

## 6. CONCLUSIONS AND RECOMMENDATIONS

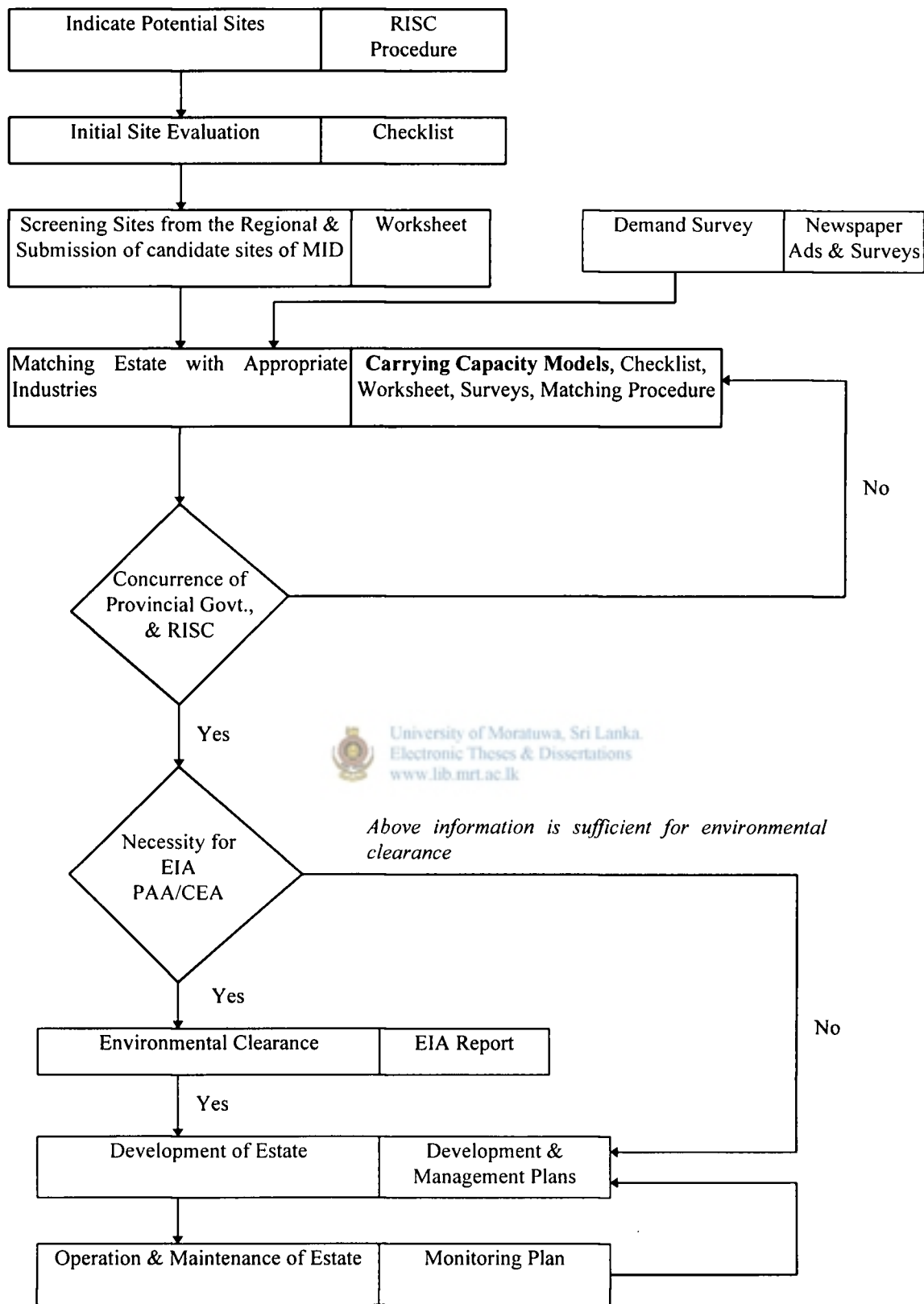
### 6.1. Conclusions

Based on the results of this study the following conclusions may be made drawn

1. The process of determining the industrial mix of a given industrial estate based on the carrying capacity of the environment is a better method than predicting environmental impact based on assumptions.
2. The proposed method for industrial siting and determining carrying capacity is as shown in Fig 10 ( see following page).
3. Limiting of the industrial production corresponding to the carrying capacity based on minimum flow conditions will minimise any risk to the environment due to waste disposal.
4. For Waljapala Watta, the best industrial mix would be one involving low polluting industries. This is because the carrying capacity of the receiving environment with respect to water quality is minimal and it may not be economical to treat the wastewater.

### 6.2. Recommendations

It is recommended that the model be developed further to incorporate other factors such as socio-economic considerations, availability of raw materials, solid waste disposal etc., to study the total impact of industrial development on the environment. This model also could be applied to other sites selected by the MID. In a regional context, this model could be used to determine the best sites for industrial development in keeping with the strategies for industrial development. It could also be augmented with the assistance of Geographical Information System (GIS) to model the carrying capacity of the environment in the regional context.



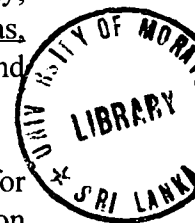
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*Above information is sufficient for environmental clearance*

**Figure 10:** The proposed method for industrial siting and determining carrying capacity (MID,1995).

## 7. REFERENCE

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## 8. ANNEXES

- Annex 1: Draft List of High Polluting Industries
- Annex 2: Gillford and Brookhaven Curves
- Annex 3: Table of Emission Factors for Different Fuels
- Annex 4: Standards for Wastewater Discharge into Water Bodies
- Annex 5: Proposed Ambient Water Quality Standards/objectives



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**Draft List of High polluting industry** (source: CEA)

1. Manufacture and/or formulation of chemicals, paints, varnish dye & dye intermediates, glass, resins, polymers, plastic materials- all sizes
2. Manufacture formulation and/or re-packing of pesticides, herbicides & fertilisers (all sizes)
3. Manufacture/formulations of pharmaceuticals - 1/2 MT/day or more.
4. Petroleum and petrochemical industry - all sizes.
5. Manufacture of soap, detergents and cleaning preparations - 1/2 MT/day or more.
6. Manufacture of tyres and tubes and tyre re-treating industries-including compounding.
7. Manufacture of iron and steel and manufacture of smelted and refined non ferrous metals.
8. Foundries - all sizes.
9. Metal Finishing Industries - All (Electroplating/Galvanising, Anodising - all sizes)
10. Sugar factories and Refineries - all
11. Distilleries & Breweries - all
12. Timber/Wood - Treating and preserving of wood (Boron Treatment is exempted)
13. Natural Rubber processing Industries/Manufacture of Latex based rubber products - all
14. Desiccated coconut Mills (DC mills) - all
15. Food and Beverages/Dairy Industries - (more than 20 workers)
16. Ceramic Industries (excludes small scale pottery, chinaware manufacture industries employing less than 5 people)
17. Manufacture and processing of cement, lime including clinker processing - all sizes
18. Purification and processing of non metallic minerals (excluding precious and semi precious stones)
19. All manufacturing units using asbestos as a raw material - all scales
20. Pulp & paper manufacturing industries > 25MT/DAY
21. Tanneries and leather finishing - all (Industries with only Dry operations are excluded)
22. Textile Processing (Printing, Dyeing & finishing, Bleaching industries) -All  
Industrial Textile & Garment washing Industries - all  
Large scale Batik Industries > 20 employees  
Powerlooms with sizing activities
23. Hotels (only Star category to be included)
24. Mechanised Metal Quarries - all sizes
25. Thermal power plants - all sizes
26. Common Waste water Treatment plants - all sizes
27. Automobile assembly with spray painting activities
28. Printing presses (Only those producing letters press with Lead smelting) production of letter press
29. Man-made fibre industries and Poly urethane foam manufacture - all sizes
30. Large scale Aquaculture Projects - More than ..... Hectares (scale to be decided)
31. Any other industry generating significant quantities of liquid effluents, air emissions, Noise/Vibration or solid/hazardous waste as determined by the CEA in consultation with the relevant agencies (i.e.: subcommittee appointed to compile the list of industries as high/Low polluting).

Suggested BOD load scale for high pollution industries based on the above list:

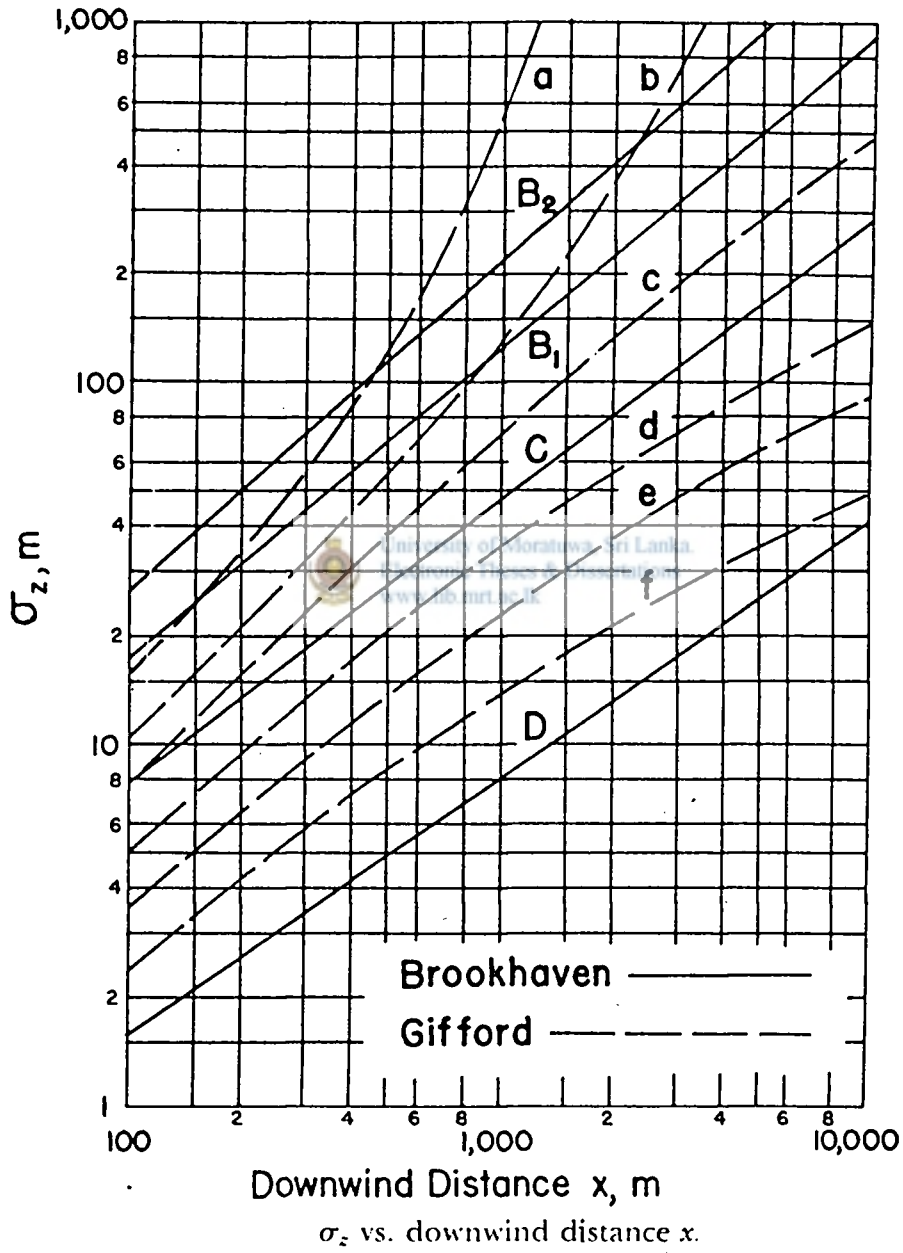
	Min Production t/d	Effluent Factor kg/unit	BOD Load kg/d
Manufacture of Soap, detergents	>0.5	13.5	6.75
Pulp and Paper	>25	6.4	160

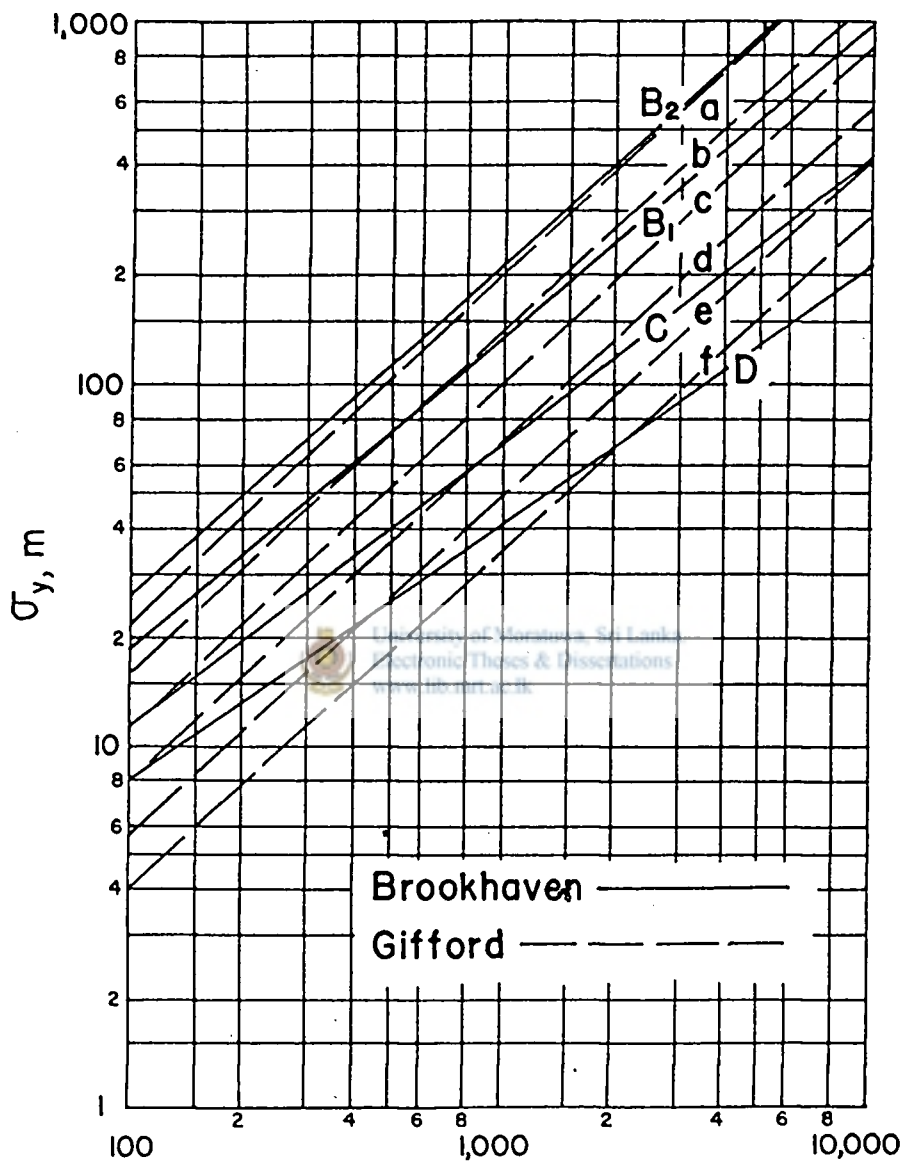
Suggest scale : Any industry that produces a BOD more that 10 kg per day should be considered high polluting industry.



Gillford and Brookhaven Curves

source: (Stern,1982)





Downwind Distance  $x$ , m  
 $\sigma_y$  vs. downwind distance  $x$ .



## Table of Emission Factors for Different Fuels

Source: (WHO, 1993)

Working table for the calculation of pollution loads from stationary combustion sources

Area .....Year .....

Type of source	Fuel burned	Unit	Consumption 10 <sup>3</sup> units per year	Particulates		SO <sub>2</sub>		Nitrogen oxides		Hydrocarbons		CO	
				kg per unit	t/year	kg per unit	t/year	kg per unit	t/year	kg per unit	t/year	kg per unit	t/year
Power plants	Lignite	t		3.5(A)		15(S)		7		0.5		0.5	
	Anthracite	t		3.5(A)		19(S)		9		0.015		0.5	
	Bituminous coal	t		5(A)		19(S)		9		0.15		0.5	
	Fuel oil	t		1.04		19.9(S)		13.2		0.13		0.66	
	Natural gas	10 <sup>3</sup> m <sup>3</sup>		0.24		16.6(S)		9.6		0.016		0.27	
		t		0.29		19.9(S)		11.5		0.019		0.42	
Subtotal													
Industrial and commercial furnaces	Lignite	t		3.5(A)		15(S)		3		0.5		1	
	Anthracite	t		1(A)		19(S)		5		0.1		3	
	Bituminous coal	t		6.5(A)		19(S)		7.5		0.5		1	
	Fuel oil, residual	t		2.87		19(S)		7.5		0.37		0.52	
	Oil, distillate	t		2.13		20.1(S)		7.5		0.41		0.59	
	Liquified petroleum gas	m <sup>3</sup>		0.21		0.01(S)		1.43		0.036		0.19	
	Natural gas	10 <sup>3</sup> m <sup>3</sup>		0.38		0.02(S)		2.6		0.065		0.35	
		t		0.29		16.6(S)		3		0.028		0.27	
		t		0.34		20.1(S)		3.6		0.058		0.32	
Subtotal													
Domestic furnaces	Anthracite (hand-fired)	t		5		15(S)		1.5		1.23		45	
	Bituminous coal (hand-fired)	t		10		19(S)		1.5		10		45	
	Wood	t		13.7		0.5		5		1		1	
	Fuel oil, distillate	t		0.37		20.1(S)		2.72		0.14		0.75	
	Kerosene	t		3		17(S)		2.3		0.4		0.25	
	Liquified petroleum gas	m <sup>3</sup>		0.23		0.01(S)		1		0.094		0.24	
	Natural gas	t		0.42		0.02(S)		1.8		0.17		0.44	
		10 <sup>3</sup> m <sup>3</sup>		0.302		16.6(S)		1.3		0.128		0.32	
		t		0.353		20(S)		1.56		0.151		0.38	
Subtotal													
Total													

Notes: Assumed average specific densities: Fuel oil, distillate = 0.845  
 Fuel oil, residual = 0.937  
 Liquified petroleum gas = 0.55 (mixture of 80% butane and 20% propane)  
 Natural gas = 0.812 kg/m<sup>3</sup> (at standard temperature and pressure)

A is the percentage ash content of combustible by weight  
 S is the percentage sulfur content of combustible by weight  
 Typical efficiency values for fly-ash control equipment  
 Electrostatic precipitators 85% to 99.5%  
 High-efficiency cyclone 30% to 90%  
 Low-resistance cyclone 20% to 80%  
 Settling chamber expanded chimney bases 10% to 30%

## Standards for Wastewater Discharge into Water Bodies

ANNEX 4

Source: National Environmental (Protection & Quality) Regulations published in Gazette Extraordinary No 595/16 dated January 08, 1990

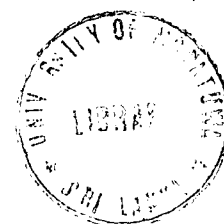
### GENERAL STANDARDS FOR DISCHARGE OF EFFLUENTS INTO INLAND SURFACE WATERS

No.	Determinant	Tolerance limit
1.	Total Suspended Solids, mg/l, max	50
2.	Particle size of total suspended solids	shall pass sieve of aperture size 850 micro m.
3.	pH value at ambient temperature	6.0 to 8.5
4.	Biochemical Oxygen Demand-BOD <sub>5</sub> in 5 days at 20° C, mg/l, max	30
5.	Temperature of discharge	shall not exceed 40° C in any Section of the Stream within 15 m down stream from the effluent outlet.
6.	Oils and greases, mg/l max	10.0
7.	Phenolic Compounds (as phenolic OH)mg/l, max	1.0
8.	Cyanides as (CN) mg/l, max	0.2
9.	Sulfides, mg/l, max	2.0
10.	Flourides, mg/l, max	2.0
11.	Total residual chlorine mg/l, max	1.0
12.	Arsenic, mg/l, max	0.2
13.	Cadmium total, mg/l, max	0.1
14.	Chromium total, mg/l, max	0.1
15.	Copper total, mg/l, max	3.0
16.	Lead, total, mg/l, max	0.1
17.	Mercury total, mg/l, max	0.0005
18.	Nickel total, mg/l, max	3.0
19.	Selenium total, mg/l max	0.05
20.	Zinc total, mg/l, max	5.0
21.	Ammoniacal nitrogen, mg/l, max	50.0
22.	Pesticides	undetectable
23.	Radió active material	
	(a) Alpha emitters micro curie/ml	10 <sup>-7</sup>
	(b) Beta-emitters micro curie/ml	10 <sup>-8</sup>
24.	Chemical Oxygen Demand (COD), mg/l, max	250

Note 1 : All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by 1/8 of the actual dilution.

Note 3 : The above mentioned General Standards shall cease to apply with regard to a particular industry when industry specific standards are notified for that industry.



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**TOLERANCE LIMITS FOR INDUSTRIAL EFFLUENTS  
DISCHARGED ON LAND FOR IRRIGATION PURPOSE**

<i>No.</i>	<i>Determinant</i>	<i>Tolerance Limit</i>
1	Total dissolved solid, mg/l, max	2100
2	pH value at ambient temperature	5.5 to 9.0
3	Biochemical Oxygen Demand (BOD <sub>5</sub> ) in 5 days at 20 °C, mg/l, max	250
4	Oils and grease, mg/l, max.	10.0
5	Chloride (as Cl), mg/l, max.	600
6	Sulfate (as SO <sub>4</sub> ), mg/l, max.	1000
7	Boron (as B), mg/l, max.	2.0
8	Arsenic (as As), mg/l, max.	0.2
9	Cadmium (as Cd), mg/l, max.	2.0
10	Chromium (as Cr), mg/l, max.	1.0
11	Lead (as Pb), mg/l, max.	1.0
12	Mercury (as Hg), mg/l, max.	0.01
13	Sodium adsorption ratio : (SAR)	10 to 15
14	Residual Sodium Carbonate, mol/l, max.	2.5
15	Radio active material :	
	(a) Alpha emitters, micro curie/ml	10 <sup>-9</sup>
	(b) Beta emitters, micro curie/ml	10 <sup>-8</sup>

**TOLERANCE LIMITS FOR INDUSTRIAL AND DOMESTIC  
EFFLUENTS DISCHARGED INTO MARINE COASTAL AREAS**

<i>No.</i>	<i>Determinant</i>	<i>Tolerance Limit</i>
1.	Total Suspended Solids, mg/l, max.	
	(a) For process waste waters	150
	(b) For cooling water effluents	Total suspended matter content of influent cooling water plus 10 per cent.
2.	Particle size of -	
	(a) Floatable Solids, max	3 mm
	(b) Setttable solids, max	850 micro m.
3.	pH range at ambient temperature	6.0 - 8.5
4.	Biochemical Oxygen Demand (BOD <sub>5</sub> ) in 5 days at 20°C, mg/l, max.	100
5.	Temperature, max	45°C at the point of discharge
6.	Oils and grease, mg/l, max.	20
7.	Residual Chlorine, mg/l, max.	1.0
8.	Ammonical Nitrogen mg/l, max.	50.0
9.	Chemical Oxygen Demand (COD) mg/l, max.	250
10.	Phenolic compounds (as phenolic OH) mg/l, max.	5.0
11.	Cyanides (as CN) mg/l, max.	0.2
12.	Sulfides (as S), mg/l, max.	5.0
13.	Fluorides (as F), mg/l, max.	15
14.	Arsenic (as As) mg/l, max.	0.2
15.	Cadmium (as Cd) Total, mg/l, max.	2.0
16.	Chromium (as Cr) Total, mg/l, max.	1.0
17.	Copper (as Cu) total, mg/l, max.	3.0
18.	Lead (as Pb) total, mg/l, max.	1.0
19.	Mercury (as Hg) total, mg/l, max.	0.01
20.	Nickel (as Ni) total, mg/l, max.	5.0



No.	Determinant	Tolerance Limit
21.	Selenium (as Se) total, mg/l, max.	0.05
22.	Zinc (as Zn) total, mg/l, max.	5.0
23.	Radio active material	
	(a) Alpha emitters, micro curie/ml, max	$10^{-6}$
	(b) Beta emitters, micro curie/ml, max	$10^{-7}$
24.	Organo - Phosphorus compounds	1.0
25.	Chlorinated hydrocarbons (as Cl), mg/l, max.	0.02

Note 1 : All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by 1/8 of the actual dilution.

#### TOLERANCE LIMITS FOR EFFLUENTS FROM RUBBER FACTORIES DISCHARGED INTO INLAND SURFACE WATERS

No.	Determinant	Tolerance Limit	
		Type I Factories*	Type II Factories**
1.	pH value at ambient temperature	6.5 to 8.5	6.5 to 8.5
2.	Total suspended solids, mg/l, max	100	100
3.	Total solids, mg/l, max	1500	1000
4.	Biochemical Oxygen Demand (BOD <sub>5</sub> ) in 5 days at 20°C, mg/l, max	60	50
5.	Chemical Oxygen Demand (COD) mg/l, max	400	400
6.	Total Nitrogen, mg/l, max	300	60
7.	Ammoniacal Nitrogen, mg/l, max	300	40
8.	Sulfides, mg/l, max	2.0	2.0

\* Type I Factories - Latex Concentrate

\*\* Type II Factories - Standard Lanka Rubber; Crepe Rubber and Ribbed Smoked Sheets

Note 1 : All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by 1/8 of the actual dilution.

#### TOLERANCE LIMITS FOR EFFLUENTS FROM TEXTILE INDUSTRY DISCHARGED INTO INLAND SURFACE WATERS

No.	Determinant	Tolerance Limit
1.	pH value at ambient temperature	6.5 to 8.5
2.	Temperature, °C, max	40 measured at site of sampling
3.	Total suspended solids, mg/l, max	50
4.	Biochemical Oxygen Demand (BOD <sub>5</sub> ) in 5 days at 20 °C mg/l, max.	60
5.	Chemical Oxygen Demand (COD) mg/l, max.	250
6.	Oils and grease, mg/l, max.	10.0
7.	Phenolic compounds (as phenolic OH), mg/l, max.	1.0
8.	Sulfides, mg/l, max.	2.0
9.	Chromium total, mg/l, max.	2.0
10.	Hexavalent chromium, mg/l, max.	0.5
11.	Copper, total, mg/l, max.	3.0
12.	Zinc total, mg/l, max.	5.0
13.	Ammoniacal nitrogen, mg/l, max.	60
14.	Chloride (as Cl) mg/l, max.	70

Note 1 : All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by 1/8 of the actual dilution.

## Proposed Ambient Water Quality Standards/objectives

Source: (bkh,1991)

## Proposed inland water quality standards for different uses

Parameter	Unit, Type of limit	Nature conservation	Drinking water, only disinfection	Bathing	Fish and aquatic life	Drinking water, convent. treatment	Irrigation and agriculture	Other
Colour	H.u., max.	n	10 av 30 max	-	-	300	-	-
Odour		n	unobj.	unobj.	-	-	-	-
Dissolved oxygen	mg/l, min.	n	6	4	6 mean 4	-	3	-
BOD (5 days, 20°C)	mg/l, max.	n	-	-	-	3	-	4
pH		n	6.5-8.5	6-8.5	6-8.5	5.0-8.5	-	5.0-8.5
Nitrates (NO <sub>3</sub> -N)	mg/l, max.	n	-	-	-	-	-	5
Total ammonia (NH <sub>3</sub> -N)	mg/l, max.							
- pH < 7.5		n	-	-	10.3	-	-	10.3
- pH = 8.0		-	-	4.9	-	-	4.9	-
- pH = 8.5		-	-	1.8	-	-	1.8	-
Chlorides (Cl)	mg/l, max		200 des. 1200 max.	-	-	200 des. 1200 max.	-	-
Cyanides (CN)	mg/l, max.	n	-	-	0.005	-	-	0.005
Fluorides (F)	mg/l, max.	n	1.5	-	-	1.5	-	-
Sulphates (SO <sub>4</sub> )	mg/l, max.	n	400	-	-	400	-	-
Total coliform	MPN/100 ml, (P = 80%)	n	50	5000	20,000	5000	-	-
Total arsenic (As)	µg/l, max.	n	50	-	50	50	-	50
Total cadmium (Cd)	µg/l, max.		5		H Cd < 60 0.2 60-120 0.8 120-180 1.3 > 180 1.8	5	-	5

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Proposed inland water quality standards for different uses - continued

Parameter	Unit, Type of limit	Nature conser- vation	Drinking water, only disinfection	Bathing	Fish and aquatic life	Drinking water, convent. treatment	Irrigation and agriculture	Other
Total chromium (Cr)	µg/l, max.	n	50	-	2	50	-	50
Total copper (Cu)	µg/l, max.	n	-	-	<u>H</u> <u>Cu</u> < 60 2 60-120 2 120-180 3 > 180 4	-	-	100
Iron (Fe)	µg/l, max.	n	-	-	300	2	-	-
Lead (Pb)	µg/l, max.	n	50	-	<u>H</u> <u>Pb</u> < 60 1 60-120 2 120-180 4 > 180 7	50	-	50
Manganese (Mn)	µg/l, max.	n	-	-	-	-	-	1000
Mercury (Hg)	µg/l, max.	n	1	-	0.1	1	-	2
Nickel (Ni)	µg/l, max.	n	-	-	<u>H</u> <u>Ni</u> < 60 25 60-120 65 120-180 110 > 180 150	-	-	100
Selenium (Se)	µg/l, max.	n	10	-	1	10	-	-
Zinc (Zn)	µg/l, max.	n	-	-	30	-	-	1000

Continued on next page

Proposed inland water quality standards for different uses - continued

Parameter	Unit, Type of limit	Nature conser- vation	Drinking water, only disinfection	Bathing	Fish and aquatic life	Drinking water, convent. treatment	Irrigation and agriculture	Other
Gross alpha radioact.	pC/l, max.	n	3	3	-	3	-	3
Gross betha radioact.	pC/l, max.	n	30	30	-	30	-	30
Phenolic comp. (C <sub>6</sub> H <sub>5</sub> OH)	µg/l, max.	n	2	5	1	5	-	5
Anionic deterg. as MBAS	µg/l, max.	n	200 des. 1000 max.	1000	-	200 des. 1000 max.	-	-
Total pesticides	µg/l, max.	n	-	-	-	-	-	50
Aldrin	µg/l, max.	n	-	-	-	-	-	0.1
DDT	µg/l, max.	n	-	-	0.001	-	-	1
Dieldrin	µg/l, max.	n	-	-	0.004	-	-	0.1
Endrin	µg/l, max.	n	-	-	0.0023	-	-	-
Heptachlor & heptachlorepoxyde	µg/l, max.	n	-	-	0.01	-	-	0.2
α-Hexachlorocyclohexane	µg/l, max.	n	-	-	-	-	0.02	-
Other organic micro-pollutants		n	-	-	see table 3.12	-	-	-
Conductivity	dS/m, max.	n	-	-	-	-	0.7	-
Boron	mg/l, max	n	-	-	-	-	0.5	-

Abbreviations:

H = Hardness (CaCO<sub>3</sub>), mg/l

des. = desirable

max. = maximum

P=80% = 80% of the samples give a value that is equal to or less than the indicated limit

