

**SEWERAGE SERVICES DEPARTMENT  
MINISTRY OF ENERGY, WATER, AND  
COMMUNICATIONS  
MALAYSIA**

**THE STUDY ON  
IMPROVEMENT OF PLANNING CAPABILITY  
IN SEWERAGE SECTOR  
IN MALAYSIA  
FINAL REPORT**

**MANUAL FOR  
REVIEWING/EVALUATION/PRIORITISING OF  
SEWERAGE CATCHMENTS/PROJECTS**

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**JAPAN INTERNATIONAL COOPERATION AGENCY**

**NJS CONSULTANTS CO., LTD.  
and  
NIHON SUIDO CONSULTANTS CO., LTD.**

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## < Structure of Report >

### **Main Report**

### **Manual for Reviewing/Evaluation/Prioritising of Sewerage Catchments/Projects**

### **Exchange Rate**

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= Malaysian Ringgit (RM) 3.4575

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International Monetary Fund (IMF)

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## **Introduction**

This handbook has been prepared in accordance with the following provision in the Scope of Work for the Study on Improvement of Planning Capability in the Sewerage Sector in Malaysia agreed upon between the Government of Malaysia and the Government of Japan on December 20, 2006.

### *II. Formulation of Manual for reviewing/evaluation/prioritising of catchment strategies/plans and sewerage projects in the catchment plans*

#### *1. Review of existing systems for reviewing/evaluation/prioritising*

#### *2. Formulation of manual for the use of SSD counterparts to evaluate/review/ prioritise catchment strategies/plans and sewerage projects in the catchment plans, including consideration of the rationalisation and centralization and mechanisms and procedures for investment in sewerage development in the private and government sectors.*

The process by which the evaluation components and indicators used in prioritising sewerage projects were ultimately selected is described in the Main Report. This manual was prepared with an emphasis on how the Main Report should be used.

## **1 Objectives**

### **1.1 Anticipated Users of the Manual**

This Manual (hereinafter referred to as “Manual”) was prepared to review/evaluate/prioritise sewerage projects in the sewerage strategies and plans and catchment plans. It was been developed as a management tool to support managers and professionals in sewerage sectors of the government offices.

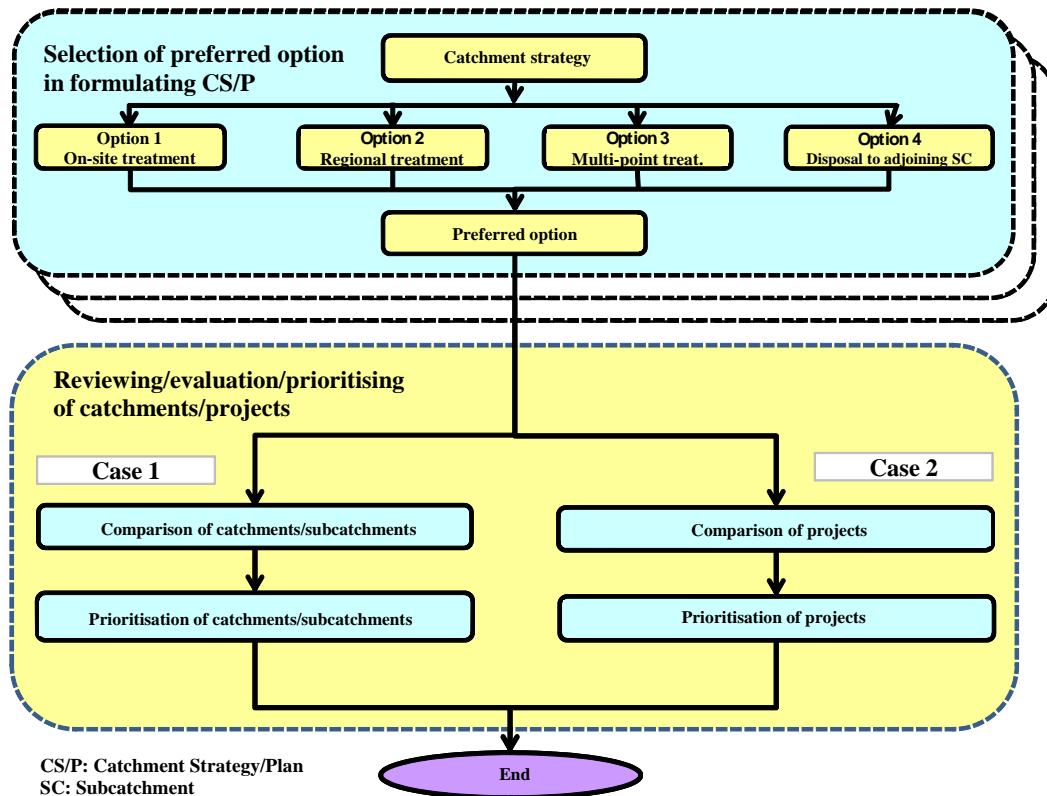
This Manual provides a set of instructions, definitions of data and indicators, data sources, the structure of the scoring system, ways of look at spreadsheets, rules for catchment/project selection and other aspects to facilitate the work of the engineer who is first involved in prioritising sewerage catchments/projects.

### **1.2 Anticipated Application of the Manual**

The objective of the Manual is to review, evaluate and prioritise the sewerage catchments/projects. In actual practice, the Manual would be used to review/evaluate/prioritise

the catchments/sub-catchments, as well as to prioritise projects located in different catchments, as described below. The relationship between these applications is depicted as in **Figure 1.1**.

- Case 1: Review/evaluation/prioritisation of sewerage catchments/sub-catchments  
 Case 2: Review/evaluation/and prioritisation of sewerage projects in the different catchments



**Figure 1.1 Application of the Manual for Reviewing/Evaluating/Prioritising Sewerage Catchments/Projects**

The catchment/sub-catchment is the planning unit established for the purpose of sewerage planning and refers to a specific area. However, when used in setting priorities, it refers to the overall plan for a sewerage system proposed for such catchments/sub-catchments. When a catchment and a sub-catchment each have independent sewerage systems, a sub-catchment is treated as equivalent to a catchment in setting priorities. It should be noted that there are some cases in which multiple sewerage systems are proposed for a single catchment or sub-catchment, or cases in which a proposal is made to integrate a single catchment or sub-catchment with another catchment or sub-catchment to form one centralized sewage treatment plant.

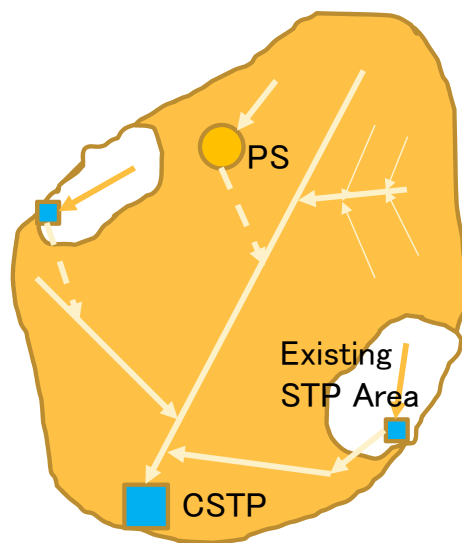
In contrast, the scale of the project means that the phased construction plan would only

complete one-third or one-fourth of the full plan for catchments or sub-catchments. Accordingly, catchments and sub-catchments cannot be compared to projects, with the exception of catchments and sub-catchments whose full planning scale is small enough to be handled as a project.

Although this manual applies to the prioritisation of projects as well as catchments/sub-catchment, data at the project implementation level is required in the case of projects. Accordingly, this is noted at the end as a consideration when prioritising projects.

### 1.3 Limitations to Applicability of the Manual

A sewerage system is a self-contained unit and usually composed of trunk, main, branch and reticulation sewers, pumping stations and a centralised sewerage treatment plant (CSTP) including the areas covered by existing sewerage treatment plants (STPs) to be rationalised as shown in **Figure 1.2**. Therefore the design PE of a CSTP includes the PE of such existing STPs.



**Figure 1.2 Image of a Sewerage System Used for Prioritisation**

On the process of phased construction of total rationalisation, however, a project which has not yet included the rationalisation of existing STPs in the total sewerage covered area shall be evaluated excluding such STPs as independent systems. This means the design PE of such project included in a CSTP system should exclude the design PE of the independent systems. Consequently, the CSTP system is to be evaluated in a proper manner in the prioritisation of sewerage catchments/projects without over-evaluation.

It should be noted that the manual cannot be basically applied to the prioritisation of sewerage systems with different conditions, for example those with a STP and without a STP. Therefore, as the construction cost is required to show its breakdown, or the costs for land, a sewer system, pumping stations and a STP, it is recommendable to exclude the catchments/projects whose construction cost of a STP is zero, from prioritisation of sewerage catchment/projects.

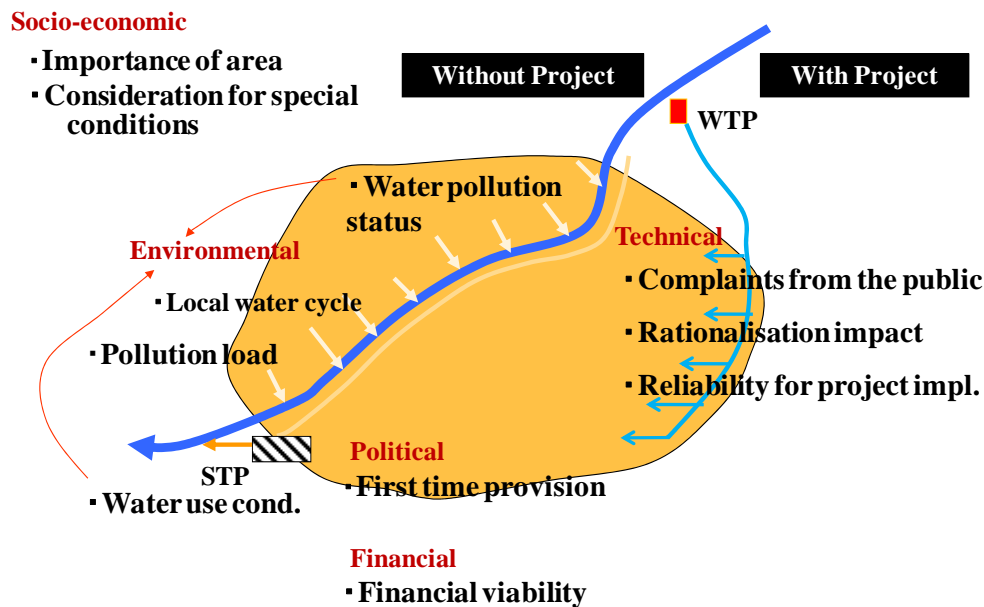
This Manual is prepared supposing the comparison of sewerage systems that are generally composed of trunk sewers, sewer network, pump stations and sewage treatment plants (STPs). Therefore, it would not be suitable to compare different kinds of sewerage projects such as construction of a centralized sludge treatment facility (CSTF), refurbishment or upgrading of existing STPs, rehabilitation of sewers, replacement of equipment, or similar projects.

Sewerage projects falling into these different categories will be reviewed/evaluated/ prioritised separately based on the following concepts.

- 1) Projects are classified by category
- 2) Projects are prioritised within each category
- 3) Budget allocations are made for category based on administrative decisions
- 4) Budgets are allocated to each project in accordance with its priority

## **2 Viewpoints and Indicators of the Manual for Reviewing/Evaluation/Prioritising of Sewerage Catchments/Projects**

Sewerage catchments and projects are evaluated in terms of their socio-economic, environmental, technical, political and financial aspects. Taking into account conditions before the project was implemented (“without project”) and changes after implementation (“with project”), 11 such aspects were selected as evaluation components, as shown in **Figure 2.1**, and 25 indicators were established to measure them.



**Figure 2.1 Viewpoints Used to Evaluate Sewerage Catchments/Projects**

The evaluation components are measured using the following indicators.

Given difficulties in obtaining data, 10 evaluation components and nineteen indicators, with the exception of the above in parentheses, are currently targets for evaluation.

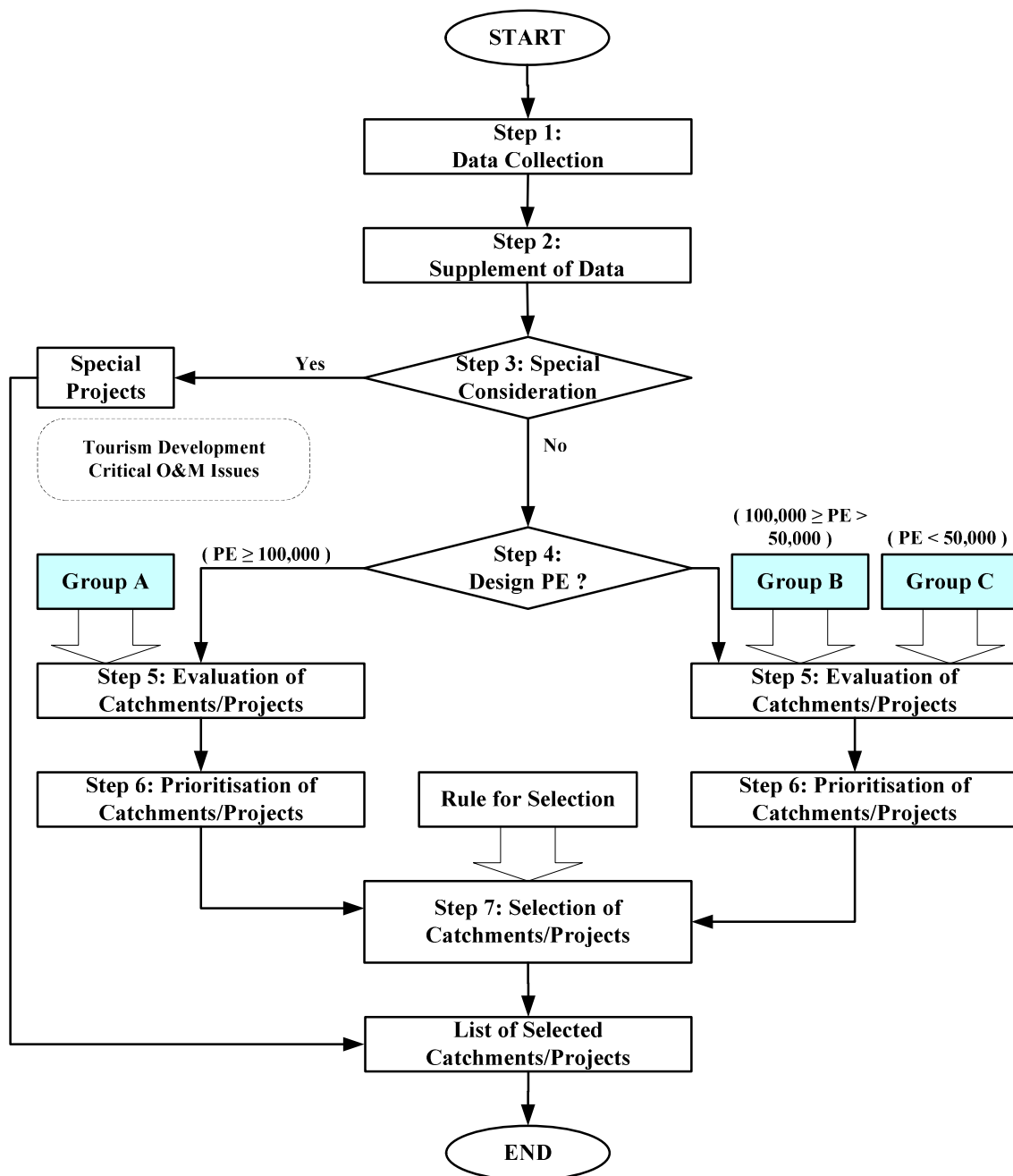
- 1) Importance of the Area
  - Population growth rate
  - (Design PE density )
  - Planned population
  - (Rate of commercial and industrial PE to total PE)
  - Number of hotel guests annually
- 2) Pollutant Load
  - Pollution load generated
- 3) Water Pollution of Water Body into which Effluent is discharged
  - (Water Quality Index (WQI) )
  - BOD<sub>5</sub> SI
  - NH<sub>3</sub>-N SI
- 4) Complaints from the Public
  - Complaints on existing STPs
  - No. of existing STPs
- 5) Use of Water from Water Body into which Effluent is discharged
  - Total water production at all WTPs downstream

- Duration of water intake closure at all downstream WTPs
- No. of water intakes for irrigational use
- Recreational use such as swimming (class II)
- 6) Impact of Rationalisation on Existing STPs
  - Reduction of O&M manpower requirement
  - Potential for new connections in growth areas
- 7) (Conservation of Local Water Cycle)
  - (Study on local water cycle)
- 8) Construction of First Permanent CSTP
  - Existence of permanent CSTP
- 9) Reliability of Project Implementation
  - Prospective of land acquisition for STP site
- 10) Financial Analysis
  - NPV/ Design PE
  - Construction cost and pollution load discharged
- 11) Consideration for Special Conditions
  - Involvement with national projects
  - Inclusion of sludge treatment on the CSTP site
  - Extension of a discharge pipe for sewage effluent from a CSTP to an area downstream of an intake point

### **3 Basic Flowchart for Reviewing/Evaluation/Prioritising of Sewerage Catchments/Projects**

**Figure 3.1** shows the process for setting priorities for sewerage catchments/projects, as outlined in the Manual.

- Step 1: Collect data from existing CSRs and SLPs
- Step 2: Supplement data
- Step 3: Exclude special projects
- Step 4: Group catchments/projects based on design PE
- Step 5: Give scores in accordance with the Manual
- Step 6: Prioritise catchments/projects
- Step 7: Select catchments/projects



**Figure 3.1 Flowchart for Prioritisation of Sewerage Catchments/Projects**

(1) Step 1: Collect data from existing CSRs/SLPs

Data is collected from existing Catchment Strategy Reports (CSPs) and Sewerage Local Plans (SLPs) in order to fill in the data sheet showing what kind of data is necessary. This includes not only the direct data but also indirect data concerned, such as the published year of the report, the option ultimately selected (CSTP, multipoint or on-site systems), structure

of catchments/sub-catchments, etc. Some indicators require that data be processed from the raw data.

(2) Step 2: Supplement data

Some data may need to be reviewed before the manual is applied. The data sheet is scrutinized to determine whether there is missing data, numerically abnormal values, discrepancies between relevant data, etc. If relevant, ways to legitimately supplement and correct such data are considered. Even if this data cannot be supplemented successfully, those projects would not be excluded when setting priorities for sewerage catchments/projects, but instead would have a disadvantage when scoring under the principle of “no data, no score”.

(3) Step 3: Exclude special projects

Special consideration may be paid to sewerage projects with special features. Examples of such projects would be island resorts for tourism development, which are unlikely to be selected under the normal prioritisation procedure but satisfies national policy, or a sewerage project that require urgent measures but without such measures could have a serious environmental impact. The possibilities are not limited to these two examples.

(4) Step 4: Group catchments/projects based on design PE

The catchments/projects are categorized into three groups with a design PE, namely  $PE \geq 100,000$  (Group A: high PE),  $100,000 > PE \geq 50,000$  (Group B: middle PE) and  $PE < 50,000$  (Group C: low PE).

(5) Step 5: Give scores

Scoring is done for the three groups, respectively, with "Group A" for high PE, "Group B" for middle PE and "Group C" for low PE, which show the criteria for classifying each evaluation component. As the default values are embedded in the cells on the Excel worksheet, they are automatically scored before and after being weighed. The default values can be changed, if necessary.

(6) Step 6: Prioritise catchments/projects

Sewerage catchments/projects are prioritised based on the scores. Three project lists are prepared for the high, middle and low design PE groups, respectively.

(7) Step 7: Select catchments/projects

This last step applies to the special project list from Step 3 and the three priority project lists by design PE size from Step 5. Catchments/projects are selected in accordance with the rules.

#### 4 Breakdown of Each Step

(1) Step 1: Collect data from existing CSRs and SLPs

Defects in the data that has been entered are often due to problems with the CSRs themselves.

In the example in **Table 4.1**, the data for sub-catchment A is given, but the conclusion of the report is that sub-catchment A is further subdivided into four districts which are covered by an independent CSTP system, respectively, and only data for the design PE and construction costs is provided. The purpose of the CSR is to clarify the outline of a plan for sewerage systems, not sub-catchments. This is tantamount to not providing any data at all, and cannot be used in setting priorities. In this example, sub-catchment A is made up of four CSTP systems, but catchments such as this with four systems cannot be fairly contrasted to a catchment with one system and would not be equitable.

**Table 4.1 Defects in Data Entered (1)**

	Sub-catchment A				
	X1	X2	X3	X4	Sub-total
Population growth rate					XXX
Planned population					XXX
Design PE	XXX	XXX	XXX	XXX	XXX
Tourists by locality					XXX
Pollution load generated					XXX
Construction costs	XXX	XXX	XXX	XXX	XXX
O&M manpower req. reduction					XXX
Const. cost/pollution load generated					XXX
Recommended sewerage system	1 CSTP	1 CSTP	1 CSTP	1 CSTP	

In the example in **Table 4.2**, adequate data is given for sewerage systems, but data on construction costs is only provided on the total for sub-catchments so that the planner's intentions are not conveyed.

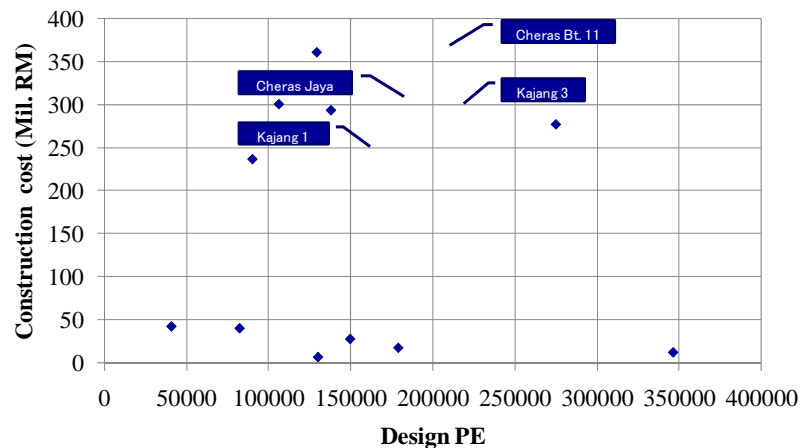
Defects such as this found in the CSRs are presumably caused by the lack of understanding of planners and supervisors as to the purpose of the reports. The catchments/sub-catchments are set conveniently for planning purposes, but do not always correspond to the boundaries of the sewerage systems ultimately adopted. In such cases, the elements involved in planning sewerage systems should be clarified again; otherwise, sewerage catchments/projects cannot be prioritised.

**Table 4.2 Defects in Data Entered (2)**

	Sub-catchment A				
	X1	X2	X3	X4	Sub-total
Population growth rate	XXX	XXX	XXX	XXX	
Planned population	XXX	XXX	XXX	XXX	
Design PE	XXX	XXX	XXX	XXX	
Tourists by locality	XXX	XXX	XXX	XXX	
Pollution load generated	XXX	XXX	XXX	XXX	
Construction costs					XXX
O&M manpower req. reduction	XXX	XXX	XXX	XXX	
Const. cost/pollution load generated					XXX
Recommended sewerage system	1 CSTP	1 CSTP	1 CSTP	1 CSTP	

The following points should be kept in mind when entering data:

- Enter accurate data.
  - Be careful with the required units for the data.
  - It is often effective to check data by preparing a correlation diagram for the two data sets.
- **Figure 4.1** shows some abnormal data for construction costs. It is found that the group with low construction costs does not include the cost for CSTP construction.



**Figure 4.1 Example of Correlation Graph for Construction Costs and Design PE**

- Spelling mistakes can be fatal for some data.
  - If there is a spelling error, it is assumed that it does not fit within any category and the lowest mark is given.
- Pay attention to the target year.
  - If the target year is 2020, construction costs through 2020 must be entered.

(2) Step 2: Supplement data

The planned population is supplemented as described below.

- For example, even if the planned population is not given, the design PE is always given in any report. In Malaysia, a conversion factor of 1.10 – 1.25 for the planned population to design PE is generally accepted. Although the number of reports adopting factors that exceed this value are increasing, the planned population shall be calculated by dividing the design PE by 1.25, when no population data is indicated.
- When only the total population is given in the report, it shall be allocated to catchments/sub-catchments as the planned population in proportion to design PE.

(3) Step 3: Exclude special projects

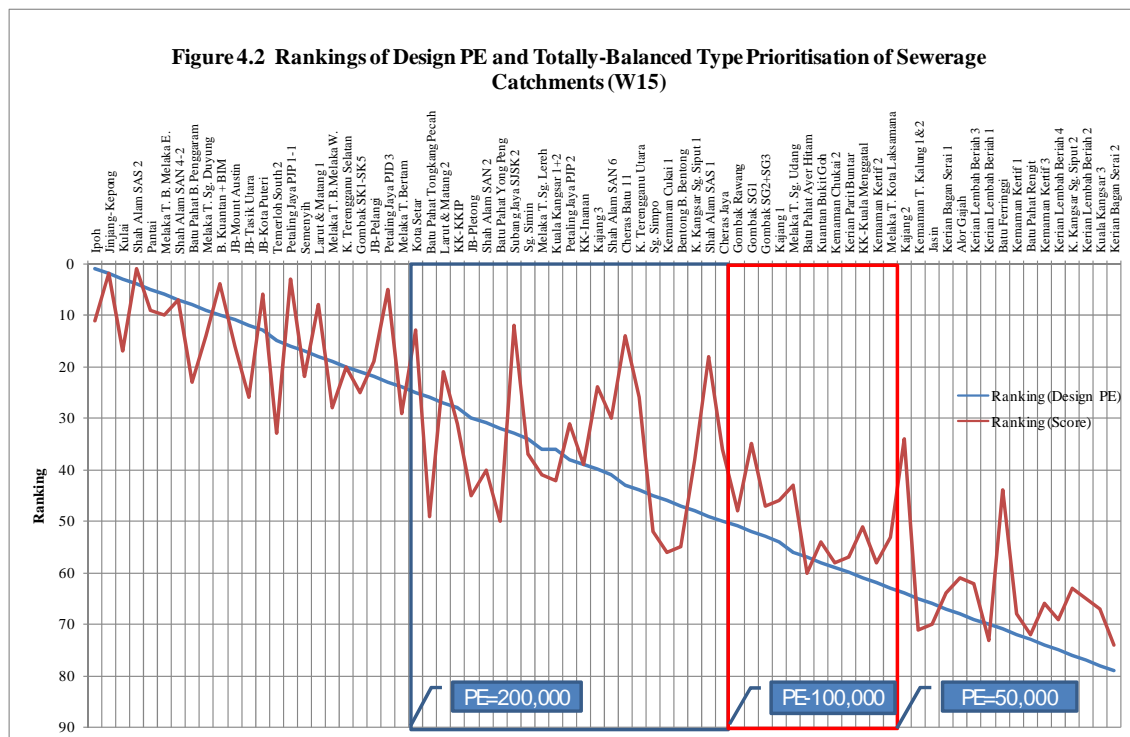
The island resort development project has a small design PE compared to other areas and cities because of its nature as an island, and the data on hotel guests by locality is not available due to the lack of such projects in the past. For this reason, it has a lower chance of being highly ranked in the process of prioritising sewerage catchments/projects. However, acquiring foreign currency through tourism has a big weight in Malaysia, and island resort development has been identified as an industry that must be

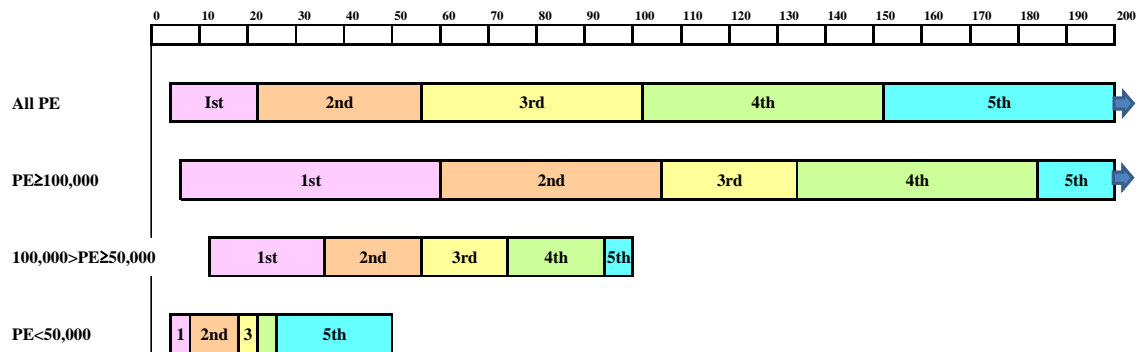
developed in future.

(4) Step 4: Group catchments/projects based on design PE

The sewerage catchments/projects are grouped based on design PE for the following reasons:

**Figure 4.2** shows the relationship between design PEs and rankings in a comprehensively balanced prioritisation. There is a tendency as a whole that the larger the design PE, the higher the priority ranking. The high PE group is still competitive with the top group, but the middle and low PE groups cannot compete. This leads to a disadvantage in marking.





**Figure 4.3 Differences in Scoring Range Among Design PE Groups**

(5) Step 5: Give scores

When the data is input in the given field, the scores for sewerage catchments/projects before and after weighting are immediately calculated, with reference to the scoring criteria. Although it takes time to prepare a reliable database file, once completed the results of the prioritisation of sewerage catchments/projects can be obtained immediately, even if the weighting or default values used in the equations are changed. Further, the optimum combination of weighting and default values can be identified by evaluating such prioritisation results.

(6) Step 6: Prioritise catchments/projects

Since sewerage catchments/projects are prioritised concurrently with Step 5, efforts should be made to display the results in an intelligible manner.

(7) Step 7: Select catchments/projects

The selection flow of sewerage/catchment/projects is shown in **Figure 4.4**.

The procedure for selecting catchment/projects is as follows:

- First, the validity of each special project shall be reviewed, taking into account background information. If the agencies concerned determine that the project is valid, the first portion of the budget shall be allocated for this project.
- If several island resort tourism development projects are proposed, these development projects must be prioritised. In this case, the planned tourism population or the number of hotel rooms would serve as reasonable evaluation indicators.
- When selecting catchments/projects from three lists, there are two options, as follows:

Option 1: Select a certain number of catchments/projects from the groups with low and middle design PE.

Option 2: Allocate a certain percentage of the budget to the groups with low and middle design PE.

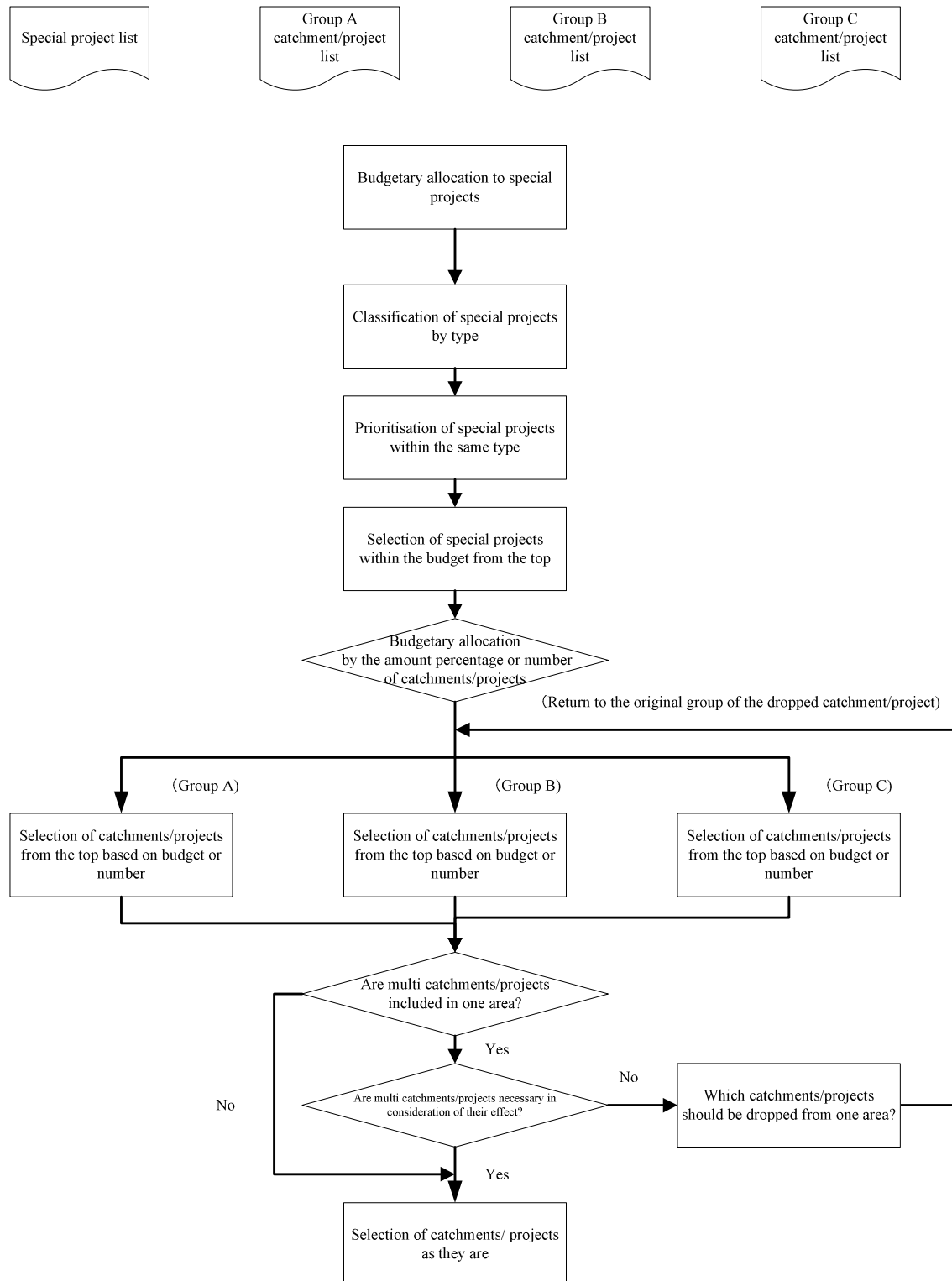


Figure 4.4 Selection Flow of Sewerage Catchments/Projects

A certain number or a certain percentage of catchments/projects shall be stipulated, taking into account priority issues, local conditions, urgency, the prevalence of sewerage systems, and other issues when setting priorities.

It should be noted that the construction cost per project in the middle and low PE groups is, in general, lower than that of the high PE group, as shown in **Table 4.3**.

**Table 4.3 Comparison of Construction Costs between Two PE Groups**

	High PE group (PE $\geq$ 100,000)	Middle & low PE group (PE<100,000)
No. of catchments	31 catchments	26 catchments
Average design PE	310,000	48,000
Average construction cost	RM 159.0 mil.	RM 41.0 mil.

The following principle shall always be considered in selecting catchments/projects.

Principle of “one project from one area”

- This principle should be respected as much as possible with the aim of spreading access to sewerage systems throughout the country.
- However, in some areas, implementing only one project may not be enough to solve the problem, taking into account its impact and urgency. Accordingly it is permitted to implement more than one project in the same area.

The catchment strategy report usually proposes multi sewerage systems with respective priorities. There is an idea that, since the comparison of proposed sewerage systems has been already made in the report, it is not necessary to redo it using the Manual and the prioritization should be done only for the sewerage systems with highest priority in respective reports. Consequently, the possibility that multi systems are selected from one area can be completely excluded.

## **5 Preparation of Data sheet and Scoring**

This chapter describes ways to collect the data from the catchment strategy report, prepare a datasheet and perform supplementary calculations. The contents of each item in the scoring sheet, equations used for automatic calculation, structure of a scoring sheet and calculation steps and default values are provided in the subsequent chapters for reference and customization.

The process for entering data is explained here using the Draft Final Report of “Sewerage Catchment Planning and Sludge Management Strategy Study for Upper Langat River Basin” (prepared by Antara Jurutera Perunding Sdn Bhd in July 2008) as an example.

## 5.1 Preparation of Prototype File for Scoring

The Excel file “ScoringSheet\_Prototype” is the blank datasheet, but equations for automatic calculations are embedded in some cells and it provides worksheets for different design PE groups and cases of different weighting using default values. This shall be the permanent file.

As shown in **Table 5.1**, the file contains 24 worksheets and with the exception of worksheets No. 31 to 33, worksheet titles are given in accordance with these rules:

### 01\_E30A

- 01** Worksheet No. (G after Worksheet No. means "chart")
- E** Prioritisation type
  - T: Prioritisation on overall balance
  - E: Prioritisation on environmentally-friendly aspects
  - R: Prioritisation on promotion of rationalisation
  - I: Prioritisation on investment efficiency
- 30** Maximum weighting
- A** Design PE group
  - A: for all PE
  - H: for  $PE \geq 100,000$
  - M: for  $100,000 > PE \geq 50,000$
  - L: for  $PE < 50,000$

**Table 5.1 Worksheet List in File Name: Scoring Sheet\_Base**

Worksheet No.	Contents
01_T15A	Prioritisation on overall balance for all PE
02_T15H	Prioritisation on overall balance for $PE \geq 100,000$
03_T15M	Prioritisation on overall balance for $100,000 > PE \geq 50,000$
04_T15L	Prioritisation on overall balance for $PE < 50,000$
05_E30A	Prioritisation on environmentally-friendly aspects for all PE
06_R30A	Prioritisation on promotion of rationalisation for all PE
07_I30A	Prioritisation on investment efficiency for all PE
08_E50A	Prioritisation on environmentally-friendly aspects for all PE

Worksheet No.	Contents
09_R50A	Prioritisation on promotion of rationalisation for all PE
10_I50A	Prioritisation on investment efficiency for all PE
11G_T15A	Graph: Prioritisation on overall balance for all PE
12G_T15H	Graph: Prioritisation on overall balance for $PE \geq 100,000$
13G_T15M	Graph: Prioritisation on overall balance for $100,000 > PE \geq 50,000$
14G_T15L	Graph: Prioritisation on overall balance for $PE < 50,000$
15G_E30A	Graph: Prioritisation on environmentally-friendly aspects for all PE
16G_R30A	Graph: Prioritisation on promotion of rationalisation for all PE
17G_I30A	Graph: Prioritisation on investment efficiency for all PE
18G_E50A	Graph: Prioritisation on environmentally-friendly aspects for all PE
19G_R50A	Graph: Prioritisation on promotion of rationalisation for all PE
20G_I50A	Graph: Prioritisation on investment efficiency for all PE
21G_T15A ( Sorted )	Graph: Prioritisation on overall balance for all PE
31_Summary	Summary of prioritisation
32_Summary (2)	Summary of prioritisation for sorting
33G_PEvScore	Graph: Rankings of design PE and prioritisation on overall balance prioritisation for all PE

## 5.2 Data Input

### (1) Preparation of the Input-Only File

When data is actually entered, the file of “ScoringSheet\_Prototype” is opened as “read only” and its filename is changed to “ScoringSheet\_Datasheet”. The range of O24:CZ106 is covered with a transparent red seal in order to protect the equations embedded in the cells, and data cannot be entered. If the red border is clicked and deleted, data can be entered. As the input-only file, data will be added to this file whenever catchment strategy reports are reviewed or newly prepared. The “ScoringSheet\_Datasheet” file will be kept for permanent preservation.

The following points should be noted:

- 1) The data input field is set at R3:CZ110, therefore, the maximum number of sewerage catchments/projects that can be compared at one time is 87.
- 2) Evaluation component written in red indicate that the equations are embedded in the cells of that row for automatic calculation and cannot be used for data input.

## (2) Data Input

**Appendix A** provides an excerpt of an actual catchment strategy report, and **Figure 5.1** summarises which parts are used in entering data. The “X” mark indicates the minimum data required to directly affect the scoring. For example, the population growth rate is automatically calculated using the four pieces of data, namely the base year, present population, target year and planned population. Accordingly, these four data points are marked with X, but not population growth rate itself. As shown in Appendix A, the data is mostly given in the table, but some data are given in the description, which makes it essential to read the report carefully. Some of the data may have to be obtained from IWK, the Ministry of Tourism (TOR), the Department of Environment (DOE) and the DOE’s concession company (ASMA) for environmental quality monitoring, and in addition separate surveys contacting the relevant agencies directly may be required for some issues.

The color of the letters in **Table 5.1** denotes the following:

- Black: Manually input
- Red: Automatically calculated
- Blue: Separately calculated and transferred to input datasheet

For indicators that are not expressed in numerical data, such as the DOE’s water quality classification, existence of a permanent CSTP and the reliability of project implementation, refer to **Chapter 6** for an explanation of the particular indicators as there are limitations to notations. ,

**Figure 5.2** shows examples of input data for the Upper Langat River Basin.

The applicable pages of the report are attached to clarify where data is obtained.

Points to consider for major indicators are stated below.

### 1) Catchment and/or sub-catchment (**Appendix A** p. 3-3)

The Upper Langat River Basin is made up of seven catchments: Kajang, Cheras, Bandar Bar Bangi (BBB), Seminiyh, Beranang, Bangi South and Langat. As shown in **Figure 5.2**, complete data equivalent to a catchment is given for three sub-catchments (Cheras Batu 11, Cheras Jaya and Cheras East) in Cheras and three (Kajang 1, Kajang 2 and Kajang 3) in Kajang, and they are thus treated as equivalent to catchments.

Langat Catchment is subdivided into two sub-catchments, Seminiyh into four and Bangi South into two, but the report provides very little data on these, as shown in **Figure 5.2**. However, the catchment data is provided, and is thus shown as a sub-total for

sub-catchment data (however, when the sub-total for sub-catchment data differs from that of catchment data, such as design PE, priority is given to the latter). The purpose of a catchment strategy report is to clarify the outline of the sewerage systems ultimately adopted, and this report does not meet such requirement.

2) Area to be covered by sewerage (**Appendix A** p. 3-3)

Be careful to note whether the data refers to the area targeted in a study or the area to be covered by a sewerage system. The latter data is required for these purposes.

3) Base year, present population, target year and planned population (**Appendix A** p. 5-2)

As distinct from data collected to set priorities, it is better to keep the data on the planned population for each five-year interval together with the design PE so that adjustments can be made promptly when the target year changes.

4) Present PE and design PE (**Appendix A** p. E-2)

The PE is projected using three methods: (1) census data, (2) submitted data and (3) land use data. Ultimately, the PE was projected using land use data, and was entered in the datasheet.

5) Planned sewage flow (**Appendix A** p. 5-6)

The planned sewage flow is automatically calculated and can be used to check the figure in the catchment strategy report.

6) Construction costs (**Appendix A** p. E-3, A5-21 and 22)

The total construction cost on p. E-3 shows total costs through 2035 and accordingly cannot be used here to set priorities. Although p. A5-21 and p. 22 give a breakdown of the investments up through 2035, the target year is set at 2020 so the investment up to 2020 is entered. For some catchments, the construction costs cover only the installation of sewer trunk, manhole and connection and do not include the construction of a CSTP.

7) Water use conditions downstream of sewage effluent discharge point (**Appendix A** p. 2-3 & 2-4)

The report provides a map showing the locations of water intakes for water supply, but it would be better if the map also showed the locations of DOE monitoring stations and sewage effluent discharge point from the proposed CSTP. The report also provides the water treatment capacities of water treatment plants taking water from the Langat River

watershed.

8) Information on existing STPs (**Appendix A** p. 4-10)

The minimum data required on existing STPs is provided in the text for each sub-catchment, although many reports give such data in appendices. It is important that the data be organised by catchments/projects. If data for existing STPs, especially on the treatment process, and the linked PE is sorted as shown in **Figure 5.6**, the rationalisation impact or O&M manpower reduction, BOD<sub>5</sub> pollution load discharged and other can be calculated. The results are shown in **Figure 5.1**.

9) Information on existing ISTs (**Appendix A** p. 4-9 & 6-5)

The total number of existing ISTs is given in the text, but those provided in the Appendix are not categorized by sub-catchment.

10) Financial viability

The data on design PE and construction costs is applied to the supporting programme in Appendix B to calculate the NPV and B/C ratio, which are transferred to **Figure 5.1**.

As shown in **Figure 5.2**, there is insufficient data for sewerage systems in Langat, Seminiyh and Bangi Lama, and there is little point to supplementing the planned population for them alone. Accordingly, they must be excluded when prioritising catchments/projects.

### 5.3 Preparation of Working File

A working file is prepared and scoring is done in line with the following steps.

The file of “ScoringSheet\_Database” is opened as “read only” and its filename is changed to “ScoringSheet\_priotritisation1” for working purposes. Work is done on Worksheet 01\_T15A.

1) Arrange data levels and delete unnecessary column data

The examples in **Figure 5.2** show all catchments/sub-catchments and sewerage systems, and this Figure is used as the basic datasheet. However, it should be noted that it cannot be used to prioritise sewerage catchments/projects as is. When prioritising, unnecessary data must be deleted to arrange data levels. Even if this data is hidden, the results would be wrong as the data is included in the calculation. In the examples in **Figure 5.2**, the columns for Langat 1, Langat 2, Seminiyh 1, Seminiyh 2, Seminiyh 3, Seminiyh 4, Bangi South 1 and Bangi South 2 and Total must be deleted.

Prioritisation on overall balance for all sewerage catchments/projects

- 2) Group sewerage catchments/projects based on the size of design PE, and give the first row a group color.
- 3) Check the result of the prioritisation on overall balance to ensure that it is correct.
- 4) Prepare the table for the scoring range by executing Macro 8 and Macro 9 after placing the cursor on A1.
- 5) Prepare Worksheet\_01\_T15A (2) by copying Worksheet\_01\_T15A.
- 6) Copy and paste the field S232:BE440 of Worksheet\_Form at the same place on Worksheet\_01\_T15A to erase the previous calculation results.

Prioritisation for different design PE groups

- 7) Copy and paste the field R3:CZ111 of Worksheet\_01\_T15A (2) at the same place on the worksheets for three design PE groups.
- 8) Delete column data on sewerage catchments/projects that do not meet the design PE conditions by identifying the colour mark; confirm that the results of the prioritisation on overall balance for each design PE groups is correct.
- 9) Copy and paste the field R3:CZ111 of Worksheet\_02\_T15H for a high design PE group at the same place on the Worksheet\_01\_T15A as the function to prepare the table showing the scoring range is available only at Worksheet\_01\_T15A; execute Step (4)
- 10) Copy and paste the field S232:BE440 at the same location on the Worksheet\_02\_T15H if the table showing the scoring range can be obtained.
- 11) Copy and paste the field S232:BE440 of Worksheet\_Form at the same place on the Worksheet\_01\_T15A to erase the previous calculation results.
- 12) Follow the same steps from (9) to (11) for middle and low design PE groups.

Prioritisation for cases with different weighting (see **Figure 8.1**)

- 13) Copy and paste the field R3:CZ111 of Worksheet\_01\_T15A (2) at the same place on the worksheets for cases with different weighting if sewerage catchments/projects are prioritised for different weighting.
- 14) Follow the same steps from (9) to (11) for the cases with different weighting.

### Preparation of graph

15) If there is no change in the worksheet title, the scoring results are automatically compiled in Worksheet 31\_Summary to create a graph. However, the graph assumes that data for 87 catchments/projects will be provided, and does not sort the data based on the score. Accordingly, if the column data has been deleted or left blank, the graph will be blank (see **Figure 5.4**).

16) The bar charts can be improved by removing blanks after sorting the data.

For example, Worksheet 32\_Summary (2) is prepared by copying Worksheet 31\_Summary. at Table 01\_T15A;

- Designate the sorting range at B2:CJ17.
- Select “Sort and filter”, “Option” and “Direction: Column”.
- Put “Column” at Column 17, “Key for sorting” at Value and “Order” at “Ascending.”
- Designate the charting range at B2:BW2, B5:BW15 to remove the blank field to obtain Worksheet No. 33 (see **Figure 5.5**).

17) Repeat the same process as above for the necessary cases.

**Figures 5.3 (1) and (2)** provide examples of a scoring sheet.

## 5.4 Calculation of O&M Manpower Reduction, etc.

The rationalisation impact or O&M manpower reduction is calculated using the file “PollutionLoad” in the CD-ROM attached.

- 1) This file is used to calculate the rationalisation impact (O&M manpower reduction), BOD<sub>5</sub> pollution load discharged from existing STPs and land area of redundant STP sites, using the data on existing STPs (see **Figure 5.6**).
- 2) The existing STP data is arranged so that Asset No. is located in Column B, STP type in Column F and Connected PE in Column G and the right side is kept blank for calculations.
- 3) The equations are embedded in the range of I8:AG8 and used so that “paste and copy” corresponds to the number of existing STPs (green portion in **Figure 5.6**).

- 4) The light-blue portion in **Figure 5.6** calculates the total connected PE and the number of existing STPs. The range of SUM and COUNT functions corresponding to the number of existing STPs must be adjusted.
- 5) The grey portion in **Figure 5.6** gives the default values to calculate O&M manpower reduction, which are the same as those in **Table 6.7**. The row below the default values shows the calculation results.
- 6) The existing STP data is first classified based on the type of facility (CST, IT/OP/STP or NPS) and the size of connected PE (I11:AC25 in the example in **Figure 5.6**) to calculate O&M manpower reduction.
- 7) The default values for sewage effluent BOD<sub>5</sub> concentrations by treatment process as shown in **Table 8.3** are given at P5:AC6 in **Figure 5.6**, which can be changed if necessary.
- 8) The red portion judges the treatment process of existing STPs, calculates “connected PE” × “sewage effluent BOD<sub>5</sub> concentration” and converts their total to BOD<sub>5</sub> pollution load discharged (ton/day) at the right cell (AF26 in the example in **Figure 5.6**). Sewage effluent BOD<sub>5</sub> concentrations are based on **Table 8.3**.
- 9) The yellow portion calculates the land area of redundant STP sites after rationalisation. The top cell (AG11 in the example in **Figure 5.6**) gives important data on the applicable sewage effluent discharge standard (“Std. A” or “Std. B”), which changes the applicable equation.
- 10) The description of AE27:AG31 in **Figure 5.6** shows the place in **Figure 5.2** to which the calculation results are transferred.

	K	L	M	N	O	P	Q	R	CA	CB	CC
1	Figure 5.1 Input Data and Data Source										
2	Data source										
3	Cover	X	Table A Base Data								
5	PP.3-3, "3.2 Catchments"	X									
6	pp.3-3, Table 3.1 (sub-catchment )	X									
9	pp. 6.5-6, "6.2.5 Sewerage Option"	X									
10											
11	Cover	X									
12	pp.3-3, Table 3.1 (total area of catchment)	X									
13	pp.3-3, Table 5.2 (2005)	X									
14	pp.3-3, Table 5.2 (2005)	X									
15	pp.E-2, Table (projected PE)										
16	pp.3-3, Table 5.2 (2020)	X									
17	pp.3-3, Table 5.2 (2020)	X									
18	pp.E-2, Table (projected PE)	X									
19	pp.3-3, Table 5.2 (2035)										
20	pp.3-3, Table 5.2 (2035)										
21	pp.E-2, Table (projected PE)										
22	N.A.										
23	N.A.										
24	auto calc.										
25	auto calc.										
26	pp.5-6, Table 5.10 (sewage flow)										
27	N.A.										
28	auto calc.										
37	N.A.										
38	N.A.										
39	N.A.										
40	N.A.										
41	pp.6-5 Table 6.3	X									
42	pp.A5-21~22	X									
43	pp.A5-21~22	X									
44	pp.A5-21~22	X									
45	auto calc. or given	X									
46	pp.A5-21~22										
47	auto calc.										
48	auto calc.										
49	pp.A5-21~22										
50	N.A.										
51	N.A.										
52	pp.A5-21										
53	auto calc.										
54											
55	auto calc.										
56	auto calc.										
57	auto calc.										
58	auto calc.										
59	auto calc.										
60	auto calc.										
61	Ministry of Tourism	X									
62											
63	auto calc.	X									
64	auto calc.										
65	auto calc.										
66	auto calc.										
67	separate calc. by Table 5.5 in Manual										
68	auto calc.										
69											
70	ASMA	X									
71	ASMA	X									
72	ASMA	X									
73	ASMA	X									
74	DOE										
75	DOE										
76											
77	IWK	X									
78	IWK	X									
79											
80	pp.2-4, Table 2.3 (water intake points)	X									
81	separate survey	X									
82	separate survey	X									
83	DOE										
84	DOE	X									
85											
86	separate calc. by Table 5.5 in Manual										
87	separate calc. by Table 5.5 in Manual										
88	auto calc. or given										
89	pp.4-9 "4.2.1.1-3 (Description)"	X									
90	separate calc. by Table 5.5 in Manual	X									
91	auto calc.										
92	auto calc.										
93	auto calc.	X									
94	separate calc. by Table 5.5 in Manual										
95	auto calc.										
96											
97	N.A.	X									
98											
99	IWK	X									
100											
101	pp.6-5, "6.2.4 (Description)"	X									
102											
103	separate calc. by Appendix B	X									
104	separate calc. by Appendix B										
105	auto calc.										
106	auto calc.										
107											
108	separate survey	X									
109	check "Sludge management strategy"	X									
110	check "Sewerage management strategy"	X									
111											
112	X	Data required at the minimum									
113	Note:	In the 13th row, "pp.3-3, Table 5.2 (2005)" means that the data of base year is given in Item "2005" of Table 5.2 at page 3-3 of the catchment strategy report.									

**Figure 5.2 Example of Input Data (Upper Langat)**

[illegible]

Figure 5.3(1) Scoring Sheet for Prioritisation of Sewerage Catchments/Projects

225	Per PE sewage flow (Lpcd)	123,456.7	Data manually input
55	Per PE BOD5 pollution load (gpcd)	123,456.7	Data supplemented
70	Effluent BOD5 of IST (mg/L)	123,456.7	Data automatically calculated but sometimes manually input
20	Effluent BOD5 after sewerage provision (mg/L)		
10	Number of ISTs desludged per day	123,456.7	Data transferred from separate calculation sheets
312	Annual working days		
2	No. of workers per crue for IST desludging		

Table A Base Data

	Catchment Strategy Report (CSR)	Jinjang-Kepong	Gombak	Gombak	Gombak	Gombak
	Catchment	Jinjang-Kepong	Sg. Gombak	Sg. Gombak	Sg. Kelang	Sg. Selangor
	Sub-catchment	Jinjang-Kepong	Gombak SG1	Gombak SG2+SG3	Gombak SK1-SK5	Gombak Rawang
	Recommended sytem	1 CSTP	2 CSTPs	To Bunus	To Bunus	1 CSTP
Planning Fundamentals						
	Year of report completed	1998/10	2004/12	2004/12	2004/12	2004/12
	Area to be sewerd	(ha)	6,860			
	Base year	1997	2000	2000	2000	2000
	Present population	(nos.)	441,997	50,594	72,045	178,598
	Present PE	(PE)	730,873	66,401	72,045	189,987
	Target year	2015	2015	2015	2015	2015
	Design Population	(nos.)	806,750	74,199	93,148	217,887
	Design PE for sewage treatment	(PE)	1,171,422	86,204	93,148	231,740
	Design population	(nos.)				
	Design PE for sewage treatment	(PE)				
	Design residential PE		724,157	74,199	93,148	211,294
	Design commercial & industrial PE	(PE)	270,376	6,820	0	13,853
	Desion PE / Design population	(times)	1.45			
	Design PE / Present PE	(times)	1.80			
	Dry weather average flow	(m3/day)	263,570	21,848	20,958	52,142
	Wet weather average flow	(m3/day)	317,000			
	Sewage treatment process		989,423	61,563	59,820	134,627
	Design PE for sludge treatment					
	Design sludge volume for CSTF	(m3/day)				
	Design dry solids for STP	(ton/day)				
	Design sludge volume for IST	(m3/day)				
	Design dry solids for IST	(ton/day)				
	Sludge treatment process					
	Final sludge condition					
	Construction period Phase 1	1997-2000				
	Construction period Phase 2	2001-2006				
	Construction cost Phase 1	(Mil. RM)	82.4			
	Construction cost Phase 2	(Mil. RM)	260.9			
	Land cost	(Mil. RM)	81.6			
	Sewer system	(Mil. RM)				
	Pumping station	(Mil. RM)				
	Sewage treatment Plant	(Mil. RM)				
	Construction cost	(Mil. RM)	664.8	38.3	128.4	142.7
	Annual O&M cost	(Mil. RM/yr)	14.6	1.6	4.0	4.3
	Per PE construction cost	(RM/PE)	568	398	1,379	616
	Per PE annual O&M cost	(RM/yr/PE)	12	16	43	19
	Period for NPV calculation	(yr)				
	NPV of construction cost (at 8.0%)	(Mil. RM)			87.8	94.9
	NPV of annual O&M cost (at 8.0%)	(Mil. RM)			942	409
	Total NPV (at 8.0%)	(RM/PE)				48.8
	Importance of the area					
	Growth rate of population	(%)	3.4	2.6	1.7	1.3
	Per PE density	(PE/ha)				
	Growth rate of design PE	(%)	2.7	2.5	1.7	1.3
	Design population	(nos.)	806,750	74,199	93,148	217,887
	Rate of residential PE	(%)	61.9	77.1	100.0	81.2
	Rate of commercial & industrial PE	(%)	23.1	6.9	0.0	6.0
	Annual hotel guests	(nos.)	15,012,021			
	Pollution loads					
	Total pollution load generated	(ton/day)	64,428	5,291	5,123	12,748
	Total pollution load removed by existing STPs & ISTs	(ton/day)	12,532	0.000	0.000	0.000
	Total pollution load reduced	(ton/day)	46,633	4,858	4,704	11,703
	BOD5 load after sewerage provision	(ton/day)	5,271	0.433	0.419	1,043
	BOD5 load discharged from existing STPs	(ton/day)	3,273			
	BOD load discharged from existing ISTs	(ton/day)	1,505			
	Water pollution status					
	DOE water quality monitoring station	1 K22	1K18	1K18	1K18	1K18
	Standard A/B	B	B	B	B	B
	Sub-index for BOD5	71	76	76	76	76
	Sub-index for NH3-N	0	36	36	36	36
	River basin	Batu	Gombak	Gombak	Gombak	Gombak
	River status	P	SP	SP	SP	SP
	Complaints from the public					
	Complaints on STPs	(nos.)	83	15	15	15
	No. of STPs	(nos.)	96			
	Water use condition					
	Total water production by WTPs	(m3/day)				
	Duration time of water intake closure at WTPs	(hrs)				
	No. of intakes for irrigational use	(nos.)				
	Classification by WQI					
	DOE class	III	III	III	III	III
	Rationalisation of existing sewerage facilities					
	Design PE of STPs to be rationalised	(PE)	219,118			
	No. of STPs to be rationalised	(nos.)	96			
	Design PE of ISTs to be connected	(PE)	95,560			
	No. of ISTs to be connected	(nos.)	19,112			
	Existing STP O&M man-power requirement	(man-day)	47			
	Existing IST O&M man-power requirement	(man-day)	12.3			
	Total O&M man-power requirement	(man-day)	59.4	0.0	0.0	0.0
	Design PE of growth	(PE)	952,304	96,204	93,148	231,740
	Redundant land area after rationalisation	(ha)	21.59			
	PE rationalisation rate	(%)	18.7			
	Conservation of local water cycle					
	Study on local water cycle					
	Existence of permanent CSTP					
	Existence of permanent CSTP	YNN	NNN	NNN	NNN	NNN
	Reliability of project implementation					
	Prospective of land acquisition for STP site	Existing STP	Existing STP	Existing STP	Existing STP	No resettlement
	Financial analysis					
	NPV / Design PE	(RM/PE)	-652.0	-41.3	-130.6	-142.3
	B/C ratio		0.13	0.16	0.06	0.12
	NPV / Design PE	(RM/PE)	-55.7	-46.0	-140.2	-61.4
	Construction cost / Pollution load discharged	(Mil RM/ton)	10.3	7.2	25.1	11.2
	Consideration for special conditions					
	Involvement in national projects					
	Inclusion of sludge treatment in CSTP site					
	Extension of sewage effluent discharge pipe					

Table B Weightage and Scoring Conditions

Weightage	Unit	Scoring Criteria					Score				
[1]	[2]	1st class	2nd class	3rd class	4 th class	5th class	1st class	2nd class	3rd class	4 th class	5th class
15	%	4	3	2	1	Less	10	8	6	4	2
40	person	120000	80000	40000	20000	Less	10	8	6	4	2
20	person	1600000	800000	400000	200000	Less	10	8	6	4	2
5	100	ton/day	10	7.5	5	2.5	Less	10	8	6	4
0	0	ton/day					10	8	6	4	2
15	60		79	90	More		10	6	3		
40	person	70	91	More			10	6	3		
15	100	P	SP	C			10	6	3		
5	50	cases	40	20	10	1	Less	10	8	6	4
50	nos.	75	50	25	5	Less	10	8	6	4	2
10	40	person	240000	120000	60000	30000	Less	10	8	6	4
20	days	10	7	5	3	Less	10	8	6	4	2
20	nos.	4	3	2	1	0	10	8	6	4	2
20		II	III				5	0			
15	60	man-year	25	15	5	1	Less	10	8	6	4
0	ha	60	40	20	10	More	10	8	6	4	2
0	%						10	8	6	4	2
40	PE	200000	100000	50000	25000	Less	10	8	6	4	2
0	100	Yes	No				10	0			
5	100	NNN	YNN	YYN			10	6	3		
10	100	Existing STP	Gazetted	Public	to resettlement	Resettlement	10	8	6	4	2
15	60	RM/PE	-40	-60	-80	-400	Less	10	8	6	4
40	mil RM/ton/day	20	14	10	8	Less	2	4	6	8	10
5	100	Yes	No				10	0			
0		Yes	No				10	0			
0		Yes	No				10	0			
0		Yes	No				10	0			

100	800
-----	-----

Table E Appearance Frequency of Score

Total	1st class	2nd class	3rd class	4 th class	5th class
72	15	13	18	13	13
72	14	14	15	14	15
33	6	7	7	7	6
74	14	15	15	15	15
74	42	24	8		
74	61	7	6		
65	12	13	13	27	0
64	12	13	13	13	13
9	1	2	5	0	1
6	1	5	0	0	0
0	0	0	0	0	0
74	19	55			
68	13	14	13	14	14
47	47	0	0	0	0
0	0	0	0	0	0
74	14	15	15	15	15
76	69	2	1	2	2
74	20	4	13	31	6
74	14	15	15	15	15
74	14	15	15	15	15
6	6	0			
0	0	0			
0	0	0			
0	0	0			

Table D Score after Weightage Application

Importance of the area		13.8	7.2	6.0	8.4	7.2
Growth rate of population	(%)	4.8	3.6	2.4	2.4	3.6
Design PE density	(%)					
Design population	(nos.)	6.0	3.6	3.6	6.0	3.6
Rate of Commercial & industrial PE	(%)	0.0	0.0	0.0	0.0	0.0
Annual hotel guests	(nos.)	3.0				
Pollution loads		3.0	2.0	2.0	4.0	2.0
Total pollution load generated	(ton/day)	5.0	2.0	2.0	4.0	2.0
Total pollution loads reduced	(ton/day)					
Water pollution status		15.0	15.0	15.0	15.0	15.0
Sub-index for BOD5		9.0	9.0	9.0	9.0	9.0
Sub-index for NH3-N		6.0	6.0	6.0	6.0	6.0
WQI		15.0	9.0	9.0	9.0	9.0
Complaints from the public		5.0	1.5	1.5	1.5	1.5
Complaints on STPs	(nos.)	2.5	1.5	1.5	1.5	1.5
No. of STPs	(nos.)	2.5				
Water use condition		0.0	0.0	0.0	0.0	0.0
Total water production by WTPs	(m3/day)					
Water intake suspension days at WTPs	(hrs)					
No. of intakes for irrigational use	(ha)					
Classification by WQI		0.0	0.0	0.0	0.0	0.0
Rationalisation of existing sewerage facilities		15.0	5.4	5.4	7.8	5.4
Total O&M man-power requirement reduction	(man-year)	9.0	1.8	1.8	1.8	1.8
Redundant land area after rationalisation	(ha)	0.0				
PE rationalisation rate	(%)					
Connecting potential in the new service area	(nos.)	6.0	3.6	3.6	6.0	3.6
Conservation of local water cycle		9.0	0.0	0.0	0.0	0.0
Study on local water cycle						
Existence of permanent CSTP		3.0	5.0	5.0	5.0	5.0
Existence of permanent CSTP		3.0	5.0	5.0	5.0	5.0
Reliability of project implementation		10.0	10.0	10.0	10.0	4.0
Prospective of land acquisition for STP site		10.0	10.0	10.0	10.0	4.0
Financial analysis		12.0	13.2	6.0	9.0	12.0
NPV / Design PE	(RM/PE)	7.2	7.2	3.6	5.4	7.2
Construction cost / Pollution load discharged	(mil RM/ton)	4.8	6.0	2.4	3.6	4.8
Consideration for special conditions		0.0	0.0	0.0	0.0	0.0
Involvement in national projects						
Inclusion of sludge treatment in CSTP site						
Extension of sewage effluent discharge pipe						
TOTAL		78.6	59.3	50.9	60.7	52.1
Ranking		2	31	45	27	46

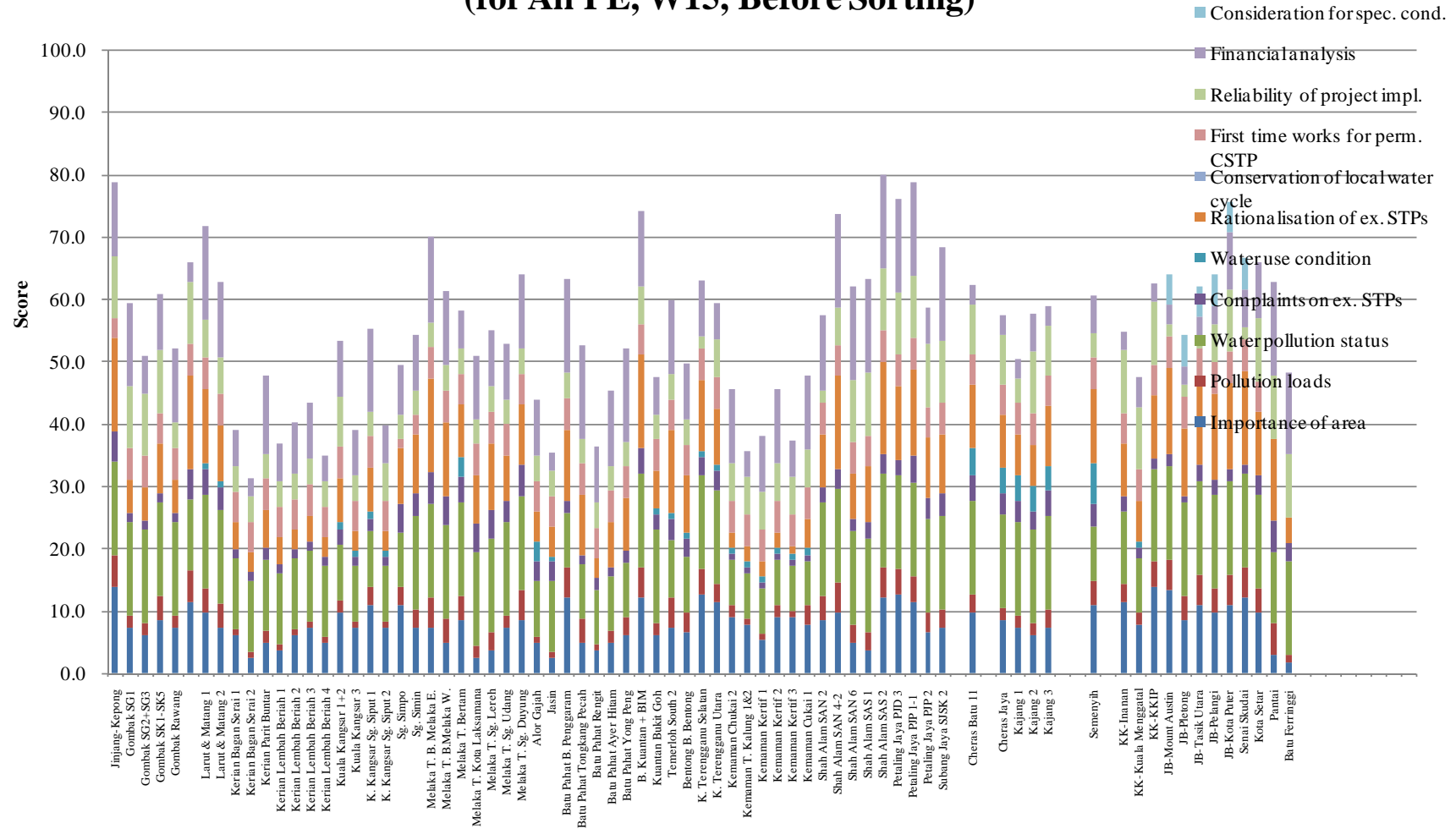
Table F Summary of Scoring

	Jinjang-Kepong	Gombak	Gombak	Gombak	Gombak
	Jinjang-Kepong	Sg. Gombak	Sg. Gombak	Sg. Kelang	Sg. Selangor

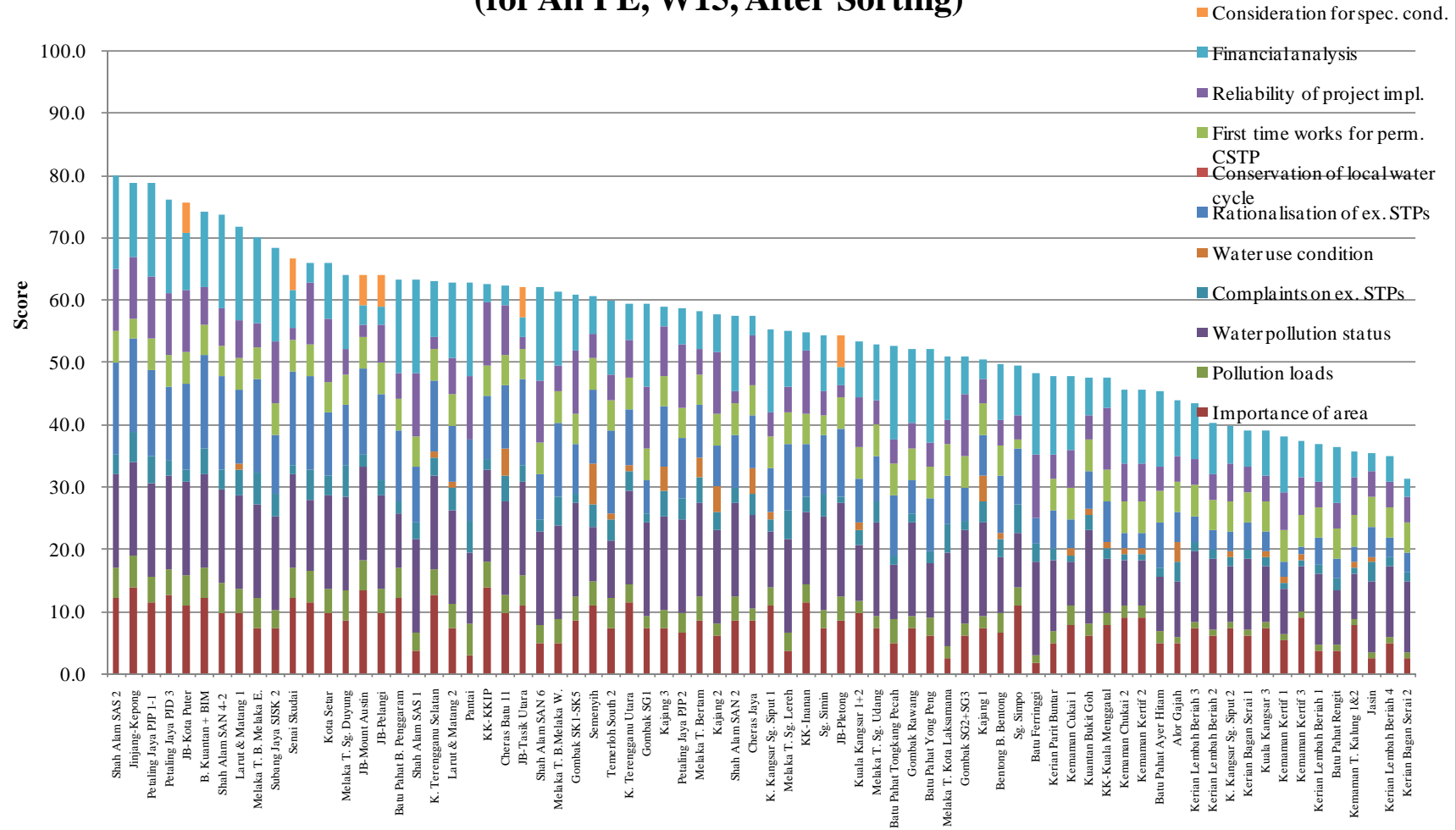
Table G Scoring Criteria (As Computational Results)

Growth rate of population		Design population		Annual hotel guests		Total pollution loads generated		Complaints on STPs		No. of STPs													
No. of Data		72		No. of Data		72		No. of Data		33		No. of Data		74		No. of Data		65		No. of Data		64	
Ranking		Growth rate of population	Ranking		Design population	Ranking		Annual hotel guests	Ranking		Total pollution loads generated	Ranking		Complaints on STP	Ranking		No. of STPs			No. of STPs		No. of STPs	
72	1	-3.0	72	1	3,428	28	1	90,991	74	1	0.481	46	1	0	58	1	0						
71	2	-1.8	71	2	3,805	28	2	90,991	73	2	0.532	46	2	0	58	2	0						
70	3	-1.0	70	3	6,123	28	3	90,991	72	3	0.705	46	3	0	58	3	0						
69	4	-0.7	69	4	6,219	28	4	90,991	71	4	0.983	46	4	0	58	4	0						
68	5	-0.1	68	5	6,492	28	5	90,991	70	5	1.335	46	5	0	58	5	0						
67	6	0.4	67	6	8,189	28	6	90,991	69	6	1.343	46	6	0	58	6	0						
66	7	0.5	66	7	9,950	23	7	329,667	68	7	1.353	46	7	0	58	7	0						
65	8	0.6	65	8	9,730	23	8	329,667	67	8	1.589	46	8	0	58	8	0						
64	9	0.8	64	9	11,594	23	9	329,667	66	9	1.650	46	9	0	56	9	0						
63	10	0.8	63	10	14,770	23	10	329,667	65	10	1.843	46	10	0	55	10	0						
61	11	0.9	62	11	17,041	23	11	329,667	64	11	2.001	46	11	0	53	11	3						
61	12	0.9	61	12	19,108	22	12	333,088	63	12	2.084	46	12	0	53	12	3						
60	13	1.1	60	13	20,219	21	13	567,457	62	13	2.087	46	13	0	52	13	4						
57	14	1.2	59	14	21,112	19	14	781,369	61	14	2.110	46	14	0	51	14	6						
57	15	1.2	58	15	21,180	19	15	781,369	60	15	2.209	46	15	0	49	15	7						
57	16	1.2	57	16	21,458	18	16	803,615	59	16	2.244	46	16	0	49	16	7						
55	17	1.3	56	17	21,756	17	17	826,725	58	17	2.362	46	17	0	46	17	9						
55	18	1.3	55	18	22,205	14	18	1,100,656	57	18	2.989	46	18	0	47	18	9						
54	19	1.5	54	19	23,176	14	19	1,100,656	56	19	3.063	46	19	0	45	19	10						
52	20	1.6	53	20	26,272	14	20	1,100,656	55	20	3.203	46	20	0	45	20	10						
52	21	1.6	52	21	26,965	12	21	1,668,743	54	21	3.566	43	21	0	43	21	11						
49	22	1.7	51	22	30,585	12	22	1,668,743	53	22	4.029	43	22	1	43	22	14						
49	23	1.7	50	23	35,809	7	23	2,645,518	52	23	4.074	43	23	1	41	23	20						
49	24	1.7	49	24	35,986	7	24	2,645,518	51	24	4.289	39	24	3	41	24	20						
47	25	1.8	48	25	40,138	7	25	2,645,518	50	25	4.980	39	25	3	40	25	21						
47	26	1.8	47	26	41,050	7	26	2,645,518	49	26	5.123	39	26	3	39	26	24						
42	27	1.9	46	27	43,385	7	27	2,645,518	48	27	5.291	39	27	3	38	27	26						
42	28	1.9	45	28	49,406	6	28	3,468,063	47	28	5.403	34	28	4	37	28	27						
42	29	1.9	44	29	51,411	3	29	4,917,513	46	29	5.945	34	29	4	36	29	29						
42	30	1.9	43	30	56,386	3	30	4,917,513	45	30	6.489	34	30	4	35	30	31						
42	31	1.9	42	31	60,133	3	31	4,917,513	44	31	6.422	34	31	4	34	31	33						
40	32	2.0	41	32	67,316	1	32	15,012,021	43	32	6.568	34	32	4	32	32	35						
40	33	2.0	40	33	69,066	1	33	15,012,021	42	33	6.796	32	33	6	32	33	35						
39	34	2.1	39	34	74,189				41	34	6.897	32	34	6	29	34	36						
37	35	2.2	38	35	82,437				40	35	6.960	26	35	15	29	35	36						
37	36	2.2	37	36	82,792				39	36	7.086	26	36	15	29	36	36						
36	37	2.5	36	37	87,767				38	37	7.116	26	37	15	28	37	38						
34	38	2.6	35	38	87,767				37	38	7.363	26	38	15	27	38	44						
34	39	2.6	34	39	93,148				36	39	7.592	26	39	15	26	39	46						
31	40	2.7	33	40	95,278				35	40	7.827	26	40	15	25	40	47						
31	41	2.7	32	41	99,682				34	41	7.867	25	41	16	24	41	49						
31	42	2.7	31	42	100,789				33	42	8.021	23	42	28	23	42	51						
30	43	2.8	30	43	102,203				32	43	8.396	23	43	28	22	43	55						
29	44	2.9	29	44	104,453				31	44	8.548	20	44	29	19	44	66						
27	45	3.0	28	45	106,180				30	45	9.351	20	45	29	19	45	66						
27	46	3.0	27	46	110,812				29	46	9.715	20	46	29	19	46	66						
26	47	3.1	26	47	112,042				28	47	9.767	14	47	36	18	47	67						
25	48	3.3	25	48	115,339				27	48	9.862	14	48	36	17	48	69						
24	49	3.4	24	49	117,285				26	49	10,413	14	49	36	16	49	71						
23	50	3.5	23	50	121,763				25	50	10,840	14	50	36	15	50	76						
21	51	3.6	21	51	123,474				24	51	11,777	14	51	36	14	51	77						
21	52	3.6	21	52	127,075				23	52	12,018	14	52	36	13	52	82						
18	53	3.8	20	53	130,730				22	53	12,095	13	53	39	12	53	87						
18	54	3.8	19	54	131,967				21	54	12,386	11	54	83	11	54	88						
16	55	3.8	18	55	133,016				20	55	12,746	11	55	83	10	55	96						
16	56	4.0	17	56	136,855				19	56	13,002	10	56	91	9	56	98						
16	57	4.0	16	57	139,113				18	57	13,454	9	57	145	8	57	105						
14	58	4.4	15	58	139,619				17	58	13,983	2	58	154	7	58	113						
14	59	4.4	14	59	146,792				16	59	15,129	2	59	154	6	59	117						
13	60	4.8	13	60	152,660				15	60	16,721	2	60	154	5	60	145						
11	61	5.1	12	61	165,815				14	61	19,036	2	61	154	4	61	168						
11	62	5.2	11	62	169,908				13	62	19,333	2	62	154	3	62	193						
10	63	5.5	10	63	172,998				12	63	19,767	2	63	154	2	63	248						
9	64	5.8	9	64	175,073				11	64	20,263	2	64	154	1	64	330						
8	65	7.2	8	65	183,058				10	65	20,302	1	65	178									
7	66	7.5	7	66	187,171				9	66	20,426												
6	67	9.5	6	67	191,870				8	67	21,216												
5	68	5	5	68	217,887				7	68	21,878												
4	69	10.4	4	69	259,092				6	69	34,990												
3	70	11.9	3	70	476,056				5	70	39,100												
2	71	12.9	2	71	744,804				4	71	43,502												
1	72	21.3	1	72	806,750				3	72	50,276												
									2	73	64,428												
									1	74	70,580												

**Figure 5.4 Totally-Balanced Type Prioritisation of Sewerage Catchments  
(for All PE, W15, Before Sorting)**



**Figure 5.5 Totally-Balanced Type Prioritisation of Sewerage Catchments  
(for All PE, W15, After Sorting)**



[illegible]

## 6 Requirements and Sources of Data

Data must be entered to prioritise sewerage catchments/projects. The data includes data directly obtained from the Catchment Strategy Reports (CSRs), data automatically calculated in accordance with equations embedded in the cells in the Excel worksheet, data provided from external resources and others. Careful examination of the extent to which the CSR meets the requirements reveals the quality of a sewerage planning report. Most data on population, design PE, existing sewage treatment plants and other sanitation facilities are first given on the Mukim basis, but such data has no meaning if not converted to that on a sewerage system basis.

Some reports review the existing sewage treatment plants on the Mukim basis, but we cannot help but conclude that the planner does not have a good understanding of sewerage planning. Issues in sewerage planning should not be compared on the Mukim basis, but on the sewerage system basis, such as catchments/sub-catchments.

The data required for prioritisation of sewerage catchments/projects includes the following:

### (1) General information

Row No.	Item	Note	Data input	Data source
R03	Name of study area		Manual	Report cover
R04	Name of state		Manual	Report cover
R05	Name of catchment	*1	Manual	Population and design PE projection
R06	Name of sub-catchment	*1	Manual	-ditto-
R07	Name of sewerage planning unit	*1	Manual	-ditto-
R08	Name of local authorities involved		Manual	Outline of the study area
R09	Recommended sewerage system	*3	Manual	Sewerage mgt. plan
R10	(Title)			
R11	Year/ Month that the report published		Manual	Report cover

\*1 Catchments, sub-catchments and sewerage planning units shall be arranged to show relationship between their locations.

For example, Kuala Terengganu is divided into Selatan and Utara, while the former is subdivided into Terengganu Town, Bukit Besar-K. Ibai and Chendering, while the latter is divided into Gong Badak and Seberang Takir, as shown in **Figure 6.1**. By clicking on the negative (-) mark in the square, the table can be changed to show

“subtotal” and/or” total (LA basis)”.

Description of sub-catchments may be suddenly subdivided into multiple CSTP areas. In such cases, the individual CSTP system should be shown as an independent system on the Excel worksheet with the requisite information to the extent possible. As stated earlier, it is not fair to compare sewerage systems dealing with multiple CSTP systems to single CSTP system on equal basis.

Click here

	P	DH	DI	DJ	DK	DL	DM	DN	DO
4	State	Terengganu	Terengganu	Terengganu	Terengganu	Terengganu	Terengganu	Terengganu	Terengganu
5	Catchment	K. Terengganu Selatan	K. Terengganu Selatan	K. Terengganu Selatan	K. Terengganu Selatan	K. Terengganu Utara	K. Terengganu Utara	K. Terengganu Utara	K. Terengganu
6	Sub-catchment	K. Terengganu Town	Bukit Besar-K. Ibai	Chendering	Sub-total	Gong Badak	Seberang Takir	Sub-total	Total (sewerage)
8	Major municipalities involved	MP K. Terengganu	MP K. Terengganu	MP K. Terengganu	MP K. Terengganu	MP K. Terengganu	MP K. Terengganu	MP K. Terengganu	MP K. Terengganu
9		1 CSTP	1 CSTP	1 CSTP	3 CSTPs	1 CSTP	1 CSTP	2 CSTPs	5 CSTPs
10	Planning Fundamentals								
11	** Year of report completion	2007/04	2007/04	2007/04	2007/04	2007/04	2007/04	2007/04	2007/04
12	** No. of municipalities involved								
13	** Area to be sewered								
14	** Base year	2005	2005	2005	2005	2005	2005	2005	2005
15	** Present population	42,039	54,814	11,607	108,480	83,035	11,314	74,349	18,000
16	** Present PE	75,629	65,029	13,925	154,563	83,241	15,800	99,041	25,000
17	** Target year	2020	2020	2020	2020	2020	2020	2020	2020
18	** Design Population	50,337	97,107	16,454	169,908	105,715	16,048	121,763	29,000
19	** Design PE for sewage treatment	100,617	119,828	16,561	236,406	107,600	21,000	128,830	36,000
20	** Target year	2,035	2,035	2,035	2,035	2,035	2,035	2,035	2,035
21	** Design Population								
22	** Design PE for sewage treatment	115,976	158,914	18,725	292,615	138,603	27,991	167,584	48,000
23	** Design residential PE								

	P	DK	DN	DO	DV	DZ	EO	ED	EE
4	State	Terengganu	Terengganu	Terengganu	Terengganu	Terengganu	Terengganu	Terengganu	Terengganu
5	Catchment	K. Terengganu Selatan	K. Terengganu Utara	K. Terengganu	P. Redang & P. lang Tengah	Cukai	Teluk Kalang	Teluk Kalang	Teluk Kalang
6	Sub-catchment	Sub-total	Sub-total	Total (sewerage)	Total (sewerage)	Sub-total	Sub-total	Teluk Kalang 3	Sub-total
8	Major municipalities involved	MP K. Terengganu	MP K. Terengganu	MP K. Terengganu	MP K. Terengganu	MD Kemaman	MD Kemaman	MD Kemaman	MD Kemaman
9		3 CSTPs	2 CSTPs	5 CSTPs	3 CSTPs + MP		1 CSTP	1 CSTP	
10	Planning Fundamentals								
11	** Year of report completion	2007/04	2007/04	2007/04	2007/03	2001/08	2001/08	2001/08	2001/08
12	** No. of municipalities involved					1	1	1	1
13	** Area to be sewered				2,812				
14	** Base year	2005	2005	2005	2005	2000	2000	2000	2000
15	** Present population	108,460	74,349	162,969	1,845	75,079	7,536	0	14,000
16	** Present PE	154,563	99,041	253,604	8,882	80,590	15,480	0	34,000
17	** Target year	2020	2020	2020	2020	2020	2020	2020	2020
18	** Design Population	169,908	121,763	291,671	3,757	148,622	29,103	1,870	46,000
19	** Design PE for sewage treatment	236,406	128,830	365,236	26,991	171,144	40,165	3,930	94,000
20	** Target year	2,035	2,035	2,035					
21	** Design Population								
22	** Design PE for sewage treatment	292,615	167,584	460,259					
23	** Design residential PE				4,699	136,351	21,620	1,760	41,000

Figure 6.1 Method for Expressing Composition of Catchments/Sub-catchments

When the construction cost is shown only as the subtotal for Selatan, the row “subtotal” is necessary, but would not be necessary when the construction cost by sub-catchment is given. It should be noted that the subtotal is not always

calculated through simple addition.

- \*2 When the data by sub-catchment cannot be obtained, or the sub-catchment data cannot be interpolated from the overall data, the overall data may be assigned to each sub-catchment as shared data. We must note the principle, “No data, no score”.

- \*3 The recommended sewerage system can be described as follows:

On-site	On-site treatment by ISTs or pour flush latrines
MP	Multi-point system in which development is entrusted to private developers
1 CSTP	Sewerage system with one centralized sewage treatment plant with which other existing STPs are consolidated.
2 CSTPs	Sewerage system with two centralized sewage treatment plants with which other existing STPs are consolidated.
2 CSTPs + MP	Combination of a multi-point system and a sewerage system with two centralized sewage treatment plants

When there is more than one CSTP, data for each CSTP system should be provided in a separate column to the extent possible.

This data is required to review conditions when prioritising sewerage catchments/projects it would not be fair to compare a system with one CSTP to a system with two CSTPs.

## (2) Design Fundamentals

Row No.	Particular	Note	Data input	Data source
R12	Area to be sewered	*4	Manual	General
R13	Base year	*5	Manual	Population and design PE projection
R14	Population in the base year		Manual	-ditto-
R15	Design PE in the base year		Manual	-ditto-
R16	Target year	*6	Manual	-ditto-
R17	Planned population in the target year		Manual	-ditto-
R18	Design PE in the target year		Manual	-ditto-
R19	Final year		Manual	-ditto-
R20	Planned population in the final year		Manual	-ditto-
R21	Design PE in the final year		Manual	-ditto-

- \*4 The area to be served refers to the area in which a sewer system will actually be

provided, but not the study area, which may include undeveloped areas, and IST or pour flush latrine area. This data is not given in most existing reports, but it is essential to develop new indicators such as construction cost per hectare, average sewer length per hectare, design PE per hectare, etc. in the future. The construction cost of the sewer network can be estimated by multiplying an area by the construction cost per hectare.

- \*5 The base year refers to the year closest to the year in which the report was completed, when the planned population is given in the table below (2005 in the example below).

Year	2005	2010	2015	2020	2025	2030	2035
Population	76,024	91,989	110,847	133,016	158,281	186,781	218,534

- \*6 The target year refers to the fiscal year set to prioritise sewerage catchments/projects, but is not the final year in the report (2035 in the above example). Recent reports mostly have a final year of 2035, but old reports set a target year of 2020 and this report has a target year at 2020 for trial application of the proposed handbook.

It is advisable that planned population and PE be recorded at five-year intervals by a final year after 2020, as it not known what target year will be used for comparison in the future.

The census will be conducted around 2010 and it will be important to compare the planned population in the existing reports with the census population. Existing reports show a tendency to overestimate populations.

### (3) PE by Usage and Design Sewage Flow

Row No.	Particular	Note	Data input	Data source
R22	Residential design PE	*7	Manual	Appendix
R23	Commercial and industrial design PE	*7	Manual	-ditto-
R24	Design PE / planned population rate	*8	Auto- calc (below Table)	
R25	Design PE / present PE rate	*8	-ditto-	
R26	Average sewage flow in dry weather	*9	-ditto-	Estimated sewage flow
R27	Average sewage flow in wet weather	*9	Manual	-ditto-
R28	Peak sewage flow in wet weather	*9	Auto- calc (Table below)	-ditto-

Row No.	Equation used in the Excel worksheet
R24	= [ R18 ] / [ R17 ]
R25	= [ R18 ] / [ R15 ]
R26	= [ R18 ] × [ B9 ] / 1,000
R28	= 4.7 × ( [ R18 ] × 1,000 ) ^ (-0.11) × ( [ R18 ] × [ B9 ] / 1,000 )

The shaded cell indicates the default value (see **Table 8.1**).

IF functions are often used in the actual equations to make various determinations, but they are omitted from the equations in the above table.

- \*7 The residential design PE and commercial and industrial design PE can be obtained from the design PE projection by land use. However, few reports provide a summary of design PE by land use, and much of this data is provided in the appendices.
- \*8 Design PE / present PE rate and Design PE / present PE rate are used to confirm that the design PE is reasonable.
- \*9 Average sewage flow in dry weather, average sewage flow in wet weather and peak sewage flow in wet weather are calculated to develop new indicators such as construction cost per cubic meter of sewage flow. In the present case, the per PE sewage design flow is 225 liters by the Malaysian Standard, which is not very significant.

#### (4) Sludge Treatment (Not Applied)

Row No.	Particular	Note	Data input	Data source
R29	Location for sludge treatment	*10	Manual	Sludge mgt plan
R30	Design PE for sewage sludge		Manual	--ditto--
R31	Planned volume of sewage sludge		Manual	--ditto--
R32	Planned dry solids in sewage sludge		Manual	--ditto--
R33	IST planned sludge volume		Manual	--ditto--
R34	Planned dry solids in IST sludge		Manual	--ditto--
R35	Type of final sludge	*11	Manual	--ditto--
R36	Moisture content of final sludge for disposal		Manual	--ditto--

- \*10 The location for sewage sludge treatment must be checked in the sludge management plan. The options for input data are “at the STP site (STP)”, “at the CSTF site (CSTF)” or “other place (Other)”.
- \*11 The options for input data on “type of final sludge” are “raw sludge (Raw)”, “thickened sludge (Thickened)” or “dewatered sludge (Dewatered)”.

## (5) Construction Cost by Phase

Row No.	Particular	Note	Data input	Data source
R37	Phase 1 construction period		Manual	Project impl. programme
R38	Phase 2 construction period		-ditto-	-ditto-
R39	Phase 1 construction cost		-ditto-	-ditto-
R40	Phase 2 construction cost		-ditto-	-ditto-

## (6) Overall Project Cost

Row No.	Particular	Note	Data input	Data source
R41	Land cost		Manual	Cost estimation
R42	Construction cost for sewers		-ditto-	-ditto-
R43	Construction cost for pump stations		-ditto-	-ditto-
R44	Construction cost for STPs		-ditto-	-ditto-
R45	Construction cost		-ditto-	-ditto-
R46	Annual O&M cost		-ditto-	-ditto-
R47	Per PE construction cost		Auto-calc (Table below)	-ditto-
R48	Per PE annual O&M cost		-ditto-	-ditto-
R49	Duration period for NPV calculation		Manual	-ditto-
R50	NPV of construction cost at an annual interest rate of 8.0%		-ditto-	-ditto-
R51	NPV of O&M cost at an annual interest rate of 8.0%		-ditto-	-ditto-
R52	Total NPV		Auto-calc (Table below)	-ditto-
R53	Per PE NPV		-ditto-	-ditto-

Row No.	Equation used in the Excel worksheet
R47	$= [ R45 ] \times 1,000,000 / [ R18 ]$
R48	$= [ R46 ] \times 1,000,000 / [ R18 ]$
R52	$= [ R50 ] + [ R51 ]$
R53	$= [ R52 ] \times 1,000,000 / [ R18 ]$

## (7) Importance of Area

Row No.	Particular	Note	Data input	Data source
R55	Population growth rate	*12	Auto-calc (Table below)	
R56	Design PE density		-ditto-	
R57	Growth rate of design PE		-ditto-	
R58	Planned population		-ditto-	
R59	Residential PE / Total PE rate		-ditto-	
R60	Commercial & industrial PE / Total PE rate		-ditto-	
R61	No. of guests by locality	*13	Manual	MOT (Table 6.1)

Row No.	Equation used in the EXCEL worksheet
R55	$= (10^{(\log([R17]/[R14]), 10)} / ([R16]/[R13])) - 1 \times 100$
R56	$= [R18] / [R12]$
R57	$= (10^{(\log([R18]/[R15]), 10)} / ([R16]/[R13])) - 1 \times 100$
R58	$= [R18]$
R59	$= [R22] / [R18] \times 100$
R60	$= [R23] / [R18] \times 100$

\*12 In the CSRs, the planned population is often projected by dividing the period by the target year and changing the population growth rate, but this Manual uses the average population growth rate between the base year and the target year.

\*13 **Table 6.1** was obtained from the website of the Ministry of Tourism (TOR), which has been simplified to give the number of hotel guests by province. The Ministry of Tourism should be asked about the latest publication showing the number of hotel guests by locality, if necessary.

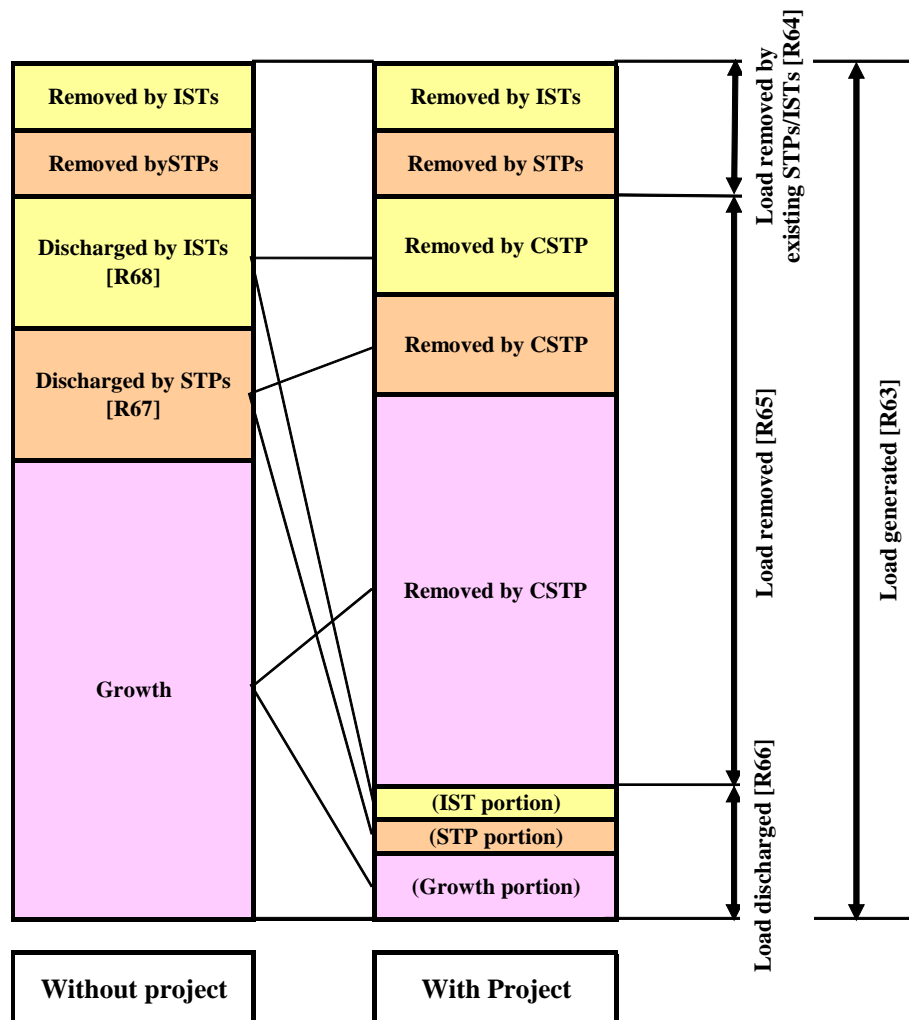
[http://www.tourism.gov.my/corporate/research.asp?page=facts\\_figures](http://www.tourism.gov.my/corporate/research.asp?page=facts_figures)

Table 6.1 Hotel Guests by Locality

BY LOCALITY	DOMESTIC			FOREIGNER			TOTAL		
	2006	2007	2007/2006	2006	2007	2007/2006	2006	2007	2007/2006
<b>KUALA LUMPUR</b>	<b>6,999,802</b>	<b>7,963,280</b>	<b>13.76</b>	<b>8,012,219</b>	<b>8,632,466</b>	<b>7.74</b>	<b>15,012,021</b>	<b>16,595,746</b>	<b>10.55</b>
<b>PUTRAJAYA</b>	<b>42,778</b>	<b>81,793</b>	<b>91.20</b>	<b>45,575</b>	<b>88,535</b>	<b>94.26</b>	<b>88,352</b>	<b>170,328</b>	<b>92.78</b>
<b>SELANGOR</b>	<b>1,626,445</b>	<b>2,021,491</b>	<b>24.29</b>	<b>1,505,614</b>	<b>1,783,343</b>	<b>18.45</b>	<b>3,132,059</b>	<b>3,804,834</b>	<b>21.48</b>
Petaling Jaya	428,617	550,615	28.46	672,039	782,133	16.38	1,100,656	1,332,748	21.09
Subang	181,726	230,332	26.75	151,362	184,107	21.63	333,088	414,439	24.42
Shah Alam	191,683	216,647	13.02	137,984	113,152	(18.00)	329,667	329,799	0.04
Sepang	134,832	256,509	90.24	302,264	397,196	31.41	437,096	653,705	49.56
Others Selangor	689,587	767,388	11.28	241,965	306,755	26.78	931,552	1,074,143	15.31
<b>PENANG</b>	<b>2,562,978</b>	<b>2,787,260</b>	<b>8.75</b>	<b>2,125,526</b>	<b>2,399,351</b>	<b>12.88</b>	<b>4,688,504</b>	<b>5,186,611</b>	<b>10.62</b>
Georgetown	1,870,861	2,009,090	7.39	1,252,013	1,432,082	14.38	3,122,874	3,441,172	10.19
Batu Feringghi	206,867	253,860	22.72	531,628	549,755	3.41	738,495	803,615	8.82
Tg Bungah	201,194	226,146	12.40	167,947	225,465	34.25	369,141	451,611	22.34
Others Penang	284,055	298,164	4.97	173,938	192,049	10.41	457,994	490,213	7.03
<b>PERAK</b>	<b>1,551,336</b>	<b>1,769,095</b>	<b>14.04</b>	<b>608,752</b>	<b>663,859</b>	<b>9.05</b>	<b>2,160,088</b>	<b>2,432,954</b>	<b>12.63</b>
Ipoh	689,650	756,940	9.76	150,758	168,785	11.96	840,408	925,725	10.15
Pulau Pangkor	378,006	454,493	20.23	314,544	334,009	6.19	692,550	788,502	13.85
Lumut	203,054	230,890	13.71	114,441	121,522	6.19	317,496	352,412	11.00
Others Perak	280,627	326,772	16.44	29,009	39,543	36.32	309,635	366,315	18.31
<b>KEDAH</b>	<b>2,563,814</b>	<b>2,648,636</b>	<b>3.31</b>	<b>1,502,248</b>	<b>1,879,809</b>	<b>25.13</b>	<b>4,066,062</b>	<b>4,528,445</b>	<b>11.37</b>
Alor Setar	534,106	449,416	(15.86)	33,352	60,431	81.19	567,457	509,847	(10.15)
Sungai Petani	331,954	300,038	(9.61)	68,243	109,684	60.73	400,197	409,722	2.38
Langkawi	1,637,457	1,812,002	10.66	1,344,188	1,614,424	20.10	2,981,646	3,426,426	14.92
Others Kedah	60,297	87,180	44.58	56,465	95,270	68.72	116,762	182,450	56.26
<b>PERLIS</b>	<b>83,934</b>	<b>90,972</b>	<b>8.39</b>	<b>14,469</b>	<b>15,166</b>	<b>4.82</b>	<b>98,402</b>	<b>106,138</b>	<b>7.86</b>
<b>N. SEMBILAN</b>	<b>1,218,661</b>	<b>1,220,277</b>	<b>0.13</b>	<b>327,676</b>	<b>405,803</b>	<b>23.84</b>	<b>1,546,337</b>	<b>1,626,080</b>	<b>5.16</b>
Seremban	175,770	171,272	(2.56)	70,352	107,070	52.19	246,122	278,342	13.09
Port Dickson	984,420	996,647	1.24	242,883	268,249	10.44	1,227,304	1,264,896	3.06
Others NS	58,471	52,358	(10.45)	14,441	30,484	111.09	72,912	82,842	13.62
<b>MELAKA</b>	<b>1,532,580</b>	<b>1,764,465</b>	<b>15.13</b>	<b>1,311,057</b>	<b>1,512,941</b>	<b>15.40</b>	<b>2,843,637</b>	<b>3,277,406</b>	<b>15.25</b>
Bandar Melaka	1,327,757	1,532,017	15.38	1,090,338	1,254,840	15.09	2,418,095	2,786,857	15.25
Ayer Keroh	158,757	164,081	3.35	165,187	185,181	12.10	323,944	349,262	7.82
Others Melaka	46,066	68,367	48.41	55,532	72,920	31.31	101,598	141,287	39.06
<b>JOHOR</b>	<b>2,036,812</b>	<b>2,566,144</b>	<b>25.99</b>	<b>962,862</b>	<b>1,206,842</b>	<b>25.34</b>	<b>2,999,674</b>	<b>3,772,986</b>	<b>25.78</b>
Johor Bahru	1,518,899	1,734,075	14.17	743,891	911,443	22.52	2,262,790	2,645,518	16.91
Kota Tinggi	176,105	152,426	(13.45)	83,358	103,979	24.74	259,463	256,405	(1.18)
Mersing	111,898	118,323	5.74	96,025	93,369	(2.77)	207,923	211,692	1.81
Others Johor	229,910	561,320	144.15	39,589	98,051	147.67	269,499	659,371	144.67
<b>PAHANG</b>	<b>3,607,340</b>	<b>4,461,258</b>	<b>23.67</b>	<b>2,521,562</b>	<b>2,904,680</b>	<b>15.19</b>	<b>6,128,902</b>	<b>7,365,938</b>	<b>20.18</b>
Kuantan	1,371,381	1,467,373	7.00	297,362	337,569	13.52	1,668,743	1,804,942	8.16
Genting Highlands	1,480,587	2,164,704	46.21	1,987,476	2,227,093	12.06	3,468,063	4,391,797	26.64
Cameron Highlands	419,000	444,092	5.99	118,100	178,733	51.34	537,100	622,825	15.96
Fraser Hills	54,691	47,893	(12.43)	15,651	14,553	(7.02)	70,342	62,446	(11.23)
Jerantut	31,030	36,676	18.19	18,014	31,423	74.44	49,044	68,099	38.85
Kuala Lipis	49,527	58,552	18.22	7,933	14,375	81.22	57,459	72,927	26.92
Others Pahang	201,124	241,968	20.31	77,026	100,934	31.04	278,150	342,902	23.28
<b>TERENGGANU</b>	<b>1,028,265</b>	<b>1,018,426</b>	<b>(0.96)</b>	<b>139,422</b>	<b>150,325</b>	<b>7.82</b>	<b>1,167,687</b>	<b>1,168,751</b>	<b>0.09</b>
Kuala Terengganu	696,843	639,950	(8.16)	84,526	87,404	3.40	781,369	727,354	(6.91)
Kemaman	69,114	81,963	18.59	21,877	23,333	6.66	90,991	105,296	15.72
Others Terengganu	262,307	296,513	13.04	33,019	39,588	19.89	295,326	336,101	13.81
<b>KELANTAN</b>	<b>690,178</b>	<b>766,326</b>	<b>11.03</b>	<b>79,886</b>	<b>84,611</b>	<b>5.91</b>	<b>770,065</b>	<b>850,937</b>	<b>10.50</b>
Kota Bharu	598,199	667,394	11.57	76,093	79,904	5.01	674,292	747,298	10.83
Others Kelantan	91,979	98,932	7.56	3,794	4,707	24.07	95,773	103,639	8.21
<b>PENINSULA MALAYSIA</b>	<b>25,544,923</b>	<b>29,159,423</b>	<b>238.73</b>	<b>19,156,868</b>	<b>21,727,731</b>	<b>265.83</b>	<b>44,701,790</b>	<b>50,887,154</b>	<b>244.25</b>
<b>SABAH</b>	<b>3,032,389</b>	<b>3,506,933</b>	<b>15.65</b>	<b>2,357,487</b>	<b>2,662,056</b>	<b>12.92</b>	<b>5,389,876</b>	<b>6,168,989</b>	<b>14.46</b>
Kota Kinabalu	2,050,336	2,467,661	20.35	2,159,887	2,449,852	13.42	4,210,223	4,917,513	16.80
Sandakan	288,346	323,648	12.24	52,474	60,595	15.48	340,820	384,243	12.74
Others Sabah	693,707	715,624	3.16	145,126	151,609	4.47	838,833	867,233	3.39
<b>LABUAN F.T</b>	<b>212,711</b>	<b>251,493</b>	<b>18.23</b>	<b>68,169</b>	<b>88,117</b>	<b>29.26</b>	<b>280,880</b>	<b>339,610</b>	<b>20.91</b>
<b>SARAWAK</b>	<b>3,110,467</b>	<b>3,335,740</b>	<b>7.24</b>	<b>874,808</b>	<b>916,708</b>	<b>4.79</b>	<b>3,985,275</b>	<b>4,252,448</b>	<b>6.70</b>
Kuching	1,134,394	1,236,048	8.96	504,458	511,351	1.37	1,638,851	1,747,399	6.62
Miri	1,132,937	1,222,615	7.92	245,855	265,402	7.95	1,378,792	1,488,017	7.92
Others Sarawak	843,136	877,077	4.03	124,495	139,955	12.42	967,631	1,017,032	5.11
<b>GRAND TOTAL</b>	<b>31,900,490</b>	<b>36,253,589</b>	<b>279.85</b>	<b>22,457,332</b>	<b>25,394,612</b>	<b>312.80</b>	<b>54,357,821</b>	<b>61,648,201</b>	<b>286.32</b>

(8) BOD<sub>5</sub> Pollution Load Generated

Row No.	Particular	Note	Data input	Data source
R63	Pollution load generated	<b>Fig. 6.2</b>	Auto-calc (Table below)	
R64	Pollution load removed by existing STPs/ISTs	-ditto-	-ditto-	
R65	Pollution load additionally removed by CSTP	-ditto-	-ditto-	
R66	Pollution load discharged after project impl.	-ditto-	-ditto-	
R67	Pollution load discharged from existing STPs	-ditto-	Separate-calc ( <b>Fig. 5.6</b> ), manual	
R68	Pollution load discharged from existing ISTs	-ditto-	Auto-calc (Table below)	

**Figure 6.2 Definition of Sludge**

The BOD<sub>5</sub> pollution load discharged from existing STPs is calculated individually using **Table 8.3**.

Row No.	Equation used in the EXCEL worksheet
R63	= [ R18 ] × [ B10 ] / 1000000
R64	= [ R86 ] × [ B10 ] / 1000000 - [ R67 ] + [ R88 ] × [ B10 ] / 1000000 - [ R68 ]
R65	= [ R63 ] - [ R64 ] - [ R66 ]
R66	= [ R18 ] × [ B9 ] / 1000000 × [ B13 ]
R68	= [ R88 ] × [ B12 ] × [ B9 ] / 1000000

**Table 6.2 Water Quality of Sewage Effluent by Treatment Process from Existing STPs**

Treatment Process		BOD <sub>5</sub>	COD	NH <sub>3</sub> -N	O&G	SS
Aerated Lagoon (AL)	Average	24.6	90.1	17.7	6.0	43.4
	Std. dev.	16.7	47.7	10.5	4.9	28.8
	No. of data	1934	1,934	1,933	537	1,933
Activated Sludge (AS)	Average	16.2	65.0	16.2	4.8	27.3
	Std. dev.	20.1	53.4	12.9	4.9	29.5
	No. of data	44,191	44,177	43,988	9,433	44,184
Bio Drum (BD)	Average	26.7	81.1	21.8	2.5	32.7
	Std. dev.	15.1	43.2	6.7	1.4	18.5
	No. of data	204	204	204	112	204
Bio Filter (BF)	Average	43.5	120.5	25.9	10.5	46.6
	Std. dev.	44.2	86.7	13.6	9.9	43.9
	No. of data	933	932	913	292	936
Bio Soil (BS)	Average	72.9	183.5	32.5	13.2	63.8
	Std. dev.	58.0	112.0	16.7	12.9	51.9
	No. of data	197	197	19	77	197
Communal Septic Tank (CST)	Average	66.5	158.9	28.3	7.9	54.5
	Std. dev.	71.9	133.3	37.8	30.6	66.8
	No. of data	1,419	1,404	1,164	890	1,419
Imhoff Tank (IT)	Average	36.1	99.2	26.2	6.2	34.0
	Std. dev.	37.3	82.1	16.1	6.5	35.1
	No. of data	4,658	4,650	4,404	1,828	4,642
Oxidation Pond (OP)	Average	29.3	105.7	16.5	5.5	50.4
	Std. dev.	22.2	59.1	10.0	4.3	33.0
	No. of data	4,503	4,502	4,502	1,224	4,501
Rotating Biological Contactor (RBC)	Average	33.3	100.1	17.8	5.9	37.3
	Std. dev.	38.7	87.8	14.1	5.7	38.4
	No. of data	258	258	259	76	257
Trickling Filter (TF)	Average	22.0	68.0	15.0	3.0	29.0
	Std. dev.	22.1	55.7	11.9	3.7	31.6
	No. of data	268	267	265	137	268
Upward Flow Anaerobic Sludge Blanket (UASB)	Average	91.5	228.8	31.9	10.9	82.5
	Std. dev.	73.4	157.6	16.8	7.0	64.5
	No. of data	54	58	57	14	60

Source: Calculated by the JICA Study Team based on water quality data provided by IWK

## (9) Pollution Situation of the Receiving Water Body

Row No.	Particular	Note	Data input	Data source
R70	DOE monitoring station	*14	Manual	
R71	Sewage effluent discharge standard A/B		-ditto-	
R72	BOD <sub>5</sub> SI	*15	-ditto-	
R73	NH <sub>3</sub> -N SI	*15	-ditto-	
R74	River name		-ditto-	
R75	Classification of river by use and purpose	*16	-ditto-	

\*14 The code for the DOE monitoring station is entered.

\*15 The equation used to calculate the Water Quality Index (WQI) is made up of six parameters such as DO, BOD<sub>5</sub>, COD, NH<sub>3</sub>-N, SS and pH, but it does not closely reflect the water pollution status caused by residential sewage, since COD and pH are affected by the inflow of industrial wastewater. For this reason sub-indicators for BOD<sub>5</sub> and NH<sub>3</sub>-N are adopted because they closely reflect water pollution status caused by residential sewage, which are calculated using the equation below.

Water Quality Index (WQI)

$$\text{WQI} = 0.22 \times \text{SIDO} + 0.19 \times \text{SIBOD} + 0.16 \times \text{SICOD} + 0.15 \times \text{SIAN} + 0.16 \times \text{SISS} + 0.12 \times \text{SIPH}$$

Sub-index for BOD

$$\begin{aligned} \text{SIBOD} &= 100.4 - 4.23 x && \text{for } x \leq 5 \\ &= 108 e^{-0.055 x} - 0.1 x && \text{for } x > 5 \end{aligned}$$

Sub-index for AN

$$\begin{aligned} \text{SIAN} &= 100.5 - 105 x && \text{for } x \leq 0.3 \\ &= 94 e^{-0.573 x} - 5 x - 2 && \text{for } 0.3 < x < 4 \\ &= 0 && \text{for } x \geq 4 \end{aligned}$$

\*16 The classification of water pollution status of the river is based on **Table 6.3**.

**Table 6.3 Classification of Water Pollution Status of the River**

Parameters	Indicators		
	Clean (C)	Slightly polluted (SP)	Polluted (SP)
WQI	81 - 100	60 - 80	0 - 59
BOD <sub>5</sub> SI	91 - 100	80 - 90	0 - 79
NH <sub>3</sub> -N SI	92 - 100	71 - 91	0 - 70
SS SI	76 - 100	70 - 75	0 - 69

Source: DOE, "Malaysia Environmental Quality Report 2006"

## (10) Complaints from the Public on Existing STPs

Row No.	Particular	Note	Data input	Data source
R77	No. of complaints on existing STPs	*17	Manual	IWK
R78	No. of existing STPs		Manual	IWK

\*17 Complaints on existing STPs under IWK's O&M received by IWK are categorized into twelve items, of which seven items involving operational/functional issues are selected as targets for evaluation (see **Table 6.4**). The remaining five items—refencing, hole in fence, rubbish/pests, weed growth and trespassing—are excluded. The total number of complaints on existing STPs was 1,685 in 2007, of which 1,616 cases were concerned with operability and functionality.

**Table 6.4 Complaints Regarding Existing STPs under IWK O&M (2007)**

Category	No. of cases	Percentage (%)
Pump not working	1,124	69.5
Overflow	23	1.4
Odour	329	20.4
Noise	50	3.1
Damage	51	3.2
Damage (utility)	12	0.7
Outlet submerged	27	1.7
Total	1,616	100.0

## (10) Water Use Condition

Row No.	Particular	Note	Data input	Data source
R80	Total average water production at the downstream WTPs		Manual	Water supply operator
R81	Annual duration of water intake closure at the downstream WTPs		Manual	-ditto-
R82	No. of water intakes for irrigational use	*18	Manual	DID regional office
R83	Water pollution classification by WQI	*19	Manual	ASMA
R84	Water pollution status of the river	*20	Manual	ASMA

"Annual Malaysia Environmental Quality Report" can be downloaded at DOE's website.

\*18 The duration of water intake closure at the water treatment plants located at the Upper Langat Reach is shown in **Table 6.5** for 2007.

**Table 6.5 Duration of Water Intake Closures at the WIPs in the Upper Langat Reach**

WTP	Date	Duration of intake closure		Cause
Cheras Batu 11	February 12	14.5 hrs		High concentration of NH <sub>3</sub> -N
Bukit Tampoi		Old module	New module	
	February 5	7.6 hrs		Ditto
	February 6	267.0 hrs	252.0 hrs	Ditto
	March 13	38.75 hrs	39.75 hrs	Ditto

- \*19 The JICA study team conducted a survey on water intake points for irrigational use at 24 areas entrusted to ASMA. The replies from the concerned agencies included water intake amounts and/or irrigational area, but did not include data on coordinates, which led to a failure to identify the locational relationship between water intake points and discharge points of sewage effluent from proposed CSTPs. This may be a limitation in the questionnaire survey.

The best policy would be for the planner to call on the agencies concerned with maps used for planning and ask the officer to plot the location of water intake points during the study on catchment strategy.

- \*20 The National Water Quality Standards for Malaysia defines water classes and uses as shown in **Table 6.6**. Classes I or II are worthy of being conserved. The latest version of the “Malaysian Environmental Quality Report” is available at the DOE website and would be helpful in learning the classification of river water quality.

**Table 6.6 National Water Quality Standards for Malaysia**

Parameter	Unit	Class				
		I	II	III	IV	V
NH <sub>3</sub> -N	mg/l	< 0.1	0.1 - 0.3	0.3 - 0.9	0.9 - 2.7	> 2.7
BOD <sub>5</sub>	mg/l	< 1	1 - 3	3 - 6	6 - 12	> 12
COD	mg/l	< 10	10 - 25	25 - 50	50 - 100	> 100
DO	mg/l	> 7	5 - 7	3 - 5	1 - 3	< 1
pH	mg/l	> 7.0	6.0 - 7.0	5.0 - 6.0	< 5.0	> 5.0
SS	mg/l	< 25	25 - 50	50 - 150	150 - 300	> 300
WQI		> 92.7	76.5 - 92.7	51.9 - 76.5	31.0 - 51.9	< 31.0
Class IIA		Water supply II – conventional treatment required Fishery II – Sensitive aquatic species				
Class IIB		Recreational use with body contact				

## (11) Rationalisation of Existing STPs/ISTs

Row No.	Particular	Note	Data input	Data source
R86	Total design PE of existing STPs to be consolidated	*21	Separate-calc. (Fig. 5.6), Manual	
R87	No. of existing STPs to be consolidated	*21	-ditto-	
R88	Total design PE of existing ISTs to be connected to a public sewerage system	*22	Manual	
R89	No. of existing ISTs to be connected to a public sewerage system	*22	-ditto-	
R90	O&M manpower reduction at existing STPs	*21	Separate-calc. (Fig. 5.6), Manual	
R91	O&M manpower reduction at existing ISTs	*22	Auto-calc (Table below)	
R92	Total O&M manpower reduction		-ditto-	
R93	Total design PE of a growth area		-ditto-	
R94	Redundant land area after consolidation of existing STPs	*23	Separate-calc. (Fig. 5.6), Manual	
R95	PE consolidation rate		Auto-calculation	

Row No.	Equation used in the Excel worksheet
R91	= [ R89 ] / ( [ B15 ] × [ B16 ] ) × [ B17 ]
R92	= [ R91 ] + [ R92 ]
R93	= [ R18 ] - [ R86 ]
R95	= [ R86 ] / [ R18 ] × 100

\*21 The O&M manpower reduction at existing STPs is calculated by classifying the facilities by type and size and applying the O&M manpower requirement as shown in Table 6.7 and Figure 5.6. This is described in detail in Chapter 8.

**Table 6.7 O&M Manpower Requirement**

PE	0 – 500	500 - 2,000	2,000 - 10,000	10,000 - 20,000	20,000 - 50,000	50,000 -
CST	3 staff / 80 CST	3 staff / 40 CST		3 staff / 20 CST		
IT, OP, STP	3 staff / 20 STP (1 check/wk)	3 staff / 10 STP (2 check/wk)	3 staff / 4 STP (5 check/wk)	3 staff (daytime only)	9 staff* <sup>1</sup> (24 hours)	17 staff* <sup>2</sup> (24 hours)
NPS	3 staff / 20 NPS	3 staff / 10 NPS		3 staff / 3.34 NPS		3 staff / 2 NPS

This table is developed by the JICA study team taking into account the actual practice of IWKs O&M works, but the O&M staff requirement is set with some allowance.

CST: Communal Septic Tank, IT: Imhoff Tank, OP: Oxidation Pond, STP: Mechanized Sewerage Treatment Plant, NPS: Network Pumping Station

Notes: \*1. Staff is composed of 1 Manager, 2 Engineers and 6 Technicians

\*2. Staff is composed of 1 Manager, 4 Engineers and 12 Technicians

- \*22 When the total design PE for existing ISTs is given in the report, it is used in calculations as is. However, when it gives only the number of existing ISTs, its design PE is calculated by multiplying the number by 5 PE.

The O&M manpower reduction in IST desludging work is calculated based on the following achievement.

No. of workers per crew	2 persons
Annual operational days	312 days (Monday to Saturday)
Daily desludging work	10 units (8 to 10 units)

- \*23 The Guidelines for Developers Volume 4 “Sewage Treatment” gives the tables on land requirements for STP based on design PE size and treatment process. As the land area of a STP is decided so as to meet this requirement, the approximate equations are developed as shown in **Table 6.8** to calculate the rough land area of redundant STPs after consolidation in **Figure 5.6**.

Classes 1 to 6 in **Table 5.8** are based on the criteria in **Table 6.9**.

**Table 6.8 Equations to Calculate Approximate Land Area of Redundant STPs**

STP size	Sewage effluent discharge standard A	Sewage effluent discharge standard B
Class 1 & 2	$y = (0.00031 x^2 + 1.293 x + 134.6) / 10000$ $R^2 = 0.997$	
Class 3 - 6	$y = -5.13 \times 10^{-11} x^2 + 4.26 \times 10^{-5} x + 2.9$ $R^2 = 0.995$	$y = -4.48 \times 10^{-11} x^2 + 3.87 \times 10^{-5} x + 0.22$ $R^2 = 0.997$
OP & AL	$y = -1.05 \times 10^{-10} x^2 + 1.69 \times 10^{-4} x + 0.36$ $R^2 = 1.000$	$y = -1.17 \times 10^{-10} x^2 + 6.78 \times 10^{-5} x + 0.64$ $R^2 = 0.997$

y: Rough land area of a STP (ha) x: Design PE

OP: Stabilization Pond

AL: Aerated Lagoon

Note: These equations shall be applied to the STPs constructed before the enforcement of “Guidelines for Developers Volume 4”.

**Table 6.9 Classification of STP Size**

Classification	PE
Class 1	6 - 150
Class 2	151 - 2,000
Class 3	2,001 - 5,000
Class 4	5,001 - 10,000
Class 5	10,001 - 100,000
Class 6	> 100,000

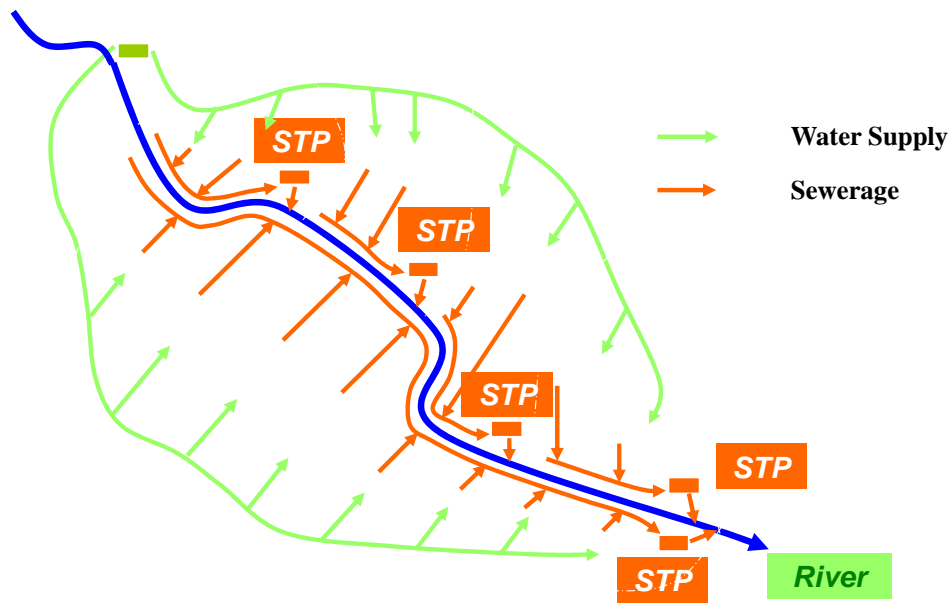
Since the data on existing STPs is only available in hard copy (report) at present, it takes a great deal of time to reproduce the Excel worksheet for further data processing through data scanning, transferring images into machine-editable text and data checking. Therefore, the following is suggested:

- 1) Request the consultants to submit electronic files providing the data on exiting STPs as well as design PE projection by land use for the past studies, if possible, and
- 2) Require that such an electronic file be submitted to the study's consultants in the Terms of Reference to for studies conducted in the future.

(12) Conservation of Local Water Cycle

Row No.	Particular	Note	Data input	Data source
R97	Study on conservation of local water cycle	*24	Manual	

- \*24 When water is taken upstream of an urban area to be used for the water supply and discharged downstream through sewerage provisions, the river flow may be so reduced at the span that the ecology in the river is threatened. In such a case, if an urban area is served by several STPs and sewage effluent is discharged into the river at several points, the river can keep the minimum flow to conserve its ecology. This is the concept of conservation of local water cycle as shown in **Figure 6.3**. Since such studies have not been done in any existing report, this concept is not applicable at present. However, such a study should be included in the Terms for Reference for the catchment strategy to be reviewed or conducted in future. The options for data input are "Yes" or "No".



**Figure 6.3 Concept of Local Water Cycle**

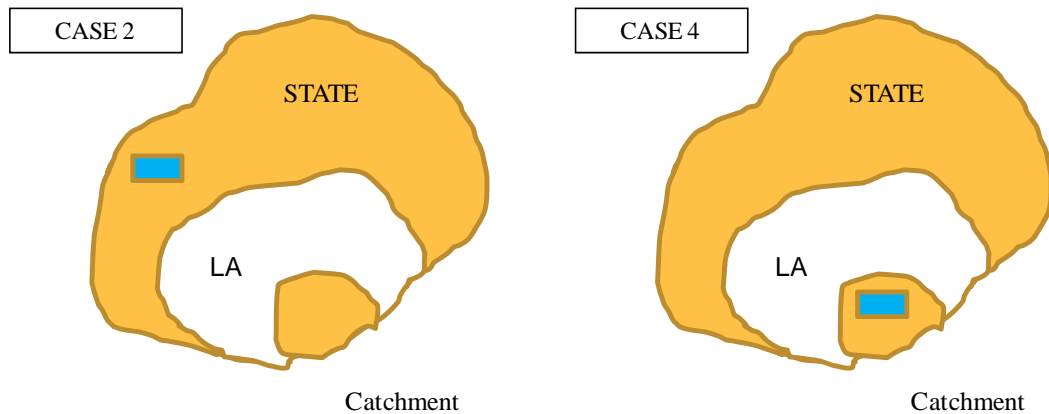
(13) First-time Work for Permanent CSTP

Row No.	Particular	Note	Data input	Data source
R100	First time works for permanent CSTP	*25	Optional	

\*25 Some STPs have already played a key role in urban areas regardless of whether they were constructed with government funds or by private developers, and have been accredited as permanent CSTPs. These facilities are expected to become part of the core sewerage facility in the future. It is essential that this kind of core facility be constructed in areas with no permanent CSTP. The (1) state, (2) local authority and (3) particular catchment are checked to determine whether a permanent CSTP has been built. There are four possible scenarios, as shown in **Table 6.10**.

**Table 6.10 Four Potential Scenarios for Existence of Permanent CSTP**

	State	Local Auth.	Catchment	Option for input data	Mark
Case 1	No	No	No	NNN	10
Case 2 (Fig. 6.4)	Yes	No	No	YNN	7
Case 3	Yes	Yes	No	YYN	4
Case 4 (Fig. 6.4)	Yes	Yes	Yes	YYY	1



**Figure 6.4 Existence of Permanent CSTP**

(14) Reliability of Project Implementation

Row No.	Particular	Note	Data input	Data source
R101	Outlook for STP site land acquisition	*26	Optional	

\*26 The categories for the various outlooks for land acquisition for a proposed CSTP site and the options for data input are as follows.

Categories (options for input data): "existing STP site (Existing STP)", "officially gazetted as STP site (Gazetted)", "public land (Public)", "private land with no resettlement (No Resettlement)" or "private land with no resettlement (Resettlement)".

When IWK has already acquired the land for a proposed SCSTP, it is handled as "Existing STP".

(15) Financial Viability

Row No.	Particular	Note	Data input	Data source
R103	NPV	*27	Separate-calc. (Ap. B), Manual	
R104	B/C ratio	*27	-ditto-	
R105	Per design PE NPV		Auto-calc. (Table below)	
R106	Construction cost per pollution load discharged		-ditto-	

Row No.	Equation used in the EXCEL worksheet
R105	$= [ R103 ] \times [ R18 ] / 1000000$
R106	$= [ R45 ] \times [ R63 ]$

- \*27 The NPV and B/C ratio are calculated using the supporting programme in **Appendix B**, which is developed to evaluate the financial viability of sewerage catchments/projects using data on investments, revenue, expenditures and the replacement cost of mechanical and electrical equipment. The major difference with the existing Guidelines Vol. 1 in calculating NPV is that the revenue and replacement cost of mechanical and electrical equipment are included in order to reflect the actual conditions as much as possible. This programme can also be used to calculate NPV for the selection of preferred options in the study of catchment strategy. When prioritising sewerage catchments/projects, the NPV obtained from the supporting programme is used to calculate NPV per design PE.

(17) Consideration for Special Conditions

Row No.	Particular	Note	Data input	Data source
R108	Involvement with national project area	*28		
R109	Biomass treatment at CSTP site	*29		
R110	Extension of a sewage effluent discharge pipe to the downstream of an water intake	*30		
R111	(Reserved)			

The options for input data are "Yes" or "No" in all cases.

- \*28 The national projects supposed here are as follows:  
 Iskandar regional development  
 Northern corridor economic region  
 Eastern economic corridor
- \*29 As the CSTP is expected to become the biggest sewage sludge production source in the area, it would not be economical to transfer sewage sludge to another place for treatment, except in the case of regional CSTF that collect sewage sludge from plural CSTPs. Given the importance of promoting sludge treatment at the same CSTP or CSTF site, such catchments/projects are evaluated positively.
- \*30 When a discharge pipe of sewage effluent from a proposed CSTP is extended to the area downstream of a water intake point for water supply or irrigational use in the plan, it is highly evaluated as an environmentally-friendly project.

## 7 Composition of Scoring Sheet

The scoring sheet is composed of seven tables from **Tables A to G** on the Excel worksheet, as shown in **Figure 5.3**. Each function is described in **Table 7.1**.

There are two options for point allocation criteria included in **Table B** as shown in **Figures 7.1 and 7.2**. In **Figure 7.1**, the point allocation criteria are set beforehand so that the points are allocated equally. For this reason, it is necessary to adjust the table for the point allocation criteria whenever there is an increase or decrease in the number of data. To avoid such a situation, as shown in **Figure 7.2**, an equation is embedded in each cell of the allocation chart so that the number of data and ranking of each data is calculated and the points are automatically allocated by spreading these ranks across percentages such as 0-20%, 20-40%, 40-60%, 60-80% and 80-100% from the top and to decide a mark. The appearance frequency of each point may not always be equal due to common data for catchments/sub-catchments or a bias in data distribution.

**Figure 7.3** shows the calculation flow among **Tables A to D** in **Figure 7.1** using the population growth rate as an example. In **Table A** the population growth rate is calculated at 3.8% from four data points for the base year, target year, present population and planned population. The point allocation criteria are applied to check the class and determine a point of 8, corresponding to the class in **Table B**, which is indicated in **Table C**. Then the two weighting in **Table B** are multiplied by the point to get a score of 4.8 in **Table D**.

In the flow of **Figure 7.2**, the scoring criteria in **Table B** are given as the results of automatic scoring.

**Figure 7.4** shows how to look at the point allocation criteria in **Table B**.

Point Allocation Criteria					Points				
1st class	2nd class	3rd class	4 th class	5th class	1st class	2nd class	3rd class	4 th class	5th class
4	3	2	1	Less	10	8	6	4	2
120000	80000	40000	20000	Less	10	8	6	4	2
1600000	800000	400000	200000	Less	10	8	6	4	2

Point allocation criteria	4	3	2	1	Less
Meaning of criteria	$X \geq 4$	$4 > X \geq 3$	$3 > X \geq 2$	$2 > X \geq 1$	$X < 1$
Point	10	8	6	4	2

**Figure 7.4 Point Allocation Criteria and Definitions**

**Table 7.1 Function of Tables on Scoring Sheet**

Table Field used	Description
Table O2:CZ111	<p>The data collected from existing catchment strategy reports (CSRs) or local sewerage plans (LSPs) is shown, composed of raw data and data calculated automatically using the equations embedded in the cells and transferred after separate calculation.</p> <p>The input data field is designated in the range of the columns R to CZ and one set of catchment/sub-catchment data is filled in one column. Therefore, <b>the maximum number of catchments/projects that can be compared at one time is eighty-seven (87)</b>. In other words, the tables on the Excel worksheet in <b>Figure 5.2</b> are designed assuming 87 sets of data. When increasing the maximum number of data, it is necessary to redesign tables and equations embedded in the cells</p>
Table B A112:M156	The data on the marking and scoring conditions such as two-step weighting, point allocation criteria and marks corresponding to criteria is kept by evaluation index.
Table C O112:CZ156	This table shows the marking results before weighting. The data in <b>Table A</b> are classified using the point allocation criteria and the marks are given based on such classification results.
Table D O157:CZ200	This table shows the scoring results after weighting. The marks in <b>Table C</b> are converted to scores using the weighting in <b>Table B</b> . There are two kinds of weighting data: data for evaluation indicators composing respective evaluation items, and data for evaluation items. The calculation of this two-step weighting is done once.
Table E H157:CZ200	This table summarises the appearance frequency of marks. Except for sub-indicators for BOD <sub>5</sub> and NH <sub>3</sub> -N, WQI, existence of a permanent CSTP, prospect of land acquisition for a proposed CSTP and consideration for special conditions, the appearance frequency of marks should be almost equal, but this may not always be possible due to biases in data distribution.
Table F O203:CZ22	In this table, the results in <b>Table D</b> are summarised by evaluation item.
Table G R230:BE440	<p>This table is the calculation sheet used to arrive at the point allocation criteria by calculating backwards when points are given automatically using equations by categorizing the data into five classes based on the ranking percentage from the top using the number of data and ranking of each data.</p> <p>The table is large due to the use of Excel functions (VLOOKUP and MATCH), but is created instantly by placing a cursor at <b>A1</b> and execute “Macro 8” and “Macro 9” continuously. This macro also assumes that the maximum number of data is eighty-seven (87).</p>

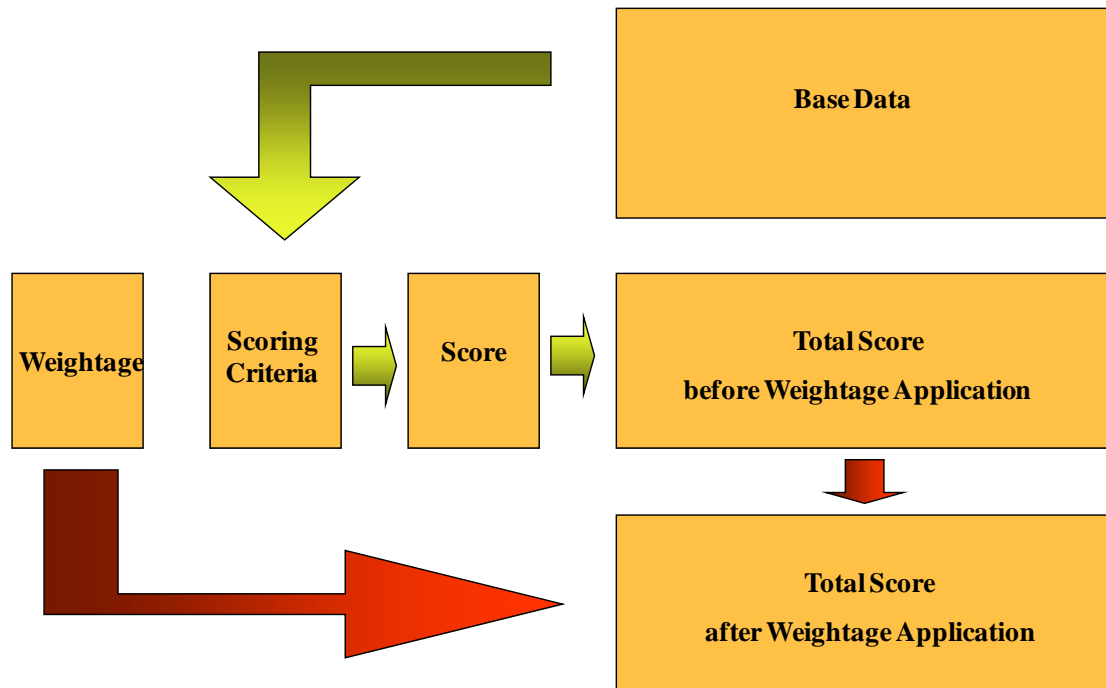


Figure 7.1 Example of Point Allocation Criteria Set in Advance

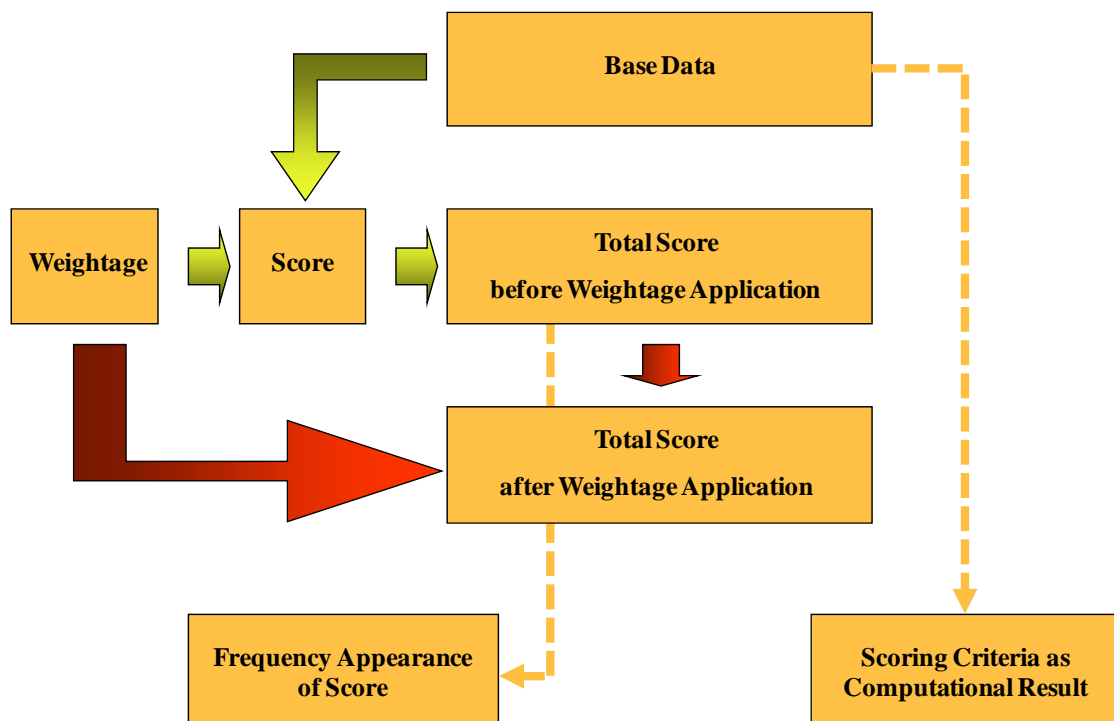


Figure 7.2 Example of Scoring Classification Criteria Generated by Calculation

**Figure 7.3 Calculation Flow among Tables A to D**

Number of ISTs desludged per day  
Annual working days  
No. of workers per crew for IST desludging  
Effluent BOD5 of IST (mg/L)  
Effluent BOD5 after sewerage provision (mg/L)  
Kuala Langat District Council and surrounding seven Mukims  
Not including IWK-operated STPs due to no information on catchment

Weightage(1)	Weightage(2)	Unit	Mark	Classification Criteria	Mark
15	40	%	4	3	2
40	person	120000	80000	40000	20000
20	person	1600000	800000	400000	200000
5	100	ton/day	10	7.5	5
15	60		79	90	More
40	40		70	91	More
5	100		NNN	YNN	YYN
10	100		Existing STP	Gazetted	Public
15	60	RM/PE	-40	-60	-80
40	40	mil RM/ton/day	20	14	10
5	100	Y/N	Yes	No	
100	900				

P	Q	BW	BY	BZ	CA
Catchment Strategy Report (CSR)		Upper Langat	Upper Langat	Upper Langat	Upper Langat
State		Cheras	Cheras	Kajang	Kajang
Catchment		Cheras	Cheras	Kajang	Kajang
Sub-catchment		Cheras Batu 11	Cheras Jaya	Kajang 1	Kajang 2
Sub-catchment zone					
Major municipalities involved		MP Kajang	MP Kajang	MP Kajang	MP Kajang
1 CSTP		1 CSTP	1 CSTP	1 CSTP	1 CSTP
Planning Fundamentals					
** Year of report completion		2008/07	2008/07	2008/07	2008/07
** No. of municipalities involved (nos.)		1	1	1	1
** Area to be sewered (ha)		23,900		16,200	3,300
** Base year		2005	2005	2005	2005
** Present population (nos.)		76,024	57,605	62,775	31,125
** Present PE (PE)		85,147	64,517	70,308	34,860
** Target year		2020	2020	2020	2020
** Design Population (nos.)		133,016	100,789	82,792	41,050
** Design PE for sewage treatment (PE)		129,377	106,264	90,177	40,800
Importance of city/area					
Growth rate of population (%)		3.8	3.8	1.9	1.9
Growth Rate of Population in Urban Area Involved (%)		8.3	8.3	8.3	8.3
Growth rate of Design PE (%)		2.8	3.4	1.7	1.1
Design population (nos.)		133,016	100,789	82,792	41,050
Rate of residential PE (%)					
Rate of commercial & industrial PE (%)					
Annual hotel guests (nos.)					
Importance of city/area					
Growth rate of population (%)		8.0	8.0	6.0	6.0
Design population (nos.)		8.0	6.0	6.0	4.0
Annual hotel guests (nos.)					
Pollution loads					
Total pollution loads generated		6.0	4.0	4.0	4.0
Water pollution status					
WQI(BOD5)		10.0	10.0	10.0	10.0
WQI(NH3-N)		10.0	10.0	10.0	10.0
Existence of permanent CSTP		10.0	10.0	10.0	10.0
Reliability of project implementation					
Prospective of land acquisition for STP site		8.0	8.0	4.0	10.0
Financial analysis					
NPV / design PE (RM/PE)		2.0	2.0	2.0	4.0
Construction cost / pollution load discharged (mil RM/ton/day)		2.0	2.0	2.0	4.0
Consideration for national projects					
Necessity for consideration					
Importance of city/area		9.6	8.4	7.2	6.0
Growth rate of population (%)		4.8	4.8	3.6	3.6
Design population (nos.)		4.8	3.6	3.6	2.4
Annual hotel guests (nos.)					
Pollution loads		3.0	2.0	2.0	2.0
Total pollution loads generated (ton/day)		3.0	2.0	2.0	2.0
Water pollution status		15.0	15.0	15.0	15.0
WQI(BOD5)		9.0	9.0	9.0	9.0
WQI(NH3-N)		6.0	6.0	6.0	6.0
Complaints from the public		4.0	3.5	3.5	3.0
Complaints on STPs (nos.)		2.0	2.0	2.0	2.0
No. of STPs (nos.)		2.0	1.5	1.5	1.0

## 8. Default Values

The following are the default values used in calculations.

**Table 8.1 Default Values Used in Figure 5.3**

Cell No.	Default value	Description
B9	225	Per PE sewage flow (L/capita/day)
B10	55	Per PE BOD <sub>5</sub> pollution load generated (g/capita/day)
B12	70	IST effluent BOD <sub>5</sub> concentration (mg/L)
B13	20	Sewage effluent BOD <sub>5</sub> concentration (mg/L) after project implementation
B16	10	Daily average IST desludging times per crew (times)
B17	312	Annual working days of IST desludging crew (days)
B18	2	No. of workers per IST desludging crew (nos.)

Weightings for evaluation items (%) and indicators (%), point allocation criteria and marks in **Figure 5.3** are set as default values, which can be changed if necessary, and can be used to check the way in which the prioritisation of sewerage catchments/projects changes when these values are changed.

**Figure 8.1** shows examples of weighting combinations for evaluation items. The maximum weighting and the maximum/minimum rate of 15% and 3 times, respectively, in the comprehensively balanced prioritisation of sewerage catchments/projects are shown in **Table 8.2**. In weighting according to prioritisation of important factors, the weighting of a specified evaluation items is raised to 30 % or 50% so as to heighten the maximum/minimum rate to 6 or 10 times, respectively, from the viewpoint of environmental considerations, consolidation of existing STPs and investment efficiency. Water pollution is evaluated for environmental considerations, the impact of consolidation for consolidation promotion and financial viability for investment efficiency. The comprehensively balanced prioritisation of sewerage catchments/projects is recommended, and prioritisation of important factors is intended to be used for specific purposes.

**Table 8.2 Examples of Weighting Combinations for Evaluation Items**

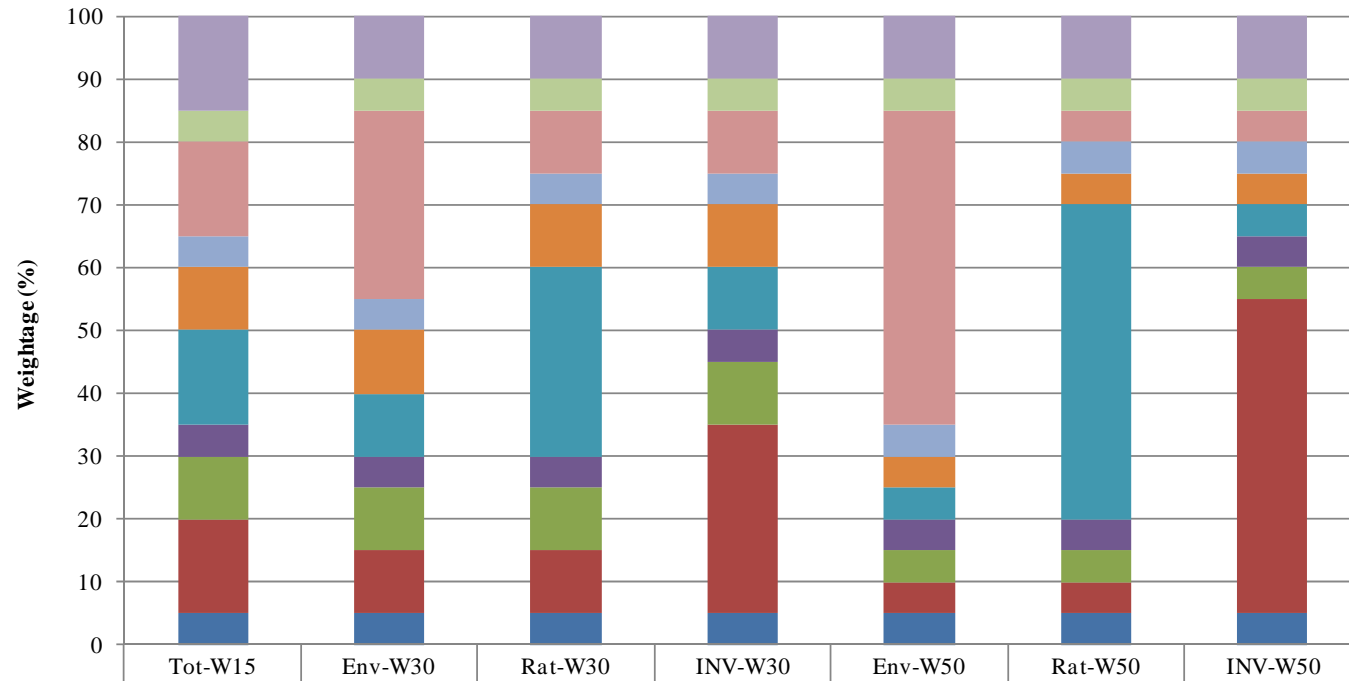
	Weighting				
	5%	10%	15%	30%	50%
Prioritisation on overall balance	4	2	4	-	-
Prioritisation of environmentally-friendly aspects 30%	4	5	-	1	-
Prioritisation of promotion of consolidation 30%	4	5	-	1	-
Prioritisation of investment efficiency 30%	4	5	-	1	-
Prioritisation on environmentally-friendly aspects 50%	8	1	-	-	1
Prioritisation of promotion of consolidation 50%	8	1	-	-	1
Prioritisation of investment efficiency 50%	8	1	-	-	1

The contents of O&M manpower requirement in **Table 6.7** are given as default values in **Figure 5.6** (grey portion).

In addition, the sewage effluent BOD<sub>5</sub> concentrations by treatment process, as shown in **Table 8.3**, are used as default values, developed from **Table 6.2**.

**Table 8.3 Sewage Effluent BOD<sub>5</sub> Concentrations by Treatment Process**

Code	Treatment process	Sewage effluent BOD <sub>5</sub> (mg/L)
AL	Aerated Lagoon	30
AS	Activated Sludge	20
BD	Bio Drum	30
BF	Bio Filter	50
BS	Bio Soil	80
CST	Communal Septic Tank	70
IT	Imhoff Tank	40
OP	Oxidation Pond	30
RBC	Rotating Biological Contactor	40
TF	Trickling Filter	30
UASB	Upward Flow Anaerobic Sludge Blanket	100

**Figure 8.1 Weightage Allocation by Prioritisation Type**

Importance of area	15	10	10	10	10	10	10
Pollution load	5	5	5	5	5	5	5
Water pollution status	15	30	10	10	50	5	5
Complaints of existing STPs	5	5	5	5	5	5	5
Beneficial water use	10	10	10	10	5	5	5
Rationalisation impact on existing STP/IST	15	10	30	10	5	50	5
Existence of permanent CSTP	5	5	5	5	5	5	5
Reliability of project implementation	10	10	10	10	5	5	5
Financial viability	15	10	10	30	5	5	50
Consideration for special conditions	5	5	5	5	5	5	5

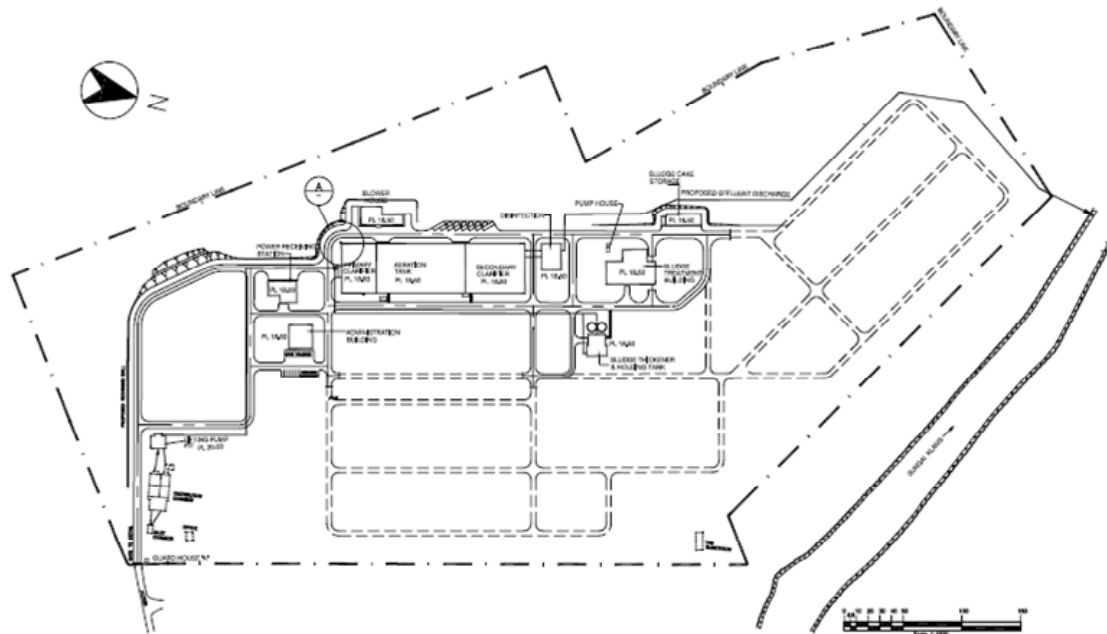
## 9 Prioritisation of Sewerage Catchments/Projects

The prioritisation of sewerage catchments as described thus far applies to the entire sewerage system to achieve the design PE in the target year. However, with the exception of small-scale sewerage systems, it is rare for the sewerage facility to be constructed at the full design PE from the start. Rather, one-third or one-fourth of the full design PE is usually constructed under a staged construction plan, as shown in **Figure 9.1**. As the extent of a service area is naturally reduced corresponding to the reduction of design PE (**Figure 9.2**), the data for the whole of a sewerage system is no longer used in prioritising sewerage projects. Such data includes the importance of an area (design population), BOD<sub>5</sub> pollution load generated, complaints on existing STPs from the public, rationalisation impact (O&M manpower reduction) and financial viability (construction cost) as shown in **Table 9.1**. Sewerage projects can be compared at implementation scale if this data can be provided.

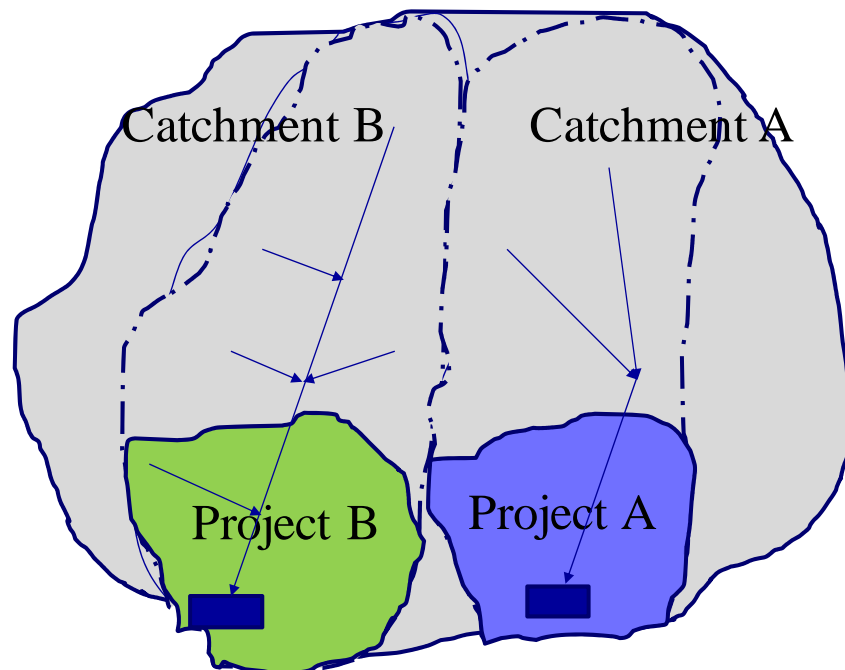
**Table 9.1 Data Required to Prioritise Sewerage Catchments/Projects**

Evaluation item	Catchments (Whole system)	Projects (for implementation)
Importance of area	×	×*
Pollution load generated	×	×*
Water pollution status	×	×
Complaints from the public	×	×*
Water use condition	×	×
Rationalisation impact	×	×*
First- time work of a permanent CSTP	×	×
Reliability of project implementation	×	×
Financial viability	×	×*
Consideration for special conditions	×	×

X\* Data should be given on the actual PE basis for implementation



**Figure 9.1 Example of Staged Construction (Puchon STP, Kuala Lumpur )**



**Figure 9.2 Reduction of Service Area under the Staged Construction**

## **APPENDIX A**

### **Excerpt from the Draft Final Report of “Sewerage Catchment Planning and Sludge Management Strategy Study for Upper Langat River Basin”**

**(Prepared by Antara Jurutera Perunding Sdn Bhd in July 2008)**

### 3. Population Equivalent

The total projected PE for the study area consisting of residential area, commercial and industrial area is 2.75 million by the year 2035, as shown below.

**Projected PE of Upper Langat**

Sub-Catchment	2005	2010	2015	2020	2025	2030	2035
Bangi Lama	55,833	64,670	73,507	82,344	91,181	100,019	108,856
BBB North	103,799	112,574	121,349	130,124	138,899	147,674	156,450
BBB South	151,569	216,554	281,538	346,523	411,507	476,492	541,476
Beranang	18,960	58,004	97,048	136,092	175,136	214,180	253,224
Cheras Bt 11	85,147	106,810	128,474	150,138	171,801	193,465	215,129
Cheras East	83,353	110,690	138,027	165,364	192,701	220,038	247,375
Cheras Jaya	64,517	84,964	105,412	125,859	146,306	166,753	187,200
Kajang 1	70,308	76,931	83,554	90,177	96,800	103,424	110,047
Kajang 2	34,860	36,840	38,820	40,800	42,780	44,760	46,740
Kajang 3	88,703	105,148	121,593	138,038	154,483	170,928	187,373
Langat	69,720	96,391	123,063	149,734	176,405	203,077	229,748
Semenyih	79,680	144,810	209,939	275,069	340,198	405,328	470,457
<b>TOTAL</b>	<b>906,448</b>	<b>1,214,385</b>	<b>1,522,323</b>	<b>1,830,261</b>	<b>2,138,199</b>	<b>2,446,137</b>	<b>2,754,075</b>

### 4. Proposed Sewerage Management

The sewerage management options recommend the acquisition of land for the siting of CSTPs as shown below. The total land cost is estimated to be RM137.5 million.

Catchment	Sub-Catchment	Option	Lot No.	Land Required (ha)
Kajang	Kajang 1	-	1283 and part of 792	6.88
	Kajang 2	-	HLT 010 (Tmn Kajang Utama)	1.032
	Kajang 3	-	518,519,972,360,1210,359	5.87
Cheras	Cheras Bt. 11	-	614,615,616, Part of lot 1744	7.89
	Cheras Jaya	-	No Lot Number	4.47
Semenyih	Semenyih Bandar	Option 1B	1748	0.472
			299	3.024
			301	1.26
	Bandar Baru Rinching	Option 2A	905	1.392
			906	1.822
	Semenyih Utara	Option 3	2357	10.16
	Semenyih Industrial Area	Option 4	975	3.64
Bangi South	Bangi South 1	Option 1A	8652	2.127
Langat	Langat	Option 1C	640	2.34

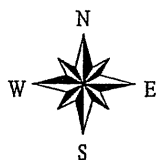
The total capital cost required to implement rationalization of all the sewerage treatment options is RM 1.481 billion, not including land cost. The data for each catchments are shown on below.

**Total Capital and NPV Amount for All Catchment**

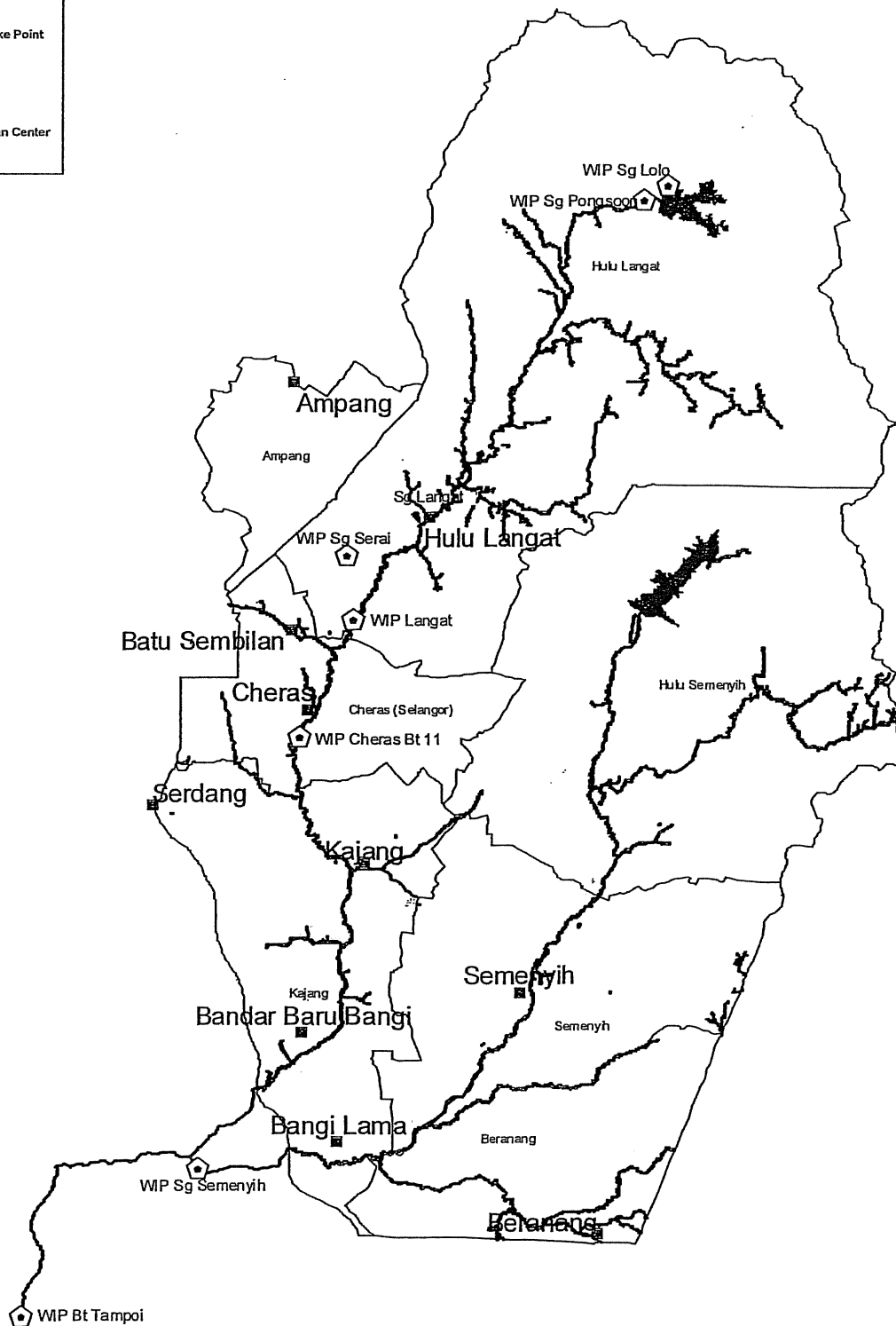
CATCHMENT	OPTION	CAPITAL COST (RM)	TOTAL CAPITAL COST (RM)	NPV
Langat	Option 1C	15,399,160.00		
	Option 2A	6,245,250.00	21,644,410.00	16,023,380.00
Bandar Baru Bangi	Option 1	6,973,469.00		
	Option 2	12,415,840.00	19,389,309.00	12,192,015.00
Bangi South	Option 1A	31,825,275.00		
	Option 2	5,150,000.00	36,975,275.00	18,664,234.60
Semenyih	Option 1B	92,870,482.50		
	Option 2A	45,810,190.00		
	Option 3	65,924,465.00		
	Option 4	25,600,790.00	230,205,927.50	126,851,491.22
Beranang	Option 1	3,169,260.00	3,169,260.00	1,768,678.00
Cheras East	Option 1	5,746,940.00	5,746,940.00	2,376,781.72
Cheras Bt 11	Phase 1	147,490,000.00		
	Phase 2	192,091,000.00	339,581,000.00	175,942,276.68
Cheras Jaya	Phase 1	107,715,000.00		
	Phase 2	192,665,000.00	300,380,000.00	144,635,135.84
Kajang 1	Phase 1	97,340,000.00		
	Phase 2	113,370,000.00	210,710,000.00	122,372,427.66
Kajang 2	Phase 1	42,554,500.00	42,554,500.00	23,295,817.98
Kajang 3	Phase 1	109,990,000.00		
	Phase 2	161,222,500.00	271,212,500.00	124,667,329.18
<b>GRAND TOTAL</b>			<b>1,481 million</b>	<b>768,789,568</b>

## 5. Proposed Sludge Management

All IST sludge are collected and treated at Bandar Baru Bangi HLT217 (CSTF). For short-term planning, while waiting for the development of five new CSTPs, all IST and STP sludge collected from nearby STPs will be sent to the upgraded centralized STPs (CSTF). For short and long term goals, sludge will be managed by the respective future CSTF, shown next page (following option 1):



LEGEND	
	Water Intake Point
	Boundary
	River
	Lakes
	Major Urban Center



CLIENT:



DEPARTMENT OF SEWERAGE SERVICES  
MINISTRY OF ENERGY, WATER AND COMMUNICATIONS

PREPARED BY:



ANTARA JURUTERA PERUNDING SDN BHD

TITLE:

FIGURE 2.1: LOCATION OF MAIN RIVER  
AND WATER INTAKE POINTS IN UPPER  
LANGAT AREA

DATE: JULY 2008

SCALE: 1: 232000

PAGE: 2-3

Table 2.3: Water Intake Points in Sungai Langat Basin

No.	WIP	Nominal Capacity (mld)	Water Sources	District
1	Pangsoon	1.82	Sg. Langat	Hulu Langat
2	Lolo	0.41	Sg. Langat	Hulu Langat
3	Serai	0.90	Sg. Langat	Hulu Langat
4	Langat	454	Sg. Langat	Hulu Langat
5	Cheras	27	Sg. Langat	Hulu Langat
6	Semenyih	636	Sg. Semenyih	Hulu Langat
7	* Bukit Tampoi	28	Sg. Langat	Kuala Langat
8	* Salak Tinggi	11	Sg. Labu	Sepang

Note: \* Bt. Tampoi and Salak Tinggi WIP are not in Upper Langat

## 2.3 Topography and Drainage

### 2.3.1 Topography Pattern

Upper Langat is one of major sub-basin in Langat Basin. The topography of the Langat Basin can broadly be divided into three regions, namely:

- The mountainous areas
- The hilly areas
- The lowlands

The mountainous areas are located in the north-eastern part of the basin. At the top end of the mountainous terrain the land elevation is around 1000m above mean sea level (MSL). However, most of the mountainous areas are below 500m (MSL). The change from mountainous to hilly land is gradual and the change is at around 150m (MSL). About 10% from Upper Langat Basin is covered by mountainous areas.

The hilly areas are characterized by rolling hills with gentle slopes and predominate over a large part of the middle section of the basin. The elevation ranges from 150m to 50m (MSL). About 30% from Upper Langat sub-basin is covered by hilly areas.

The lowlands are located in the southwest part of the basin bounded by hilly areas in the north and east and by the relatively gentle terrain in the southwest. About 40% of the Upper Langat sub-basin is covered by undulating lowlands. Other than the occurrence of some isolated hills e.g. Bukit Jugra, the elevation of the lowlands is less than 20m (MSL). The sub-basin lies on granites and meta-sediments, which encompass 93 and 7% of the area, respectively. Figure 2.2 shows the contour map of Upper Langat which has been designed to show the area of each type of topography pattern in Upper Langat area.

### 3.2 Catchments

The Upper Langat River Basin comprises of a large area approximately 800 km<sup>2</sup>. In order to improve effluent quality and evaluating all pollution issues in the catchment area, the study has been divided into 7 catchments which include:

- (i) Kajang catchment
- (ii) Cheras catchment
- (iii) Bandar Baru Bangi catchment
- (iv) Semenyih catchment
- (v) Beranang catchment
- (vi) Bangi South catchment
- (vii) Langat catchment

The area covered by Upper Langat sewerage catchment are further divided into 12 sub-catchments which cover a total of approximately 290 km<sup>2</sup>, they are shown as Table 3.1

**Table 3.1: Land Area Covered by Sewerage Catchment in Study Area**

Sub-Catchment	Total area of catchment (km <sup>2</sup> )	% Total Sewerage Catchment
Bangi Lama	14.4	5.0
BBB North	11.5	4.0
BBB South	29.7	10.2
Beranang	15.4	5.3
Cheras Bt 11	23.9	8.3
Cheras East	19.1	6.6
Cheras Jaya	15.3	5.3
Kajang 1	16.2	5.6
Kajang 2	3.3	1.1
Kajang 3	24.0	8.3
Langat	61.7	21.3
Semenyih	55.4	19.1
<b>Total</b>	<b>290.0</b>	<b>100</b>

#### 3.2.1 Physical description of Kajang Catchment

Kajang is a town in the eastern part of Selangor and located 24 km to the south-west of Kuala Lumpur. It is the major urban and administrative centre in Hulu Langat district. The total population of Kajang has grown rapidly in the past few years. It had a population of 189,400 in 2001 while in 2005 the population is increase into 276,900.

Extensive development has occurred in the Kajang area over the last few years. These include at Taman Prima Saujana (straight from Jalan Cheras), Taman Kajang Perdana (Kajang Highlands), Taman Sepakat Indah I & II (Sg Chua) etc. The central town area is already fully developed, with shops, houses, offices and light industrial areas. The area is notorious for its traffic congestion during rush-hour periods. There has been

43	HLT P019	Na
44	HLT P024	Na
45	HLT P027	177
46	Palm Garden Golf Club	240
47	Impian Golf Resort	240
48	Resort Villa Golf Course	240
49	Lembaga Hasil Dalam Negeri Kajang	180
50	Bangunan JKR Hulu Langat	180
51	Penjara Kajang	Na
52	BP	1,000
53	R&R Bukit Dukung	1,000
54	Pusat Latihan ABIM	1,000
55	Bukit Kajang Tol Plaza	177
56	Saujana Impian Tol	200
57	Sg Long Tol Plaza	200
	<b>Total</b>	<b>15,462</b>

Note: Na – private data not available

#### 4.2.1.1 Existing Sewerage Development in Sub-Catchment Kajang 1

There are currently 36 public Sewage Treatment Plants, 3 units of Private STPs, about 1500 units of Individual Septic Tanks (IST) and 100 units of pour flush located within the Kajang 1 sub-catchment. The public STPs are shown in Table 4.6 below.

#### 4.2.1.2 Existing Sewerage Development in Sub-Catchment Kajang 2

There are currently 9 public Sewage Treatment Plants, about 500 units of Individual Septic Tanks (IST) and about 50 units of pour flush located within the Kajang 2 sub-catchment. All public STP has been listed down as shown in Table 4.7 below.

#### 4.2.1.3 Existing Sewerage Development in Sub-Catchment Kajang 3

There are currently 47 public Sewerage Treatment Plants and 2 private STPs, more than 2000 units of Individual Septic Tanks (IST) and about 100 units of pour flush located within the Kajang 3 sub-catchment. Table 4.8 lists down all public STP and private STP in Kajang 3 sub-catchment area.

Table 4.6: List of Public STP in Kajang 1

NO	ASSET NO	LOCATION	DESIGN PE	CURRENT PE	STP TYPE
1	HLT092	TMN MULIA JAYA	250	250	AB
2	HLT160	TMN BERJAYA BARU	2055	890	AB
3	HLT180	TMN SRI KEJORA	330	330	AB
4	HLT136	TMN MUHIBBAH	2290	2290	BFPS
5	HLT012	TMN BERJAYA	1000	1000	BS
6	HLT298	RUMAH MURAH SG RAMAL LUAR	260	260	CST
7	HLT103	KAW PERINDUSTRIAN SG CHUA	6000	6000	EA
8	HLT117	KAWASAN PERUSAHAAN BUKIT ANGKAT	545	545	EA
9	HLT122	TMN PASIR MAS	720	720	EA
10	HLT135	TMN KAJANG INDAH	1200	1388	EA
11	HLT137	TMN KAJANG MEWAH	6000	5921	EA
12	HLT157	TMN SRI KENARI FASA 2	5000	5000	EA
13	HLT178	TMN BIDARA	870	700	EA
14	HLT190	TMN DESA KARUNMAS	5000	1825	EA
15	HLT202	TMN PUTRA BUDIMAN	4500	3315	EA
16	HLT213	TMN SEPAKAT INDAH	18000	6261	EA
17	HLT221	TMN BERJAYA BARU	386	386	EA
18	HLT237	TMN TANMING EMAS	800	800	EA
19	HLT268	TMN BUKIT MAS	1750	1340	EA
20	HLT255	SUTERA EMAS APARTMENT	1550	1480	EAPS
21	HLT257	TMN PUTRA KAJANG	8300	4695	EAPS
22	HLT261	TMN SRI EMAS	950	940	EAPS
23	HLT154	TMN PASIR EMAS FASA 2	425	355	HK
24	HLT243	TMN DESA MERINGIN	275	100	HKPS
25	HLT169	TMN BALAKONG JAYA	14560	7213	IDEA
26	HLT028	TMN SERI SAGA	1200	1200	ITPS
27	HLT008	TMN SRI INTAN	1800	1084	OP
28	HLT011	TMN KOPERASI LLN	1000	1000	RBC
29	HLT027	TMN KAJANG RAYA	2190	2196	RBC
30	HLT029	TMN SRI RAMAL	1700	1700	OD
31	HLT059	TMN CENDANA	4000	4000	OPPS
32	HLT096	TMN MELOR FASA 1	1435	1290	OPPS
33	HLT128	TMN SEMARAK	2000	1980	OD
34	HLT280	KAW PERUSAHAAN BUKIT ANGKAT	3315	3315	OD
35	HLT302	BUKIT GITA BAYU, SERI KEMBANGAN	2600	1120	
36	PTG068	TMN DESA SERDANG	8450	8450	OD

studied. The population data of other similar but larger cities are also plotted in such manner that all the curves are coincident at the present population of the city being studied. These curves are used as guides in future projection.

**Table 5.2 : Population Projection based on Census data**

Sub-Catchment	2005	2010	2015	2020	2025	2030	2035
Bangi Lama	46,527	50,017	53,268	56,198	59,008	61,663	64,129
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
Beranang	15,800	16,274	16,762	17,265	17,783	18,317	18,866
Cheras Bt 11	76,024	91,989	110,847	133,016	158,289	186,781	218,534
Cheras East	69,461	84,048	101,277	121,533	144,624	170,656	199,668
Cheras Jaya	57,605	69,702	83,990	100,789	119,938	141,527	165,587
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
Langat	58,100	65,944	73,857	82,350	91,409	101,007	111,107
Semenyih	66,400	83,996	103,735	127,075	154,397	186,820	225,118
<b>Total</b>	<b>782,000</b>	<b>888,651</b>	<b>1,003,891</b>	<b>1,131,020</b>	<b>1,270,872</b>	<b>1,424,509</b>	<b>1,592,420</b>

### 5.2.1 Population Equivalent Conversion

Jabatan Perangkaan Malaysia has provided only population data in Upper Langat. For this report, Population Equivalent is more important than population data. To obtain PE, a conversion factor is needed (shown as Table 5.3). The PE conversion factor used is from range 1.10 to 1.25 in which 1.10 represents the most developed area and higher value is to represent the less developed area.

**Table 5.3: Conversion Factor**

Sub-Catchment	Conversion Factor
Bangi Lama	1.23
BBB North	1.12
BBB South	1.25
Beranang	1.25
Cheras Bt 11	1.12
Cheras East	1.23
Cheras Jaya	1.12
Kajang 1	1.2
Kajang 2	1.12
Kajang 3	1.2
Langat	1.2
Semenyih	1.25

projects, taking into account some constraint due to land topography as well. The ultimate PE for Upper Langat is 2.7 million in year 2035.

## 5.6 Sewage Flow Estimation

Sewage Flow Estimation is important to estimate the flow changes along the years. It is also as guidance to the design of the sewer pipelines and the design of STP itself.

Table 5.10 shows the Sewage Flow Estimation based on PE. To obtain the flow, the multiplication of flow factor must be done to the PE value. The factor is 0.225 m<sup>3</sup>/PE/day. The flow estimation will change with the changes of PE. For the study area, the projected sewage flow will be 607,657 m<sup>3</sup>/day by year 2035.

The trend in sewage flow can be seen in Table below, where the highest flow occurs in Bandar Baru Bangi South while Kajang 2, being the smallest and has the lowest flow.

**Table 5.10: Sewage Flow Estimation based on PE**

Sub-Catchment	2005	2010	2015	2020	2025	2030	2035
Bangi Lama	12,562	14,551	16,539	18,527	20,516	22,504	24,493
BBB North	23,355	25,329	27,304	29,278	31,252	33,227	35,201
BBB South	34,103	48,725	63,346	77,968	92,589	107,211	121,832
Beranang	4,266	13,051	21,836	30,621	39,406	48,191	56,975
Cheras Bt 11	19,158	22,475	25,793	29,110	32,427	35,744	39,061
Cheras East	18,754	25,930	33,106	40,282	47,458	54,634	61,810
Cheras Jaya	14,516	17,647	20,778	23,909	27,040	30,171	33,302
Kajang 1	15,819	17,309	18,800	20,290	21,780	23,270	24,761
Kajang 2	7,844	8,289	8,735	9,180	9,626	10,071	10,517
Kajang 3	19,958	23,658	27,358	31,058	34,759	38,459	42,159
Langat	15,687	21,688	27,689	33,690	39,691	45,692	51,693
Semenyih	17,928	32,582	47,236	61,890	76,545	91,199	105,853
<b>TOTAL</b>	<b>203,951</b>	<b>271,235</b>	<b>338,520</b>	<b>405,804</b>	<b>473,088</b>	<b>540,373</b>	<b>607,657</b>

\* (Unit in m<sup>3</sup>/day)

BOD load of sullage in Kajang 1 was 81 kg/d. Therefore, sullage issue is considered moderate and is going to be increasingly significant for this catchment. Mitigation step can be taken seriously by MPKj to restrict discharge of sullage into municipal drains. This can be done using by-laws on sanitation and drainage

### 6.2.3 IST areas

On the whole, all Kajang catchment serves the highest amount having ISTs added up to 8,317 units. The large number of IST may directly contribute to pollution in the river. Normally, the contents of the septic tank should be pumped every two to three years or when the total depth of sludge and scum exceeds one-third of the liquid depth of the tank. If the tank is not cleaned periodically, the solids are carried into the municipal drain without treatment. It is very difficult to achieve compliance to effluent standard using IST. Therefore, ISTs must be slowly phased out in highly urbanized area, by connection to sewer or nearby STP.

### 6.2.4 Sewerage options

#### Option 1:

In this option, the catchment strategy for Kajang 1 requires all existing sewerage systems in the catchment to be rationalized to a centralised STP (CSTP). The total number of plants involved in this rationalization strategy is 36 public STPs, 3 nos private and the rest are ISTs, as stated in Table 6.3 below. In this manner, there will be a better control on treated effluent as the CSTP will use most efficient process with ammonia nitrogen removal as well. The total capacity required for the CSTP is 200,000 PE which will serve the ultimate population. Figure 6.1 shows the sewerage catchment strategy for Kajang 1.

The proposed centralised STP site has been identified on lot 1283 and part of lot 792 in Pekan Sg. Chua which is owned by private individual. The total land to be acquired is 6.88 ha. As per guideline for developers Volume IV requires 6.60 ha for population equivalent of 200,000. The remaining 0.279 ha is required for buffer zone.

**Table 6.3: Summary Rationalisation Strategy for Kajang 1 Catchment**

Critical Sub Catchment	Land Area Required (ha)	Sub Catchment Implementation can Rationalize			
		Public STP	Private	IST	Pourflush
<b>Kajang 1</b> Lot No.1283 and part of Lot 792	6.88 ha (Cost: RM 25.9 million)	36	3	1,500	100

**Option 2:**

For option 2, the catchment strategy for Kajang 1, all existing sewerage systems in the catchment will be optimized to designed capacity. Upgrade of OP and IT to mechanical plant may be considered, but the impact will not be beneficial as all the upgraded STPs will not be operated to get optimum result due to large numbers and requirement for full time operator. Having a CSTP is advantages for present and future connection which is expected to occur in this catchment.

Option 1 which will have CSTP will be recommended as it will rationalise all flows to a central point thus eliminating the IST, and private plant as well over a period time.

**6.2.5 Implementation strategy****(i) Immediate Strategy**

The immediate action is to refurbish and upgrade all highly inefficient STPs, especially ITs and OPs in order to improve the effluent quality so as to achieve 100% compliance to DOE Standard A criteria. The list of inefficient STP that requires immediate attention is shown previously.

**(ii) Short Term Strategy (2010 – 2015)**

Short term measure for Kajang 1 involves construction of centralised STP (CSTP) and to eliminate all ISTs whenever possible, and sewage diverted to the CSTP.

**PHASE 1**

- Land acquisition for centralised STP – 6.88 ha
- Construction – 1<sup>st</sup> Module STP (100,000 PE)
- Conversion of HLT213 into NPS – 67,000 PE
- Construction of trunk sewer of 225 mm diameter to 800mm – 9,920 m
- Construction of forcemain 600 mm diameter – 500m
- Construction and installation of manholes – 122 numbers
- Rationalisation and decommissioning of STP – 21 numbers
- Construction of Sludge Treatment Facilities

**(iii) Long Term Strategy (2015 onwards)**

Long term strategy involves construction and installation of STP which can cater about 100,000 PE and rationalization of STP.

**PHASE 2**

- Construction – 2<sup>nd</sup> Module STP (100,000 PE)

**Kajang 1****PHASE 1**

Discount rate		8%		Total Capital Cost		97,340,000.00	
n	Year	Operation & Maintenance Cost (RM)	Capital Cost (RM)	Total Cost (RM)	Discount Factor	Annual Discounted Cost (RM)	Cumm. Discounted Cost (RM)
0	2008			0.00	0.926	0	0
1	2009			0.00	0.857	0	0
2	2010			0.00	0.794	0	0
3	2011			0.00	0.735	0	0
4	2012			0.00	0.681	0	0
5	2013			0.00	0.630	0	0
6	2014		24,192,000.00	24,192,000.00	0.583	14,103,936.00	14,103,936.00
7	2015	1,072,200.00	24,192,000.00	25,264,200.00	0.540	13,642,668.00	27,746,604.00
8	2016	1,072,200.00	20,982,675.00	22,054,875.00	0.500	11,027,437.50	38,774,041.50
9	2017	1,072,200.00	13,694,000.00	14,766,200.00	0.463	6,836,750.60	45,610,792.10
10	2018	1,072,200.00	10,120,000.00	11,192,200.00	0.429	4,801,453.80	50,412,245.90
11	2019	1,072,200.00	120,000.00	1,192,200.00	0.397	473,303.40	50,885,549.30
12	2020	1,072,200.00	120,000.00	1,192,200.00	0.368	438,729.60	51,324,278.90
13	2021	1,072,200.00	120,000.00	1,192,200.00	0.340	405,348.00	51,729,626.90
14	2022	1,072,200.00	120,000.00	1,192,200.00	0.315	375,543.00	52,105,169.90
15	2023	1,072,200.00	120,000.00	1,192,200.00	0.292	348,122.40	52,453,292.30
16	2024	1,072,200.00	120,000.00	1,192,200.00	0.270	321,894.00	52,775,186.30
17	2025	1,072,200.00	120,000.00	1,192,200.00	0.250	298,050.00	53,073,236.30
18	2026	1,072,200.00	120,000.00	1,192,200.00	0.232	276,590.40	53,349,826.70
19	2027	1,072,200.00	120,000.00	1,192,200.00	0.215	256,323.00	53,606,149.70
20	2028	1,072,200.00	120,000.00	1,192,200.00	0.199	237,247.80	53,843,397.50
21	2029	1,072,200.00	400,000.00	1,472,200.00	0.184	270,884.80	54,114,282.30
22	2030	1,072,200.00	400,000.00	1,472,200.00	0.170	250,274.00	54,364,556.30
23	2031	1,072,200.00	400,000.00	1,472,200.00	0.158	232,607.60	54,597,163.90
24	2032	1,072,200.00	400,000.00	1,472,200.00	0.146	214,941.20	54,812,105.10
25	2033	1,072,200.00	400,000.00	1,472,200.00	0.135	198,747.00	55,010,852.10
26	2034	1,072,200.00	200,000.00	1,272,200.00	0.125	159,025.00	55,169,877.10
						<b>Total NPV (RM)</b>	<b>55,169,877.10</b>

Year	Component	Percentage Complete (%)	Total Component Cost (RM)	Cost per Year (RM)
2014	STP	20%	50,000,000.00	10,000,000.00
	Pumping Station	50%	6,700,000.00	3,350,000.00
	Sewer Trunk	30%	35,130,000.00	10,539,000.00
	Manholes	30%	610,000.00	183,000.00
	Connection	3%	4,000,000.00	120,000.00
	<b>Sub Total</b>			<b>24,192,000.00</b>
2015	STP	20%	50,000,000.00	10,000,000.00
	Pumping Station	50%	6,700,000.00	3,350,000.00
	Sewer Trunk	30%	35,130,000.00	10,539,000.00
	Manholes	30%	610,000.00	183,000.00
	Connection	3%	4,000,000.00	120,000.00
	<b>Sub Total</b>			<b>24,192,000.00</b>
2016	STP	20%	50,000,000.00	10,000,000.00
	Sewer Trunk	30%	35,130,000.00	10,539,000.00
	Manholes	30%	610,000.00	28,675.00
	Connection	3%	4,000,000.00	415,000.00
	<b>Sub Total</b>			<b>20,982,675.00</b>
2017	STP	20%	50,000,000.00	10,000,000.00
	Sewer Trunk	10%	35,130,000.00	3,513,000.00
	Manholes	10%	610,000.00	61,000.00
	Connection	3%	4,000,000.00	120,000.00
	<b>Sub Total</b>			<b>13,694,000.00</b>
2023	Connection	3%	4,000,000.00	120,000.00
	<b>Sub Total</b>			<b>120,000.00</b>
2029	Connection	10%	4,000,000.00	400,000.00
	<b>Sub Total</b>			<b>400,000.00</b>
2034	Connection	5%	4,000,000.00	200,000.00
	<b>Sub Total</b>			<b>200,000.00</b>

**PHASE 2**

Discount rate 8%		Total Capital Cost 113,370,000.00					
n	Year	Operation & Maintenance Cost (RM)	Capital Cost (RM)	Total Cost (RM)	Discount Factor	Annual Discounted Cost (RM)	Cumm. Discounted Cost (RM)
0	2008			0.00	0.926	0	0
1	2009			0.00	0.857	0	0
2	2010			0.00	0.794	0	0
3	2011			0.00	0.735	0	0
4	2012			0.00	0.681	0	0
5	2013			0.00	0.630	0	0
6	2014		27,649,200.00	27,649,200.00	0.583	16,119,483.60	16,119,483.60
7	2015	1,237,920.00	27,649,200.00	28,887,120.00	0.540	15,599,044.80	31,718,528.40
8	2016	1,237,920.00	27,649,200.00	28,887,120.00	0.500	14,443,560.00	46,162,088.40
9	2017	1,237,920.00	19,396,400.00	20,634,320.00	0.463	9,553,690.16	55,715,778.56
10	2018	1,237,920.00	12,180,000.00	13,417,920.00	0.429	5,756,287.68	61,472,066.24
11	2019	1,237,920.00	180,000.00	1,417,920.00	0.397	562,914.24	62,034,980.48
12	2020	1,237,920.00	180,000.00	1,417,920.00	0.368	521,794.56	62,556,775.04
13	2021	1,237,920.00	180,000.00	1,417,920.00	0.340	482,092.80	63,038,867.84
14	2022	1,237,920.00	180,000.00	1,417,920.00	0.315	446,644.80	63,485,512.64
15	2023	1,237,920.00	180,000.00	1,417,920.00	0.292	414,032.64	63,899,545.28
16	2024	1,237,920.00	180,000.00	1,417,920.00	0.270	382,838.40	64,282,383.68
17	2025	1,237,920.00	180,000.00	1,417,920.00	0.250	354,480.00	64,636,863.68
18	2026	1,237,920.00	180,000.00	1,417,920.00	0.232	328,957.44	64,965,821.12
19	2027	1,237,920.00	180,000.00	1,417,920.00	0.215	304,852.80	65,270,673.92
20	2028	1,237,920.00	180,000.00	1,417,920.00	0.199	282,166.08	65,552,840.00
21	2029	1,237,920.00	600,000.00	1,837,920.00	0.184	338,177.28	65,891,017.28
22	2030	1,237,920.00	600,000.00	1,837,920.00	0.170	312,446.40	66,203,463.68
23	2031	1,237,920.00	600,000.00	1,837,920.00	0.158	290,391.36	66,493,855.04
24	2032	1,237,920.00	600,000.00	1,837,920.00	0.146	268,336.32	66,762,191.36
25	2033	1,237,920.00	600,000.00	1,837,920.00	0.135	248,119.20	67,010,310.56
26	2034	1,237,920.00	300,000.00	1,537,920.00	0.125	192,240.00	67,202,550.56
						<b>Total NPV (RM)</b>	<b>67,202,550.56</b>

Year	Component	Percentage Complete (%)	Total Component Cost (RM)	Cost per Year (RM)
2014	STP	20%	60,000,000.00	12,000,000.00
	Sewer Trunk	30%	40,450,000.00	12,135,000.00
	Manholes	30%	814,000.00	244,200.00
	Connection	3%	109,000,000.00	3,270,000.00
	<b>Sub Total</b>			<b>27,649,200.00</b>
2015	STP	20%	60,000,000.00	12,000,000.00
	Sewer Trunk	30%	40,450,000.00	12,135,000.00
	Manholes	30%	814,000.00	244,200.00
	Connection	3%	109,000,000.00	3,270,000.00
	<b>Sub Total</b>			<b>27,649,200.00</b>
2016	STP	20%	60,000,000.00	12,000,000.00
	Sewer Trunk	30%	40,450,000.00	12,135,000.00
	Manholes	30%	814,000.00	244,200.00
	Connection	3%	109,000,000.00	3,270,000.00
	<b>Sub Total</b>			<b>27,649,200.00</b>
2017	STP	20%	60,000,000.00	12,000,000.00
	Sewer Trunk	10%	40,450,000.00	4,045,000.00
	Manholes	10%	814,000.00	81,400.00
	Connection	3%	109,000,000.00	3,270,000.00
	<b>Sub Total</b>			<b>19,396,400.00</b>
2023	Connection	3%	6,000,000.00	180,000.00
	<b>Sub Total</b>			<b>180,000.00</b>
2029	Connection	10%	6,000,000.00	600,000.00
	<b>Sub Total</b>			<b>600,000.00</b>
2034	Connection	5%	6,000,000.00	300,000.00
	<b>Sub Total</b>			<b>300,000.00</b>

## **APPENDIX B**

### **SUPPORTING PROGRAMME FOR FINANCIAL ANALYSIS**

Presently, for the financial evaluation of the selection of the priority option in the catchment strategy reports, Net Present Value (NPV) is calculated only for capital and O&M expenditure. Furthermore, O&M cost is sometimes set as a certain % of capital costs in CS/P. Therefore, in case the priority option is decided by NPV, the option with lowest capital investment tends to be given higher priority. This NPV evaluation seems to be preferred by developers who may seek to reduce the initial capital investment and avoid constructing larger STP tailored for centralization.

It is better to introduce tariff revenue of each option into the NPV calculation of the financial analysis. The reason to introduce the revenue is that lifetime profit or loss of the option can be calculated and that the option most profitable or with the least financial losses can be selected as first priority.

On the other hands, by properly estimating the O&M costs, options with larger capacity STP, in line with centralization/rationalization, may have the possibility to be selected as the priority option.

Proper estimation of O&M costs and consideration of revenue shall contribute to minimizing the lifecycle net loss of the sewerage project.

Therefore, in the financial analysis for the reviewing/evaluation/prioritization of sewerage catchments/projects, the following are considered to calculate the NPV:

- 1) Tariff revenue is included in addition to costs;
- 2) O&M costs are properly set for each treatment system.
- 3) In order to compare the variously-sized projects in an equitable manner, NPV of balance of revenue minus costs is divided by the total design PE of the project.

It is understood that projects with smaller PE have the advantage in the evaluation of NPV.

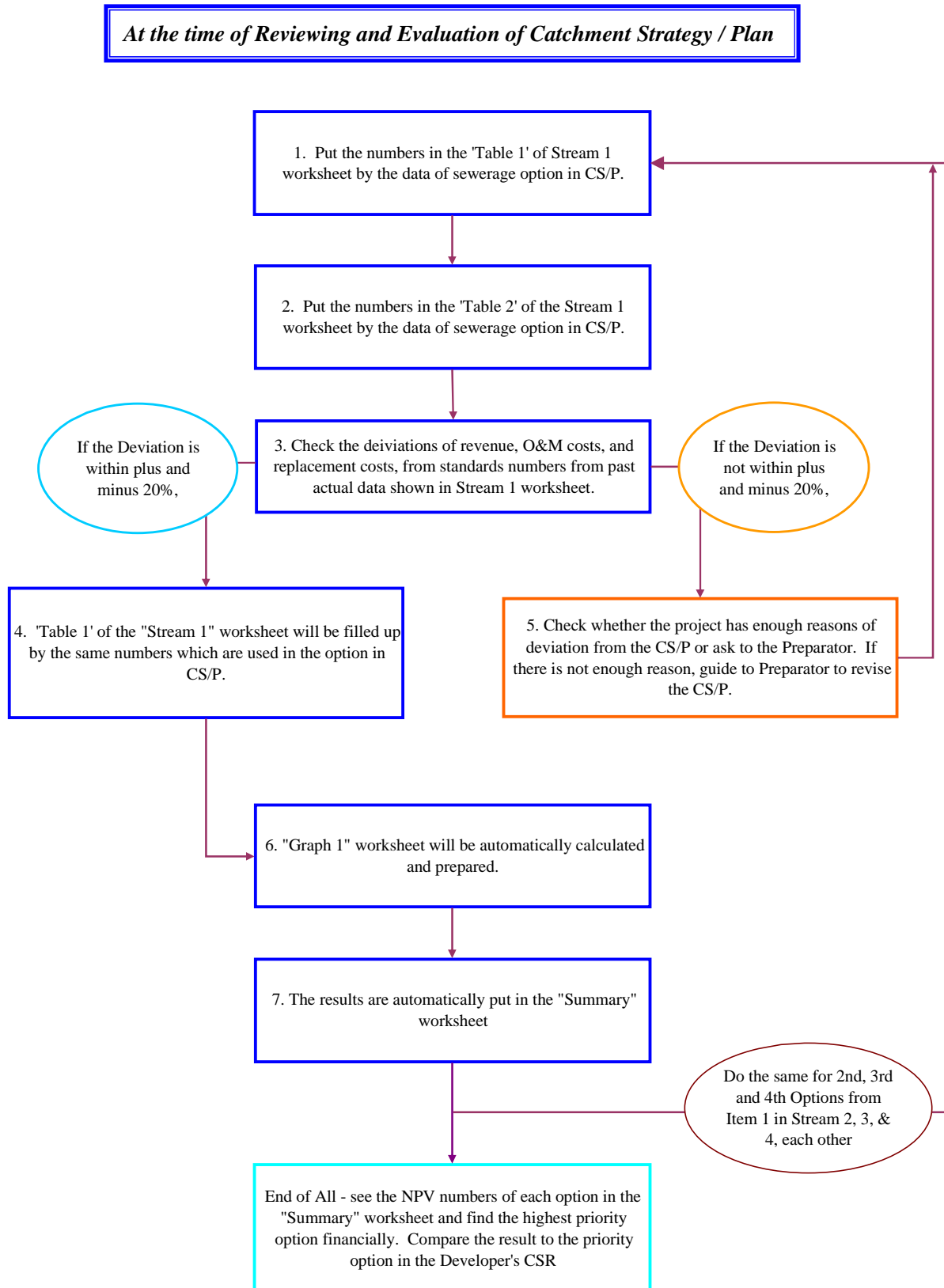
This supporting programme was developed under the idea mentioned above.

**APPENDIX B SUPPORTING PROGRAMME FOR FINANCIAL VIABILITY****General Flow - How to Use the Supporting Program****At the time of reviewing and evaluating the selection of priority option in CS/P;**

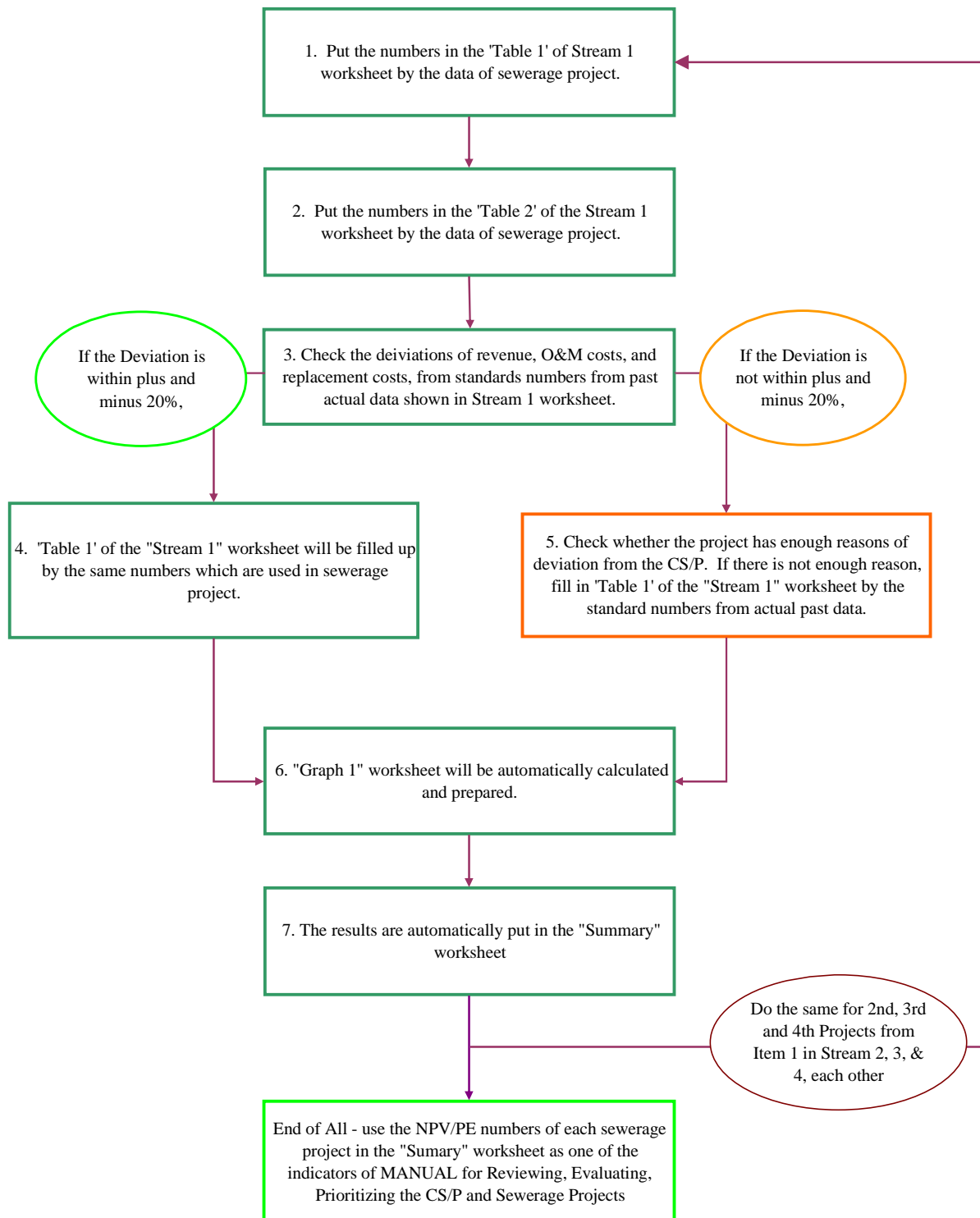
- 1) To check whether the revenue, O&M costs, and replacement costs of several options in the CS/P are relevant or not, by comparing to the standard number of the Past Actual Data.
- 2) If the revenue, O&M costs, and replacement costs are considered relevant as a result of checking, each worksheet of supporting program will be filled up by the revenue, O&M costs, and replacement costs of each option in the CS/P. If the priority project indicated by the supporting program is the same as the result of the CS/P report, priority project in the CS/P is considered financially relevant.
- 3) If some of revenue, O&M costs, and replacement costs (in CS/P) are much smaller or much bigger than standard numbers, the reason must be found in CS/P report or asked to the developer.
- 4) If there is not enough reason, guide to developer to recalculate NPV and B/C based on the standard number of the Past Actual Data. Revised CS/P report shall be checked again from the above item 1).

**At the time of prioritizing the sewerage projects of the various catchments;**

- 1) To check whether the revenue, O&M costs, and replacement costs of the sewerage projects are relevant or not, by comparing to the standard number of the Past Actual Data.
- 2) If the revenue, O&M costs, and replacement costs are considered relevant as a result of checking, each worksheet of supporting program will be filled up by the revenue, O&M costs, and replacement costs of each sewerage projects.
- 3) If some of revenue, O&M costs, or replacement costs (in CS/P) are much smaller or much bigger than standard numbers, the reason must be found in CS/P report.
- 4) If there is not enough reason, standard numbers of revenue, O&M costs, and replacement costs for each PE of each sewerage project shall be filled in the supporting program to calculate NPV/PE for each project.
- 5) Sewerage projects shall be prioritized by main manual. Results of supporting program shall be one of the important evaluation items.

**FLOW CHART - HOW TO USE THE SUPPORTING PROGRAM -**

### At the time of Prioritization of Some Sewerage Projects



## Comparison of Alternative Projects

(Unit: RM in million)

PROJECTS	NPV (Mil. RM)	B/C	Net Cost Burden on Constructor		Net Cost Burden on Operator		NPV/PE (RM/PE)	Ranking	Notes		
			Total Cost	Present Value	Average cost/year	Present Value			PE	Centralized/ multi-point	Construction cost/PE
Project 1	-23.56	0.40	17.00	15.12	0.69	8.43	-129.93	1	181,300	Centralized	93.77
Project 2	-39.29	0.27	17.00	15.12	1.81	24.17	-216.71	4	181,300	4 STPs	93.77
Project 3	-31.89	0.32	17.00	15.12	1.28	16.76	-175.88	3	181,300	2 STPs	93.77
Project 4	-29.11	0.35	17.00	15.12	1.09	13.99	-160.56	2	181,300	2 STPs with expansion	93.77

Notes:

\*1; Minus NPV indicates the net present value of net loss for the evaluation period.

The bigger the NPV, the better the option, in the aspect of financial view point.

\*2; B/C indicates the relative size of present value of Benefit in proportion to present value of Cost.

The bigger the B/C, the better the option, in the aspect of financial view point.

\*3; Net Cost Burden on Constructor indicates the design and construction costs of the project.

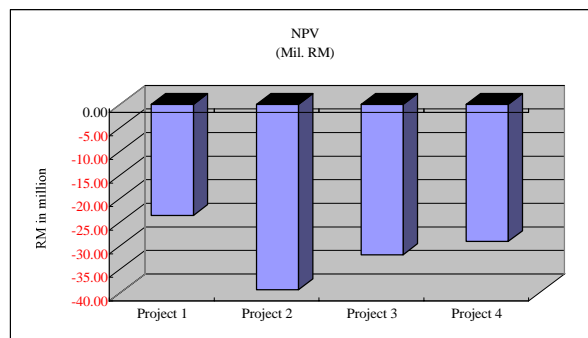
The amount of Net Cost Burden must be covered by Constructors or future land owners or others.

The bigger the total cost burden on constructor, the worse the option is for constructor and society.

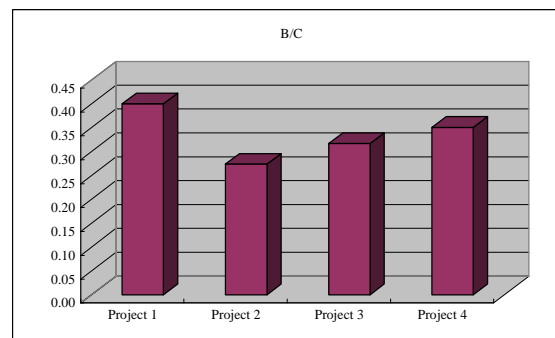
\*4; Net Cost Burden on Operator indicates the sewerage tariff revenue minus O&amp;M cost and replacement cost of the project.

The amount of Net Cost Burden on Operator must be covered by Operator budget or government budget.

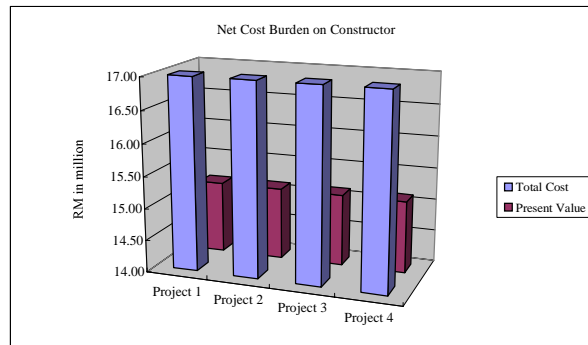
The bigger the total cost burden on operator, the worse the option is for Operator.



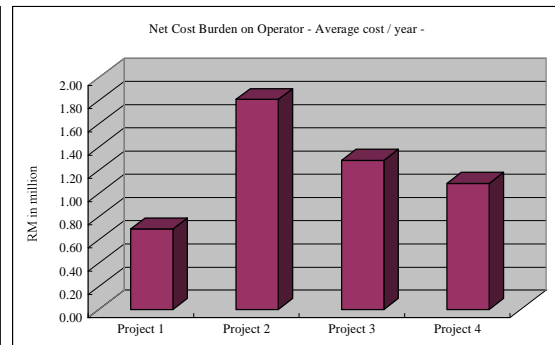
Note: The larger the NPV, the better the Project financially. In negative case, shorter the length of bar, the better the Project financially.



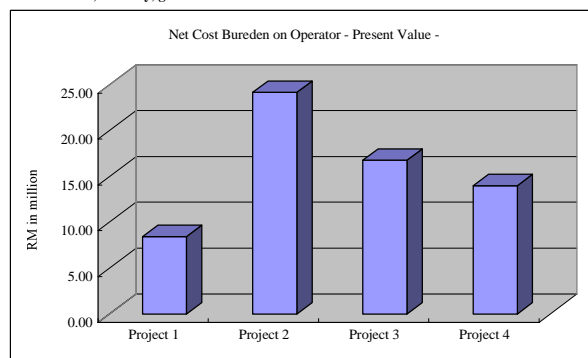
Note: The larger the B/C, the better the Project financially. If B/C is close to 1, it shows that present value of Benefit is almost equal to present value of Cost.



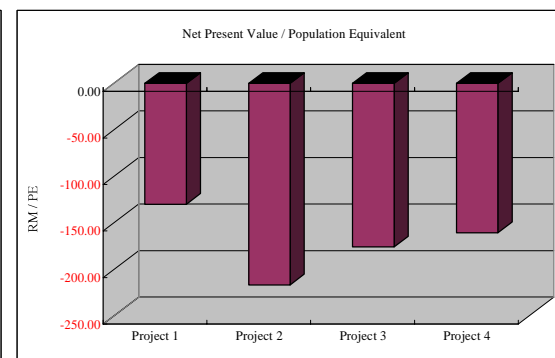
Note: The smaller the 'Total Cost' or 'Present value' of "Net Cost Burden on Constructor", the better the project is financially for Constructor and society. As the Net Cost Burden on Constructor shall be paid by Constructor or final land owners, such as households, commercial, industry, government.



Note: The smaller the 'Average cost / year' of "Net Cost Burden on Operator", the better the project is financially for Operator and society. As the Net Cost Burden on Operator may be paid by Government budget, in other words, the tax revenue at last.



Note: The smaller the 'Present value' of "Net Cost Burden on Operator", the better the project is financially for Operator and society. As the Net Cost Burden on Operator may be paid by Government budget, in other words, the tax revenue at last.



Note: The larger the NPV/PE, the better the Project financially. In negative case, shorter the length of bar, the better the Project financially.

**INSTRUCTION OF THIS WORKSHEET**

1) Put the number into the YELLOW CELL in Table 1 below and Table 2 referring from Revenue and Expenditure Stream of CS/P.

2) Check whether Revenue (maximum), O&M cost, and Replacement cost is relevant or not by analyzing the Table 2. If the deviations of them are within the plus and minus 20%, it is not necessary to change the original Revenue, O&M cost and Replacement cost. But if the deviations of them are not within the plus and minus 20%, it is necessary to check the CS/P report and find the reasons of deviations, such as geographical dispersal for high O&M cost, special technology for high O&M, or relatively more commercial and industrial customers for high revenue.

3) If there are understandable reasons, original numbers of CS/P will be used for Table 1. If there are no enough reasons, standard numbers of Revenue or O&M cost or Replacement cost shall be used and Table 1 will be changed by using those numbers.

**Note: Do not change the contents of BLUE COLOURED CELLS, as they contain automatic calculation formula.**

**Table 1. Revenue and Expenditure Stream of Project 1 of Sewerage Catchment Strategy**

(Unit: RM in 1,000)

Year	Construction	O&M	Replacement	Total	Revenue	Balance
-1 2008	8,000	0		8,000	0	-8,000
0 2009	9,000	0		9,000	0	-9,000
1 2010		1,200		1,200	850	-350
2 2011		2,400		2,400	1,700	-700
3 2012		2,400		2,400	1,700	-700
4 2013		2,400		2,400	1,700	-700
5 2014		2,400		2,400	1,700	-700
6 2015		2,400		2,400	1,700	-700
7 2016		2,400		2,400	1,700	-700
8 2017		2,400		2,400	1,700	-700
9 2018		2,400		2,400	1,700	-700
10 2019		2,400		2,400	1,700	-700
11 2020		2,400		2,400	1,700	-700
12 2021		2,400		2,400	1,700	-700
13 2022		2,400		2,400	1,700	-700
14 2023		2,400	2,500	4,900	1,700	-3,200
15 2024		2,400	2,800	5,200	1,700	-3,500
16 2025		2,400		2,400	1,700	-700
17 2026		2,400		2,400	1,700	-700
18 2027		2,400		2,400	1,700	-700
19 2028		2,400		2,400	1,700	-700
20 2029		2,400		2,400	1,700	-700
21 2030		2,400		2,400	1,700	-700
22 2031		2,400		2,400	1,700	-700
23 2032		2,400		2,400	1,700	-700
24 2033		2,400		2,400	1,700	-700
25 2034		2,400		2,400	1,700	-700
26 2035		2,400		2,400	1,700	-700
27 2036		2,400		2,400	1,700	-700
28 2037		2,400		2,400	1,700	-700
29 2038		2,400	2,500	4,900	1,700	-3,200
30 2039		2,400	2,800	5,200	1,700	-3,500
31 2040				0		0
32 2041				0		0
33 2042				0		0
34 2043				0		0
35 2044				0		0
36 2045				0		0
37 2046				0		0
38 2047				0		0
39 2048				0		0
40 2049				0		0
41 2050				0		0
42 2051				0		0
43 2052				0		0

NPV: -23,557 x 1,000 RM B/C: 0.40

@ Discount Rate 8.00%

Notes:

**Table 2. Basic Information and Check Items for Revenue and Expenditure Stream**

**1. Basic Information**

- 1) First year of construction  Year of the start of initial construction
- 2) Construction period  years
- 3) PE of each STP (planned in CS/P)  STP 1st  STP 2nd  STP 3rd  STP 4th  PE  
\* leave blank, if it is not necessary to put any number in the cell.
- 4) Expanded PE of Existing STP, if any From  PE To  PE  
\* leave blank, if it is not necessary to put any number in the cell.
- 5) Connected PE increase without New STP  PE (input the incremental PE)  
(Connected to Existing STP without Expansion)
- 6) STP Rehabilitation without Expansion  PE (input total PE of rehabilitated STP)  
\* 80% Revenue of the capacity is assumed to be attributed by rehabilitation project.
- 6) Average Tariff Revenue per PE  RM/PE
- 7) Collection rate of sewerage tariff  %

**2. Relevancy of Revenue, O&M cost, Replacement cost in the Catchment strategy/plan**

- 1) **Revenue**  
Standard Maximum Revenue  RM in 1,000 / year  
(from the past actual data)  
Developer / Consultant Estimation  RM in 1,000 / year  
(from catchment strategy/plan)  
**Deviation from Standard Number**  %
- 2) **O&M cost**  
Standard Maximum O&M cost / year  STP 1st  STP 2nd  STP 3rd  STP 4th   
(from the past actual data)  
 for Expanded STP  
 for Rehabilitated STP  
 (Total of the Above) RM in 1,000 / year  
Developer / Consultant Estimation  RM in 1,000 / year  
(from catchment strategy/plan)  
**Deviation from Standard Number**  %
- 3) **Replacement cost**  
Standard Replacement cost / time  RM in 1,000/time  
(30% of construction cost)  
Developer / Consultant Estimation  RM in 1,000/time  
(from catchment strategy/plan)  
**Deviation from Standard Number**  %

Deviation of Revenue (CS/P) from Standard

%

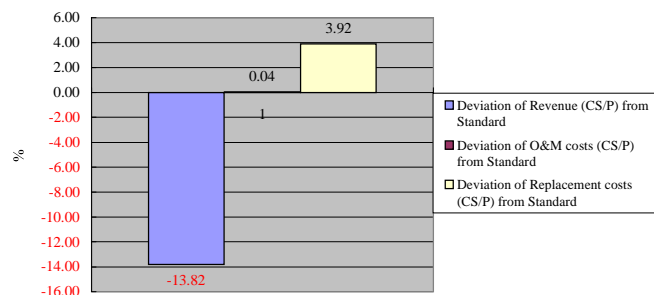
Deviation of O&M costs (CS/P) from Standard

%

Deviation of Replacement costs (CS/P) from Standard

%

**Deviation of Revenue, O&M costs, and Replacement cost from Past Actual Data**



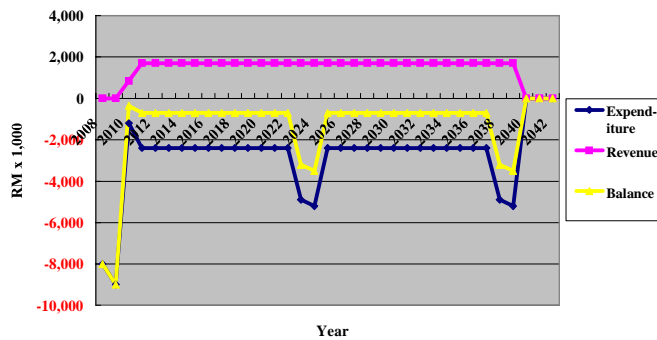
Note: If the deviation is more than 20% or less than -20%, the number (Revenue, O&M costs, or Replacement costs) is required to be checked in detail.

**INSTRUCTION OF THIS WORKSHEET**

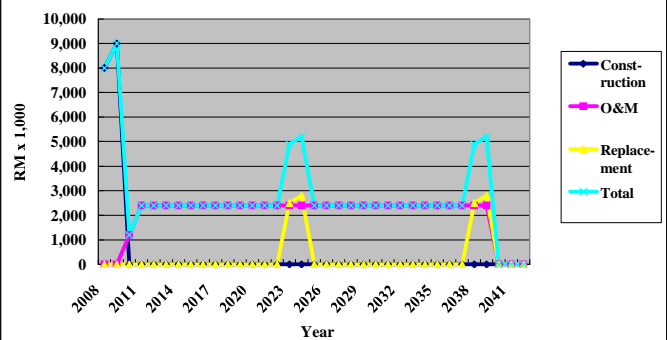
1) All the tables in this worksheet are automatically changed by putting numbers in the YELLOW CELLS of the Table 1 and Table 2 in the 'Stream 1' worksheet. No need to touch any cells on this worksheet.

**Note: Do not change the contents of BLUE COLOURED CELLS, as they contain automatic calculation formula.**

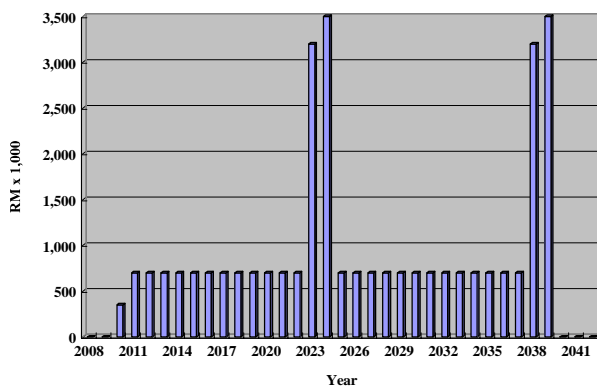
Reveue, Expenditure and Balace of the Project 1



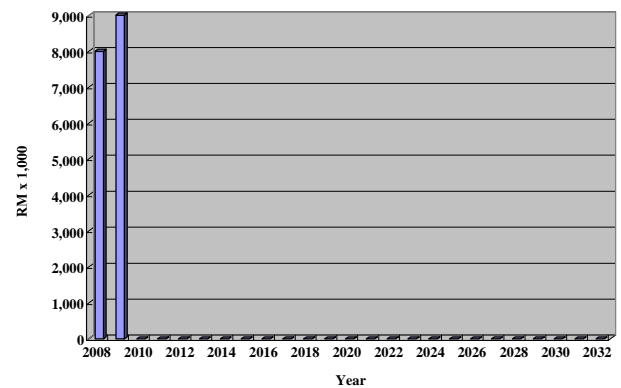
Cost Breakdown of the Project 1



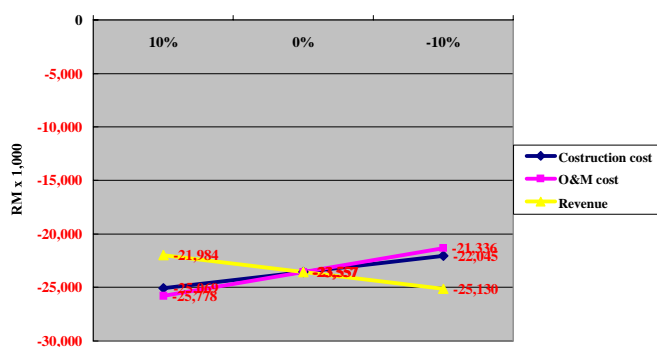
Net Cost Burden on Operator for O&amp;M, Replacement of the Project 1



Net Cost Burden on Developer for Constructor of the Project 1

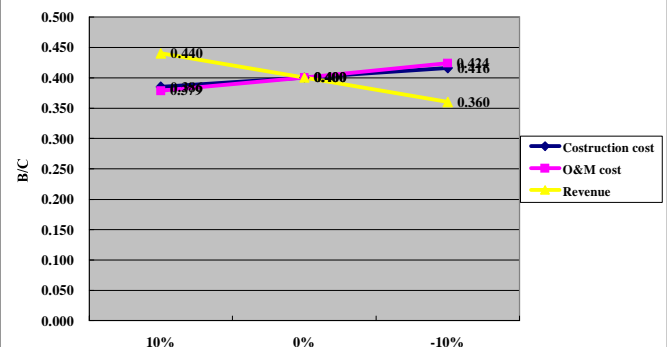


Sensitivity of NPV by changes of Construction Cost, O&amp;M Cost, and Revenue



Notes: Table shows the changes of Net Present Value of the project, in case each factor changes at plus and minus 10%. The Upper point is better in financial point of view. The steepest line is the most influential factor on NPV.

Sensitivity of B/C by changes of Construction Cost, O&amp;M Cost, and Revenue



Notes: The table show the changes of Benefit/Cost of the project, in case each factor changes at plus or minus 10%. The Upper point is better in financial point of view. The steepest line is the most influential factor on B/C.

**INSTRUCTION OF THIS WORKSHEET**

1) Put the number into the YELLOW CELL in Table 1 below and Table 2 referring from Revenue and Expenditure Stream of CS/P.

2) Check whether Revenue (maximum), O&M cost, and Replacement cost is relevant or not by analyzing the Table 2. If the deviations of them are within the plus and minus 20%, it is not necessary to change the original Revenue, O&M cost and Replacement cost. But if the deviations of them are not within the plus and minus 20%, it is necessary to check the CS/P report and find the reasons of deviations, such as geographical dispersal for high O&M cost, special technology for high O&M, or relatively more commercial and industrial customers for high revenue.

3) If there are understandable reasons, original numbers of CS/P will be used for Table 1. If there are no enough reasons, standard numbers of Revenue or O&M cost or Replacement cost shall be used and Table 1 will be changed by using those numbers.

**Note: Do not change the contents of BLUE COLOURED CELLS, as they contain automatic calculation formula.**

**Table 1. Revenue and Expenditure Stream of Project 2 of Sewerage Catchment Strategy**

(Unit: RM in 1,000)

Year	Const- ruction	O&M	Replace- ment	Total	Revenue Total	Balance
-1 2008	8,000	0		8,000	0	-8,000
0 2009	9,000	0		9,000	0	-9,000
1 2010		2,000		2,000	800	-1,200
2 2011		4,000		4,000	1,600	-2,400
3 2012		4,000		4,000	1,600	-2,400
4 2013		4,000		4,000	1,600	-2,400
5 2014		4,000		4,000	1,600	-2,400
6 2015		4,000		4,000	1,600	-2,400
7 2016		4,000		4,000	1,600	-2,400
8 2017		4,000		4,000	1,600	-2,400
9 2018		4,000		4,000	1,600	-2,400
10 2019		4,000		4,000	1,600	-2,400
11 2020		4,000		4,000	1,600	-2,400
12 2021		4,000		4,000	1,600	-2,400
13 2022		4,000		4,000	1,600	-2,400
14 2023		4,000	2,500	6,500	1,600	-4,900
15 2024		4,000	2,800	6,800	1,600	-5,200
16 2025		4,000		4,000	1,600	-2,400
17 2026		4,000		4,000	1,600	-2,400
18 2027		4,000		4,000	1,600	-2,400
19 2028		4,000		4,000	1,600	-2,400
20 2029		4,000		4,000	1,600	-2,400
21 2030		4,000		4,000	1,600	-2,400
22 2031		4,000		4,000	1,600	-2,400
23 2032		4,000		4,000	1,600	-2,400
24 2033		4,000		4,000	1,600	-2,400
25 2034		4,000		4,000	1,600	-2,400
26 2035		4,000		4,000	1,600	-2,400
27 2036		4,000		4,000	1,600	-2,400
28 2037		4,000		4,000	1,600	-2,400
29 2038		4,000	2,500	6,500	1,600	-4,900
30 2039		4,000	2,800	6,800	1,600	-5,200
31 2040				0		0
32 2041				0		0
33 2042				0		0
34 2043				0		0
35 2044				0		0
36 2045				0		0
37 2046				0		0
38 2047				0		0
39 2048				0		0
40 2049				0		0
41 2050				0		0
42 2051				0		0
43 2052				0		0

NPV: -39,290 x 1,000 RM B/C: 0.27

@ Discount Rate 8.00%

Notes:

**Table 2. Basic Information and Check Items for Revenue and Expenditure Stream**

**1. Basic Information**

- 1) First year of construction  Year of the start of initial construction
- 2) Construction period  years
- 3) PE of each STP (planned in CS/P)
- | STP 1st | STP 2nd | STP 3rd | STP 4th |
|---------|---------|---------|---------|
| 90,000  | 31,300  | 30,000  | 30,000  |
- \* leave blank, if it is not necessary to put any number in the cell.
- 4) Expanded PE of Existing STP, if any From  PE To  PE
- \* leave blank, if it is not necessary to put any number in the cell.
- 5) Connected PE increase without New STP  PE (input the incremental PE)  
(Connected to Existing STP without Expansion)
- 6) STP Rehabilitation without Expansion  PE (input total PE of rehabilitated STP)  
\* 80% Revenue of the capacity is assumed to be attributed by rehabilitation project.
- 6) Average Tariff Revenue per PE  RM/PE
- 7) Collection rate of sewerage tariff  %

**2. Relevancy of Revenue, O&M cost, Replacement cost in the Catchment strategy/plan**

**1) Revenue**

Standard Maximum Revenue  RM in 1,000 / year  
(from the past actual data)

Developer / Consultant Estimation  RM in 1,000 / year  
(from catchment strategy/plan)

Deviation from Standard Number  %

**2) O&M cost**

Standard Maximum O&M cost / year  RM in 1,000 / year  
(from the past actual data)

STP 1st	STP 2nd	STP 3rd	STP 4th
1,597	864	843	843

0 for Expanded STP  
0 for Rehabilitated STP  
4,147 (Total of the Above) RM in 1,000 / year

Developer / Consultant Estimation  RM in 1,000 / year  
(from catchment strategy/plan)

Deviation from Standard Number  %

**3) Replacement cost**

Standard Replacement cost / time  RM in 1,000/time  
(30% of construction cost)

Developer / Consultant Estimation  RM in 1,000/time  
(from catchment strategy/plan)

Deviation from Standard Number  %

Deviation of Revenue (CS/P) from Standard

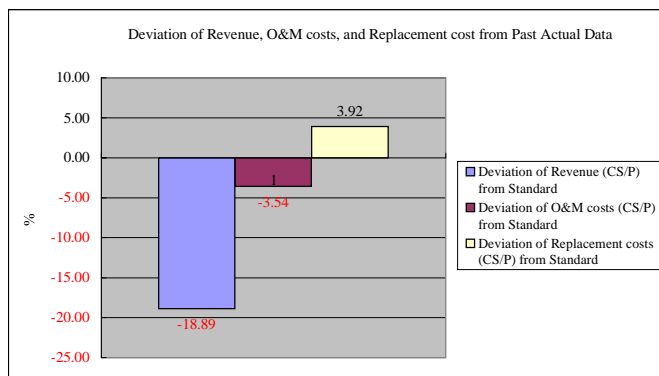
%

Deviation of O&M costs (CS/P) from Standard

%

Deviation of Replacement costs (CS/P) from Standard

%

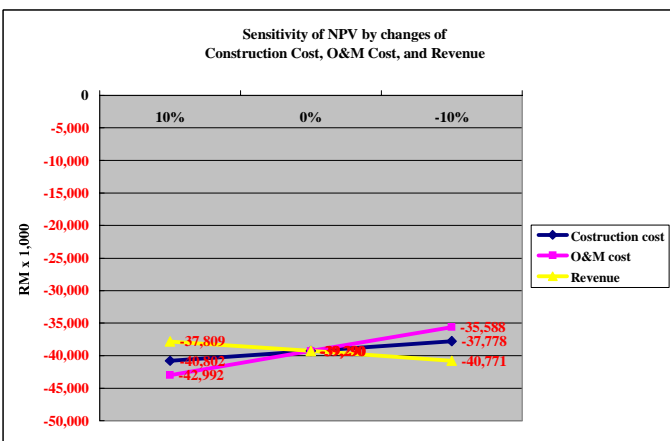
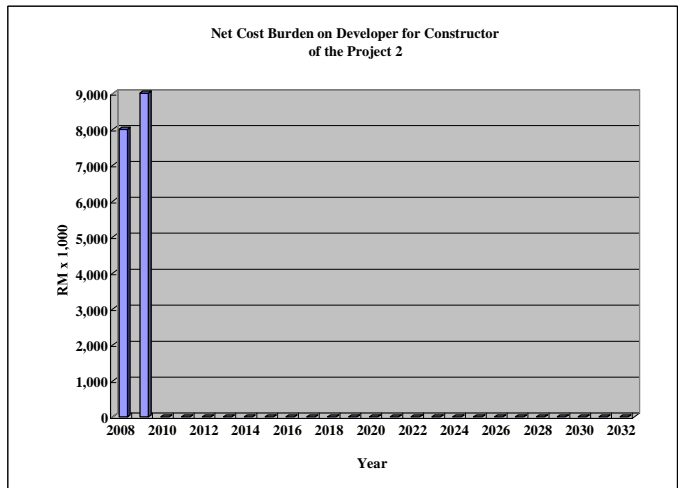
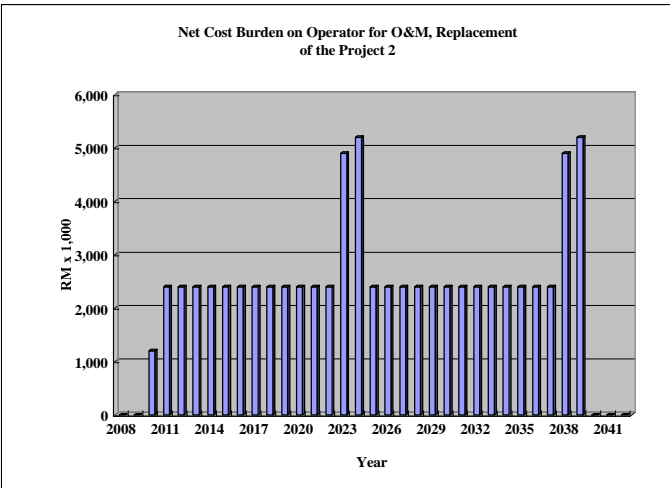
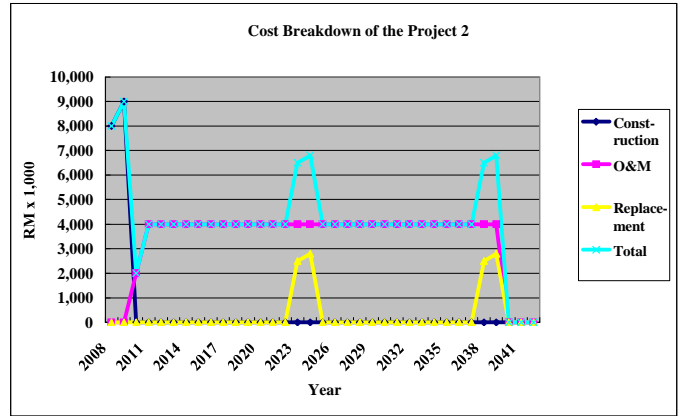
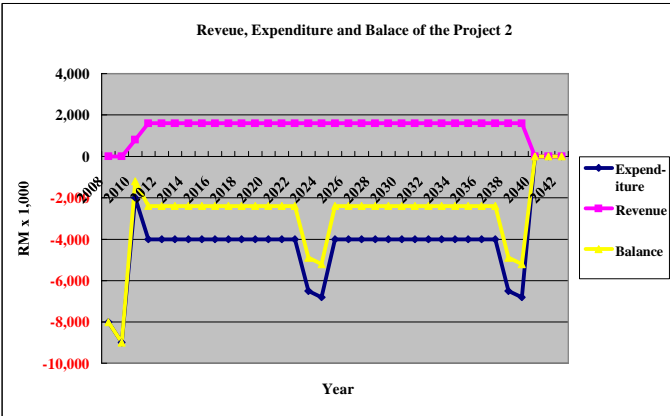


Note: If the deviation is more than 20% or less than -20%, the number (Revenue, O&M costs, or Replacement costs) is required to be checked in detail.

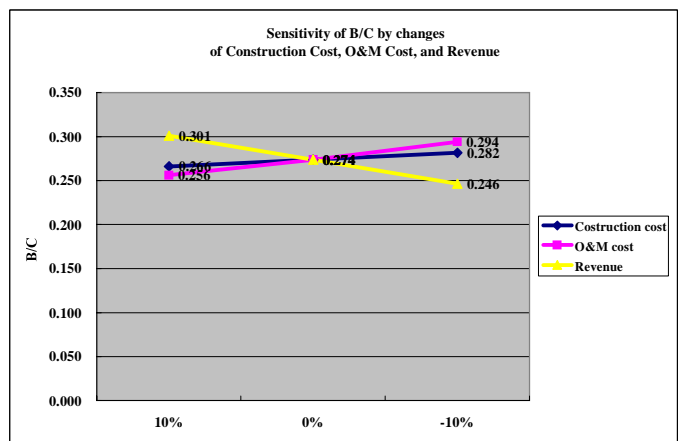
**INSTRUCTION OF THIS WORKSHEET**

1) All the tables in this worksheet are automatically changed by putting numbers in the YELLOW CELLS of the Table 1 and Table 2 in the 'Stream 2' worksheet. No need to touch any cells on this worksheet.

**Note: Do not change the contents of BLUE COLOURED CELLS, as they contain automatic calculation formula.**



Notes: Table shows the changes of Net Present Value of the project, in case each factor changes at plus and minus 10%. The Upper point is better in financial point of view. The steepest line is the most influential factor on NPV.



Notes: The table show the changes of Benefit/Cost of the project, in case each factor changes at plus or minus 10%. The Upper point is better in financial point of view. The steepest line is the most influential factor on B/C.

**INSTRUCTION OF THIS WORKSHEET**

1) Put the number into the YELLOW CELL in Table 1 below and Table 2 referring from Revenue and Expenditure Stream of CS/P.

2) Check whether Revenue (maximum), O&M cost, and Replacement cost is relevant or not by analyzing the Table 2. If the deviations of them are within the plus and minus 20%, it is not necessary to change the original Revenue, O&M cost and Replacement cost. But if the deviations of them are not within the plus and minus 20%, it is necessary to check the CS/P report and find the reasons of deviations, such as geographical dispersal for high O&M cost, special technology for high O&M, or relatively more commercial and industrial customers for high revenue.

3) If there are understandable reasons, original numbers of CS/P will be used for Table 1. If there are no enough reasons, standard numbers of Revenue or O&M cost or Replacement cost shall be used and Table 1 will be changed by using those numbers.

**Note: Do not change the contents of BLUE COLOURED CELLS, as they contain automatic calculation formula.**

**Table 1. Revenue and Expenditure Stream of Project 3 of Sewerage Catchment Strategy**

(Unit: RM in 1,000)

Year	Const- ruction	O&M	Replace- ment	Total	Revenue Total	Balance
-1 2008	8,000	0		8,000	0	-8,000
0 2009	9,000	0		9,000	0	-9,000
1 2010		1,600		1,600	800	-800
2 2011		3,200		3,200	1,600	-1,600
3 2012		3,200		3,200	1,600	-1,600
4 2013		3,200		3,200	1,600	-1,600
5 2014		3,200		3,200	1,600	-1,600
6 2015		3,200		3,200	1,600	-1,600
7 2016		3,200		3,200	1,600	-1,600
8 2017		3,200		3,200	1,600	-1,600
9 2018		3,200		3,200	1,600	-1,600
10 2019		3,200		3,200	1,600	-1,600
11 2020		3,200		3,200	1,600	-1,600
12 2021		3,200		3,200	1,600	-1,600
13 2022		3,200		3,200	1,600	-1,600
14 2023		3,200	2,500	5,700	1,600	-4,100
15 2024		3,200	2,800	6,000	1,600	-4,400
16 2025		3,200		3,200	1,600	-1,600
17 2026		3,200		3,200	1,600	-1,600
18 2027		3,200		3,200	1,600	-1,600
19 2028		3,200		3,200	1,600	-1,600
20 2029		3,200		3,200	1,600	-1,600
21 2030		3,200		3,200	1,600	-1,600
22 2031		3,200		3,200	1,600	-1,600
23 2032		3,200		3,200	1,600	-1,600
24 2033		3,200		3,200	1,600	-1,600
25 2034		3,200		3,200	1,600	-1,600
26 2035		3,200		3,200	1,600	-1,600
27 2036		3,200		3,200	1,600	-1,600
28 2037		3,200		3,200	1,600	-1,600
29 2038		3,200	2,500	5,700	1,600	-4,100
30 2039		3,200	2,800	6,000	1,600	-4,400
31 2040				0		0
32 2041				0		0
33 2042				0		0
34 2043				0		0
35 2044				0		0
36 2045				0		0
37 2046				0		0
38 2047				0		0
39 2048				0		0
40 2049				0		0
41 2050				0		0
42 2051				0		0
43 2052				0		0

NPV: -31,886 x 1,000 RM B/C: 0.32

@ Discount Rate 8.00%

Notes:

**Table 2. Basic Information and Check Items for Revenue and Expenditure Stream**

**1. Basic Information**

1) First year of construction  : Year of the start of initial construction

2) Construction period  years

3) PE of each STP (planned in CS/P)  STP 1st  STP 2nd  STP 3rd  STP 4th PE  
 \* leave blank, if it is not necessary to put any number in the cell.

4) Expanded PE of Existing STP, if any From  PE To  PE  
 \* leave blank, if it is not necessary to put any number in the cell.

5) Connected PE increase without New STP  PE (input the incremental PE)  
 (Connected to Existing STP without Expansion)

6) STP Rehabilitation without Expansion  PE (input total PE of rehabilitated STP)  
 \* 80% Revenue of the capacity is assumed to be attributed by rehabilitation project.

6) Average Tariff Revenue per PE  RM/PE

7) Collection rate of sewerage tariff  %

**2. Relevancy of Revenue, O&M cost, Replacement cost in the Catchment strategy/plan**

**1) Revenue**

Standard Maximum Revenue  RM in 1,000 / year  
 (from the past actual data)

Developer / Consultant Estimation  RM in 1,000 / year  
 (from catchment strategy/plan)

Deviation from Standard Number  %

**2) O&M cost**

Standard Maximum O&M cost / year  STP 1st  STP 2nd  STP 3rd  STP 4th  
 (from the past actual data)

Developer / Consultant Estimation  for Expanded STP  
 for Rehabilitated STP  
 (Total of the Above) RM in 1,000 / year

Developer / Consultant Estimation  RM in 1,000 / year  
 (from catchment strategy/plan)

Deviation from Standard Number  %

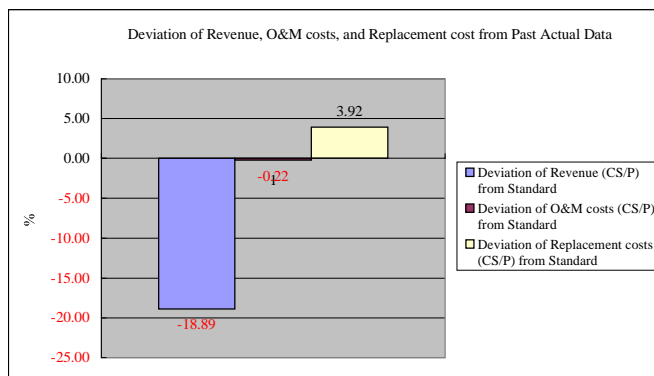
**3) Replacement cost**

Standard Replacement cost / time  RM in 1,000/time  
 (30% of construction cost)

Developer / Consultant Estimation  RM in 1,000/time  
 (from catchment strategy/plan)

Deviation from Standard Number  %

Deviation of Revenue (CS/P) from Standard  %  
 Deviation of O&M costs (CS/P) from Standard  %  
 Deviation of Replacement costs (CS/P) from Standard  %



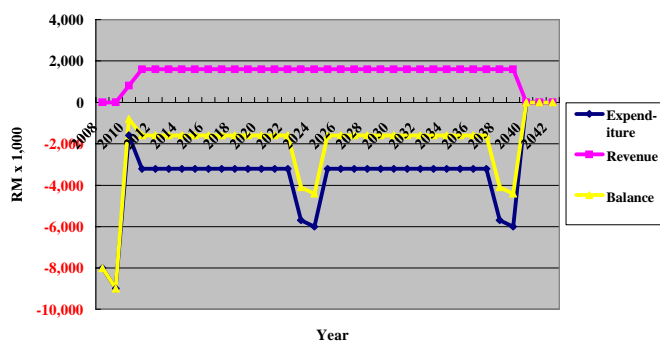
Note: If the deviation is more than 20% or less than -20%, the number (Revenue, O&M costs, or Replacement costs) is required to be checked in detail.

**INSTRUCTION OF THIS WORKSHEET**

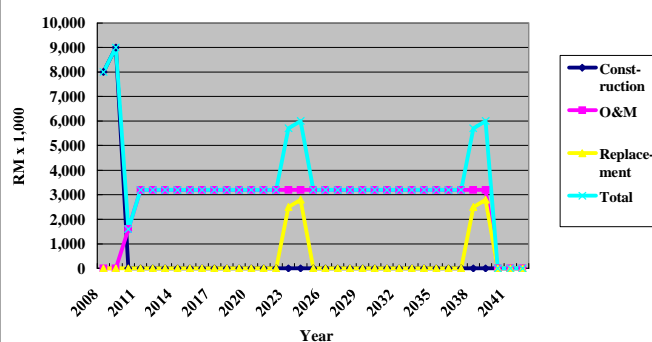
1) All the tables in this worksheet are automatically changed by putting numbers in the YELLOW CELLS of the Table 1 and Table 2 in the 'Stream 3' worksheet. No need to touch any cells on this worksheet.

**Note: Do not change the contents of BLUE COLOURED CELLS, as they contain automatic calculation formula.**

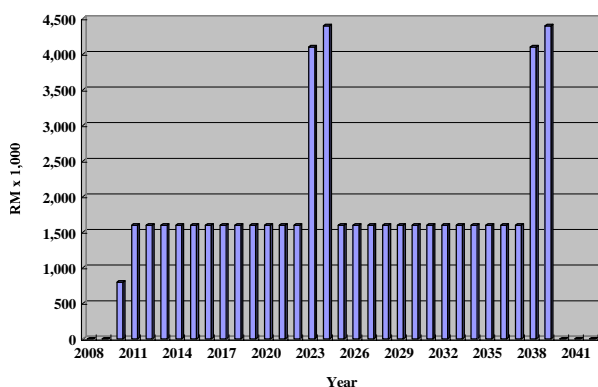
Reveue, Expenditure and Balace of the Project 3



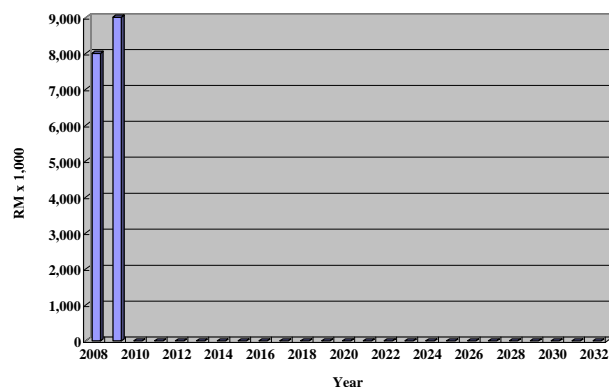
Cost Breakdown of the Project 3



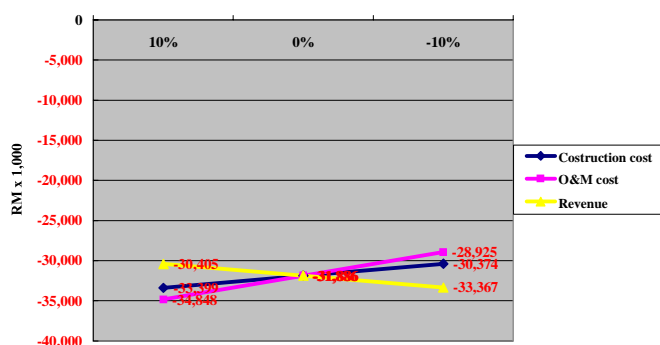
Net Cost Burden on Operator for O&amp;M, Replacement of the Project 3



Net Cost Burden on Developer for Constructor of the Project 3

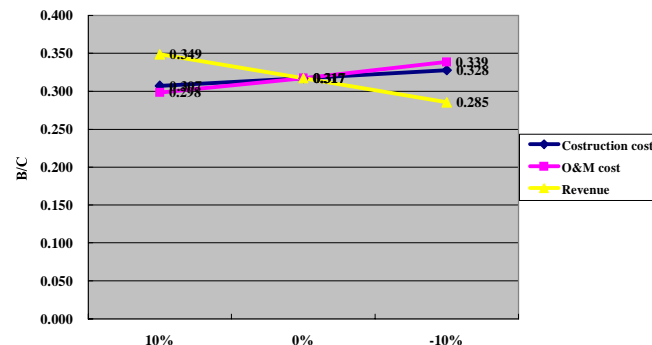


Sensitivity of NPV by changes of Construction Cost, O&amp;M Cost, and Revenue



Notes: Table shows the changes of Net Present Value of the project, in case each factor changes at plus and minus 10%. The Upper point is better in financial point of view. The steepest line is the most influential factor on NPV.

Sensitivity of B/C by changes of Construction Cost, O&amp;M Cost, and Revenue



Notes: The table show the changes of Benefit/Cost of the project, in case each factor changes at plus or minus 10%. The Upper point is better in financial point of view. The steepest line is the most influential factor on B/C.

**INSTRUCTION OF THIS WORKSHEET**

1) Put the number into the YELLOW CELL in Table 1 below and Table 2 referring from Revenue and Expenditure Stream of CS/P.

2) Check whether Revenue (maximum), O&M cost, and Replacement cost is relevant or not by analyzing the Table 2. If the deviations of them are within the plus and minus 20%, it is not necessary to change the original Revenue, O&M cost and Replacement cost. But if the deviations of them are not within the plus and minus 20%, it is necessary to check the CS/P report and find the reasons of deviations, such as geographical dispersal for high O&M cost, special technology for high O&M, or relatively more commercial and industrial customers for high revenue.

3) If there are understandable reasons, original numbers of CS/P will be used for Table 1. If there are no enough reasons, standard numbers of Revenue or O&M cost or Replacement cost shall be used and Table 1 will be changed by using those numbers.

**Note: Do not change the contents of BLUE COLOURED CELLS, as they contain automatic calculation formula.**

**Table 1. Revenue and Expenditure Stream of Project 4 of Sewerage Catchment Strategy**

(Unit: RM in 1,000)

Year	Const- ruction	O&M	Replace- ment	Total	Revenue Total	Balance
-1 2008	8,000	0		8,000	0	-8,000
0 2009	9,000	0		9,000	0	-9,000
1 2010		1,500		1,500	850	-650
2 2011		3,000		3,000	1,700	-1,300
3 2012		3,000		3,000	1,700	-1,300
4 2013		3,000		3,000	1,700	-1,300
5 2014		3,000		3,000	1,700	-1,300
6 2015		3,000		3,000	1,700	-1,300
7 2016		3,000		3,000	1,700	-1,300
8 2017		3,000		3,000	1,700	-1,300
9 2018		3,000		3,000	1,700	-1,300
10 2019		3,000		3,000	1,700	-1,300
11 2020		3,000		3,000	1,700	-1,300
12 2021		3,000		3,000	1,700	-1,300
13 2022		3,000		3,000	1,700	-1,300
14 2023		3,000	2,500	5,500	1,700	-3,800
15 2024		3,000	2,800	5,800	1,700	-4,100
16 2025		3,000		3,000	1,700	-1,300
17 2026		3,000		3,000	1,700	-1,300
18 2027		3,000		3,000	1,700	-1,300
19 2028		3,000		3,000	1,700	-1,300
20 2029		3,000		3,000	1,700	-1,300
21 2030		3,000		3,000	1,700	-1,300
22 2031		3,000		3,000	1,700	-1,300
23 2032		3,000		3,000	1,700	-1,300
24 2033		3,000		3,000	1,700	-1,300
25 2034		3,000		3,000	1,700	-1,300
26 2035		3,000		3,000	1,700	-1,300
27 2036		3,000		3,000	1,700	-1,300
28 2037		3,000		3,000	1,700	-1,300
29 2038		3,000	2,500	5,500	1,700	-3,800
30 2039		3,000	2,800	5,800	1,700	-4,100
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32 2041				0		0
33 2042				0		0
34 2043				0		0
35 2044				0		0
36 2045				0		0
37 2046				0		0
38 2047				0		0
39 2048				0		0
40 2049				0		0
41 2050				0		0
42 2051				0		0
43 2052				0		0

NPV: -29,110 x 1,000 RM B/C: 0.35

@ Discount Rate 8.00%

Notes:

**Table 2. Basic Information and Check Items for Revenue and Expenditure Stream**

**1. Basic Information**

- 1) First year of construction  Year of the start of initial construction
- 2) Construction period  years
- 3) PE of each STP (planned in CS/P)  STP 1st  STP 2nd  STP 3rd  STP 4th PE  
 \* leave blank, if it is not necessary to put any number in the cell.
- 4) Expanded PE of Existing STP, if any From  PE To  PE  
 \* leave blank, if it is not necessary to put any number in the cell.
- 5) Connected PE increase without New STP  PE (input the incremental PE)  
 (Connected to Existing STP without Expansion)
- 6) STP Rehabilitation without Expansion  PE (input total PE of rehabilitated STP)  
 \* 80% Revenue of the capacity is assumed to be attributed by rehabilitation project.
- 6) Average Tariff Revenue per PE  RM/PE
- 7) Collection rate of sewerage tariff  %

**2. Relevancy of Revenue, O&M cost, Replacement cost in the Catchment strategy/plan**

**1) Revenue**

Standard Maximum Revenue  RM in 1,000 / year  
 (from the past actual data)

Developer / Consultant Estimation  RM in 1,000 / year  
 (from catchment strategy/plan)

Deviation from Standard Number  %

**2) O&M cost**

Standard Maximum O&M cost / year  STP 1st  STP 2nd  STP 3rd  STP 4th  
 (from the past actual data)  
 for Expanded STP  
 for Rehabilitated STP  
 (Total of the Above) RM in 1,000 / year

Developer / Consultant Estimation  RM in 1,000 / year  
 (from catchment strategy/plan)

Deviation from Standard Number  %

**3) Replacement cost**

Standard Replacement cost / time  RM in 1,000/time  
 (30% of construction cost)

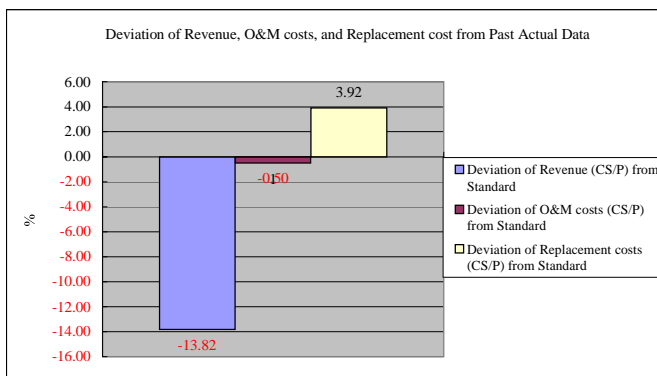
Developer / Consultant Estimation  RM in 1,000/time  
 (from catchment strategy/plan)

Deviation from Standard Number  %

Deviation of Revenue (CS/P) from Standard  %

Deviation of O&M costs (CS/P) from Standard  %

Deviation of Replacement costs (CS/P) from Standard  %

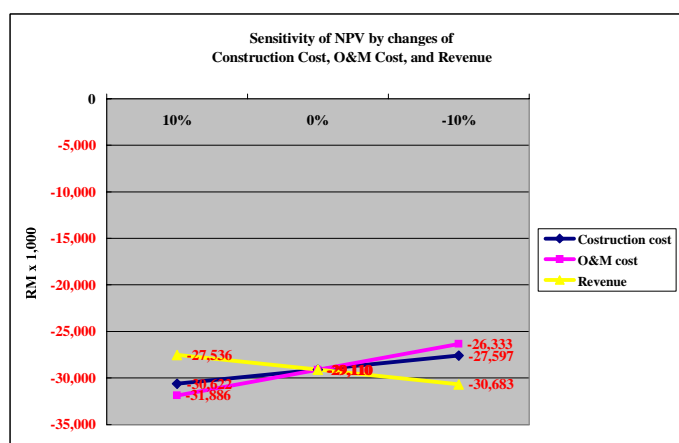
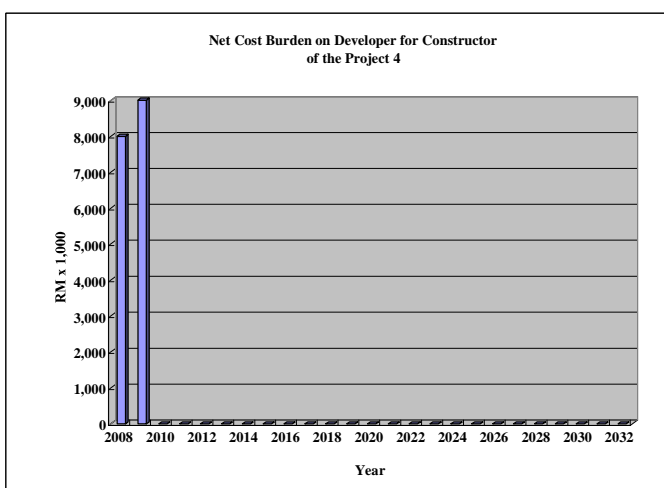
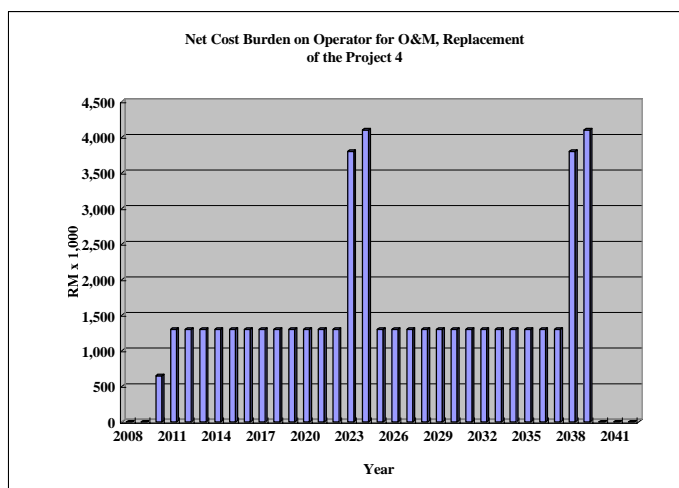
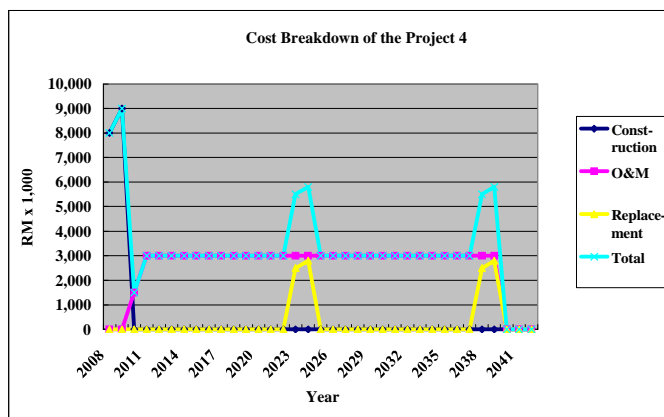
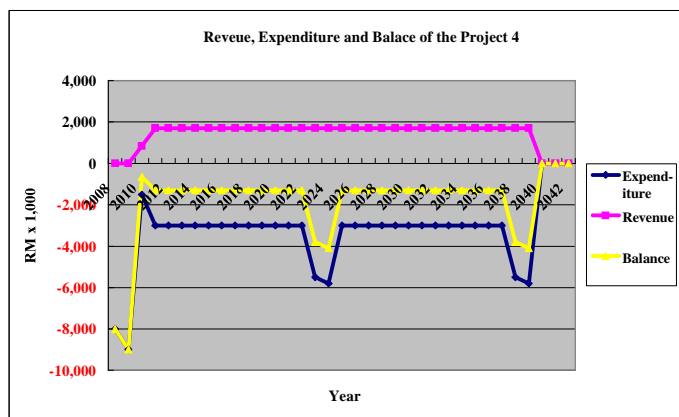


Note: If the deviation is more than 20% or less than -20%, the number (Revenue, O&M costs, or Replacement costs) is required to be checked in detail.

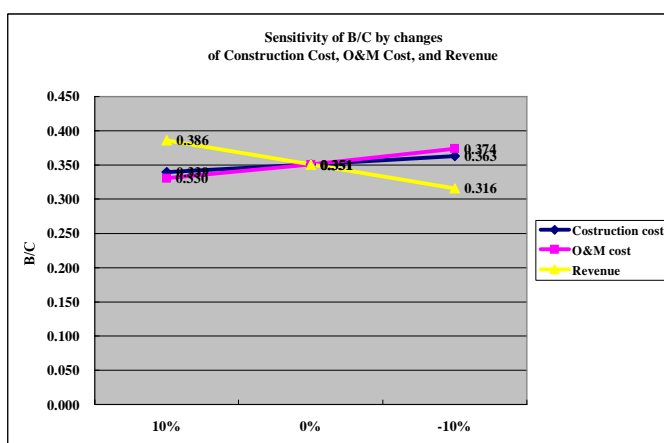
**INSTRUCTION OF THIS WORKSHEET**

1) All the tables in this worksheet are automatically changed by putting numbers in the YELLOW CELLS of the Table 1 and Table 2 in the 'Stream 4' worksheet. No need to touch any cells on this worksheet.

**Note: Do not change the contents of BLUE COLOURED CELLS, as they contain automatic calculation formula.**



Notes: Table shows the changes of Net Present Value of the project, in case each factor changes at plus and minus 10%. The Upper point is better in financial point of view. The steepest line is the most influential factor on NPV.



Notes: The table show the changes of Benefit/Cost of the project, in case each factor changes at plus or minus 10%. The Upper point is better in financial point of view. The steepest line is the most influential factor on B/C.