EVALUATION OF POST EIA : WATER QUALITY DUE TO THE CONSTRUCTION OF THE SUNGAI KINTA DAM PROJECT, PERAK

By

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ABSTRAK

Kualiti air merupakan antara elemen utama yang dikaji dalam Kajian Impak Persekitaran. Skop utama dalam kajian kes ini ialah penilaian Kajian Impak Persekitaran tentang kualiti air semasa dan selepas menyiapkan Projek Empangan Sungai Kinta, Mukim Hulu Kinta, Daerah Kinta, Perak daripada tahun 1991 hingga 2005. Kajian dibuat berdasarkan data yang diperoleh daripada pihak Pengurus Projek; Metropolitan Utilities Corporation Sdn. Bhd. Didapati, isu utama yang perlu diberikan perhatian ialah kekeruhan kerana ia juga dapat memberi gambaran secara fizikal tentang masalah pada parameter-parameter kualiti air yang lain seperti warna, nitrat, kekerasan, jumlah pepejal terampai dan sebagainya. Punca utama yang mendorong kepada penurunan kualiti air tersebut ialah aktiviti manusia di kawasan kajian iaitu kerja-kerja pembinaan empangan serta pembinaan lebuh raya di bahagian hilir kawasan tadahan hujan. Kualiti air di Sungai Kinta yang terjejas akan menjadi semakin baik selepas kedua-dua aktiviti tersebut tamat bagi menjamin bekalan air yang bersih dan selamat dibekalkan kepada penduduk Ipoh serta kawasan sekitarnya. Kesimpulannya, kualiti air di Sg. Kinta semasa pembinaan empangan adalah konsisten dengan penilaian yang telah dibuat dalam Kajian Impak Persekitaran yang telah disediakan sebelum projek dimulakan.

ABSTRACT

Water quality is one of the main element that is studied thoroughly in an Environmental Impact Assessment. The main scope of this case study is to determine the EIA on water quality during and after completing the construction works Sungai Kinta Dam Project, Mukim Hulu Kinta, Kinta District, Perak from 1991 until 2005. The analysis are done based on the data that were obtained from the Project Manager; Metropolitan Utilities Corporation Sdn. Bhd. The most critical issue is the turbidity because it can reflects the physical impacts to the other water quality parameters such as colour, nitrate, hardness, total suspended solids and etc. The main sources that contribute to the decreasing of water quality are the construction activities of dam and the construction of the Highway across the upper catchment areas. The water quality of Sungai Kinta that was affected will recover after both activities are completed to ensure safe and clean water can be supplied to population in Ipoh and the outlying areas. In conclusion, the water quality on the construction of the Sg. Kinta Dam Project, Perak is consistent with the evaluation of EIA that had been prepared before the project started.

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1.5 Background

Environmental Impact Assessment (EIA) is the systematic identification and evaluation of the potential impacts of proposed project. It is important for the developers, engineers and consultants to control, retain and improve the quality of environment before starting any development or project. The requirements depend on type and size of projects that have been listed by the Department of Environment (DOE) which involves 19 types of projects until now.

The construction of dams can bring a lot of impacts to the environments, which as listed in the EIA report of the Kinta Dam Project are:

i. Impacts on Physical Landforms and Soil
ii. Impacts on Land use
iii. Impacts on the Orang Asli
iv. Climatological Impacts
v. Soil erosion and Sedimentation Impacts
vi. Hydrological Investigations
vii. Impacts on Water Quality
viii. Impacts on Air Quality
ix. Impacts on Noise and Vibration

x. Impacts on the Flora, Fauna and Aquatic Environment

xi. Socio-economic Impacts

Mitigation measures have been taken to minimize and control the impacts stated including the Environmental Management Plan (EMP). The EMP has been formulated to ensure that the environmental quality is in compliance with the standards and regulations. As the scope on environmental issue is quite big, it had been narrowed down till it met the main scope of this project that is to determine the EIA on water quality during and after completing the construction works of Kinta Dam Project, Perak since the dam is constructed based on a need to provide sufficient potable water demanded by a fast growing population to Ipoh and the outlying areas.

Besides that, the water quality can slightly cause several negative impacts to the structure of the constructed dam through physical or chemical reactions. That is why it is really important to analyze and monitor the water quality along the time to ensure safe and clean water is provided.

1.6 Aims

The aim of this case study is to evaluate the water quality issue on the Post EIA of the Sg. Kinta Dam Project, Perak.

1.7 Objectives

The main objectives to be accomplished are:

1. To evaluate the issue related to the Post Environmental Impact Assessment on water quality during construction.
2. To determine the causes and impacts of water contamination.

1.8 Organization of Report

The report is organized into several main chapters in a continuous flow to clarify the ideas and to accomplish the aims and objectives of this case study. The chapters are:

- Chapter 1 - Introduction

  Consists of the background of this case study, aims, objectives and organization of the report.

- Chapter 2 - Literature Review

  Definition and clarification of terms used and related issues are being discussed in this chapter based on the references.

- Chapter 3 - Study Area

  Consists of the project description, topography, geology and hydrological of the Sg. Kinta Dam Project, Perak.

- Chapter 4 - Methodology

  Activities such as desk study, field study, laboratory test and analysis of results are discussed in the chapter.

- Chapter 5 - Results and Discussion

  Data of water quality are being analyzed through tables and graphs and the results are discussed.

- Chapter 6 - Conclusion and Suggestion

  Conclusions of the results that have been obtained are stated in this chapter and several suggestions on improving the analysis are listed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Water is the most essential element in life. For most human uses, as well as some commercial ones, the quality of the water is as important as its quantity. Lately, there were many cases reported in the media on pollution of our environment especially the water quality that will bring great impacts to the water supplies if no strict actions are taken. Many types of projects, activities and programs have brought severe impact implications for the surface-water environment such as rivers, lakes and oceans.

Construction of dams do effect the water quality somehow because instead of the highly cost of construction, it also destruct the natural habitat in streams and surrounding lands. (Smith & Enger, 1998) In addition, impounded water in dams has created a greater surface area, thus increases evaporation. In areas where water is scarce, the amount of water lost can be serious. This is particularly evident in hot climates. Furthermore, flow is often intermittent below the dam, which alters the water's oxygen content and interrupts fish migration. The populations of algae and other small organisms are also affected. Therefore, dam constructions require careful planning and the Environmental Impact Assessment is needed in reporting, evaluating and monitoring the impacts.

Mitigation measures can be taken as well as the Environmental Management Plan to ensure that the project complies with the requirements needed through the proper procedures and guidelines stated. Therefore, an evaluation has to be made in order to monitor the efficiency of the Environmental Management Plan that is also known as the Post Environmental Impact Assessment.

2.1.1 Hydrologic cycle

Over 70 percent of the earth's surface is covered by water. Water is an essential ingredient for life to exist on earth. Water vapor is highly variable in the atmosphere, ranging from 2 percent in cold dry climates to as such as 5 percent in the humid tropics. These numbers seem small but for every minute of the day nearly 1 billion tons of water is given up to the atmosphere. 80 percent of the water present in the atmosphere comes from evaporation from oceans. The geography of water plays a crucial role in shaping the earth, the distribution of soils, vegetation, and animals. (http://www.uwsp.edu/geo/faculty/ritter/geog101/uwsp_lectures/lecture_atmospheric_moisture.html)

Water is locked into a constant recycling process called the hydrologic cycle (See Figure 2.1). The figure shows the simple pattern of how the cycling of water through the environment and it is very important to understand the concept. Moisture in the atmosphere condenses into droplets that fall to the earth as rain or snow, supplying all living things with its life-sustaining properties.

Water that flows over the earth as surface water or through the soil as groundwater returns to the oceans, where it evaporates back into the atmosphere to begin the cycle again. We can determine the source of pollution to the environment and especially on water quality since it is a natural cycle to the flow of water and when a flow of water in streams is interrupted or altered, the value of the stream is changed.

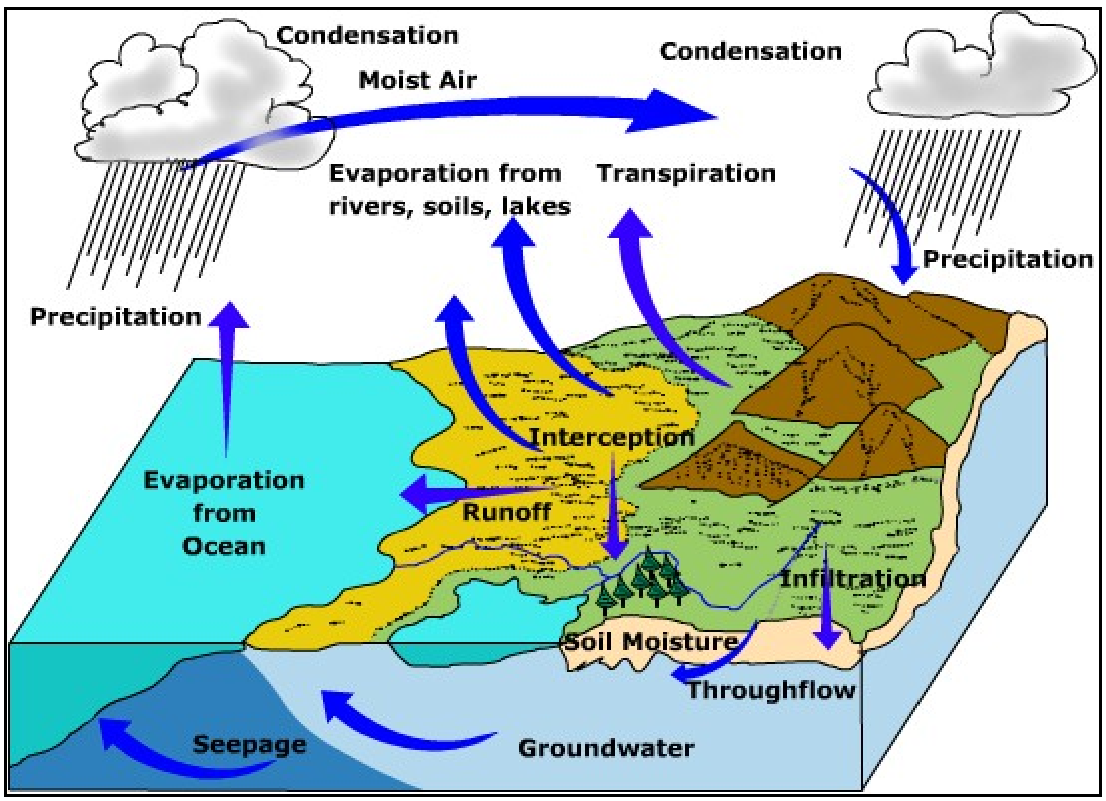

Figure 2.1: The Hydrologic Cycle

(Source: http://www.uwsp.edu/geo/faculty/ritter/images/hydrosphere/hydrocyc.jpg)

2.1.2 Water Quality

Water quality is related to the use intended for the water. It can be defined as the reflection of water composition as affected by nature and human cultural activities, expressed in term of both measurable quantities and narrative statements. In the United States, the descriptive water quality parameters are related to intended water use and for each intended use and water quality benefit; there may be different parameters to express the water quality. (Novotny, 2003).

Generally, the quality of water depends upon its physical, chemical and biological characterization of water. Physical parameters include colour, odour, temperature, solids (residue), turbidity, oil content, and grease content. Chemical parameters associated with the organic content of water include Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon (TOC), and Total Oxygen Demand. Inorganic chemical parameters include salinity, hardness, pH, acidity, alkalinity, and the presence of substances including iron, manganese, chlorides, sulfates, sulfides, heavy metals (mercury, lead, chromium, copper, and zinc), nitrogen (organic, ammonia, nitrite, and nitrate), and phosphorus. Biological properties include bacteriological parameters such as coliform, fecal coliforms, specific pathogens, and viruses. (Canter, 1996). These elements will affect the type of treatment needed in order to obtain the desired quality of treated water that is important for processing the drinking water.

Two main sources that adverse changes in water quality are contamination from natural sources and pollution from human activities. For example, contamination from natural sources can be from the original rainfall that is contaminated by acid deposition; more typically, runoff may draw organic matter and strong colour from material such as peat into the river system while pollution from human activities can be in different forms that are organic pollution, toxic pollution, microbial pollution, thermal pollution and radioactivity (Carpenter, 2001).

2.1.2.1 Water Quality Parameters

The selection of parameters or variables depends on the objectives of any programme or analysis in order to meet the objectives, efficiently and in the most cost effective way. The methods employed to measure the selected variables depend on access to equipment and reagents, availability of technical staff and their degree of expertise, and the level of accuracy required by the objectives of the programme (Chapman, 1992).

a) pH

The pH is an important parameter in water quality as it influences many biological and chemical processes within a water body and all processes associated with water supply and treatment. It is a measure of the acid balance of a solution and is defined as the negative of the logarithm to the base 10 of the hydrogen ion concentration.

The pH scale runs from 0 to 14 (i.e. very acidic to very alkaline), with pH 7 representing a neutral condition. Variations in pH can be caused by the photosynthesis and respiration cycles of algae in eutrophic water, as shown in figure 2.2 (Chapman, 1992).

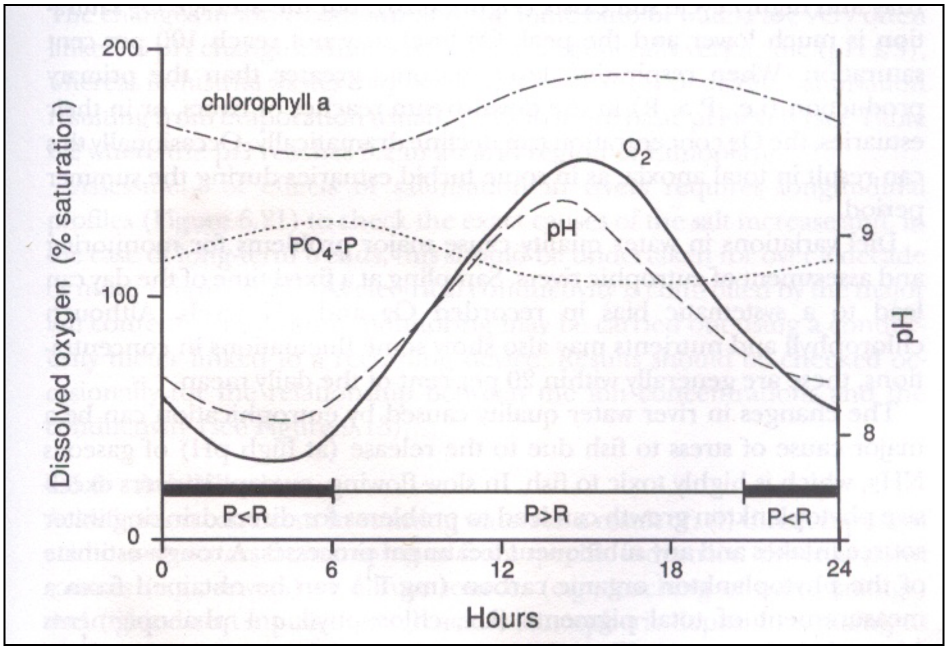

Figure 2.2: Theoretical variations in O_2 and pH associated with algal production in a euthropic river (P production; R respiration)

The pH of most natural waters are in the range of 4 to 9 with soft, acidic waters from "gelam" areas having low pH values and hard waters which have percolated through limestone having high values. Waters of low pH tend to be more corrosive and if the pH value is very low, water can have a sour or acidic taste. Generally, Malaysian river waters have pH values of less than 7.0 with 60% of them having values from 6.5 to 8.5 (Chuan, 1994).

b) Turbidity

Turbidity may be due to organic or inorganic impurities suspended in water. In Malaysian waters, silt, clay and finely divided organic matter are the predominant suspended solids. It is an indication of the clarity of water and is defined as the optical property that causes light to be scattered and absorbed rather than transmitted in straight line through a sample of water. Malaysian river waters have high turbidity, mostly of silt with 47% of them having more than 50 mg/l of suspended solids. The maximum acceptable raw water turbidity level is 1000 mg/l. It can be reduced to acceptable levels by appropriate coagulation, flocculation, sedimentation and filtration (Chuan, 1994).

c) Colour

Water should be as colourless as possible. Presence of colour indicates the presence of complex organic compounds, colloidal forms of iron and manganese, or highly coloured industrial wastes. Colour in any unpolluted water caused by natural organic colour producing substances such as humic and fulvic acids may be toxic (Chuan, 1994). Polluted water may have quite a strong apparent colour (Chapman, 1992).

d) Biochemical Oxygen Demand

The Biochemical Oxygen Demand (BOD) is an approximate measure of the amount of biochemical degradable organic matter present in a water sample.

It is defined by the amount of oxygen required for the aerobic micro-organisms present in the sample to oxidize the organic matter to a stable inorganic form (Chapman, 1992). Generally, the following classification can be made to access the degree of organic pollution in a water source (Chuan, 1994).

Table 2.1: Classification of BOD

BOD (mg/)	Classification
0 – 4	Clear
4 – 8	Mildly polluted
8 – 12	Moderately polluted
> 12	Grossly polluted

e) Chemical Oxygen Demand

The chemical oxygen demand (COD) is a measure of the oxygen equivalent of the organic matter in a water sample that is susceptible to oxidation by a strong chemical oxidant, such as dichromate. COD is a useful, rapidly measured, variable for many industrial wastes and has been in use for several decades form (Chapman, 1992).

f) Hardness

The hardness of natural waters depends mainly on the presence of dissolved calcium and magnesium salts, which can be further divided into carbonate hardness (determined by concentrations of calcium and magnesium hydro carbonates) and noncarbonate hardness (determined by calcium and magnesium salts of strong acids) (Chapman, 1992). Most rivers in Malaysia, the water is soft with less than 60 mg/l of hardness although some 10% of them may have hardness of more than 100 mg/l (Chuan, 1994). A comparison of hardness levels may be given as follows:

Table 2.2: Comparison of Hardness Level

Range (mg/l)	**Hardness Level**
0 – 50	Soft
50 – 100	Moderately soft
100 - 150	Slightly hard
150 – 200	Moderately hard
200 – 300	Hard
Over 300	Very hard

g) Manganese

Manganese resembles iron in its chemical behaviour and occurs in natural waters, but normally in lower concentrations than iron. Manganese can be a troublesome element even when present in small quantities.

In general, a lesser amount of manganese can be tolerated in a supply system than iron because although the deposition of manganese is slow, it is continuous. The recommended standard should be 0.1 mg/l (Chuan, 1994).

h) Organic Matter

Most freshwaters contain organic matter which can be measured as total organic carbon (TOC). In most samples, COD > BOD > TOC. However, in some situations these relationships may not be true such as when the sample contains toxic substances.

2.1.3 Environmental Impact Assessment

Environmental Impact Assessment (EIA) is essentially a planning tool for preventing environmental problems due to an action. It seeks to avoid costly mistakes in project implementation, either because of the environmental damages that are likely to arise during project implementation, or because of modifications that may be required subsequently in order to make the action environmentally acceptable. (http://www.doe.gov.my/index.php)

In other words, it can also be defined as a systematic activity designed to identify, evaluate and predict the potential impact on the physical-chemical, biological, cultural and socioeconomic components of environment and on man's health and well-being of legislative proposals, policies, programs, projects and operational procedures, and to interpret and communicate information about the impacts (Canter, 1996).

In Malaysia, EIA is required under section 34A, Environmental Quality Act, 1974. The guidelines & procedures can be referred to the manual of EIA from Department of Resource & Environment, Malaysia.

The implementing authority involved is the Department of Environment (DOE) in the Ministry of Natural Resources and Environment. The aim is to assess the overall impact on the environment of development projects. The objectives of Environmental Impact Assessment are:

1. To examine and select the best from the project options available.
2. To identify and incorporate into the project plan appropriate abatement and mitigating measures.
3. To predict significant residual environmental impacts.
4. To determine the significant residual environmental impacts predicted.
5. To identify the environmental costs and benefits of the project to the community.

There are three major steps in the EIA procedure adopted in Malaysia that are as follows:

1. Preliminary assessment of all prescribed activities. It should be initiated during the early stages of project planning and requires resources that are a small proportion of the man hours, money, skills and equipment committed to a pre-feasibility study and the assessment should be completed within the time frame of that study.

2. Detailed assessment of those prescribed activities for which significant residual environmental impacts have been predicted in the preliminary assessment. It should continue during project planning until the project plan is finalized.
3. Review of assessment reports. It is carried out internally by the DOE with the assistance from the relevant technical agencies for preliminary assessment reports and by an ad hoc Review Panel for detailed assessment reports.

According to the DOE's Client Charter, the period allocated for a review of a term of reference (TOR) and EIA report are as follows:

Term of Reference	-	2 months
Preliminary EIA Report	-	3 months
Detailed EIA Report	-	5 months

Based on Environmental Quality (Prescribed Activities) EIA, Order 1987 the EIA is required in water supply for construction of dams or impounding reservoirs with a surface area of 200 hectares or more. (http://www.doe.gov.my/index.php)

2.1.3.1 Mitigation Measures

Mitigation measures refer to project-activity design or operational features that can be used to minimize the magnitude of the impacts. According to the U.S. practice, mitigation includes:

1. Avoiding the impact altogether by not taking a certain action or parts of an action.

2. Minimizing the impact by limiting the magnitude of action and its implementation.
3. Rectifying the impact by repairing, rehabilitating or restoring the affected environment.
4. Reducing or eliminating the impact over time by preservation and maintenance operations during actions.
5. Compensating for the impact by replacing or providing substitute resources or environment.

These measures should be applied in sequence, beginning with avoiding the impact or according to ease of application. (Canter, 1996)

2.1.4 Post Environmental Impact Assessment

Post Environmental Impact Assessment encompasses effects or impact monitoring, and/or compliance monitoring. It has delineated three types of environmental monitoring which may be associated with the life cycle of an undertaking; these are baseline monitoring, effects or impact monitoring, and compliance monitoring. “Baseline monitoring” refers to the measurement of environmental variables during a representative pre-project period to determine existing conditions, ranges of variation, and processes of change. “Effects monitoring” or “impact monitoring” involves the measurement of environmental variables during project construction and operation to determine the changes which may have occurred as a result of the project.

Finally, "compliance monitoring" takes the form of periodic sampling and/or continuous measurement of levels of waste discharge, noise, or similar emissions, to ensure that conditions are observed and standards are met (Canter, 1996).

2.1.5 Environmental Management Plan

The Environmental Management Plan or EMP is a plan to undertake an array of follow-up activities which provide for the environmental management of a project so that the adverse environmental impacts are minimized and mitigated; beneficial environmental effects are maximized; and sustainable development is ensured. It will facilitate in terms of planning, monitoring, control and protecting the environment as well as the enforcement implementation by the Department of Environment to ensure the compliance of Environmental Impact Assessment conditions and the Environmental Quality Act, 1974. (http://www.doe.gov.my/index.php).

It should be modified along the way if:

1. Objectives and targets are revised or added.
2. Targets are not met.
3. Legal framework, products, markets, processes, facilities change and
4. Other factors that cause policy, objectives and targets to change, such as the changes in company or national financial situation arise.

The consideration factors in evaluating EMP are as follows:

- affordable
- feasible
- support from other functions e.g. finance, personnel and marketing
- realistic time frame to meet target
- compatible with business strategy
- proper selection and use of materialistic purchasing
- Incorporate research and development, design, production and distribution issues
- result in long/ short term environmental improvements (Hussein,1999)

Usually, in managing the water quality, analysis of water and obtaining the data have to be done every month to indicate any contamination that may occur in order to maintain the quality of water.

2.2 Impacts of Dam Construction

Dams are structures that block rivers in order to be the important source for water supply, hydroelectric energy etc. (Carpenter, 2001). Water resources projects, such as dam construction, often influence water quality and sometimes viewed as non-point sources of pollution. The process starts when the stream is dammed, the velocity of water will decrease.

Then, sediments formerly held in suspension settle out and water turbidity reduced. Pool of sediments will be created behind the dam where heavy metals and organic substances originally sorbed on sediments may become dissolved at the sediment-water interface and effects water quality below the dam.

Water released from the dam has low turbidity and the downstream pattern of bank erosion and sediment deposition will be different from what it was before the dam was built. These occurrences will really affect the water quality and somehow can create big problems to the dam structure and hydraulic machineries. Besides that, changes in river flow due to control and diversion can change the flood pattern of the rivers and sediment transportation will varies according to the type of flow, either it is an increased flow or a decreased flow (Ortolano, 1997).

The construction of dams will also change the quantity and quality of land use and land resources that if no mitigation measures or actions taken when negative impacts occur can affect the local economic and social impacts such as loss of property, displacement of people, ecological disturbance etc.

2.3 Water Quality Index (WQI)

A Water Quality Index (WQI), in common with many other indices systems, relates a group of water quality parameters to a common scale and combines them into a single number in accordance with a chosen method or model of computation.

The main objective of the WQI system is to use it as a preliminary means of assessment of a water body for compliance with the standards adopted for five designated classes of beneficial uses. The desired used of WQI to an assessment of water quality trends for management purposes even though it is not meant specially as an absolute measure of the degree of pollution or the actual water quality. (http://agrolink.moa.my/did/river/sgklang/sgklang_wqi.htm).

The WQI can be calculated based on the formula prepared by the Department of Environment (DOE), Malaysia. The parameters chosen for the WQI based on the DoE's formula are DO, BOD, COD, SS, AN and pH. The formula 2.1(http://www.doe.gov.my/index.php) used in the calculation of the DoE's WQI is:

$$WQI = (0.22 \times SIDO) + (0.19 \times SIBOD) + (0.16 \times SICOD) + (0.15 \times SIAN) + (0.16 \times SISS) + (0.12 \times SIpH) \quad (2.1)$$

SI - Sub index of each parameter
DO - Dissolve Oxygen
BOD - Biological Oxygen Demand
COD - Chemical Oxygen Demand

AN - Ammoniacal Nitrogen
SS - Suspended Solid
pH - Acidity/Alkalinity

The quality criteria or quality index of raw water can also be referred to Table 2.4 from the manual of Malaysian Water Association (MWA) Design Guidelines for Water Supply Systems.

The manual is an adaptation of the JKR Design Criteria and Standards for Water Supply Systems (Chuan, 1994). The criteria list the desirable level of various parameters suitable for conventional treatment (Environmental Quality (Sewage and Industrial Effluents) Regulations 1979).

Table 2.3 : General Rating Scale for the Water Quality Index (WQI)

<table>
<tr><td>Usage</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td><td>60</td><td>70</td><td>80</td><td>90</td><td>100</td><td>WQI</td></tr>
<tr><td>General</td><td colspan="6">Very Polluted</td><td colspan="2">Slightly Polluted</td><td colspan="3">Clean</td></tr>
<tr><td>Water Class</td><td colspan="4">V</td><td>IV</td><td colspan="3">III</td><td>II</td><td colspan="2">I</td></tr>
<tr><td>Public Water Supply</td><td colspan="4">Not Acceptable</td><td>Doubtful</td><td colspan="3">Necessary Treatment Becoming more Expensive</td><td>Minor Purific Required</td><td colspan="2">Purification not Necessary</td></tr>
<tr><td>Recreation</td><td colspan="2">Not Acceptable</td><td>Obvious Pollution Appearing</td><td>Only for Boating</td><td>Doubtful for Water Contact</td><td colspan="2">Becoming Polluted Still Acceptable Need Bacteria Count</td><td colspan="4">Acceptable for all Sports</td></tr>
<tr><td>Fish, Shellfish and Wildlife</td><td colspan="3">Not Acceptable</td><td>Coarse Fish Only</td><td>Handy Fish Only</td><td>Doubtful for Sensitive Fish</td><td>Marginal for Trout</td><td colspan="4">Acceptable for all Fish</td></tr>
<tr><td>Navigation</td><td colspan="3">Not Acceptable</td><td>Obvious Pollution Appearing</td><td colspan="7">Acceptable</td></tr>
<tr><td>Treated water Transportation</td><td>Not Acceptable</td><td colspan="10">Acceptable</td></tr>
<tr><td></td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td><td>60</td><td>70</td><td>80</td><td>90</td><td>100</td><td>WQI</td></tr>
</table>

Table 2.4 : Interim National River Water Quality Standards for Malaysia

Parameters (units)	**Classes**					
	I	**IIA**	**IIB**	**III**	**IV**	**V**
Ammoniacal Nitrogen (mg/l)	0.1	0.3	0.3	0.9	2.7	>2.7
BOD_5 (mg/l)	1	3	3	6	12	>12
COD (mg/l)	10	25	25	50	100	>100
DO (mg/l)	7	5-7	5-7	3-5	<3	<1
pH	6.5-8.5	6-9	6-9	5-9	5-9	-
Colour (TCU)	15	150	150	-	-	-
Elect. Cond.# (mmhos/cm)	1,000	1,000	-	-	6,000	-
Floatables	N	N	N	-	-	-
Odour	N	N	N	-	-	-
Salinity# ($^{0}/_{00}$)	0.5	1	-	-	2	
Taste	N	N	N	-	-	
Total Diss. Solid# (mg/l)	500	1,000	-	-	4,000	
Total SS (mg/l)	25	50	50	150	300	>300
Temperature (^{o}C)	-	Normal± 2	-	Normal± 2	-	-
Turbidity (NTU)	5	50	50	-	-	-
F. Colif+ (counts/100ml)	10	100	400	5,000	5,000	-
Tot. Colif. (counts/100ml)	100	5,000	5,000	(20,000)* 50,000	(20,000)* 50,000	>50,000

N - No visible floatable materials/debris, or no objectionable odour, or no objectional taste

- Related parameters, only one recommended for use

+ - Geometric mean

* - Maximum not to be exceeded

Table 2.5 : Effluent Discharge Standards to Malaysian Inland Waters

Parameter (mg/l unless otherwise stated)	Maximum Permitted Value	
	Standard A	Standard B
Temperature (^oC)	40	40
pH (units)	6.0-9.0	5.5-9.0
BOD_5 at 20^oC	20	50
COD	50	100
Suspended Solids	50	100
Mercury	0.005	0.05
Cadmium	0.01	0.02
Chromium, hexavelant	0.05	0.05
Arsenic	0.05	0.10
Cyanide	0.05	0.10
Lead	0.10	0.5
Chromium, trivalent	$0.20^{\#}$	1.0^{+}
Copper	$0.20^{\#}$	1.0^{+}
Manganese	$0.20^{\#}$ 0.20^{+}	1.0^{+}
Nickel	$0.20^{\#}$ 0.20^{+}	1.0^{+}
Tin	$0.20^{\#}$	1.0^{+}
Zinc	1.0	1.0
Boron	1.0	4.0
Iron	1.0	5.0
Phenol	0.001	$1.0^{⇳}$
Free Chlorine	1.0	$2.0^{⇳}$
Sulphide	0.5	0.5
Oil and Grease	Not detectable	10.0

<u>Notes:</u>

* The legislation does not specify any tolerance percentiles for the maximum permitted values and as such they are absolute values.

Where two or more of these metals are present in the effluent, the concentration of these metals shall not be greater than 0.50 mg/l in total.

+ Where two or more of these metals are present in the effluent, the concentration of these metals shall not be greater than 3.0 mg/l in total or 1.0mg/l in total for solution forms.

⇳ When both phenol and free chlorine are present, the concentration of phenol shall not be greater than 0.2 mg/l nor the concentration of free chlorine greater than 1.0 mg/l.