KAJANG 1 SUB-CATCHMENT

Diameter	Length (m)	No. of MH	MH Size	MH Unit Rate (RM/MH)	Excavation (RM)	Cost (RM)
225mm	6,069	100	1,200	3,244	130	337,360
300mm	1,460	25	1,200	3,244	130	84,340
375mm	485	10	1,500	3,650	203	38,525
400mm	0	0	1,500	3,650	0	0
450mm	2,245	10	1,500	3,650	203	38,525
500mm	382	10	1,500	3,650	203	38,525
525mm	935	10	1,500	3,650	203	38,525
600mm	0	0	1,800	3,759	0	0
700mm	244	10	1,800	3,759	292	40,506
750mm	779	10	1,800	3,759	292	40,506
900mm	0	0	1,800	3,759	0	0
100mm (DI)	116	N/A				
150mm (DI)	0					
200mm (DI)	0					
300mm (DI)	634					
400mm (DI)	617					
500mm (DI)	0					
600mm (DI)	0					
800mm (DI)	0					
	13,966	**185**				**656,812**

KAJANG 3 SUB-CATCHMENT

Diameter	Length (m)	No. of MH	MH Size	MH Unit Rate (RM/MH)	Excavation (RM)	Cost (RM)
225mm	12,700	120	1,200	3,244	130	404,832
300mm	2,581	20	1,200	3,244	130	67,472
375mm	1,475	35	1,500	3,650	203	134,838
400mm	0	0	1,500	3,650	203	0
450mm	65	0	1,500	3,650	203	0
500mm	909	15	1,500	3,650	203	57,788
525mm	0	0	1,500	3,650	0	0
600mm	232	15	1,800	3,759	292	60,759
700mm	507	10	1,800	3,759	292	40,506
750mm	1,533	35	1,800	3,759	292	141,771
900mm	119	0	1,800	3,759	0	0
100mm (DI)	1,280	N/A				
150mm (DI)	0					
200mm (DI)	0					
300mm (DI)	399					
400mm (DI)	1,279					
500mm (DI)	0					
600mm (DI)	0					
800mm (DI)	0					
900mm (DI)	0					
	23,079	**250**				**907,965**

Breakdown of construction cost for network pump station (NPS) by catchment

Trunk Sewer

PS	PE	Dia (mm)	Rate (RM/PE)	Total (RM)
HLT 271	112,000	800	70	7,840,000
HLT 165	426,859	1600	70	29,880,130
HLT 280	25,170	400	150	3,775,500
HLT 245	123,900	900	70	8,673,000
Total				**50,168,630**

CHERAS BATU 11 SUB-CATCHMENT

PS	PE	Dia (mm)	Rate (RM/PE)	Total (RM)
HLT 035	5,500	200	400	2,200,000
HLT 037	4,000	200	400	1,600,000
HLT 043	5,000	200	400	2,000,000
HLT 162	19,500	400	150	2,925,000
HLT 133	4,511	200	400	1,804,400
HLT 271	Trunk Sewer			
Total				**10,529,400**

CHERAS JAYA SUB-CATCHMENT

PS	PE	Dia (mm)	Rate (RM/PE)	Total (RM)
HLT 081	56,233	600	100	5,623,300
HLT 165	Trunk Sewer			
HLT 202	4,500	200	400	1,800,000
HLT 203	29,850	500	150	4,477,500
HLT 205	2,125	150	500	1,062,500
HLT 272	72,562	600	100	7,256,200
Total				**20,219,500**

KAJANG 1 SUB-CATCHMENT

PS	PE	Dia (mm)	Rate (RM/PE)	Total (RM)
HLT 096	1,435	100	500	717,500
HLT 128	10,300	300	300	3,090,000
HLT 190	21,310	400	150	3,196,500
HLT 213	20,145	400	150	3,021,750
HLT 280	Trunk Sewer			
Total				**10,025,750**

KAJANG 3 SUB-CATCHMENT

PS	PE	Dia (mm)	Rate (RM/PE)	Total (RM)
HLT 021	19,939	400	150	2,990,850
HLT 023	9,615	300	350	3,365,250
HLT 083	27,914	400	150	4,187,100
HLT 197	3,600	200	500	1,800,000
HLT 143	905	100	300	271,500
HLT 209	21,680	400	150	3,252,000
HLT 099	12,500	300	150	1,875,000
HLT 119	1,415	100	300	424,500
HLT 245	Trunk Sewer			
Total				**18,166,200**

Appendix III-6.4 Basic Design Schedule

Work Item		Period (Month)	Basic Design Period 1	2	3	4	5	6	7	8	9	Remarks
Bacic Design												
＜Review of Sewerage Plan & Topographic Survey/ Soil Investigation (Boring)＞												
BD-1	Review of Sewerage Area	0.3										Review of PPP F/S
BD-2	Review of Sewerage Population	0.3										Review of PPP F/S
BD-3	Review of Sewerage Flow	0.3										Review of PPP F/S
BD-4	Review of Inflow and Treated Water Quality	0.3										Review of PPP F/S
BD-5	Investigation of Existing STP	1.0										Review of PPP F/S
BD-6	Soil Investigation (Boring)	5.0										Included sub contract period
BD-7	Topographic Survey	5.0										Included sub contract period
＜STP＞												
BD-8	Selection of Treatment Method	0.3										
BD-9	Design Criteria	0.5										
BD-10	Capacity Calculation	0.5										
BD-11	Hydraulic Calculation	0.5										
BD-12	Study of Facility Arrangement	0.5										
BD-13	Mechanical Equipment Design	2.0										
BD-14	List of Mechanical Equipment	1.0										
BD-15	Electrical Equipment Design	2.0										
BD-16	Monitoring System Design	1.0										
BD-17	Study of Facility Foundation (STP)	1.0										
BD-18	Preparation of Basic Design Drawing	3.0										
BD-19	Quantity Survey (STP)	1.0										
＜Sewer Pipe Design＞												
BD-20	Design Criteria for Sewer Pipe Design	0.5										
BD-21	Underground Utility Investigation	3.0										
BD-22	Selection of Sewer Route	3.0										
BD-23	Pipe Flow Calculation	1.0										
BD-24	Preparation of Plan & Profile Drawing	4.0										
BD-25	Study of Pipe Installation Method	1.0										
BD-26	Capacity & Hydraulic Calculation of Pump Station	1.0										
BD-27	Capacity & Hydraulic Calculation of MPS	1.0										
BD-28	Mechanical Design for Pump Equipment	1.0										
BD-29	Electrical Design for Pump Equipment	1.0										
BD-30	Preparation of Basic Design Drawing for PS & MPS	2.0										
BD-31	Quantity Survey (Pipe/Pump Station/MPS)	1.0										
＜EIA, BOQ & Specification＞												
BD-32	Social-Environmental Consideration	1.0										Submission/Approval of EIA
BD-33	Preparation of Operation & Maintenance Plan	0.5										
BD-34	Preparation of PQ Document	1.0										
BD-35	Preparation of Rough Construction Cost	2.0										
BD-36	Preparation of Implementation Plan	0.5										
BD-37	Preparation of Specification	3.0										
BD-38	Preparation of Bidding Document	1.5										

Appendix III-6.5 Breakdown of O&M Cost

OPEX Assumption for Model Project

Major items of STP OPEX are Chlorine (for disinfection), Polymer (for coagulant), Labor, Repair, Electricity, Sludge Disposal, and others.

We regarded Labor as the fixed costs and others as variable costs. (Of course, Labor costs in Phase-1 and Phase-2 are different.)

For the variable costs projection, we estimated the ultimate amount of each variable cost, then calculated average variable cost (per PE). Once we get the per PE cost, each year's variable cost can be calculated in accordance with the PE projection.

1. Labor costs

<The 1st phase>

Position	Number	Monthly costs per person	Annual costs (in total numbers)
Head	1	RM 7,000	RM 84,000
Supervisor	2	RM 6,000	RM 144,000
Engineer	2	RM 4,000	RM 96,000
Pump operator	2	RM 3,000	RM 72,000
Sewage operator	12	RM 3,000	RM 432,000
Sludge operator	11	RM 3,000	RM 396,000
Driver	2	RM 1,500	RM 36,000
Worker	7	RM 1,500	RM 126,000
Guard	2	RM 1,500	RM 36,000
TOTAL			RM 1,422,000

<The 2nd phase>

Position	Number	Monthly costs per person	Annual costs (in total numbers)
Head	1	RM 7,000	RM 84,000
Supervisor	3 (+1)	RM 6,000	RM 216,000
Engineer	2	RM 4,000	RM 96,000
Pump operator	2	RM 3,000	RM 72,000
Sewage operator	17 (+5)	RM 3,000	RM 612,000
Sludge operator	16 (+5)	RM 3,000	RM 576,000
Driver	2	RM 1,500	RM 36,000
Worker	10 (+3)	RM 1,500	RM 180,000
Guard	3 (+1)	RM 1,500	RM 54,000
TOTAL			RM 1,926,000

2. Chlorine costs

Dosage rate : 2.0 mg/l

Required amount : 207,000 m_3/day x 2.0 x 10^{-3} = 414.0 kg/day

414.0 kg/day x 365 days x RM17.5/kg = RM 2,644,425 /year

RM 2,644,425 x 80% load = RM 2,115,540 (RM 2.3/PE/year)

3. Polymer costs

For thickener

Dosage rate : 4.0 kg/DS ton

Required amount : Dry Sludge of 34,952 kg/day x 4.0 x 10^{-3} = 139.8 kg/day

139.8 kg/day x 365 x 20 RM/kg = 1,020,540 RM/year

RM 1,020,540/year x 80% load = RM 816,432/year

For dewatering

Dosage rate : 15.0 kg/DS ton

Required amount : Dry Sludge of 32,978 kg/day x 15.0 x 10^{-3} = 494.6 kg/day

494.6 kg/day x 365 x 20 RM/kg = 3,610,580 RM/year

RM 3,610,580/year x 80% load = RM 2,888,464

RM 816,432 + RM 2,888,464 = RM 3,704,896/year

4. Electricity costs

Equipment	Electricity (A)	Quantity (B)	Electricity (A x B)	Operation Hour/day
Sewage Lift Pump	250.0 kw	6 units	1,500.0 kw	12h
Auto Screen	3.7 kw	6 units	22.2 kw	3h
Return Sludge Pump	22.0 kw	8 units	176.0 kw	24h
Excess Sludge Pump	3.7 kw	4 units	14.8 kw	16h
Sludge Collector (Primary Clarifier)	0.75 kw	16 units	12.0 kw	24h
Blower	150.0 kw	6 units	900.0 kw	24h
Mixer 1	8.0 kw	8 units	64 kw	24h
Mixer 2	12.0 kw	8 units	96 kw	24h
Circulation Pump	22.0 kw	16 units	352.0 kw	24h
Sludge Collector (Secondary Clarifier)	2.2 kw	16 units	35.2 kw	24h
Mechanical thickener	6.0 kw	5 units	30.0 kw	16h
Digester Stirrer	22.0 kw	8 units	176.0 kw	24h
Digested Sludge Dewatering Unit	5.2 kw	6 units	31.2 kw	16h
Total			3,409 kw	

1,500 x 12/24 + 22.2 x 3/24 + (176+12+900+64+96+352+35.2+176) x 24/24 + (14.8 + 30 + 31.2) x 16/24

= 2,614.6 kwh

2,614.6 kwh + 522.9 kwh (miscellaneous, 20%) = about 3,137 kwh

3,137 kwh x 24hours x 365days x 0.377 RM/kwh = 10,360,005 RM/year (12.4 RM/PE/year)

RM 10,360,005 /year x 80% load = RM 8,288,004 /year

5. Sludge disposal costs

Sludge amount : 148 m^3/day

Sludge disposal cost : 148 m^3/day x 365 days x 175 RM/m^3 = 9,453,500 RM/year

In our model project, we will utilize the sludge after dewatering process for fertilizer use. We don't assume the revenues from these fertilizer sales, but at least we assume the sludge will be taken over without any charge, while JPP project will have to bear the sludge disposal costs.

6. Repair costs

0.1% of Civil cost and 0.5% of M&E cost

0.1% x RM 214,463,913 + 0.5% x RM 216,292,204 = RM 1,295,925/year

7. Others (Fixed cost + Variable cost) x 10% = RM 17,330,365 x 10% = RM 1,733,037

8. Contingency (10%) RM 1,906,340

9 Pump Stations (for ultimate cost)

- Electricity: RM 5,713,000
- Screening: RM 96,000
- Repair: RM 286,000
- Others: RM 305,000
- Total: RM 6,400,000

10 Sewer Pipe

- Cleaning of Pipe for Outsource: RM 192,000