

HANDBOOK FOR LEGISLATORS

A GUIDE TO  
**Water Quality**

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Environmental Quality Council



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A GUIDE to water quality : handbook for legislators /  
Environmental Quality Council.

A GUIDE TO  
**Water Quality**

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*With The Compliments  
of the  
Director-General  
Department of Environment  
Malaysia.*

## Minister's Message



The Environmental Quality Council, EQC has taken the initiative to put together basic scientific ideas, environmental terms and concepts for legislators in the form of a Handbook.

The Handbook consists information on the most important components of the environment, i.e.; air and water, which will help decision-makers formulate new strategies and plan of action to stimulate more awareness on the environment among Malaysians so that the country can move forward in its endeavours to realize the goals of Vision 2020.

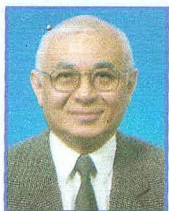
In essence, this Handbook will provide informative guidance on environmental issues in order that the environment will remain clean, safe, healthy and productive. This would further strengthen our effort to achieve sustainable development in the most optimal manner.

My congratulation and sincere appreciation to the EQC members, the Department of Environment and all others involved for their commendable initiative towards the betterment of the environment.

A handwritten signature in black ink, appearing to read 'Law Hieng Ding'. The signature is fluid and stylized, with a long horizontal stroke extending to the left.

**Dato' Seri Law Hieng Ding**  
Minister of Science, Technology and Environment  
Malaysia

## Chairman's Statement



There is so much to do for the environment; yet those of us who are often legally responsible for making decisions that affect the environment know so little about it. And this is what this book is about - a handbook to guide what is and what is not to be

done when confronted with an environmental concern or problem.

The Environmental Quality Council is a statutory body created under the Environmental Quality Act of 1974. Its function is to advise the Minister concerned with the environment on all matters coming within the preview of the Act (see <http://www.jas.sains.my/doe/egcqc.htm>). Hence, it involves itself in debating on what are the proper approaches and action to be taken to conserve and protect and at times to improve the quality of the environment. Often, the debate involves environmental policies to be pursued and this includes the substance laws and regulations should have and the form they must take to achieve the betterment of the environment.

Members of the Council lament the often unnecessary and avoidable problems caused by a misunderstanding, from the environmental viewpoint, of two most essential components of the environment - air and water. Good quality air and water are necessary to good health and safety. It is our fervent hope that this handbook to guide decision-makers will fill a gap so sorely needed.

A handwritten signature in black ink, appearing to be 'Kok Wee Kiat', with a horizontal line underneath.

**Dato' Kok Wee Kiat**

A.M.N., Dato' Seri Ketam (Sel), O.M.R.I. (Italy), O.B.O.H. (Chile), LL.B (Hons)(Sing)

Chairman

Environmental Quality Council Malaysia

November, 2003

# Contents

Minister's Message	2
Chairman's Statement	3
Introduction	5
Defination of Water Quality	6
Natural Processes of the Environment	6
Water Quality and Environment	10
Federal Government Agencies Related To Water Resource In Malaysia	12
Current Status of Malaysian River Basin	12
Sources of Pollution	14
Remedial Action to Curb Pollution	16
Procedures for Public Complaint	17
Water Quality Determination	17
Water Quality Parameters	19
Data Analysis	20
Malaysian Effluent Discharge Standards	24
Water Pollution and Human Health	27
Conclusion	29
References	30
Acknowledgements	31

## Introduction

Water Quality Guidelines are developed to provide basic scientific information about the effects of water quality parameters on uses in order to assess water quality issues and concerns and to establish water quality objectives for specific sites.

The use of terms, criteria, guidelines, objectives and standards varies according to the individual country and agency. Basically these terms could be defined as follows:

1. **Criteria:** scientific data estimated to derive the recommended limits for water uses.
2. **Water quality guideline:** numerical concentrations are narrative statements recommended to support and maintain a designated water use.
3. **Water quality objective:** numerical concentration is narrative statement which has been established to support and protect the designated uses of water of a specified site.
4. **Water quality standard:** an objective that is recognized in an enforceable environmental control laws of or level of government.

The aim of this handbook is to facilitate the legislator regarding the water quality and to promote awareness pertaining to environment.



# Natural Processes of Environment

There are four spheres involved in the natural processes of the environment, each having their own significant contribution in influencing the environment (Figure 1).

- Atmosphere
  - Contributes carbon dioxide and oxygen
- Hydrosphere
  - Contributes water
- Biosphere
  - Supplies carbon dioxide and organic acid
- Lithosphere
  - The end point where it contributes the end products through chemical weathering.

Atmosphere + Hydrosphere + Biosphere  
= Carbon Dioxide Charged Water

Soil, Sediment,  
Dissolved Salt

← Results

Lithosphere

Chemical  
Weathering

Figure 1 : Reactions among the four spheres in the environment

## Definition of Water Quality

Water quality involves a long list of characteristics and chemical constituents (Brook et al., 1997). It has traditionally become a concern when human health considerations are at stake. However, in developed countries there are a great number of other beneficial uses.

The following impairments of beneficial uses of water as a consequence of water pollution are considered:

- Restrictions on fish and wildlife consumption
- Tainting of wildlife and wildlife flavour
- Degradation of fish and wildlife populations
- Fish tumors and other deformities
- Bird or animal deformities or reproductive problems
- Degradation of benthos
- Restriction on dredging activities
- Eutrophication or undesirable algae
- Restrictions on drinking water consumption or taste or odour problems
- Beach closings
- Degradation of aesthetics
- Added costs to agriculture or industry
- Degradation of phytoplankton and zooplankton communities
- Loss of fish and wildlife habitat

Other important considerations in relation to water quality are:

- the assimilative capacity of a stream
- the break down of wastes by bacteria, fungi and invertebrates
- the utilization of wastes products for the growth of algae and other forms of aquatic life.

Various water quality problems exist due to the great diversity of lakes, reservoir and rivers. The most common water quality problems include:

- Eutrophication, from the abundance of nutrients
- Oxygen depletion from the degradation of organic matter
- Hygienic problems from the existence of pathogenic organisms
- Salinization due to high concentration of ions such as calcium, sodium and chloride

- Acidification from atmospheric deposition
- The persistence of heavy metal, organochlorides or other toxins
- High turbidity and high amounts of suspended material
- Thermal pollution, which depend on flow control and climate

Water quality is discussed based on the following aspects:

- foreign substances and effects on people and aquatic environment
- aesthetic aspects
  - visual
  - odour
- quality of aquatic environment on inorganic substances and state of aquatic biota found in a water body
  - concentration
  - speciation
  - physical partition
  - composition

Water quality can be defined as a set of parameters that describes a water body:

- physical characteristics
- chemical characteristics
- biological components

Some references to water quality are as follows :

- A standard for water body
  - River suitable for survival of organisms
- Better index means cleaner water body (Plate 1)
  - Measured by level of suitability of uses
- Various efforts have been undertaken by the Malaysian government to increase water quality for optimization of usage
- Water quality measurement is important for its management

- Test of oxygen demand character is used as an indicator to show level of use for human.
- Water quality can be predicted based on :
  - Intended use of water
  - Gross determination of the quality
  - Dissolved impurities
- Water quality parameters have evolved qualitatively reflecting the impacts of various impurities on selected uses of water
- Analytical procedures have been developed to qualitatively measure these parameters
- Knowledge on common parameters related to water and waste-water treatment processes is essential to citizens of a country



Plate 1: Higher water quality status within the forested catchment area

# Water Quality and Environment

Basic natural causes of water pollution:

- High mobility of water in the hydrologic cycle
- Water acting as a universal solvent
- Dumping ground for human wastes
- Irresponsible dumping of highly toxic industrial waste

The above factors influence the transportation of pollutants in the forms of compound.

Water pollution leads to:

- Destruction of aquatic life
- Threatening of human life
- Harming wildlife and have the potential of breaking the life chain
- Impairing industrial operations

Signs of pollution indicating a stressed aquatic environment

- Algae-coated lake
- Floating debris
- Discoloured water
- Foul odours

Natural processes also contribute to river pollution:

- Climate of the region
- Mineral heritage of watershed
- Types of aquatic life in the river

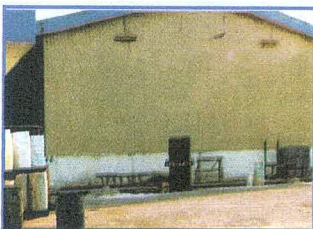


Plate 2: The discharge of effluent affects the natural state of water

River water quality management plays a major role in ensuring the discharge of pollutants and the quality is not degraded to an unacceptable extent below the natural level (Plates 2 and 3).

Water quality status indicates

- Level of pollutant composition related to human activities
- Water quality for various types of water body which varies with
  - Input loads
  - Flow rate
  - Quantity of water

A river is classified as polluted when:

- \* Composition and condition of the river has changed
- \* Less suitable for any objectives and function intended

Pollution standards for each water body will be measured by the following selected parameters:

- Physical
- Chemical
- Biological



*Plate 3: Degradation of water quality due to human activity*

Water quality monitoring is a crucial activity in water quality management to evaluate the quality of water body.

# Federal government agencies related to water resource in Malaysia

Department of Environment  
Environment

Drainage and Irrigation Department  
River

Ministry of Health  
Health

Department of Mineral and Geoscience  
Groundwater

Public Work Department  
Water supply

Department of Fishery  
Aquaculture

Forestry Department  
Catchment area

Department of Agriculture  
Water and soil conservation

## Current Status of Malaysian River Basin

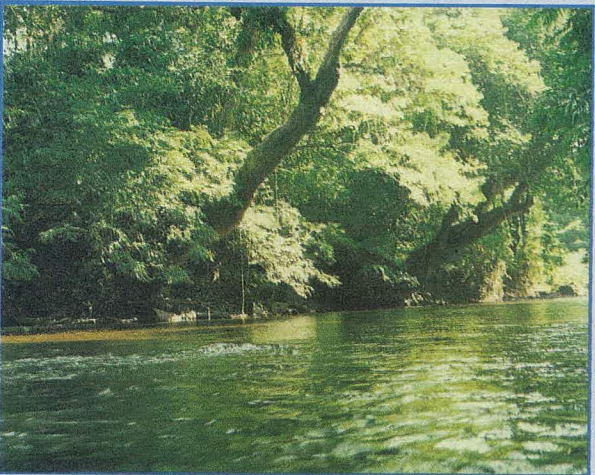
Table 1 shows a list of polluted river basins (DOE, 1999) and Table 2 shows a list of clean river basins.

State	River Basin
Kedah	Merbok
Penang	Juru, Pinang/Kluang, Jejawi
Selangor	Buloh, Klang
Johor	Air Baloi, Segget, Kempas, Danga, Rambah, Tukang Batu
Terengganu	Landas
Total	13

Table 1 : List of polluted river basins in Malaysia as classified by DOE (1999)

State	River Basin
Kedah	Melaka, Kedah, Muda
Perak	Temerloh, Bruas
Selangor	Selangor
Johor	Sedili Besar, Paloi, Mersing, Jemaluang, Pontian, Anak Endau
Pahang	Rompin, Bebar, Merchong, Bera, Bertam, Lepar, Mentiga, Pahang
Terengganu	Kemaman, Kertih, Paka, Dungun, Terengganu, Setiu, Besut
Kelantan	Kemasin, Semerak, Kelantan, Golok
Sarawak	Kayan, Lupar, Rajang, Balingian, Tatau, Kemena, Similajau, Suai, Limbang, Trusan, Lawas
Sabah	Mengalong, Padas, Membakut, Papar, Moyog, Damit/Tuaran, Kadamaian, Bengkoka, Sugut, Labok, Kaya, Kinabatangan, Segama, Silabukan, Tingkayu, Tawau, Umas-Umas, Brantian, Kalabakan
<b>Total</b>	<b>61</b>

Table 2 : List of clean river basins in Malaysia as classified by DOE (1999)



## Sources of Pollution

In Malaysia, the major pollution sources can be divided into four categories;

- Agriculture activity (Plate 4)
  - Nutrients
  - Pesticides
  - Herbicides
  - Fungicides
  - Sediments

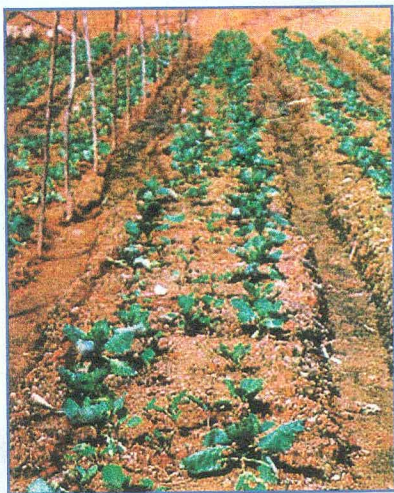


Plate 4: Example of agricultural activity in Malaysia

- Land development (Plate 5)
  - Sediments that will later affect the turbidity of receiving water bodies due to soil erosion especially upstream
  - Organic wastes and landfill sites residential areas from the residential area (Plates 6 and 7)
  - Generation of rubbish/garbage, waste oil and sewage.
- Mining activity
  - Sediments that will later affect the turbidity of rivers.
  - Activating the content of heavy metals such as tin and arsenic



*Plate 5: Pollution caused by land development project*



*Plate 6: Contribution from the residential area*



*Plate 7: Landfill site as a result of establishment of residential area*

- Industrial activity (Plate 8)
  - Heavy metals
  - Organic wastes through effluent discharge
  - Runoff from waste storage
  - Generation of rubbish/garbage, sewage and oil



Plate 8: Pollution from the industrial area

Table 3 shows the significance of the selected activities and their contribution to pollution in Malaysia.

Type of pollution Sources	Significant pollution indicator	Percentage of river affected
Sewage, Agro-based, Manufacturing Industries	Biochemical Oxygen Demand (BOD)	18
Sewage	Ammoniacal-nitrogen (NH <sub>3</sub> -N)	20
Earthworks and Land Clearing	Suspended solids (SS)	33

Table 3: Sources contributing to pollution in Malaysia (DOE, 2001)

## Remedial Action to Curb Pollution

- Improve water treatment facilities
- Controlled and planned land development project
- Efficient enforcement programme
- Strict penalty on polluter

## Procedures for Public Complaint

- Locate the pollution sources
- Record the date and time (if possible)
- Identify the polluter (if possible)
- Provide proof (photos of affected area – if possible)
- Estimate the magnitude of pollution
- File a report with the Department of Environment

## Water Quality Determination

Steps involved in an assessment of river water quality:

- Sampling
- Analysis
- Standard methods used based on APHA (1999), (Plate 9) and guidance from EQA (1974) (Plate 10)

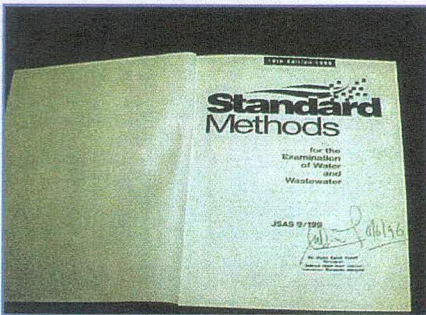


Plate 9: Standard Methods (APHA, 1999)

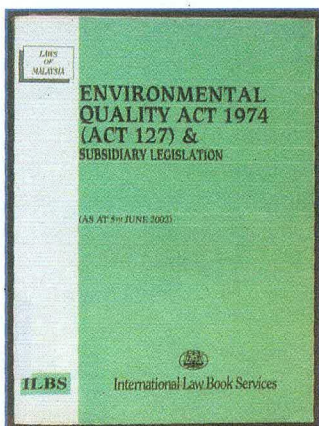


Plate 10: EQA, 1974

Factors to be considered while assessing water quality and to determine number of samples and parameters to be analyzed for pollution status:

- Location
- Methodology (Plate 11)
- Manpower
- Budget

Factors determining the reliability of data:

- Location of samples
- Samples taken at random
- Total depth of river is measured and taken into consideration

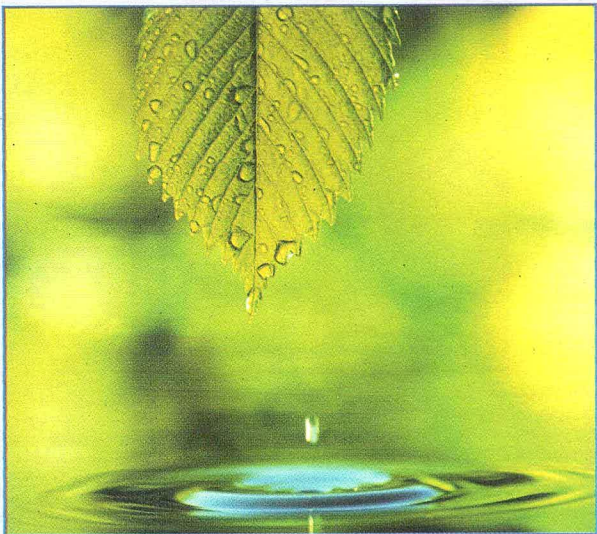


Plate 11: Sampling procedure ( $d$ =depth,  $x$ =sampling point)

# Water Quality Parameters

Water quality parameters are divided into two categories:

- In-situ parameters:
  - Definition: direct sampling parameters obtained readings from site. Examples of the parameters are as follows:
    - Dissolved oxygen (DO)
    - pH
    - Temperature
    - Electrical conductivity (Ec)
    - Salinity
    - Turbidity
    - Color
  - Laboratory parameters
    - Suspended solids (SS)
    - Biochemical oxygen demand (BOD)
    - Chemical oxygen demand (COD)
    - Oil and grease
    - Phenols
    - Metals
    - Nutrients
    - Bacteria
    - Others



## Data Analysis

- Data collected will be subjected to interpretation
- Analyzed data will serve as indicators on conditions of rivers
- Analysis done by calculation of water quality index:
  - DOE-WQI
  - Harkin's Index
- Indicators divided into 5 classes:
  - Class 1 – no treatment needed except disinfections or boiling only
  - Class 2 – suitable for aquaculture, recreational
  - Class 3 – intensive treatment needed
  - Class 4 – suitable for agriculture
  - Class 5 – no usage
- In Malaysia, DOE has published literature on selected river classification (Plate 12)

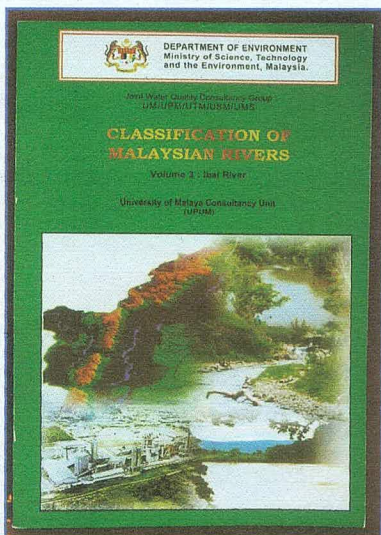


Plate 12: Example of river classification publication in Malaysia

Tables 4, 5 and 6 show the different levels of water quality parameters with different land uses.

Parameter	Unit	Reading
DO	mg/l	7
Ec	mS/cm	0.03
Temperature	°C	28.30
Ph		5.93
BOD	mg/l	0.71
COD	mg/l	
Turbidity	NTU	1
Hardness	mg/l	14
NH <sub>3</sub> -N	mg/l	0
NO <sub>3</sub> -N	mg/l	0
WQI		99.86
Escherichea coli	ml	0/100
Suspended Solid	mg/l	2.0

Table 4: Comparison of Water quality data in Air Hitam Forest Reserve

Parameter	Unit	Titi	Tasik
Temperature	°C	24.7	24.6
Ec	mS/c	0.30	0.30
DO	mg/l	3.2	3.6
COD	mg/l	1.0	1.0
NH <sub>3</sub> -N	mg/l	0.01	0.01
NO <sub>3</sub> N	mg/l	0.7	0.5
PO <sub>4</sub>	mg/l	0.02	0.04
SO <sub>4</sub>	mg/l	2.0	1.0
Mg	mg/l	6.500	6.300
K	mg/l	0.147	0.323
Ca	mg/l	19.90	20.78
Cl-	mg/l	2.2	3.2

Table 5: Water quality of two locations in Perlis State Park, Wang Kelian, Perlis

	Symbol	Unit		
pH			6.99	6.25
Temperature	T	°C	28.30	29.30
Electrical Conductivity	Ec	mS/cm	0.06	0.04
Dissolved Oxygen	DO	mg/l	3.00	2.40
Biochemical Oxygen Demand	BOD	mg/l	0.46	0.87
Dissolved PO <sub>4</sub>		mg/l	0.03	0.96
Total PO <sub>4</sub>		mg/l	0.10	1.24
Ammoniacal Nitrogen	NH <sub>3</sub> -N	mg/l	0.05	0.41
Nitrate	NO <sub>3</sub>	mg/l	0.9	1.2
Chlorophyll - A		mg/m <sup>3</sup>	2.0044	5.234
Total Coliform		Count	1000	1600
		100ml		

Table 6: Water quality of Putrajaya Lake

Plates 13, 14 and 15 show the impact of land disturbance on the receiving rivers in the downstream areas.

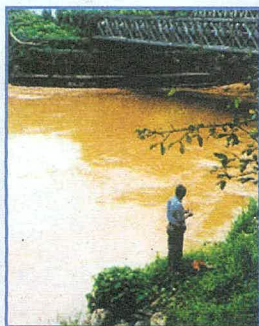


Plate 13: The impact of land clearing for shifting cultivation on the Sg. Sook in Sabah (Turbidity = 210 NTU, SS = 198 mg/l, WQI = 64.35 (Class 111))

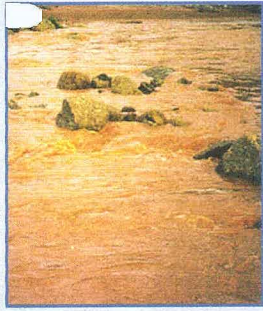


Plate 14: The impact of land clearing for agriculture on the Sg. Belatop in Kelantan (Turbidity = 204 NTU, SS = 218 mg/l, WQI = 85.63 (Class II))



Plate 15: The impact of river deepening on Sg. Tiram in Perak (Turbidity = 250 NTU, SS = 372 mg/l, WQI = 61.2 (Class II))

## Malaysian Effluent Discharge Standards

Table 7 shows the Malaysian effluent discharge standards (EQA, 1974), Table 8 shows standards compared with other countries in the world and Table 9 shows the raw water standard.

Parameter	Unit	Standard	
		A	B
1. Temperature	*C	40	40
2. pH Value	-	6.0 - 9.0	5.5 - 9.0
3. BOD5 at 20*C	mg/l	20	20
4. COD	mg/l	50	100
5. Suspended Solids	mg/l	50	100
6. Mercury	mg/l	0.005	0.05
7. Cadmium	mg/l	0.01	0.02
8. Chromium,Hexavalent	mg/l	0.05	0.05
9. Arsenic	mg/l	0.05	0.10
10. Cyanide	mg/l	0.05	0.10
11. Lead	mg/l	0.10	0.5
12. Chromium, Trivalent	mg/l	0.20	1.0
13. Copper	mg/l	0.20	1.0
14. Manganese	mg/l	0.20	1.0
15. Nickel	mg/l	0.20	1.0
16. Tin	mg/l	0.20	1.0
17. Zinc	mg/l	2.0	2.0
18. Boron	mg/l	1.0	4.0
19. Iron (Fe)	mg/l	1.0	5.0
20. Phenol	mg/l	0.001	1.0
21. Free Chlorine	mg/l	1.0	2.0
22. Sulphide	mg/l	0.50	0.50
23. Oil and Grease	mg/l	Not	10.0
		detectable	

Standard A - Water Catchment Area

\* Standard B - Non Water Catchment Area

Table 7: Malaysian effluent discharge standards

Country	Physical Component (mg/l)	Chemical Component (mg/l)	Biological Component	Heavy Metal (mg/l)	Nutrient (mg/l)
	Temperature TSS	pH, COD Cyanide, Free Cl-Sulphide	BOD Oil and Grease Coliform	Hg, Cd, Cr, As, Pb, Cu, Mn, Ni, Sn, Zn, B, Fe	N, P
SEPA	TSS = 30	pH = 6.0-9.0 Cyanide = 0.2	O&G = 40 BOD = 30 Coliform = 200 no. /100ml	B = 0.73, As = 0.1 Cd = 0.04, Cr = 0.4 Cu = 0.40, Pb = 0.1 Hg = 0.01, Ni = 0.4 Sn = 0.04, Zn = 1.0	
California (USA)	T = 25°C TSS = 75	pH = 6.0-9.0 Cyanide = 0.2 Cl = 300 SO <sub>4</sub> = 385	BOD = 20 O&G = 15	Hg = 0.002, Ph = 0.2 Cd = 0.03, Zn = 0.5 Cr = 0.01, As = 0.02 Ni = 0.2, Cu = 0.3	
New York (USA)	TSS = 10	pH = 7.01 Cl = 177 SO <sub>4</sub> = 150		B = 2-8, Pb = 2.0 Fe = 1-2, Zn = 1.0 Cr = 2.0, Cu = 0.5 Ni = 0.15	
WHO Europe		Cl = 200 SO <sub>4</sub> = 250		Hg = 0.21, Pb = 0.1 Cd = 0.01, Cu = 50 Cr = 0.05, As = 0.05 Zn = 5.0, Mn = 0.05	
Japan	T = 27.6°C TSS = 5.0	pH = 7.2 Cl = 101		Fe = <0.05 Mn = <0.05	
United Kingdom	T = 30°C TSS = 80	pH = 6-9 COD = 120 Cyanide = 0.2 Cl = 300 SO <sub>4</sub> = 500	BOD = 40	Hg = 0.01, Pb = 0.1 Cd = 0.02, Zn = 1.0 Cr + 1.0, B = 4.0 Ni = 2.0, Cu = 0.05	
Germany	T 19.4°C	pH = 7.6 COD = 150	BOD = 40		p = 1.2
Denmark	T = 30°C TSS = 30	pH = 6.5-8.5 Free Cl = 0.3	BOD = 20	Cr = 0.2, Pb = 0.1 Cu = 0.1, Ni = 0.2 As = 0.5, Zn = 0.5 Ag = 0.05	N = 8 P = 1.5
Malaysia	T = 40°C TSS = 50	pH = 6.0-9.0 COD = 50	BOD = 20 O&G = Not detectable	Hg = 0.005, As = 0.05 Cd = 0.01, Pb = 0.1 Cr = 0.05, Cu = 0.2 Mn = 0.2, Ni = 0.2 Zn = 1.0, B = 1.0 Fe = 1.0	

Table 8: Comparison of Malaysian effluent discharge standards with other countries in the world.

No. Parameter	Maximum permitted limit(mg/l except for pH, color and turbidity)
1.Color	15 true color unit
2.Turbidity	5 NTU
3.PH	6.5 to 8.5
4.Aluminium (as Al)	0.2
5.Ammonia (as N)	0.5
6.Anionic detergent (MBAS)	1.0
7.Arsenic (as As)	0.05
8.Biocides (total)	0.1
9.Cadmium (as Cd)	0.005
10.Carbon chloroform extract	0.5
11.Chloride (as Cl)	250
12.Chloroform	0.03
13.Chromium (as Cr)	0.05
14.Copper (as Cu)	1.0
15.Cyanide (as CN)	0.1
16.Fluoride (as F)	1.5
17.Hardness (as CaCO <sub>3</sub> )	500
18.Iron (as Fe)	0.3
19.Lead (as Pb)	0.05
20.Manganese (as Mn)	0.1
21.Mercury (as Hg)	0.001
22.Mineral Oil	0.3
23.Nitrate (as N)	10
24.Phosphate (as PO <sub>4</sub> )	0.2
25.Residual chlorine (Free)	0.1
26.Selenium (as Se)	0.1
27.Silver (as Ag)	0.05
28.Sodium (as Na)	200
29.Sulphate (as SO <sub>4</sub> )	400
30.Zinc (as Zn)	5

Table 9: Standard for raw water (Twenty-fifth schedule)

## Water Pollution and Human Health

Water pollution and scarcity affect human health in three primary ways:

- Access to a minimum per capita amount of water is necessary to ensure physical survival and promote hygiene.
- Water serves as a pathway for exposure to microbial and contagious disease. Water pollution exacerbates water-borne infectious and parasitic diseases such as hepatitis A, diarrhoea disease, typhoid, roundworm, guinea worm, leptospirosis and schistosomiasis.
- Surface and groundwater can act as sinks or transportation routes for chemicals, heavy metals, algal toxins and organic substances that produce chronic systemic illnesses, malignancies, birth defects and impair immune system functions as a result of direct drinking contaminated water or direct consumption of plants or harvested from contaminated waters.

As countries begin to industrialize:

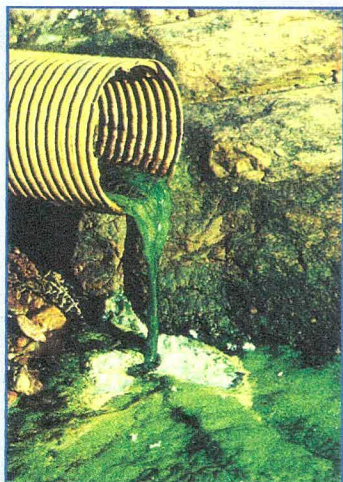
- They often undergo a health risk transition
- Encompasses a shift from a predominance of traditional diseases (infectious and parasitic) to a predominance of modern diseases (eg: cancer, heart disease, respiratory)

Water resources and public health literature indicates three principal contributors to water pollution and degraded water that threaten human health:

- Rapid and unregulated expansion of industrial activities
- Growth of urban and suburban areas without adequate investment in water supply infrastructure
- Increased use of fertilizers combined with a continued reliance on sewage irrigation

## Impacts of rapid industrialization

- Adverse effects on pregnant women and young children
- Dying and staining of plants due to high average concentrations of aniline and phenol
- Abnormal pregnancy outcomes including spontaneous miscarriage, fatal death, premature birth and infantile death
- Physical and mental development of children
- Elevated cancer rates and gastrointestinal diseases have also been associated with industrial pollution of drinking water supplies
- Hepatitis A
- Bacterial dysentery
- Infectious diarrhoea
- Para-cholera
- Typhoid
- Esophageal and liver cancer
- Anemia and elevated immune responses



## Conclusion

Any land disturbance, regardless of the purpose, will have a negative impact on the receiving rivers especially in the downstream areas. This reduces the river water quality status. The impacts of degradation in water quality also referred to as water pollution are as follows:

- Impacts on factors influenced by water characteristics:
  - Human and animal health
  - Aquatic life
  - Drainage
  - Agriculture
  - Soil
  - Aesthetic values
- Impacts on factors influenced by soil characteristics:
  - Crop productivity
  - Soil-Water movement
  - Groundwater contamination

Significant approaches in overcoming water pollution problems which the government can adopt are as follows:

- Education (formal and non-formal)
- Trainings
- Campaigns
- Participation at all levels

The effects of bathing in polluted water:

- Itchiness
- Stained body odour due to contaminated water
- Headaches
- Exposure to skin diseases e.g eczema
- Worm injections

### The effects of consuming polluted water:

- Vomiting
- Diarrhoea
- Headaches
- Hepatitis
- Cancer
- Worm injections
- Nerve disorders
- Sudden miscarriages
- Fetus mutations
- Conceiving problems

### The effects of pollution on the environment (recreational effects)

- Bad odour
- High water turbidity
- Reduction of aquatic life
- Losses in aesthetic values



### The effects of polluted water on industrial activities

- Poor quality products
- Increase cost of water treatment operation

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