ENVIRONMENTAL PROTECTION DEPARTMENT

MINISTRY OF ENVIRONMENT & NATIONAL BEAUTIFICATION

Presents

TABLE OF PROHIBITED CONCENTRATIONS

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In association with: New Water Incorporated

ENVIRONMENTAL PROTECTION DEPARTMENT

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Glossary of Terms

µg/l	micrograms/litre ≡ 0.001 mg/l ≡ parts per billion.
µg P/l or µg N/l	The mass of the phosphorous or nitrogen in a litre rather than the mass of the atoms they are attached to, e.g. oxygen in nitrates.
% Saturation	The measured concentration compared with the normal atmospheric equilibrium concentration at that temperature.
Anzec	ANZECC and ARMCANZ, 2000. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand Guidelines for fresh and marine water quality. National Water Quality Management Strategy. Available at http://www.ea.gov.au/water/quality/nwqms
Best Available Technology	The most accurate and available methods of detection.
Bioaccumulation	The retention and accumulation of a chemical within the tissues of a biological organism.
Class 1 Waters	Surface and subsurface waters extending from the farthest distance inland to the 100 metres isobath[1] or 200 metres seaward of the outer edge of the bank reef whichever is farthest.
Class 2 Waters	Marine waters extending the outer most boundary for class 1 waters but within the territorial waters of Barbados.
Geometric mean	The list of values are multiplied together and then the taken to the power 1/n, where n is the number of values.
Half-life	The time period required for a process to remove half of the original quantity
Organic/inorganic	Organic compounds contain Carbon. Inorganic compounds do not contain carbon.
PSU	Practical Salinity Units, numerically equivalent to parts per thousand or grams/kilogram.
NTU	Nephelometric Turbidity Units. Turbidity is measured using a Nephelometer that measures the amount of sediment in the water by measuring the light that is scattered at a 90-degree angle by the suspended material. This measurement generally provides a very good correlation with the concentration of particles in the water.
Toxic	Poisonous to biological organisms.
Volatile	Prone to evaporate rapidly.

[1] Isobath- A contour line on a map connecting points if of equal depth in a body of water or below the Earth's surface.

Table 1. List of Pollutants and Ambient Standards.

Parameter	Rationale	Ambient Water Quality Standard (µg/l) unless otherwise stated.
Chlorophyll *a*	An indicator of the presence of algae, which can be an indicator of high nutrient levels.	0.5
Dissolved Oxygen[2]	Essential for aquatic life. Requirements vary depending on species, life stage, and life processes. Many compounds become more toxic as Dissolved Oxygen decreases; so can have an indirect effect.	90 (% saturation) -actual concentration varies with temperature.
Faecal streptococci / enterococci	Public health indicator of sewage pollution in seawater. This is generally the preferred indicator of health risk.	Geometric mean of min. 5 samples should not exceed 35 colonies/100ml in any 30-day period.
Faecal coliform	Public health indicator of sewage pollution in freshwater, but historically used in seawater as well.	Geometric mean of min. 5 samples not exceed 200 colonies/ 100ml in any 30-day period. No more than 10% of samples exceed 400 colonies/100ml.
Phosphate (Filterable Reactive)	Primary nutrient causes high algal growth, which then impacts on coral by blocking light and smothering.	2.48 (µg P/l)
Oxides of Nitrogen (nitrate/nitrite)	Primary nutrient causes high algal growth, which then impacts on coral by blocking light and smothering.	9.8 (µg N/l)
Ammonia	Form of nitrogen most easily used by plants. Causes high algal growth, which then impacts on coral.	9.8 (µg N/l)
Total nitrogen (inorganic and organic)	Better indicator of nutrient loading as measures organic load as well.	100
Total phosphorous (inorganic and organic)	Better indicator of nutrient loading as measures organic load as well.	15
pH	General indicator of acidity/alkalinity. Change in pH can be either toxic directly or indirectly by changing the toxicity of other pollutants.	7.0-8.7
Salinity	General parameter describing the total salt content of seawater. An indicator of the presence of freshwater or hyper saline discharges.	30-38 (psu)
Temperature	Indicator of thermal pollution from, for example, cooling water discharges. Changes in temperature can affect the toxicity of chemicals or kill coral directly through bleaching.	<31°C
Total Suspended Solids (TSS)	Suspended solids increase turbidity, reduce light penetration, and decrease photosynthetic activity – the basis of coral growth. Also important in the transport of other pollutants that are strongly associated with the solids, such as metals.	5 (mg/l)
Sedimentation Rate	Indicator of the amount of solids that settles on the seabed. Settling solids can smother a reef. Bank reefs are more susceptible than fringing reefs.	Fringing reefs: 25 $mg/cm^2/day$ Bank Reefs: 5 $mg/cm^2/day$
Turbidity	Aesthetic impact; reduced water clarity; impact on photosynthetic capacity of corals. Another measure of the amount of sediment in the water column.	1.5 (NTU)
Chlorine (Total Residual	Chlorine is commonly used as a disinfectant in potable	2

[2] Dissolved Oxygen – is measured as a concentration then the saturation level is calculated based on the Normal Atmospheric Equilibrium Concentration (NAEC). At 35psu and 24°C the NAEC for oxygen is 5.5ml/l. Around Barbados we typically measure 6.5-7mg/l, which is equivalent to approximately 4.6-4.9ml/l assuming these measurements were taken at standard pressure.

Parameter	Rationale	Ambient Water Quality Standard (µg/l) unless otherwise stated.
Chlorine)	water and in sewage treatment, toxic to many marine species.	
Cyanide (un-ionised HCN)	Used in metal plating / metal finishing and photo-processing. Toxic. HCN (hydrocyanic acid) is the most toxic form of cyanide as it can cross biological membranes.	4
Cadmium	Used in metal plating, in batteries, and in the manufacture of semiconductors. Toxic. Bio-concentration can be significant for bivalves. If shellfish from the area are consumed an even lower trigger value of 0.2 µg/l is recommended. Causes kidney damage in humans.	0.7
Chromium III (trivalent)	Used in metal plating, leather industry and as a corrosion inhibitor in cooling systems. Toxic. Chromium III less toxic than Chromium VI.	27.4
Chromium VI (hexavalent)	Used in metal plating, leather industry and as a corrosion inhibitor in cooling systems. Toxic.	4.4
Copper	Commonly used metal, specifically by the rum industry. An essential trace element, but toxic at higher concentrations. Readily accumulated by plants and animals. Copper toxicity to marine species generally increases as salinity decreases. Long-term exposure causes liver and kidney damage in humans.	1.3
Lead	Historically added to paint and gasoline; used in old water pipes. Toxic.	4.4
Mercury (inorganic)	Used in switches, thermometers, and dentistry. Can be converted by microorganisms in sediment to methyl mercury. Methyl mercury is soluble, more toxic than inorganic mercury and bio-accumulates.	0.1
Nickel	Used in metal plating, present in batteries. Nickel toxicity increases with decreasing salinity. The 95% [3] protection level not deemed to provide sufficient protection to juvenile mysids and molluscs.	7
Silver	Used in the electronics and photography industries. The acute toxicity of silver to marine fish is considerably lower than to freshwater fish. Toxicity to most species increases with decreasing salinity.	1.4
Vanadium	Occurs in 4 valency states. Vanadium +5 (Vanadate) is the most common in water and the most toxic.	100
Zinc	In greater than trace concentrations, harmful to aquatic organisms. Zinc uptake and toxicity generally decrease as salinity increases.	15
Tributyltin	Highly toxic to marine bivalves. Present in marine antifouling paints and wood preservative.	0.006
Ethanol	Present in alcohol distillery waste. Volatile and completely mixable with water. Large inputs can significantly reduce Dissolved Oxygen levels. Limited marine toxicity data. Anzecc present a low reliability value taken from the freshwater value, which should be considered only as an interim working value. It is	1400

[3] The 95% protection level means that at this concentration it is expected that 95% of species will be protected.

Parameter	Rationale	Ambient Water Quality Standard (µg/l) unless otherwise stated.
	recommended for inclusion due to the known presence of ethanol in marine waters off of the west coast of Barbados.	
1,1,2- trichloroethane	Volatile and relatively soluble in water. Commonly used industrial solvent. Not expected to bioaccumulate significantly.	1900
1,1,2,2-tetrachloroethylene (perchloroethylene)	Commonly used in the dry cleaning industry in Barbados. Not expected to bioaccumulate or to bind to sediment. Volatile with a half-life of 1-6 days in water. Due to its known use in Barbados the Anzecc marine low reliability value is recommended as an interim working value. Anzecc considers that there is insufficient data to generate a marine medium reliability trigger value.	70
Benzene	Benzene, toluene, ethyl benzene and xylene (BTEX) are the simplest aromatic hydrocarbons. Products of oil refining and important common aromatic solvents. Commonly associated with contaminated petroleum sites (e.g. Needham's Point). BTEX compounds are highly volatile, have low water solubility and have low bioaccumulation potential. However, water managers should be aware of possible additive effects (mixture toxicity). Anzecc 99% [4] protection level is recommended to provide protection against chronic toxicity to crabs.	500
Toluene	Insufficient data. Low reliability value recommended as an interim value.	180
Ethyl benzene	Insufficient data. Low reliability value recommended as an interim value.	80
Xylenes	Insufficient data. Low reliability value recommended as an interim value for m-xylene.	75
Naphthalene	Naphthalene is the simplest polycyclic aromatic hydrocarbon (PAH), used as an insect-proofing agent for stored materials and clothes. Will absorb strongly to sediment. UV light increases the toxicity. Only PAH that Anzecc considers there are sufficient data to generate a moderately reliable guideline value. Due to chronic toxicity to the crab *C. magister*, the Anzecc 99% protection level is recommended.	50
PCBs	Used as a dielectric fluid in transformers and capacitors. No longer used by the Barbados Light & Power Company Ltd. High persistence and potential to bioaccumulate. Moderate reliability trigger values have been derived for Arochlors 1242 &1254 in freshwater. These numbers have been converted to marine low reliability figures and should be considered as interim values.	Arochlor 1242: 0.3 Arochlor 1254: 0.01
Phenol	Commonly used raw material in the manufacture of a wide range of products. A common by-product of oil	400

[4] The 99% protection level means that at this concentration it is expected that 99% of species will be protected**.**

Parameter	Rationale	Ambient Water Quality Standard (µg/l) unless otherwise stated.
	refining. Readily soluble in water and low bioaccumulation potential. Imparts taste and odour in fish and shellfish at low concentrations. Variable toxicity.	
Pentachlorophenol (PCP)	A biocide, disinfectant, pesticide and wood preservative. Found in chlorinated effluents from sewage treatment plants. Impair taste, more toxic at lower pH. The Anzecc 99% protection level is recommended in the absence of local bioaccumulation data.	11
All organochlorine (OC) pesticides	The use of OC pesticides was phased out in Barbados more than a decade ago. However, the compounds are persistent with high bioaccumulation potential. The detection limits for most OC's are greater than the standards, so it is recommended that OC's should not be detectable in marine waters.	Not detectable, based on Best Available Technology.
All organophosphate (OP) pesticides	Commonly used in Barbados. Toxic to most species. Detection limits in the order of 0.02 µg/l in water. Recommended standards are lower. Therefore, it is recommended that OP's should not be detectable in marine waters.	Not detectable, based on Best Available Technology.
Other Insecticides, Herbicides and Fungicides	Insufficient data currently exists to allow Anzecc to generate moderate reliability trigger levels for other pesticides at this time. To be precautionary, it is recommended that a No Detection limit be used as a default in the absence of other data.	Not detectable, based on Best Available Technology.

Table 2. Domestic Waste End of Pipe Standards.

Parameter	Rationale	End of Pipe Standard
Biochemical Oxygen Demand	When there is a large quantity of biological matter in the water bacteria will break it down but use up oxygen at the same time. This is a measure of that oxygen demand and will lead to a drop in dissolved oxygen levels.	Class 1 – 30mg/l Class 2 – 150mg/l
Total Suspended Solids (TSS)	Suspended solids increase turbidity, reduce light penetration, and decrease photosynthetic activity – the basis of coral growth. Also important in the transport of other pollutants that are strongly associated with the solids, such as metals.	Class 1 – 30mg/l Class 2 – 150mg/l
Total nitrogen (inorganic and organic)	Better indicator of nutrient loading as measures organic load as well. The end-of-pipe standards have been set to meet the ambient standard in Class 1 waters within a 50:1 mixing zone.	Class 1 – 5mg/l Class 2 – 45mg/l
Total phosphorous (inorganic and organic)	Better indicator of nutrient loading as measures organic load as well. The end-of-pipe standards have been set to meet the ambient standard in Class 1 waters within a 50:1 mixing zone.	Class 1 – 1mg/l Class 2 – 10mg/l
pH	General indicator of acidity/alkalinity. Change in pH can be either toxic directly or indirectly by changing the toxicity of other pollutants.	6-9 in Class 1 and 2 waters.
Faecal streptococci	Public health indicator of sewage pollution in seawater. This is generally the preferred indicator of health risk.	Class 1 - Geometric mean of min. 5 samples should not exceed 35 colonies/100ml in any 30-day period.
Faecal coliform	Public health indicator of sewage pollution in freshwater, but historically used in seawater as well.	Class 1 - Geometric mean of min. 5 samples not exceed 200 colonies/ 100ml in any 30-day period. No more than 10% of samples exceed 400 colonies/100ml.
Total Residual Chlorine	Chlorine is commonly used as a disinfectant in potable water and in sewage treatment, toxic to many marine species.	Class 1 - 0.1mg/l
Fats, Oils and Grease	Found in urban runoff and domestic waste. Smothers shoreline ecosystems. Can be toxic.	Class 1 – 15mg/l Class 2 – 50mg/l
Floatables	Plastics and other materials that are not easily removed by natural processes. They can smother or be ingested by organisms.	Not visible in Class 1 and 2 waters.

Table 3. Petroleum Hydrocarbons End of Pipe Standards for Class 1 Waters.

Parameter	Rationale	End of Pipe Standard
Total Petroleum Hydrocarbons (TPH)	Important chemicals used in the production of oils and fuels. Found in industrial discharges and urban runoff. Smothers shoreline ecosystems. Lighter fractions are most toxic.	Max. daily discharge (mg/l): 10 Av. Daily concentration over 30 consecutive days (mg/l): 5
Total Oils & Greases	Found in industrial discharges and urban runoff. Smothers shoreline ecosystems. Can be toxic.	Max. daily discharge (mg/l): 10 Av. Daily concentration over 30 consecutive days (mg/l): 5
Total Organic Carbon	The level of organic carbon can influence the availability of other pollutants. Directly non-toxic.	Max. daily discharge (mg/l): 110 Av. Daily concentration over 30 consecutive days (mg/l): 55

References

ANZECC and ARMCANZ, 2000. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand Guidelines for fresh and marine water quality. National Water Quality Management Strategy. Available at http://www.ea.gov.au/water/quality/nwqms

CCME (Canadian Council of Ministers of the Environment), 1999. Canadian Environmental Quality Guidelines. Publication No. PN1299: ISBN 1-896997-34-1. Summary available at www.ccme.ca/publications/can_guidelines.html#108.

CEHI, 1998. Guidelines for Sensitive Waters. Caribbean Environmental Health Institute.

Delcan, 1994. Nearshore Marine Water Quality of the West and Southwest Coasts of Barbados: Present Status and Management Recommendations. Government of Barbados Coastal Conservation Project Unit.

EEC, 1976. Bathing Water Directive 76/160/EEC. Available at http://europa.eu.int/water/water-bathing/directiv.html

State of Wyoming, 2000. Department of Environmental Quality/Water Quality Division Public Notice. August 31, 2000.

United Nations Environment Program, 1999. Protocol Concerning Pollution from Land-Based Sources and Activities to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region. Available at http://www.cep.unep.org/law/lbsmpnut.php

US EPA, 1995. CFR Title 40 – Protection of the Environment. Subchapter N – Effluent Guidelines and Standards, Part 419.22, Petroleum Refining Point Source Category. http://www.epa.gov/epacfr40/chapt-I.info/chi-toc.htm

US EPA, 2002. Implementation Guidance for Ambient Water Quality Criteria for Bacteria. May 2002. Draft.

World Bank, 1999. Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production. ISBN: 0-8213-3638-X SKU: 13638