THE INSTITUTION OF ENGINEERS, MALAYSIA (IEM)

POSITION PAPER ON WATER QUALITY & ENVIRONMENT

SYNOPSIS

In view of the country's rapid development towards becoming a fully developed nation by 2020, various environmental issues, in particular those relating to water pollution have arisen and caught the attention of the general public. In our dynamism and excitement to achieve this status, the quality of the environment must also be preserved for the benefit of future generations. Water pollution, which degrades the water quality of rivers not only destroys aquatic habitation but also comprises economic diversity, such as fishery activities, eco-tourism and potable water resource. Although a general improvement trend is depicted in the current Water Quality Index (WQI) benchmarking scheme, the perception of the public sentiment and perception still remain critical. This perception is not entirely without basis, as the WQI benchmarking system has its own shortcomings and should not be taken as the ultimate indicator of a water quality condition.

One of the key problems related to river basin management is the disintegrated institutional approach that has been in place since independence, such as the segmentation of state and federal level agencies related to river management. The disintegration results in inadequate control of pollution sources and disparity of management policies. To tackle these problems at a macro-level, defragmentation of the current condition must first be achieved, coherent to the Integrated River Basin Management (IRBM) aspiration. Legal provisions that put emphasis on the total amount of pollution load entering the water column or Total Maximum Daily Load (TMDL), relative to its Waste Assimilative Capacity (WAC) must be devised, for sustainable outcome. This TMDL approach must encompass all pollution sources and should not be bounded by jurisdictional boundaries. The centralization of sewage and industrial pollution sources to centralized treatment facilities will help facilitate the TMDL objective.

Besides structural control measures, management practices can also help improve water quality such particularly in the case of NPS pollution. Riparian zone preservation and other Best Management Practices (BMPs) help minimize the impact of NPS pollution at the same time creating a good riverside habitat. A good road map to achieve sustainable water quality preservation is the national river studies conducted by many federal and state levels agencies. These studies may need to be further rationalized and integrated to achieve a common goal, putting emphasis of all aspects of water quality and river preservation.

1.0 INTRODUCTION

Water quality management of water resources in the country has come under close scrutiny and critic by many parties. Being so, whether the public is aware of it or not, various efforts and initiatives have been taken by the government and authorities to preserve, improve and rehabilitate river in Malaysia. In general, to preserve and improve the water quality status of our water bodies, pollution sources that input various constituents into the watercourses need to be appropriately managed and mitigated (control at source). Pollution sources are divided into two main categories; point and non-point sources of pollution and is characterized by their physical, chemical and biological attributes where some common constituents are listed in **Table 1.1** (Sawyer et al., 2003). Contrary to popular belief, water pollution is not only restricted to siltation, sedimentation and what is only visually observable in the river, but inculcates a wider spectrum of pollutants, each with its own effect towards the environment and beneficial uses of the water body. The management of these pollution sources falls under the jurisdiction of several agencies in the country, though not all possess legal authority. It is also a common misconception that the management of **ALL** pollution sources falls under the purview of the Department of Environment (DOE) through the Environmental Quality Act, 1974.

Table 1.1 : Water Quality Constituents

Physical	Chemical	Biological
• Total Suspended Solids (TSS) • Total Dissolved Solids (TDS) • Turbidity • pH	• Dissolved Oxygen (DO) • Biological Oxygen Demand (BOD) • Chemical Oxygen Demand (COD) • Total Organic Carbon (TOC) • Ammoniacal Nitrogen (NH_3-N) • Nitrite and Nitrate Nitrogen (NO_2-N and NO_3-N) • Phosphorous • Heavy Metals and Minerals • Pesticides	• Total coliform • Fecal foliform • *Escherichia coli* (*E. coli*) • Enterococci • Phytoplankton • Algae (chlorophyll) • Macroinvertabrates

This lack of legal authority only forms part of the problem; existing laws also possess certain deficiencies, if looking strictly from the viewpoint of environmental preservation. Malaysia is a developing country and environmental legislations cannot be too strict that it hampers economic growth. This is the dilemma faced by many stakeholders and government authorities, to strike a balance between environmental preservation and economic growth. That being so, in-line with Vision 2020 and the status of a developed nation, the country must now seriously look at a progressive and sustainable environmental management strategy. Dedication and devotion towards environmental quality preservation is a key attribute of a developed nation.

This paper aims to provide the input of the Institution of Engineers Malaysia (IEM) pertaining to various issues related to water quality and environmental management of water bodies in the country. The paper is divided to two main segments, the first segment (**Sections 2.0 – 2.6**) discusses about the current conditions of rivers in Malaysia and problems related to management, whereas the second segment (**Sections 3.0 – 3.6**) proposes solutions to these problems.

2.0 ISSUES PLAGUING WATER QUALITY AND ENVIRONMENTAL MANAGEMENT

Before a palatable solution concerning water quality and environmental preservation can be reached, the various underlying issues and problems must first be unraveled and thoroughly understood. In this section, the importance of water quality and problems plaguing its preservation in Malaysia will be discussed, with the aim of drafting a sustainable solution framework.

2.1 Clean Rivers for Life and Livelihood

Rivers in Malaysia in their natural state support a wide variety of ecological species; take for example the Similajau and Semba rivers (*Sg. Similajau* and *Sg. Semba*) located north-east of Bintulu, Sarawak. The aquatic species present, particularly near the estuarine region includes the rare Irrawaddy Dolphin, Leatherback Turtle (*Penyu Belimbing*) and even the saltwater crocodile, which feast on crayfish that can be found in abundance here. This is unsurprising, as the ambient water quality status is very pristine. A study by Zainudin (2009) showed the dissolved oxygen (DO) levels to be hovering between 6.8 – 7.5 mg/L, whereas the organic levels (BOD_5) was at 1 mg/L for majority of the areas monitored. Shrimp are also a source of economic prowess for local villagers that live within the vicinity such as Kg. Kuala Nyalau (**Figure 2.1**).

Figure 2.1 : Clean Rivers and Ecology

Another survey of Sg. Pahang also depicts the same condition, albeit under different circumstances (Zainudin, 2009). Temerloh town, located along the riverbank is famous for the silver catfish (*Ikan Patin*). The fish is bred in cage cultures in Sg. Pahang. DO levels remained fairly good between 7.2 – 7.4 mg/L, whereas the in-stream BOD was between 2 – 3 mg/L, ideal for most aquaculture activities. There is also wild Patin present in the Pahang River, but these, in the commercial market costs much more. Enthusiasts are willing to pay the extra amount to have a taste, of the fish cooked in gravy of gulai tempoyak. These fish are an important source of income for the aquaculturists along Sg. Pahang, in fact not long a ago several news portals reported a contingent of people paying as much as RM 13,000 for one serving of Patin (Utusan Malaysia, 2011).

The two examples illustrate the importance of pristine water quality for ecological diversity translating into a source of income for local residents hence also contributing to the local economy. The importance of water quality preservation inculcates environmental preservation and can be further extended to other beneficial uses of water including for potable water supply. Elevated levels of nitrate (NO_3-N) in access of 10 mg/L in drinking water can lead to *Methemoglobinemia* (blue baby syndrome), whereas heightened pathogen levels (bacteria and viruses) not only compromise use of the water for drinking, but for recreational (skin contact) activities as well (US EPA, 2009). Heavy metals in turn are carcinogenic (US EPA, 2009) which can lead to a wide variety of complications. Ammoniacal nitrogen (NH_3-N) contamination in raw water source not only emits a pungent odor, but also react with the chlorine used in the disinfection process producing chloramines (Yee et al., 2008) which in-turn may effect the potency of disinfection. These are but a few examples illustrating the effects of the contaminants present in the water column besides the obvious physical deterioration (increased turbidity) due to sediment loading.

2.2 Water Quality Statuses and River Pollution in Malaysia

From a macro level perspective, based on the Environmental Quality Report (EQR), 2011 published by the Department of Environment (DOE), the level of pollution is not at worrying level, with only 39 rivers being classified as “polluted” whereas 275 is denoted as being “clean” as shown in **Figure 2.2**. Between 2005 and 2011, there appears to be a decreasing trend of “polluted” rivers which of course results in an upward trend of “slightly polluted” and “clean” rivers (DOE, 2006). At first glance, this may appear to be satisfying trend, and for the most part it is true, though from a water quality management perspective this may not truly be representative of the actual water quality attributes. The classification method implored to arrive at these conclusions is the DOE-WQI or Water Quality Index.

The DOE-WQI is an opinion poll formula, developed from a select set of six parameters to represent the water quality conditions for a specific river basin (DOE, 2011). The DOE-WQI is indeed a useful tool for instantaneous water quality benchmarking, though there are times when this tool may not be appropriately used coherent to the objective hand. Such is the instance when trying to represent the water quality status of a particular basin, using a single number as shown in the EQR. Malaysia is a tropical country, susceptible to weather changes throughout the course of the year; therefore one would indeed expect some variation in the water quality status coherent to these changes. Using a **single** WQI classification, to designate the water quality variations throughout the year, at many different sampling locations is inappropriate, even more so when only six parameters are taken into account.

In Australia, river benchmarking is not only done by reviewing the water quality component alone, but other components as well, including flow (hydrology and hydraulics), aquatic life, riparian zone (streamside zone) and physical form (DSE, 2004) using the Index of Stream Condition (ISC). A sample of the ISC output is shown in **Figure 2.3**, whereas in Canada, a wider spectrum of parameters is used in a target oriented WQI which can be easily adapted in Malaysia (Neary et al., 2001). This is not to say that the DOE-WQI is totally inferior, it can still be used as a benchmarking tool, though not a decision making tool. For target-based decision-making, the National Water Quality Standards (NWQS) should be referred to coherent to the desired target class. Unfortunately, there is still a lack of understanding amongst authorities as to the specific meaning of each class of the NWQS and how they were derived. Unless this lack of understanding is mitigated, water quality preservation efforts in the country will continue to be hampered. An article published by the IEM in the February 2010 edition of Jurutera elaborates further on water quality benchmarking (Zainudin, 2010).

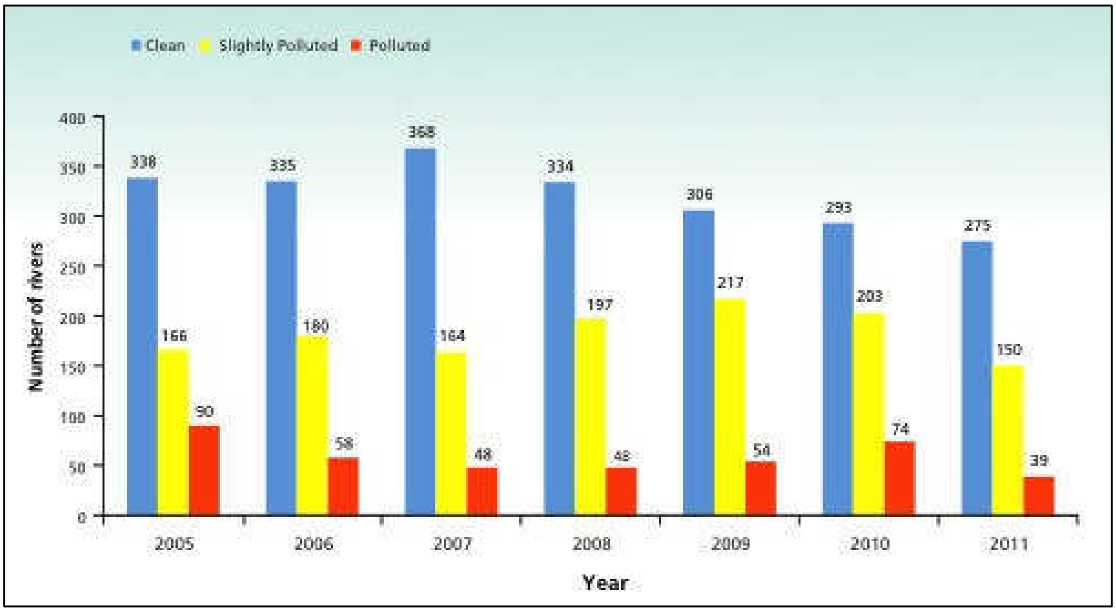

Figure 2.2 : DOE-Water Quality Index Classification, 2005 – 2011 (DOE, 2011)

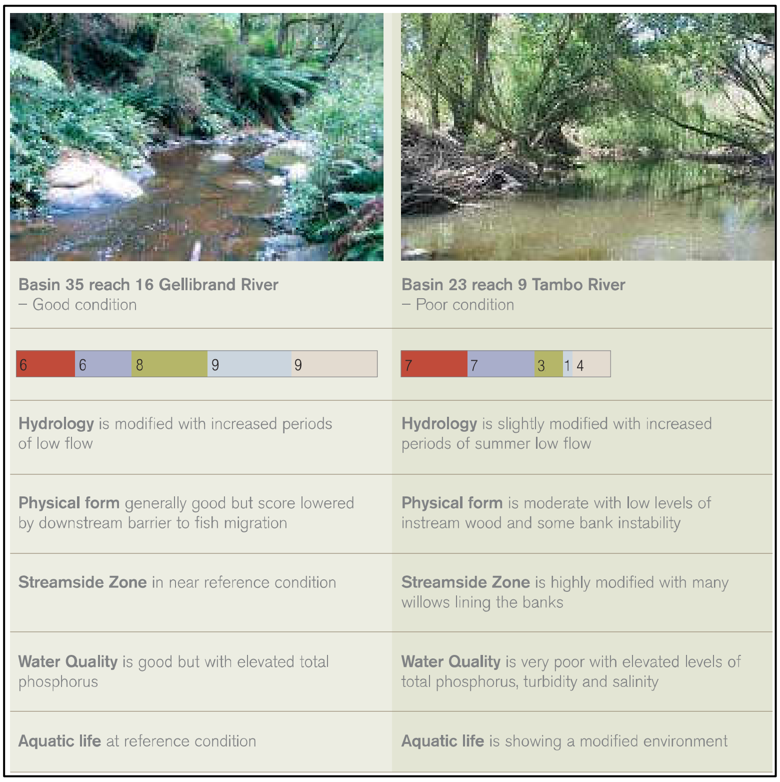

Figure 2.3 :

Sample Output Department of Sustainability and Environment (Australia), Index of Stream Condition (ISC) Benchmark for Two Rivers (DSE, 2004)

The issue of river pollution in Malaysia is function of many things; most protruding is the rapid developmental activities propelling the country's economic growth throughout the years. The palm oil industry for example, generates huge revenues and wealth, though sometimes at the expense of environmental preservation. **Figure 2.4**, depicts Sg. Pang Burong, severely affected by Palm Oil Mill Effluent (POME) released from the upstream mills, resulting in anaerobic water quality conditions. Land application practice in Sabah permits discharge of untreated or partially treated effluent on land (Ogg, 2007) with the objective enriching the topsoil organic content, unfortunately during precipitation, the topsoil becomes saturated with rainwater, inhibiting percolation, thus most of the organic laden effluent will enter the nearest watercourse, instigating oxygen demand, consequentially depleting the in-stream

DO. In addition, plantation boundaries also encroach into the riparian zone, which results in 3 major effects (Klapproth and Johnson, 2009):

a) Destruction of riparian habitat, which are host to a wide variety of flora and fauna.
b) The flora acts as natural biofilter, which traps suspended solids from plantation runoff as well as up taking organic and inorganic matter (phytoremediation). Thus without the riparian vegetation, pollutants will enter the receiving water column more easily as shown in **Figure 2.3** (Sg. Kalumpang).
c) The buffer zone and increased spatial distance also promotes removal of pollutant species.

Figure 2.3 : Sg. Pang Burong and Sg. Kalumpang

The above example illustrates the impact of only a handful, scattered pollution sources in a rural setting. Urban rivers such as Sg. Perembi and Sg. Buloh (**Figure 2.4**), which receives cumulative pollution load from the Pasir Gudang Industrial, are area also not spared from degradation. Effluent from the industrial area is released into adjacent drains, which subsequently find its way into the river. The mix of sewage industrial effluent yields a cocktail mixture high in organics and inorganic constituents including heavy metals (Zainudin, 2005).

Figure 2.4 : Sg. Perembi and Sg. Buloh

2.3 Disintegrated River Basin Management

A major obstacle in achieving water quality preservation in Malaysia is the current disintegrated management approach for river basins that has been in place since the country's independence, particularly on the part of authorities and stakeholders. The disintegration can be traced back to the Ninth Schedule of the Constitution, which identifies three, legislative lists: the Federal List, the State List and the Concurrent List (JUC, 2009). Land and rivers are, on the whole, regarded as a "state matter", in reality however, there are various government agencies that play a role in determining the state of the river system at both state and federal levels.

For the concept of Integrated River Basin Management (IRBM) to be realized in Malaysia, inter-agency cooperation, resource sharing and coordination, must first be achieved. Although DID and DOE are currently under the same provisional cluster in the federal government now, integration or cooperative ties between the two in relation to IRBM implementation has been relatively slow (Baginda and Zainudin, 2009). DID as an entity, has a multitude of resources at their helm, with historical and hydraulic data going back since the early 1960s. Unfortunately, the resources are now under-utilized, prioritizing more towards flood mitigation and control, which unfortunately throughout the years have lead to the destruction of various river ecosystems due to straightening, channeling and construction of concrete structures in-line with its flood mitigation objective (Baginda and Zainudin, 2009). Heightened in-stream velocity inhibits propagation of aquatic species resulting in ecosystem destruction. Riparian vegetation and growth are also compromised during the channeling process.

DOE whose primary focus is on water quality and ecology, does not specifically have an IRBM plan in place, though many technically sound river rehabilitation studies have been conducted. DOE is the primary government arm in charge of enforcing the Environmental Quality Act, 1974 (EQA, 1974), which encompasses regulations related to control of point source discharge from industries in Malaysia. The problem is current regulatory provisions for effluent discharges under the EQA are mostly concentration based with little consideration for Total Maximum Daily Load (TMDL) or Waste Assimilative Capacity (WAC). TMDL is essentially the loading or rate of release of a particular pollutant entering a water column.

A classic example of TMDL and WAC is the ability of a stream to accept modest amounts of biodegradable waste, graphically illustrated in **Figure 2.5**. Bacteria in a stream utilize oxygen to degrade the organic matter (or BOD), causing the oxygen levels in the stream to fall; but the decrease in oxygen also causes additional oxygen to enter the stream from the atmosphere, a process referred to as reaeration (Mills et al., 1986). A stream can assimilate a certain amount of waste and still maintain a dissolved oxygen level high enough to support a healthy population of fish and other aquatic organisms. However, if the assimilative capacity is exceeded, the oxygen level will fall below the threshold required to protect organisms in the stream. Therefore the rate of waste or TMDL entering the water column must not exceed its WAC to preserve the current water quality status (Mills et al., 1986). The TMDL in theory should address point and non-point sources of pollution, the naturally occurring background loading with an acceptable margin-of-safety (MOS). **Tables 2.1 and 2.2** illustrate pollution loading from various point-sources in Sg. Langat and Sg. Selangor river basins. From this, there are clear variations between the significant point source pollution load, and hence the mitigation measures have to address these issues specifically.

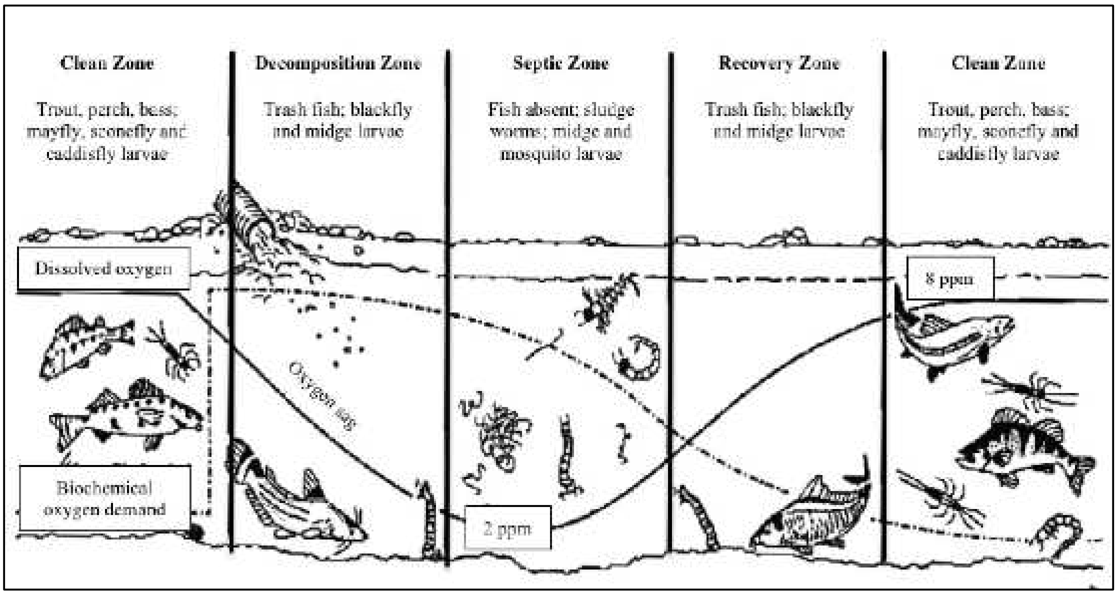

Figure 2.5 : DO Response Towards Organic (BOD) Input (Davis and Cornwell, 1998)

Besides this loophole in the law, many activities or point source pollution contributors do not fall under the purview of the EQA, hence also DOE, such as sullage or grey water sources. Sullage is wastewater that originates from domestic activities, including from residential sources (kitchen, bathing, washing), restaurants, food courts, car wash, workshops etc. These premises discharge high organic contaminants into drains and watercourses through illegal connections in contradiction to the Street, Drainage and Building Act, 1974; an act under the purview of the local councils (PNMB, 2007). The existence of illegal squatter areas or rural areas discharging sewage without treatment into the river system makes the situation even worse.

Table 2.1 : Total Estimated Pollution Load (kg/day) from various Point Sources of Pollution in the Sg Langat Basin (UPUM, 2002)

Source	BOD$_5$	COD	SS	Total Metals	NH$_3$-N
Industry	5,536	22,650	14,414	244	1,513
Wet market	384	1,073	409	5	56
Pig Farm	201	1,020	460	6	725
Sand Mining	820	20,876	206,670	2,778	57
Landfill	1,048	5,647	8,150	31	664
Public STPs	5,047	20,864	5,692	89	3,071
Private STPs	1,060	4,344	1,195	19	645
ISTs	7,140	17,256	8,354	-	2,784

Table 2.2 : Summary of Loading from Point Source in Sg. Selangor basin (kg/day) (UPUM, 2005)

Source	BOD$_5$	COD	TSS	Total Metals	NH$_3$-N
Industrial estates	1008	2124	632	1093 (181)	ND
Public STPs	2082	9196	1687	798	836
Wet Markets	132	201	48	021	6
Sand mining (3 sites)	89	771	35,133	0.056	ND
Landfill (1 site)	178	801	34	0.002	ND

TMDL is a very important point to consider in IRBM implementation, particularly when legislative and supporting regulatory standards must be in place to ensure a successful outcome of the initiative. From previous river rehabilitation studies conducted by DOE (MERC, 2010), sound technical recommendations have been made to improve overall water quality and ecology, as a direct function its WAC relative to the National Water Quality Standards (NWQS) shown in **Figure 2.6** (DOE, 2008).

PARAMETER	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2.7
Biochemical Oxygen Demand	mg/l	1	3	3	6	12	> 12
Chemical Oxygen Demand	mg/l	10	25	25	50	100	> 100
Dissolved Oxygen	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	-	-	-
Electrical Conductivity*	μS/cm	1000	1000	-	-	6000	-
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	2	-
Taste	-	N	N	N	-	-	-
Total Dissolved Solid	mg/l	500	1000	-	-	4000	-
Total Suspended Solid	mg/l	25	50	50	150	300	300
Temperature	°C	-	Normal + 2 °C	-	Normal + 2 °C	-	-
Turbidity	NTU	5	50	50	-	-	-
Faecal Coliform**	count/100 ml	10	100	400	5000 (20000)^	5000 (20000)^	-
Total Coliform	count/100 ml	100	5000	5000	50000	50000	> 50000

CLASS	USES
Class I	Conservation of natural environment. Water Supply I – Practically no treatment necessary. Fishery I – Very sensitive aquatic species.
Class IIA	Water Supply II – Conventional treatment required. Fishery II – Sensitive aquatic species.
Class IIB	Recreational use with body contact.
Class III	Water Supply III – Extensive treatment required. Fishery III – Common, of economic value and tolerant species; livestock drinking.
Class IV	Irrigation
Class V	None of the above.

Figure 2.6 : National Water Quality Standards (NWQS) and its designated uses (DOE, 2008)

2.4 The Sewage Issue

Sewage (**Figure 2.7**) was identified as one of the biggest contributor of pollution load (TMDL) in several river basins in Selangor particularly in terms of ammoniacal nitrogen (NH_3-N) (MM, 2006). Before the privatization initiative came into being (pre-1994), sewage management in the country was fragmented, typically under the purview of various local councils (IWK, 2011). After the privatization initiative, sewage management in most states was handed to the private conglomerate, Indah Water Konsortium (IWK). IWK having inherited these many aging sewage treatment plants (STPs), were under pressure to rationalize the national sewage initiative to greater heights. As a private entity, they would have to charge for their services in order to maintain operational costs. Billing the general public for sewerage services rendered, including desludging of septic tanks in various households, enables this. Unfortunately, collections of the sewage services fee have been poor, resulting in IWK running into trouble to maintain and upgrade the thousands of STPs throughout the country (Abdullah et al., 2005). Malaysians apparently, are gawking at IWK as being the major contributor of NH_3-N in the Sg. Selangor and Sg. Langat basin, but the general public themselves do not want to share the load. This is not fair to either of IWK or the environment.

Figure 2.7 : Sewage Pollution in Sg. Isap and Sg. Galing Kecil

2.5 Non-Point Source Pollution

Non-point source pollution is defined as a pollution source that occurs during a hydrological event, such as rain and snowmelt (Klapproth and Johnson, 2009), where surface depositions are carried off by the overland flow (runoff) ending up in the water column. From a water quality perspective, non-point source pollution contribute greater amounts of pollution load to rivers than point source pollution as due to the sheer amount of volumetric discharge (MERC, 2010). Referring to **Tables 2.3 and 2.4**, for Sg. Langat, NPS pollution accounts for more than 80% of the total pollution load for most constituents measured (UPUM, 2002). In Malaysia, the largest NPS pollution contributor is suspended solids (SS), which incur heightened turbidity, sedimentary deposition and siltation (**Figure 2.8**). Suspended solids are the result of poorly planned development activities (such as construction) that lack proper erosion control measures, as well as from agricultural and logging activities. Non-point source pollution from palm oil plantations also incur high ammonia, nitrate and phosphorous in the runoff stream, which can result in eutrophication of water bodies (Zainudin et al., 2009).

Figure 2.8 : Elevated Suspended Solids Level in Sg. Belatop (Cameron Highlands) and Sg. Rejang (Sibu)

Table 2.3 : Non-Point Source Pollution Event Mean Concentration (EMC) and Total Load Based on Designated Landuses (UPUM, 2002)

	Residential	Commercial	Commercial/ Residential	Forest/ Plantation	Water Body	Annual Load (ton)	Total Event Load (ton/event)
Area (ha)	8,617.50	1,502.54	33,186.61	173,342.42	3,509.43		
Runoff Coefficient,C	0.75	0.9	0.85	0.35	1		
COD (mg/L)	40.813	82.272	74.282	22.344	-	86,092	615.0
BOD (mg/L)	17.23	34.718	19.969	1.714	-	18,576	132.7
TSS (mg/L	79.175	303.68	429.002	71.576	-	390,744	2791.0
Total Metals (mg/L)	3.46	1.43	0.955	0.719	-	2,134	15.250

Table 2.4 : Point Source and Non-Point Source Pollution Load in Sg. Langat Basin (UPUM, 2002)

Pollution Source	Pollution Load (ton/day)			
	COD	BOD_5	TSS	Total Metals
Industry	22.7	5.5	14.4	0.244
Wet Market	1.1	0.4	0.4	0.005
Pig Farm	1.0	0.2	0.5	0.006
Public STPs	20.7	5.0	5.7	0.089
Private STPs	4.3	1.1	1.2	0.020
ISTs	17.3	7.1	8.4	0.000
Landfill	5.7	1.0	8.1	0.031
Sand Mining	20.9	0.8	206.7	2.778
Total PS	93.6	21.2	245.4	3.170
Total NPS	615.0	132.7	2791.0	15.250
% Point Source	13.2	13.8	8.0	18.200
% Non-Point Source	86.8	86.2	92.0	82.800

2.6 Water Supply and Demand[1]

As water becomes more and more precious, the need to reduce water usage becomes more and more important for environmental preservation. Technically the country's water resource outweighs the demand and to a certain extent this has indirectly contributed to water quality degradation. People are not concerned with the implication of water pollution as long as they have a clean supply of water to necessitate their daily activities. Physical water scarcity for in Middle East countries is present (**Figure 2.9**), therefore these countries are much more concerned about the implications of developmental activities towards water resource. Other countries are also subjugated to economic water scarcity, particularly the African nations.

[1] Drafted based on stakeholder comments at IEM Position Paper Forum on Water and Environment, Rumah Universiti, Universiti Malaya, 29th July 2011.

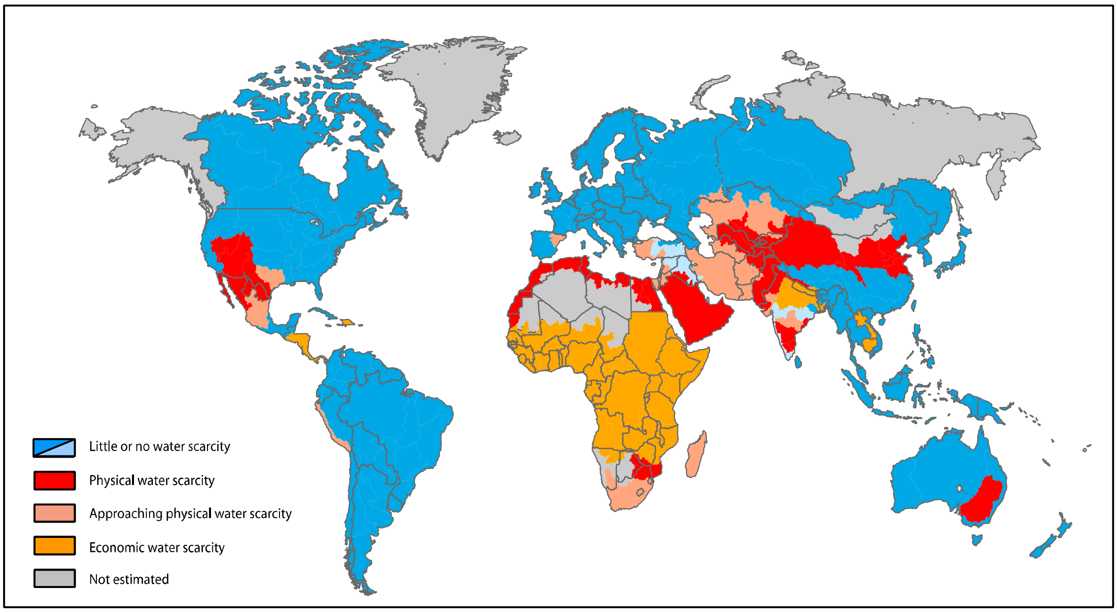

Figure 2.9 : Areas of Physical and Economic Water Scarcity (IWMI, 2007)

The Pahang - Selangor raw water transfer project, which involves building a 44 km tunnel, cutting across Titiwangsa range has raised concerns about water demand and its necessity. Water suppliers are only concerned about meeting the demand of water and give little attention towards water savings and rationalization. Although Malaysia it not a currently considered to be water scarce nation, this may not hold true for long. To add salt to the wound, the nation's water tariffs are also relatively cheap, which again causes the end users to not really value water, which are supplied to their homes. Raising the tariff without appropriate justification would most likely lead to a public revolt, therefore the best solution maybe through public education and campaigns.

3.0 RECOMMENDATIONS

Water quality preservation is not only important for water supply and meeting consumer's demand but also for environmental and ecological sustainability. The preservation steps must encompass these aspects whilst also remaining economically viable. Practical implementation of the steps is also dependent on current available resources, legal provisions and development plans, such as Vision 2020.

Below are several recommendations to improve the water quality conditions of rivers in Malaysia encompassing river basin management, engineering and structural measures.

3.1 Defragmentation of Water Management and Adoption of TMDL in Legal Provisions Pertaining to Effluent Discharge

The most important step to achieve sustainable water quality preservation is integration and coordination of all stakeholders and government agencies at both state and federal levels. Key agencies and stakeholders amongst others should include :

- Department of Irrigation and Drainage (DID)
- Department of Environment (DOE)
- Department of Sewerage Services (DSS)
- Department of Works (DW)
- National Landscape Department
- Attorney General's Chambers
- Local Councils
- Water Service Providers
- Non-Governmental Organizations (NGOs)
- Learned Societies
- Individual Specialists/Universities/Consultants/Experts

The coordination can be done through a centralized management committee such as Lembaga Urus Air Selangor (LUAS) or Suruhanjaya Perkhidmatan Air Negara (SPAN). Extensions in power and responsibility of both organizations must be made within the law to enable a wider scope of work and implementation prowess. Coordination between agencies and stakeholders must ultimately lead to :

1. Every stakeholder and government agency involved in the centralized management committee must be specifically dedicated towards water quality and environmental preservation, through coordination, cooperation and resource sharing; this can be documented and expressed in each organization's Vision and Mission.
2. Prescription and achievement of stated water quality and environmental objectives coherent to the National Water Quality Standards (NWQS); All relevant agencies and stakeholders should ultimately adopt a Class II NWQS target based on the individual parameters coherent to the beneficial uses of water within a specific basin. The WQI system can still be used to benchmark the overall water quality status but should not be the prevalent decision making tool.
3. The above objectives can be achieved through full adoption of the TMDL and WAC approach relative to the Class II target. Review of current existing

statutes and creation of new ones relative to the TMDL approach must be done. The review should entail:

a) Review of the Environmental Quality Act (EQA), 1974, where regulations pertaining to effluent discharge should sustain the Class II target, via the corresponding TMDL and WAC.
b) Further enforcement of the Street, Drainage and Building Act, 1974, prohibiting illegal sullage connections to stormwater drains. Sullage sources must be centralized to public sewage treatment plants to be treated before discharge to a watercourse.
c) Production of non-point source pollution control regulations for priority land-use activities such as agriculture (palm oil plantations) and enforcement of current guidelines pertaining to buffer zones (river reserve, refer **Table 3.1**) and riparian vegetation (DID, 2008).
d) Riparian zones that have been encroached and destroyed must be restored to their original luster, which involves selection of suitable vegetation.

Technical and administrative knowledge enrichment of the personnel involved in relation to the various aspects of river basin management and water quality preservation must also be done. This will lubricate resource and knowledge sharing amongst the various parties involved. The involvement of NGOs in this committee would also prove beneficial. This committee must be consulted on any developmental activities of any size, be it a private or public driven at both planning and implementation stages.

3.1.1 In-stream Loading and TMDL List Development

For water quality preservation to be successful, a shift in paradigm must first be made towards adopting a WAC approach. The current river monitoring networks consists of river discharge stations under the purview of the DID and water quality stations under the DOE (DOE, 2006; DID 2009). Synchronization and rationalization of both stations from a technical perspective is very important as it allows the derivation of the in-stream river loading, a major component of the WAC, which also facilitate the development of a TMDL strategy for the entire river basin. The TMDL will then give an indication as to the total amount of the development that can or cannot take place within that basin, as a function of the wastewater discharge volume and current regulatory limits (Mills et al., 1986). This TMDL list can also serve as a reference for potential project proponents on the implication of their projects towards the current ambient water quality, besides facilitating impact assessment and water quality modeling proceedings. This initiative must be propagated through inter-agency cooperation and can be placed under the centralization committee as discussed previously.

3.1.2 Tackling Sullage (Greywater) Pollution

Sullage (greywater) is a significant pollution contributor currently not subjected to the EQA, 1974 (MERC 2010; DID, 2010). A practical and efficient way to combat this problem would be to channel sullage sources to sewage treatment plants (STPs) or other types of centralized treatment facilities. The centralization of sullage sources will involve substantial cost and has some legal implications. If this strategy is adopted, the cost must be spread to all operational premises such as commercial centers, restaurants, markets, workshops etc. Residential sullage in-turn can be channeled to the respective residential STPs along with sewage as stipulated in the relevant act.

Centralization of sullage to these facilities not only enhances treatment efficiency but also directly puts it under the purview of the EQA, 1974. Installation of Oil and Grease (O & G) traps must also be made compulsory for commercial premises (or cluster of premises), as it acts as a preliminary treatment system prior to centralization. **Figure 3.1** is a schematic diagram of a typical O & G trap as a function treatment capacity.

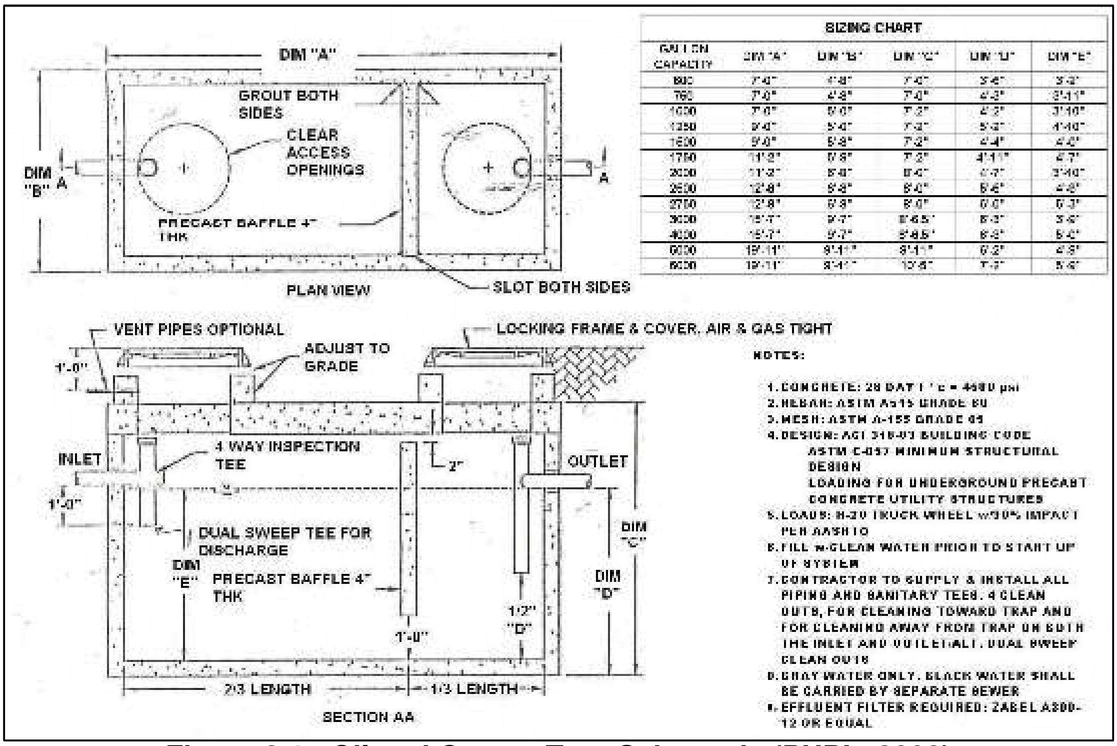

Figure 3.1 : Oil and Grease Trap Schematic (PUPL, 2008)

3.1.3 Combating Non-Point Source Pollution through Riparian Zone Preservation and Best Management Practices (BMPs)

Riparian buffer and vegetation are important elements, which can used to combat non-point source pollution. A riparian zone (**Figure 3.2**) or riparian area is the interface between land and a river or stream. These zones are important natural biofilters, protecting aquatic environments from excessive sedimentation, polluted surface runoff, erosion and is important for stream temperature regulation (Klapproth and Johnson, 2009). Research has shown that riparian zones are instrumental in water quality improvement for both surface runoff and water flowing into streams through subsurface or groundwater flow (Klapproth and Johnson, 2009). Riparian zones can also play a role in lowering nitrate contamination in surface runoff from agricultural plantations (Klapproth and Johnson, 2009).

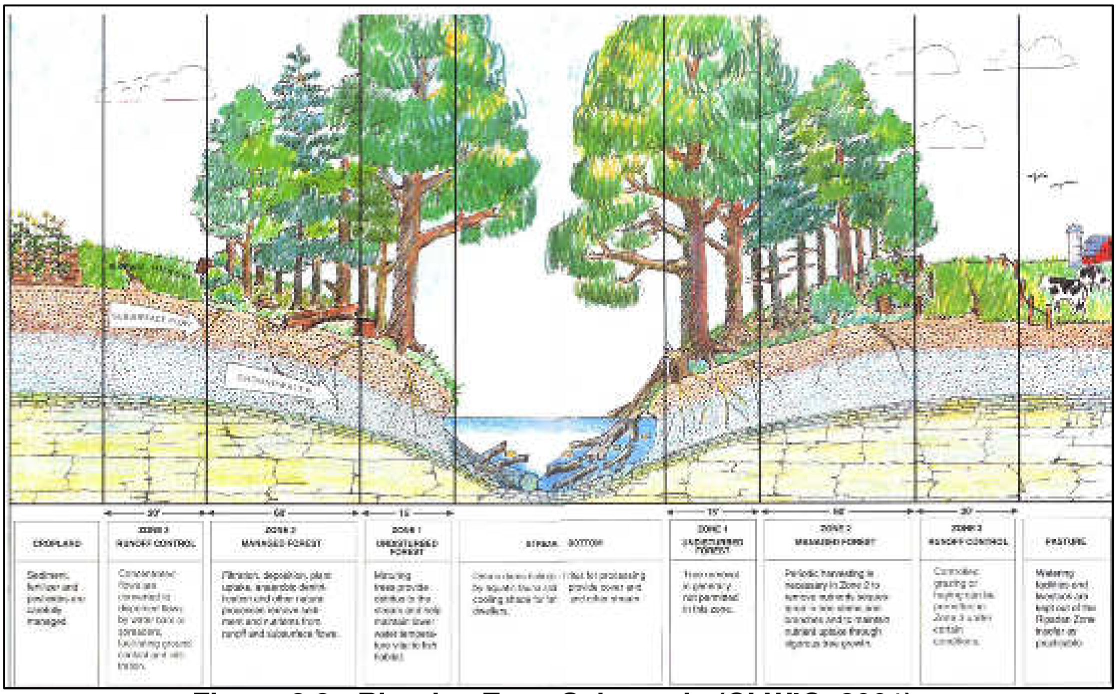

Figure 3.2 : Riparian Zone Schematic (CLWIO, 2001)

Riverbank development, not in accordance with stated river reserve guidelines, as shown in **Table 3.1**, results in the destruction of riparian zones. Therefore, the preservation of these riparian areas cannot be overemphasized, to combat non-point source pollution in both urban and rural rivers. Restoration of destroyed riparian zones must also be done and activities that lead to its destruction such as encroachment and stream channelization must also be stopped. It should be noted here, that riparian zone restoration must also entail selection of appropriate fauna native to country and climatological conditions.

Table 3.1 : River Reserves for Development based on River Width (DID, 2008)

River Width (m)	River Reserve (m)
> 40	50
20 – 40	40
10 – 20	20
5 – 10	10
< 5	5

To further minimize NPS pollution nutrient contribution from agricultural plantations, best management practices (BMPs) must be in place, including an optimal nutrient management plan (NMP) in each plantation. Similar environmental management plans related to pesticide usage and feedlots for animal husbandry can also be drafted by the respective industries to minimize impact of their activities towards a receiving water body.

Development of new project sites must also be accompanied with an appropriate Erosion and Sediment Control Plan (ESCP). The ESCP must be drafted by a certified ESCP professional, a measure recently undertaken by the DOE. Further details on ESCP can be referred to in the *IEM Position Paper on Soil Erosion and Sedimentation* (IEM, 2010).

3.2 Addressing Sewage Pollution through Centralization

Development of modern Centralized Sewage Treatment Plants (CSTPs) appears to be the best solution to resolve majority of the sewage woes that are related to the old conventional systems, inherited by IWK. Operation costs can be lowered compared to having multiple dozens of mechanical plants of equivalent capacity (Ujang, 2006) and maintenance can also be done more conveniently. The Department of Sewerage Services (DSS) and IWK have begun development of massive CSTPs throughout the country; amongst these include the Jelutong Sewage Treatment Plant (JSTP) in Penang (**Figure 3.3**), which has an ultimate PE of 1,200,000. More CSTPs of such scale are also in planning, as captured in the National Sewerage Masterplan (UTM, 2002). That being the case, such massive CSTPs will entail the release of equivalently high volumetric discharge and TMDL. To ensure that the environmental impact (of specific water bodies) is kept to a minimum, the treatment efficiency and TMDL of these facilities must be within the WAC of the receiving water column. The benefits however, typically outweigh the cons, as centralization would usually mean improvement in the water quality of other streams and rivers currently receiving poorly treated effluent from the older plants, which would now be centralized.


Figure 3.3 : Jelutong Sewage Treatment Plant (1,200,000 PE)

The maintenance cost of these CSTPs has to inevitably one day be borne by the general public, in view of population growth and increased influent loading. The general public needs to be educated on the relationship between increased sewage treatment efficiency and water quality preservation. To intensity bill payment collection efficiency, the sewage and water utilities bill will have to amalgamated together, coherent environmental preservation.

3.3 Promoting Use of Centralized Industrial Effluent Treatment Facilities (CIETP)

Most industrial facilities posses their own treatment facility to treat the incoming wastewater influent to comply with standards stipulated under the EQA, 1974, although studies have shown (MERC, 2010; DID 2010) that these industries do not necessarily contribute majority of the pollution load. There are however, instances where compliance is not achieved and because the distribution of these sources are rather scattered, control and enforcement can be difficult. To curb this, the government should consider centralizing the effluent streams from industrial areas to centralized industrial effluent treatment facilities for better management and further treatment (MERC, 2010). The development of the respective economic corridors is the best avenue to start this initiative, thus at the same time ensuring environmental preservation and sustainability is achieved. The operations and maintenance of the facility should be undertaken by the respective industries in accordance with the amount of pollutant load that is released into the environment (Polluters Pay Principle).

3.4 Cease and Decease of POME Land Application Practice

POME land application practices (**Figure 3.4**) in West Malaysia have lead to the serious organic contribution to rivers and streams in these regions. To curb this problem, issuance of discharge licenses for land application practice must be stopped and existing licenses cancelled. POME, should be regarded as any other industrial effluent, subject to provisions stipulated in the EQA, 1974 and its management and pollution control be a function of TMDL and WAC as discussed in Section 3.1 of this paper.

Figure 3.4 : POME Land Application Practice

3.5 Rationalization and Realization of River Studies

The government has undertaken various river rehabilitation studies throughout the years for specific river basins including Sg. Langat, Sg. Tebrau, Sg. Segget, Sg. Merbok, Sg. Sepetang, Sg. Kinabatangan, Sg. Linggi and Sg. Kuantan. In addition various Integrated River Basin Management (IRBM) studies have also be conducted, particularly for Sg. Selangor and Sg. Kedah. These studies have drafted various mitigation strategies and action plans to tackle water quality problems in these basins, factoring in ecological and environmental concerns. The recommendations stated in these studies are sound, based on inputs from various experts in this field of study, which provide a wealth of information of the various options that can be considered to tackle water quality problems. The information from these studies should be mined and scrutinized, rationalized and implemented for the benefit of the nation (UTM 2002; DID 2010; DOD, 2010; Zainudin, 2010).

3.6 Water Supply and Demand Management[2]

The government should start a water savings competition to promote responsible water use at the same time minimizing wastewater discharge. Government and other bodies should also be aggressive in educating public awareness. Unlike Singapore,

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[2] Drafted based on stakeholder comments at IEM Position Paper Forum on Water and Environment, Rumah Universiti, Universiti Malaya, 29th July 2011.

who already started a rationing exercise to underscore water scarcity even though there is no immediate shortage or drought. Water supply will be cut off on certain day to promote people to conserve water. Malaysia should undertake this approach. Rainwater harvesting systems will also save cost and resources.

4.0 Summary of Recommendations

Several key points which can be extracted from this position paper :

Summary of Recommendations	Relevant Agencies to Act/Engage
Centralization of all stakeholder and authoritative agencies under one umbrella agency for coordination, resource sharing and management of river basins at state level.	- National Water Services Commission (SPAN) - Department of Irrigation and Drainage (DID) - Department of Environment (DOE) - Department of Sewerage Services (DSS) - Department of Works (DW) - National Landscape Department - Attorney General's Chambers - Local Councils - Water Service Providers - Non-Governmental Organizations (NGOs) - Learned Societies - Individual Specialists/Universities/Consultants/Experts
Adoption of Class II NWQS target for all relevant government agencies.	- All stakeholders and agencies (as above)
Adoption of Total Maximum Daily Load (TMDL) and Waste Assimilative Capacity (WAC) for sustainable water quality preservation and river basin management through inculcation in existing laws and legal provisions, particularly the Environmental Quality Act, 1974.	- Department of Environment - Attorney General's Chambers
Development of the TMDL and WAC list via rationalization of DID and DOE discharge and water quality stations to derive in-stream loading relative to Class II target.	- Department of Irrigation and Drainage - Department of Environment
Better enforcement of the Street, Drainage and Building Act, 1974, prohibiting illegal connections to drains.	- Local council
Cease and decease of POME land application practice in Malaysia, including cancellation of existing discharge licenses.	- Department of Environment - State agencies - Local council

Introduction of NPS pollution control regulations in the Environmental Quality Act, 1974, which inculcates riparian vegetation and buffer zone preservation.	- Department of Environment - Attorney General's Chambers - Local council - Ministry of Agriculture
Centralization of sewage sources to centralized treatment facility coherent to the National Sewerage Master Plan and amalgamation of water and sewage bill for plant operations and maintenance.	- National Water Services Commission (SPAN) - Department of Sewerage Services - Indah Water Konsortium
Centralization of industrial effluent to treatment facilities based on each industrial zone, applicable to SMIs as well.	- Department of Environment - Attorney General's Chambers
Rationalization and realization of recommendations in RMK river studies.	- Department of Irrigation and Drainage - Department of Environment

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