Encyclopaedia of Environmental Pollution

Vol. 3

ENCYCLOPAEDIA
OF
ENVIRONMENTAL POLLUTION

ENVIRONMENTAL WATER POLLUTION

VOLUME - 3

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COMMONWEALTH PUBLISHERS
NEW DELHI (INDIA)

ENCYCLOPAEDIA OF ENVIRONMENTAL POLLUTION

First Published, 1997

ISBN 81-7169-446-2 (Set)

Published by:
AJAY VERMA
COMMONWEALTH PUBLISHERS
4378/4-B, Murari Lal Street,
Ansari Road, New Delhi - 110 002
Phone : 3272541

PRINTED IN INDIA

at
Taruna Enterprises
518/14, Anup Market, Maujpur, Delhi-110053

Preface

The term 'Water Quality' is a widely used expression which has an extremely broad spectrum of meanings. Each individual has vested interests in water for his particular use, which may involve commercial and industrial uses or recreational pursuits. Since the desirable characteristics of a water vary with its intended use, there is frequently unsatisfactor communication among the users of water where quality is concerned.

All other water uses must be subordinated to man's need for a healthful fluid for his consumption. Water for drinking and food preparation must be free from organisms capable of causing disease and from minerals and organic substances producing adverse physiological effects. To encourage man to drink this health promoting liquid, the water must be aesthetically acceptable

The book present the water quality is dynamic and its changing parameless require the water technologist to be in constant touch with many segments of the scientific world.

EDITORS

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Water Quality Impact Analysis

While transportation of large quantities of water dates back to as early as 97 A D., concern with water quality is a relatively new concept only extending over the past 150 years. The earliest documented problems of water quality degradation resulted from the use of storm drains for conveying human excrement to nearby waterways to relieve the intolerable conditions created by the privies and cesspolls which were saturating urban slums (Refs. 1,2).

The earliest noticeable effects on water quality were aesthetic; streams receiving sewage began to emit noxious odours (Ref. 1). Eventually, the role of water in transmitting disease was discovered. In London in 1854, it was proven that victims of cholera all drank from the same water source, the "Broad Street pump." This observation represents the earliest dccumented evidence of adverse water supplr (Ref. 3). In 1892, an epidemic of cholera caused 8600 deaths in Hamburg, Germany. This death rate was nearly six times greater than that in Altona, Germany, which used the same water supply source, the Elbe River, but treated its water supply by slow sand filtration (Ref. 4).

During the nineteenth century, increased crowding and disease in United States cities resulted in the development of sanitary sewerage systems (Ref. 2). In addition, advanced technology produced industrial processes which generated a variety of effluents, most of which were discharged without treatment into nearby watercourses.

As awareness of the degradation of the nation's waterways has grown, the state-of-the-art of water pollution control has advanced. Scientific and technological advancements have led to the discovery of additional sources of water quality degradation, including mining, agriculture, forestry, construction, residential development, and stream channel modifications Water quality impact assessments must be performed, and new methods of water pollution control must be devised to deal with the numerous sources of water quality degradation.

Water Quality Criteria and Standards

Before conducting a water quality impact assessment, all applicable water quality criteria and standards must be known. "Water quality criteria," as distinguished from standards, are defined as the levels of specific concentrations of constituents which are expected, if not exceeded, to assure the suitability of water for specific uses (Ref. 5).

Since the early 1900s, substantial research has been devoted to the establishment of water quality criteria. In 1952, the state of California (Ref. 6) published the first summarization of criteria for eight major uses of water. In 1963, the 1952 Water Quality Criteria was expanded and published by the Resources Agency of California, State Water Quality Board (Ref. 7). In that landmark document, which contained 3827 references, criteria were identified for a multitude of constituents as they related to domestic water supply, industrial water supply, agricultural water supply (irrigation), stock and wildlife watering, fish, and other aquatic and marine life, shellfish culture, swimming and bathing, boating, and even power and navigation.

In 1968, the National Technical Advisory Committee (NTAC) report to the Secretary of the Interior was published (Ref. 8). This report recommended concentrations of constituents which would insure the preservation of water for five specified uses: domestic water supply, recreation, fish and wildlife, agricultural uses, and industrial uses.

The latest report on water quality criteria (Ref. 5) departs from the identification of criteria for specific uses and arranges the criteria alphabetically. The criteria recommended in this report are designed to achieve the goals of Public Law (PL) 92-500; that is, to provide for the protection and propagation of fish and other aquatic life and for recreation in (and on) the water.

Both McKee and Wolf (Ref. 7) and the NTAC report (Ref. 8) are excellent guides for predicting the effects of a proposed action on specific downstream water uses. The *Quality Criteria for Water* was tailored to protect the water for use by aquatic life and for recreation and domestic supply, since those uses represent the highest beneficial water uses achievable (Ref.5). That report reflects the most recent research investigations and is continuously revised as new data become available.

"Water quality standards" are legal regulations established by the states, limiting the concentrations of various constituents in water. Stream quality standards apply to ambient waterways, and effluent standards apply to discharges of liquid effluents into those waterways. Since water quality standards are continually revised, the most recent standards for waterways under consideration should be obtained from the state (s) having jurisdiction over the initiation of water quality assessment. The states which have U.S. Environmental Protection Agency (USEPA) approved water quality standards, and the documents containing those standards, are reported in the *Federal Register* (Ref. 9). Each annual reference issue of the *Water and Sewage Works Journal* (Ref.10), publishes a directory of state and territorial water pollution control agencies, which provides the names and addresses of agencies from which water quality standards may be obtained.

For projects involving effluent discharges, state effluent standards and the effluent guidelines developed by the USEPA for the National Pollutant Discharge Elimination System (NPDES) apply. The state effluent standards are usually applicable to any discharge, while the EPA effluent guidelines are specific to an industry or type of public treatment facility. Industrial effluent guidelines have been developed for specific Standard Industrial Classification (SIC) codes and may be obtained from the Effluent Guidelines Division of the USEPA.

The Safe Drinking Water Act (PL 93-523) substantially broadened the spectrum of constituents to be considered in water quality assessment, especially in streams currently serving as source of public water supply. Subsequent to that act, the USEPA published Interim Primary Drinking Water Regulations (Ref. 11), which specified maximum allowable concentrations of constituents, including many organic chemicals. Since those regulations are in a state of evolution, the most current regulations should be obtained from the *Federal Register*.

Overview of Water Quality Impact Analysis

The activities that must be performed by the water quality assessment team are basically those that must be followed in any impact assessment process, as shown schematically in Figure 1 1. The general procedure includes the following steps:

1. Perform a preliminary review of the existing environment and proposed project
2. Select environmental indicators to be used for describing the environment and gauging the effects of the project
3. Describe the existing environment by providing quantiative descriptions of each indicator, using existing data sources
4. Conduct field sampling programmes to complete the description of the environmental setting
5. Make predictions of the effect of the proposed project on the environment (impact assessment)
6. Propose modifications which could minimize adverse impacts resulting from the project
7. Prepare the appropriate sections dealing with water quality for the environmental impact statement or report.

The activities just described and those depicted in Figure 1.1 are interrelated. If the environmental setting is not judged to be sufficiently complete, other sources of information should be investigated, or field measurements should be made to

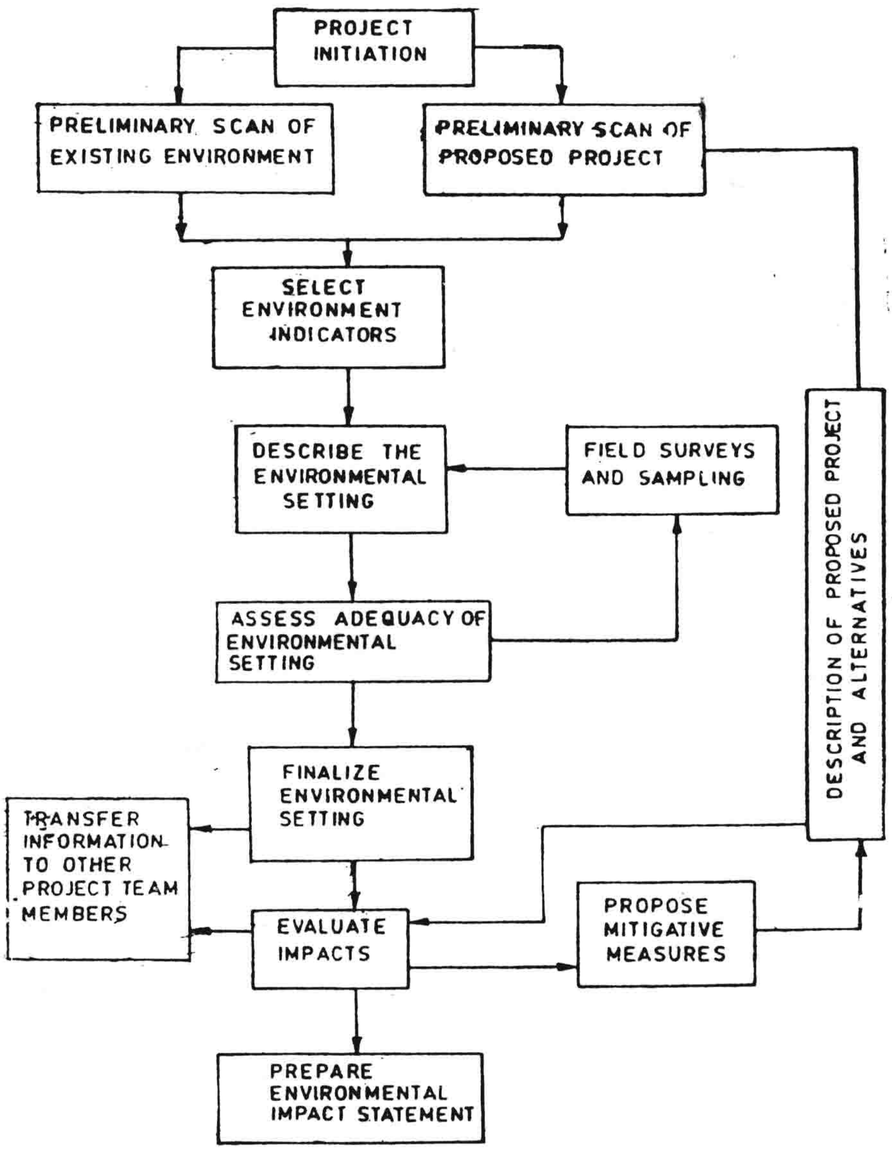

Fig. 1.1: Environmental impact assessment—work flow diagram.

complete the setting. If the impact analysis reveals that additional environmental indicators are required to fully describe the character and magnitude of the impacts, these indicators should be developed and described. The evaluation of the impacts may reveal a means of minimizing adverse impacts. As a result, modification of the proposed project may be warranted, which would necessitate re-evaluation of impacts. This highlights the fact that the impact assessment should be an integral part of the planning process and not simply an evaluation step added onto the end of the project to satisfy the requirements of the NEPA. Incorporation of the impact assessment into the planning process can minimize adverse impacts as well as public objections, while increasing the compatibility of a project with the environment.

The water quality assessment group is a member of a multidisciplinary impact assessment team. For this reason, close coordination must be maintained between the other project groups, particularly the biological and socioeconomic groups. Water quality and water quantity have a significant influence on other areas of the environment. Much of the information generated by the water quality group will be used in the assessment of biological and socioeconomic indicators. Similarly, input from other disciplines is needed for the completion of the water quality assessment.

Environmental Setting

The basic approach to conducting an assessment of water quality impacts is shown schematically in Figure 6 1. The earliest major phase of the process is the description of the environmental setting: an inventory of existing water quality, hydrologic resources, and conditions influencing water quality and water resources. This phase of the project involves the selection of appropriate environmental indicators and descriptions of the environment through literature reviews and field investigations. This phase also includes a description of aspects of the proposed project and alternative courses of action which could influence water quality or quantity.

This section focuses on the development of the environmental setting. The selection of environmental indicators is discussed, followed by a discussion of information sources for the description of the setting. The final topic addressed concerns water quality field surveys. Field surveys may play a significant role in the development of the environmental setting, particularly for a major project.

Environmental Indicators

At the onset of the assessment, the water quality team must scan the environment in the area of the proposed project and review the characteristics of the project. The object of this preliminary review is to determine possible water quality impacts which might result from the project and to identify sensitive or critical environmental areas. Surface and groundwater resources should be identified and their general water quality described (such as severely polluted, occasional violations of stream standards, clean stream, etc). Water requirements and wastewater discharges, along with construction requirements for the proposed project, should be defined. Possible changes in water quality and quantity resulting from the project are identified and described in qualitative terms.

The next task in detailing the environmental setting is the selection of environmental indicators. The environmental indicators selected should be described as quantitatively as possible during preparation of the environmental setting. During the impact evaluation phase, the proposed project is superimposed on the existing environmental setting, and predictions of the new values for each environmental indicator are made.

The selection of environmental indicators is extremely important since this selection significantly defines the level of detail to be developed during the environmental impact assessment. Selection of a multitude of extremely detailed indicators may serve to cloud the effort and bury the focus of the impact evaluation under a blanket of extraneous detail. Selection of only a few general indicators may minimize the potential for quantification and may be inadequate to fully describe the setting and anticipated project impacts.

Table 1.1 contains a list of possible environmental indicators in the following general categories: geophysics, hydrology, water quality, water systems, and wastewater systems. This is not a definitive list of indicators to be included in all impact assessments. Rather the list contains indicators which should be considered for inclusion in any impact assessment. The project team must take the responsibility for selecting appropriate indicators for each individual project and geographical location. Emphasis should be placed on this reference to "project team", because it is unlikely that any one individual will have the breadth of knowledge needed to fully address all five general categories of indicators listed in Table 1.1. Assistance from a geologist/soils scientist, hydrologist or water resources engineer and an environmental engineer may be required.

TABLE 1.1

Environmental Indicators

Category	*Sub-category*	*Indicators*
Geophysical	Geology	Bedrock type
		Bedrock characteristics
		Depth to bedrock
	Soils	Soil type
		Soil characteristics
		Depth to water table
	Topography	Watershed description
		Watershed map
		Drainage areas
		Slope
		Relief
	Erosion/sedimentation	Locate erosion problems
		Erodability of soils
		Locate sedimentation problems
		Stream bed loads

Category	*Sub-category*	*Indicators*
Hydrology	Surface water	Inventory water sources
		Inventory water withdrawals
		Water budget
		Lake water surface elevations
		Surface area
		Lake stratification
		Depth of flow
		Flow velocity
		Discharge (average, low, peak, seasonal variation)
		Flood and drought records (include flood frequency analysis)
		Describe flood control facilities
		Stream order
		Reservoirs (purposes, operating schedule)
	Groundwater	Salt water intrusion
		Permeability of aquifers
		Porosity of aquifers
		Depth to groundwater
		Yields
		Seasonal variations
		Long-term trends
		Recharge areas
		Recharge rates
		Inventory withdrawals
		Inventory deep-well discharges
	Meteorology	Temperature (daily and seasonal variation, high, low, mean)
		Wind (speed, direction, wind rose)
		Precipitation (seasonal variations, extremes, storm frequency analysis)
		Snow (monthly distribution, extremes)
		Frost (earliest, latest)
		Humidity (daily and seasonal variations)
		Dew point (daily and seasonal variations)
		Solar radiation (daily and seasonal variations)

TABLE 1.1 [*Contd.*]

Category	*Sub-category*	*Indicators*
Water quality	Surface water	Classification of stream
		Stream standards
		Temperature
		pH
		Conductivity
		Turbidity
		Total dissolved solids
		Total suspended solids
		Colour
		BOD (5-day, 20°C[1]
		BOD—ultimate[1]
		DOD[2]
		TOC[3]
		Dissolved oxygen
		Hardness
		Alkalinity
		Acidity
		Nitrate
		Nitrite
		Ammonia
		Total Kjeldahl nitrogen
		Organic nitrogen
		Phosphate
		Ortho-phosphate
		Organic phosphorus
		Sulphates
		Chloride
		Fluoride
		Iron
		Manganese
		Magnesium
		Potassium
		Sodium
		Calcium
		Silica
		Mercury
		Phenol
		Total coliforms
		Fecal coliforms
		Sodium adsorption ratio (SAR)

Category	*Sub-category*	*Indicators*
		Pesticides Radioactivity Surfactants Heavy metals Trace organics Carcinogens
	Groundwater	(Same indicators as for Surface Water)
Water systems	Water use	Flow (daily and seasonal variation) Residential water use Industrial water use Agricultural water use Commercial water use Municipal water use Metering systems Water importation Water diversion
	Water treatment facilities	Intake water quality (See water quality indicators above) Describe intake Describe plant Design capacity Current demand (time variation) Chemical additions Energy requirements Sludge type and quantity Sludge disposition Product water quality (See water quality indicators above) Operational difficulties
	Distribution system	Size of lines Age and condition of lines Capacity of lines Current flows (daily and seasonal variations) Pressure Storage requirements and capacity

TABLE 1.1 [*Contd.*]

Category	*Sub-category*	*Indicators*
Wastewater systems	Collection system	Sewer sizes Sewer age and condition Capacity Current flows (daily and seasonal variations) Problems (odour, sludge, etc.) Infiltration/inflow analysis Stormwater collection (separate and combined severs)
	Treatment system	Describe systems Locate facilities Age and condition of plants Design capacity NPDES effluent limitations[4] Raw waste characteristics (See water quality indicators above) Effluent characteristics (See water quality indicators above) Flows and loads (average and time variation) Describe sludge handling systems Sludge (type, quantity, moisture content, disposition) Outfalls Operational difficulties (odour, insects, poor effluent, etc.)

[1]Biochemical oxygen demand.
[2]Chemical oxygen demand.
[3]Total organic carbon.
[4]NPDES—National Pollutant Discharge Elimination System, administered by the U.S. Environmental Protection Agency.

The selection of environmental indicators should be based on the scope and nature of the proposed project, as well as on the nature of the local or regional environment. A preliminary