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MEDITERRANEAN ACTION PLAN

Meeting of MED POL National Coordinators

Athens, 18-22 March 1996

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GUIDELINES FOR AUTHORIZATIONS FOR THE DISCHARGE OF LIQUID WASTES INTO THE MEDITERRANEAN SEA

In collaboration with:

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PART 1

INTRODUCTION AND BACKGROUND

1.1 The widespread population growth in the coastal zone of the Mediterranean, the extension of domestic liquid waste discharge networks and the higher standards of living, have considerably increased the amount of sewage discharged into the Mediterranean Sea. This situation has been aggravated by the continuously-growing tourist population and the production of peak quantities of domestic wastes, sometimes reaching a tenfold increase in the usual flow. In addition to actual increases in sewage load, the influx of tourists from different countries contributes to an increase in the diversity of pathogenic microorganisms in the sewage discharged, with resultant higher risks to human health.

1.2 Population increase and higher standards of living in the Mediterranean have, as expected, been accompanied by the extension and diversification of industry. More new substances have been (and are being) introduced in industrial processes and products, and new uses found for existing materials. Most of these changes are reflected in their wastes, and represent an additional dimension to the problem of pollution of the receiving marine environment. An appreciable amount of such wastes, as is the case with domestic sewage, is still being discharged into the Mediterranean Sea untreated or partially treated.

1.3 Serious concern about the state of pollution of the Mediterranean Sea, mainly as a result of such discharges, reached its climax in the early 1970s, and following a serious of intergovernmental discussions, eventually led to the adoption of a comprehensive programme - the Mediterranean Action Plan - by the Governments of the region's coastal states at the Inter-Governmental Meeting on the Protection of the Mediterranean Sea, convened by the United Nations Environment Programme (UNEP) in Barcelona, Spain, from 28 January to 4 February 1975. The approved programme consisted of four main components (UNEP, 1992):

(a) Integrated planning of the development and management of the resources of the Mediterranean Basin;

(b) A coordinated programme for research, monitoring, and exchange of information , and for assessment of the state of pollution and of protection measures;

(c) A framework convention and related protocols with their technical annexes for the protection of the Mediterranean environment;

(d) Institutional and financial implications of the Action Plan.

1.4 The legal framework for the co-operative regional programme was adopted in the Final Act of the Conference of Plenipotentiaries of the Coastal States of the Mediterranean Region for the Protection of the Mediterranean Sea, convened by UNEP in Barcelona, Spain from 2 to 16 February 1976. In particular, the Conference adopted texts of three legal instruments, entitled:

(a) Convention for the Protection of the Mediterranean Sea against Pollution, adopted and signed on 16 February 1976, entered into force on 12 February 1978;

(b) Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft, adopted and signed on 16 February 1976, entered into force on 12 February 1978;

(c) Protocol concerning Cooperation in Combatting Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency, adopted and signed on 16 February 1976, entered into force on 12 February 1978.

1.5 A further three legal instruments related to the 1976 Barcelona Convention (UNEP, 1980, 1992, 1995b) were developed as follows:

(a) Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources, adopted and signed in Athens, Greece on 17 May 1980, entered into force 17 June 1983;

(b) Protocol concerning Mediterranean Specially Protected Areas, adopted and signed in Geneva, Switzerland on 3 April 1982, entered into force on 23 March 1986;

(c) Protocol for the protection of the Mediterranean Sea from Pollution resulting from exploration and exploitation of the Continental Shelf, the seabed and its subsoil, adopted and signed in .Madrid, Spain on 14 October 1994, and not yet in force.

1.6 The 1976 Convention, the 1976 Dumping Protocol and the 1982 Specially Protected Areas Protocol were amended by the Ninth Ordinary Meeting of the Contracting Parties, held in Barcelona from 5 to 8 June 1995 (UNEP, 1995b), and the instruments, as amended, were formally adopted by an *ad hoc* Meeting of Plenipotentiaries convened, also in Barcelona, from 9 to 10 June 1995 (UNEP, 1995c).

1.7 In view of the fact that more than 80% of the pollution load of the Mediterranean Sea was estimated to originate from sources on land in the form of largely-uncontrolled discharges of municipal and industrial wastes reaching the Mediterranean both directly from coastal sources and indirectly through rivers, particular attention was devoted to the preparation of an appropriate legal instrument to cover this aspect of pollution. Following a number of expert consultations held between 1977 and 1979, the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources was adopted and signed during the Conference of Plenipotentiaries of the Coastal States of the Mediterranean Region for the Protection of the Mediterranean Sea against Pollution from Land-based Sources, convened by UNEP in Athens, Greece, from 12 to 17 May 1980. The technical annexes to the protocol included a "black" list of substances by which pollution was to be eventually eliminated, and a "grey" list of substances by which pollution was to be restricted through control by means of authorization of discharges. Factors governing the issue of such authorizations were also listed in an annex. In view of the legal, technical and economic implications involved, it was agreed that the protocol should be implemented progressively.

1.8 Following the entry into force of the Protocol in June 1983, the technical preparations for its progressive implementation were carried out by the Mediterranean Action Plan Secretariat in collaboration with the UN Specialized Agencies involved within the framework of the scientific component of the Action Plan - the long-term Programme of Pollution Monitoring and Research in the Mediterranean Sea (MED POL Phase II). A meeting of experts on the technical implementation of the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources was convened by UNEP in Athens, Greece, from 9 to 13 December 1985. (UNEP, 1985b) The meeting approved a calendar of activities covering the period 1985 to 1995, such activities consisting of (a) assessments of the state of pollution of the Mediterranean Sea by individual substances listed in Annexes I and II to the protocol, including proposed control measures for submission to, and adoption by, the Contracting Parties, and (b) guidelines on various waste management topics covered by the protocol, including the issue of authorizations for discharge of liquid wastes into the Mediterranean Sea.

1.9 A new Annex to the Protocol, covering transport of pollutants through the atmosphere, was formally adopted in 1991. More recently, in conformity with the general trend of updating the Convention and Protocols, a meeting of legal and technical experts was convened by UNEP in Syracuse from 4 to 6 May 1995 to examine proposed amendments to the Protocol. UNEP, 1995a) Agreement was reached at this level on a number of issues, including consolidation of Annexes I and II into one annex, which also includes a list of terrestrial activities linked with marine pollution. The principle of subjecting all waste discharges to an official authorization process was retained. A further meeting of experts to polish the updated version of the Protocol prior to formal adoption by a Conference of Plenipotentiaries is expected to be held in March 1996.

1.10 Preliminary draft guidelines for authorizations for discharge of liquid municipal wastes into the Mediterranean Sea were prepared by the World Health Organization (WHO) within the framework of the MED POL programme, and submitted to the December 1985 meeting of experts. It was agreed by the meeting that these guidelines should be comprehensively expanded to cover industrial as well as municipal wastes. Two main revised drafts were prepared in successive years, but were considered by various expert meetings as being too complex for immediate implementation, as they included a comprehensive planning component which would require the establishment of the necessary infrastructure in a number of countries.

1.11 The present draft of the guidelines, prepared for WHO by a consultant (Dr L.J. Saliba, Malta), represent a comprehensively modified version, taking into account the conclusions and recommendations of the last expert meeting to consider the document (WHO/UNEP. 1990), through retention or appropriate modification of relevant material contained in previous drafts and addition of new material within the framework of a completely new lay-out. The guidelines are designed primarily to provide national and local authorities with relevant information, both general and specific, on requirements and conditions attached to the issue of authorizations for the discharge of liquid wastes into the coastal marine environment in terms of national legislation enacted in conformity with the provisions of the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources, and in accordance with measures adopted by Contracting Parties to date for the progressive implementation of the protocol in question.

PART 2

THE REGIONAL LEGAL FRAMEWORK FOR WASTE DISCHARGE AUTHORIZATION

2.1 The 1976 Barcelona Convention for the Protection of the Mediterranean Sea against Pollution is an umbrella convention in that it defines the regional legal framework for dealing with the various aspects of marine pollution, rather than bind Contracting Parties to any specific detail on each. In this regard, in dealing with any particular aspect of marine pollution affecting the Mediterranean Sea, Contracting Parties have the option of either utilizing an already-existing or planned international legal instrument to cover Mediterranean requirements or, in the absence of such, to develop specific Mediterranean protocols. In view of the limitations of the Barcelona Convention to a formal statement of intent, Governments must become Contracting Parties to at least one protocol at the same time as to the Convention itself.

2.2 The Convention was comprehensively amended in June 1995 (UNEP 1995b, 1995c). Whilst retaining its overall umbrella-type status, its scope has now been enlarged, and its title altered to read "Convention for the Protection of the Marine Environment and Coastal Region of the Mediterranean". Its geographical coverage, as defined in its article 1, comprises the marine waters of the Mediterranean Sea proper, including its gulfs and seas, bounded to the west by the meridian passing through Cape Spartel lighthouse, at the entrance to the straits of Gibraltar, and to the east by the southern limits of the Straits of the Dardanelles between Mehmetcik and Kumkale lighthouses. In the new version of the Convention, the same article now also stipulates that (a) the application of the Convention may be extended in coastal areas as defined by each Contracting Party within its own territory, and (b) any Protocol to the Convention may extend the geographical coverage to which that particular Protocol applies.

2.3 Article 2 of the Convention defines marine pollution as the introduction by Man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results, or is likely to result, in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities including fishing and other legitimate uses of the sea, impairment of quality for use of seawater and reduction of amenities.

2.4 Under the terms of Article 8 of the Convention, Contracting Parties have pledged themselves to take all appropriate measures to prevent, abate, combat and to the fullest possible extent eliminate, pollution of the Mediterranean Sea area, and to draw up and implement plans for the reduction and phasing out of substances that are toxic, persistent and liable to bioaccumulate arising from land-based sources. These measures shall apply:

(a) to pollution from land-based sources originating within the territories of the Parties, and reaching the sea:

- directly from outfalls discharging into the sea, or through coastal disposal;
- indirectly through rivers, canals or other watercourses, including underground watercourses, or through run-off;

(b) to pollution from land-based sources transported by the atmosphere.

2.5 The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources, developed under the terms of Article 8 of the Convention, has a more extensive geographical coverage. Apart from the Mediterranean Sea Area as defined in Article 1 of the Convention, the Protocol, in its new version which is currently under consideration, also covers:

(a) the hydrologic basin of the Mediterranean Sea Area, defined as the entire watershed area within the territories of the Contracting Parties draining into the Mediterranean Sea Area;

(b) waters on the landward side of the baselines from which the breadth of the territorial sea is measured and extending, in the case of watercourses, up to the freshwater limit, defined as the place in watercourses where, at low tides and in a period of low freshwater flow, there is an appreciable increase in salinity due to the presence of seawater;

(c) saltwater marshes and saltwater aquifers.

2.6 With specific regard to effluent discharge, the Protocol applies to discharges from land-based point and diffuse sources within the territories of the Contracting Parties which may directly or indirectly affect the Mediterranean Sea Area., such discharges including those which reach the Protocol Area through coastal disposal, rivers, canals or other watercourses, including underground watercourses, or through run-off and disposal under the seabed with access from land by tunnel, pipeline, or other means.

2.7 The Protocol also applies to polluting discharges from fixed man-made offshore structures which are under the jurisdiction of a Party and which serve purposes other than exploration and exploitation of the continental shelf and the seabed and its subsoil.

2.8 In the original version of the Protocol, pollutants were divided into "black" (Annex I) and "grey" (Annex II) categories, dealt with in Articles 5 and 6 of the Protocol respectively. In these articles, Contracting Parties undertook to eliminate pollution of the Protocol Area from land-based sources by substances listed in Annex I, and to restrict pollution by substances and sources listed in Annex II, The text of both articles dealt with the necessary programmes and measures. including in particular, common emission standards and standards for use, and the provision that discharges should be strictly subject to the issue, by the competent national authorities, of an authorization taking due account of the provisions of Annex III to the Protocol, which listed the factors to be taken into account in the issue of such authorizations.

2.9 In the new version of the Protocol currently under consideration, Annexes I and II have been amalgamated with slight modifications of the list of substances into one annex (Annex I), which also lists activities liable to result in pollution, with the former Annex III becoming Annex II. Articles 5 and 6 of the Protocol have been revised accordingly. (See point 2.5 above).

2.10 In Article 5, Contracting Parties have undertaken to eliminate pollution derived from land-based sources and activities, in particular to phase out toxic, persistent and bioaccumulative inputs of the substances listed in Annex I and, to this end, to elaborate and implement, individually or jointly. national and regional programmes and action plans containing measures and timetables for their implementation. The article also lays down, *inter alia*, that in the adoption of programmes, measures and action plans. the Parties shall take into account, either individually or jointly, the latest available techniques for point sources and the best environmental practices for point and diffuse sources including, where appropriate, clean production technologies.

2.11 Under the terms of Article 6, point source discharges to the Protocol Area and releases into water or air which reach and may affect the Mediterranean Sea Area shall be strictly subject to authorization or regulation by the competent authorities of the Parties, taking into account the provisions of Annex II to the Protocol. Such authorization or regulation shall be in conformity with relevant decisions or recommendations of the Contracting Parties and, to this end, each party shall provide for systems of inspection by their competent authorities to assess compliance with authorizations and regulations. The article also states that each Party shall consider establishing appropriate sanctions in cases of non-compliance within its own territories.

2.12 The texts of Annexes I and II to the new version of the Protocol currently under consideration are reproduced in Tables 2.1 and 2.2 respectively.

2.13 Under the terms of Article 7.1 of the Protocol, Contracting Parties have undertaken to progressively formulate and adopt, in cooperation with the competent international organizations, common guidelines and, as appropriate, standards or criteria dealing in particular with:

(a) the length, depth and position of pipelines for coastal outfalls, taking into account, in particular, the methods used for pretreatment of effluents;

(b) special requirements for effluents necessitating separate treatment;

(c) the quality of sea water used for specific purposes that is necessary for the protection of human health, living resources and ecosystems;

(d) the control and progressive replacement of products, installations and industrial and other processes causing significant pollution of the marine environment;

(e) specific requirements concerning the quantities of the substances listed in Annex I discharged, their concentration in effluents and methods of discharging them.

2.14 The terms of Article 7 of the protocol are intimately linked with the discharge authorization process, as they affect treatment of effluents prior to discharge, and mode of discharge. Furthermore, sub-para (c) above introduces the concept of water quality objectives, and authorization of any discharge would be dependent on compliance of affected areas with such quality objectives, wherever these are laid down. Some of the measures already adopted by Contracting Parties during the process of progressive implementation of the Protocol (*vide* Paragraph 2.17 below and Table 2.3) include water quality objectives as defined in sub-para (c). in addition, guidelines covering sub-paras (a) and (b) above have been prepared by WHO within the framework of the MED POL programme. (WHO/UNEP 1994a, 1994b) While agreed to by Contracting Parties, the guidelines in question are, as their nature implies, purely for information and guidance purposes in the formulation of programmes and measures, and are not legally binding. They are, however, very useful at a practical level during the authorization process, since they contain techniques and methods which can be used to make the content of effluents conform with stipulated specifications.

2.15 Article 8 of the Protocol binds Contracting Parties to carry out at the earliest possible date, monitoring activities in order to systematically assess, as far as possible, the levels of pollution along their coasts, in particular with regard to the sectors of activity and categories of substances or sources listed in Annex I to the protocol, and to evaluate the effectiveness of programmes, measures and action plans implemented under the Protocol. The first objective is essential for the authorization process in that it will provide a reasonably accurate picture of the situation, thus determining some of the conditions of authorization. The second objective will determine whether such conditions (attached to authorization of discharges) have achieved satisfactory results, or alternatively, whether they require modification.

2.16 Article 13 of the Protocol binds Contracting Parties to submit biennial reports on measures taken, results achieved and, if the case arises, of difficulties encountered in the application of the protocol. Such information is to include, *inter alia*, statistical data on authorizations granted in connection with Article 6 of the Protocol, data resulting from monitoring as provided in Article 8, and quantities of pollutants discharged from their territories, as well as measures taken in accordance with Articles 5 and 6 of the protocol.

2.17 Article 15 of the Protocol stipulates that the meetings of the Contracting Parties shall adopt, by a two-thirds majority, the regional programmes and short-term and medium-term action plans containing measures and time-tables for their implementation provided in Article 5 of the Protocol. To-date, actual measures jointly adopted by Contracting Parties in terms of Articles 5, 6 and 7 of the original version of the Protocol (UNEP 1990, 1991, 1993), which are of course still valid, are the following:

(a) interim environmental quality criteria for bathing waters (1985);

(b) interim environmental quality criteria for mercury (1985);

(c) measures to prevent mercury pollution (1987);

(d) environmental quality criteria for shellfish waters (1987);

(e) measures for control of pollution by used lubricating oils (1989);

(f) measures for control of pollution by cadmium and cadmium compounds (1989);

(g) measures for control of pollution by organotin compounds (1989);

(h) measures for control of pollution by organohalogen compounds (1989);

(I) measures for control of pollution by organophosphorus compounds (1991);

(j) measures for control of pollution by persistent synthetic materials (1991);

(k) measures for control of radioactive pollution (1991);

(l) measures for control of pollution by pathogenic microorganisms (1991);

(m) measures for control of pollution by carcinogenic, teratogenic and mutagenic substances (1993).

TABLE 2.1

PROTOCOL FOR THE PROTECTION OF THE MEDITERRANEAN SEA AGAINST POLLUTION FROM LAND-BASED SOURCES.
(new version, currently under consideration)

ANNEX I

ELEMENTS TO BE TAKEN INTO ACCOUNT IN THE PREPARATION OF PROGRAMMES AND MEASURES FOR THE ELIMINATION OF POLLUTION FROM LAND-BASED SOURCES AND ACTIVITIES

This annex contains elements which will be taken into account in the preparation of programmes, measures and action plans for the elimination of pollution from land-based sources and activities referred to in Articles 5, 7 and 15 of this Protocol.

Such programmes, measures and action plans will aim to cover sectors of activities listed in Section A of this Annex. They may also cover groups of substances cutting across the sectors of activities. Substances included in such programmes, measures and action plans will be selected on the basis of the characteristics listed in Section B of this Annex. Section C of this Annex includes various groups of substances selected on the basis of the characteristics listed in Section B. Priorities for action should be established on the basis of relative importance of the impact on public health, the ecosystem and socio-economic cultural conditions. Such programmes should cover point sources, diffuse sources and atmospheric deposition.

A. SECTORS OF ACTIVITIES

The following sectors of activities, not in priority order, will be primarily considered when setting priorities for the preparation of programmes, measures and action plans for the elimination of pollution from land-based sources and activities:

1. Energy production (from fossil fuels).
2. Fertilizer production.
3. Production and formulation of biocides.
4. Pharmaceutical industry.
5. Refineries.
6. Paper and pulp industry.
7. Cement production.
8. Tanneries.
9. Metal industry.
10. Mining.
11. Shipyards.
12. Textile industry.
13. Electronic industry.
14. Recycling industry.
15. Other sectors of the organic chemistry industry.
16. Other sectors of the inorganic chemistry industry.

TABLE 2.1 (continued)

17. Touristic establishments.
18 Agriculture.
19. Animal husbandry.
20. Food processing.
21. Aquaculture.
22. Treatment of hazardous waste at source.
23 Domestic waste disposal and treatment.
24. Urban waste disposal and treatment.
25. Sewage sludge disposal and disposal of plants' residues.
26. Incineration of waste.

B. CHARACTERISTICS OF SUBSTANCES IN THE ENVIRONMENT

In order to set priorities for substances, the Parties should take into account the characteristics listed below which are not necessarily of equal importance for the consideration of a particular substance or group of substances.

1. Persistence.

2. Toxicity or other noxious properties (*e.g.* carcinogenicity, mutagenicity, teratogenicity).

3. Bioaccumulation.

4. Radioactivity.

5. The ratio between observed concentrations and "no observed effect concentrations" (NOEC).

6. Risks of eutrophication of anthropogenic origin.

7. Health effects and risks.

8. Transboundary significance.

9. Risk of undesirable changes in the marine ecosystem and irreversibility or durability of effects.

10. Interference with the sustainable exploitation of living resources or with any other legitimate uses of the sea.

11. Effects on the taste and/or smell of products for human consumption from the sea, or effects on smell, colour, transparency or other characteristics of the water in the marine environment.

12. Distribution pattern (i.e. quantities involved, use pattern, and liability to reach the marine environment).

TABLE 2.1 (continued)

C. CATEGORIES OF SUBSTANCES

The following groups of substances were selected on the basis of characteristics listed in Section B of this annex. This list will serve as a guide in the preparation of programmes, measures and action plans for the elimination of pollution from land-based sources and activities.

1. Organohalogen compounds and substances which may form such compounds in the marine environment.[1]

2. Organophosphorus compounds and substances which may form such compounds in the marine environment.[1]

3. Organotin compounds and substances which may form such compounds in the marine environment.[1]

4. Polycyclic aromatic hydrocarbons.

5. Heavy metals and their compounds.

6. Used lubricating oils.

7. Radioactive substances, including their wastes, when their discharges do not comply with the principles of radiation protection as defined by the competent international organizations, taking into account the protection of the marine environment.

8. Biocides and their derivatives.

9. Pathogenic microorganisms and algal toxins which could result from eutrophication.

10. Crude oils and hydrocarbons of petroleum origin.

11. Cyanides and fluorides.

12. Non-biodegradable detergents and other surface-active substances.

13. Compounds of nitrogen and phosphorus.

14. Persistent synthetic materials which may float, sink or remain in suspension and which may interfere with any legitimate use of the sea.

15. Any other substance or group of substances having any characteristics listed in Section B of this annex.

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1 With the exception of those which are biologically harmless, or which are rapidly converted into biologically harmless substances.

TABLE 2.2

PROTOCOL FOR THE PROTECTION OF THE MEDITERRANEAN SEA AGAINST POLLUTION FROM LAND-BASED SOURCES.

(new version, currently under consideration)

ANNEX II

With a view to the issue of an authorization for the discharge of wastes containing substances referred to in Article 6 of this Protocol, particular account will be taken, as the case may be, of the following factors:

A. CHARACTERISTICS AND COMPOSITION OF THE WASTE

1. Type and size of waste source (*e.g.* industrial process).
2. Type of waste (origin, average composition).
3. Form of waste (solid, liquid, sludge, slurry).
4. Total amount (volume discharged, *e.g.* per year).
5. Discharge pattern (continuous, intermittent, seasonally variable, etc.).
6. Concentrations with respect to categories of substances listed in Annex I, and other substances as appropriate.
7. Physical, chemical and biochemical properties of the waste.

B. CHARACTERISTICS OF WASTE CONSTITUENTS WITH RESPECT TO THEIR HARMFULNESS

1. Persistence (physical, chemical, biological) in the marine environment.
2. Toxicity and other harmful effects.
3. Accumulation in biological materials or sediments.
4. Biochemical transformation producing harmful compounds.
5. Adverse effects on the oxygen content and balance.
6. Susceptibility to physical, chemical and biochemical changes and interaction in the aquatic environment with other sea water constituents which may produce harmful biological or other effects on any of the uses listed in Section E below.

C. CHARACTERISTICS OF DISCHARGE SITE AND RECEIVING MARINE ENVIRONMENT.

1. Hydrographic, meteorological, geological and topographical characteristics of the coastal area.
2. Location and type of the discharge (outfall, canal, outlet, etc.) and its relation to other areas(such as amenity areas, spawning, nursery and fishing areas, shellfish grounds) and other discharges.
3. Initial dilution achieved at the point of discharge into the receiving marine environment.

TABLE 2.2 (continued)

4. Dispersion characteristics such as effects of currents, tides and wind on horizontal transport and vertical mixing.
5. Receiving water characteristics with respect to physical, chemical, biological and ecological conditions in the discharge area.
6. Capacity of the receiving marine environment to receive waste discharges without undesirable effects.

D. AVAILABILITY OF WASTE TECHNOLOGIES

The methods of waste reduction and discharge for industrial effluents as well as domestic sewage should be selected taking into account the availability and feasibility of:

(a) Alternative treatment processes;
(b) Re-use or elimination methods;
(c) On-land disposal alternatives;
(d) Appropriate low-waste technologies.

E. POTENTIAL IMPAIRMENT OF MARINE ECOSYSTEMS AND SEA WATER USES

1. Effects on human health through pollution impact on:

   (a) edible marine organisms;
   (b) bathing waters;
   (c) aesthetics.

2. Effects on marine ecosystems, in particular living resources, endangered species and critical habitats.

3. Effects on other legitimate uses of the sea.

2.18 A number of these measures include criteria and standards, either for effluents containing the relevant substances, or for receiving waters. These criteria and standards (which countries pledged to observe, and as a consequence presumably incorporated into their national legislation) have to be observed, and should therefore be taken into account in the issue of authorizations for discharge of wastes. The appropriate parts of those resolutions containing measures involving, or related to, waste discharge are given in Table 2.3. It should be noted that some resolutions contain dates of commencement of the relative measures. It can be assumed that in the case of measures with no specified commencement dates, implementation would apply immediately.

TABLE 2.3

COMMON MEASURES ADOPTED BY CONTRACTING PARTIES TO THE PROTOCOL FOR PROTECTION OF THE MEDITERRANEAN SEA AGAINST POLLUTION FROM LAND-BASED SOURCES

1. INTERIM CRITERIA FOR BATHING WATERS (1985)

OPERATIVE SECTIONS

1. Taking of measures, for a transition period, that will assure as minimum common requirements that the quality of bathing waters will conform with the proposed interim WHO/UNEP environmental quality criteria concerning faecal coliforms (see table below).

2. During this period, the Contracting Parties which have already standards will continue to apply them without modifying their legislation, and will perform comparative studies between their own standards and the WHO/UNEP criteria.

TABLE

Parameter	Concentrations per 100 ml not to be exceeded in 50% of the samples	Concentrations per 100 ml not to be exceeded in 90% of the samples	Minimum number of samples	Analytical method	Interpretation method
Faecal coliforms	100	1000	10	WHO/UNEP Reference Method No. 3. "Determination of Faecal Coliforms in sea water by the Membrane Filtration Culture Method" or WHO/ UNEP Reference Method No. 22. "Determination of Faecal Coliforms in sea water by the Multiple Test Tube Method"	Graphical or Analytical adjustment to a log-normal probability distribution

TABLE 2.3 (continued)

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2. MERCURY AND MERCURY COMPOUNDS (1987)

OPERATIVE SECTIONS

1. Ensuring a maximum concentration (to be calculated as a monthly average) of 50 g mercury per litre (expressed as total mercury) for all effluent discharges before dilution in the Mediterranean Sea, in terms of Article 1 and Annex I of the Protocol.

2. Enforcement of such measure, for those effluents so demanding, through compulsory monitoring requirements and procedures including, where appropriate, (a) the taking each day of a sample representative of the discharge over 24 hours and the measurement of the mercury concentration of that sample, and (b) the measurement of the total flow of the discharge during this period.

3. Ensuring that outfalls for new discharges of mercury into the sea would be designed and constructed in such a way as to achieve a suitable effluent dilution in the mixing zone so that the increase of mercury concentrations in biota and sediments at a radius of 5 km from the outfall structures will not be more than 50% above background levels. Existing discharges of mercury into the sea would also be adjusted so as to achieve, within a period of 10 years, the above-mentioned objective. Appropriate monitoring should be implemented, for both existing and new discharges, for the verification of the above.

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3. CRITERIA FOR SHELLFISH WATERS (1987)

OPERATIVE SECTIONS

1. Adoption, as a minimum common requirement for the quality of shellfish waters, the proposed WHO/UNEP interim environmental quality criteria, as detailed in 2 and 3 below and in the accompanying table.

2. For the purpose of such criteria, consideration of the term "shellfish waters" to mean those coastal and brackish waters in which shellfish (bivalve and gastropod molluscs) live.

3. Utilization of the following in the application of such criteria:

    - for the assessment of the microbiological quality of shellfish waters, the shellfish themselves shall be taken into account;

TABLE 2.3 (continued)

SUMMARY TABLE

Matrix	Shellfish
Parameter	Faecal coliforms
Concentration	Less than 300 per 100 ml flesh + intervalvular fluid or flesh, in at least 75% of the samples
Minimum sampling frequency	Every 3 months (more frequently whenever local circumstances so demand)
Analytical method	Multiple tube fermentation and counting according to MPN (most probable number) method. Incubation period: 37 ± 0.5 ^{0}C for 24 h or 48 h, followed by 44 ± 0.2 ^{0}C for 24 h.
Interpretation method	By individual results, histograms, or graphical adjustment of a lognormal - probability distribution.

- for the determination of microbiological parameters, preference shall be given to analysis of shellfish flesh and intervalvular fluid, rather than flesh alone;

- the results of analysis of microbiological quality shall be expressed by the number of faecal coliforms recorded in 100 ml (FC/100 ml);

- the method of analysis utilised shall be incubation at 37 ± 0.5 ^{0}C with fermentation on a liquid substrate for a period of 24 to 48 hours, followed by a confirmation test at 44 ± 0.2 ^{0}C for 24 hours. Enumeration shall be effected according to the Most Probable Number (MPN) method:

- the concentration of faecal coliforms should be less than 300 per 100 ml of shellfish flesh and intervalvular fluid, or of flesh alone, in at least 75% of the samples, based on a minimum sampling frequency of once every three months;

TABLE 2.3 (continued)

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4. The taking of any other complementary measures, such as increasing sample frequency, including further parameters, and monitoring of the quality of the water itself in shellfish areas, as may be demanded by national or local circumstances for ensuring satisfactory quality of shellfish waters.

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4. USED LUBRICATING OILS (1989)

OPERATIVE SECTIONS

1. Adoption of the following definition of used lubricating oils:

   "Any mineral-based industrial or lubricating oils which have become unfit for the use for which they were originally intended and, in particular, used oils from combustion engines and transmission systems, and also mineral lubricating oils, oils for turbines and hydraulic oils, whether such oils are contaminated by dangerous chemical substances, such as PCB, or not".

2. Adoption of the principle that wastes containing used lubricating oils should not be discharged directly or indirectly into the Protocol area.

3. Progressive implementation, through appropriate national procedures, programmes and measures to ensure the annual realization of this principle as early as possible to the extent dictated by national circumstances and not later than 01 January 1994.

4. Taking into account, as and where appropriate, in the progressive formulation and implementation of national control measures, the various control measures available, i.e. recovery, and either:

   - regeneration for re-use as lubricating oils or burning as fuel in an appropriate installation, if one of these two solutions is feasible, in the case of used lubricating oils which are not contaminated by dangerous chemical substances, or

   - treatment and disposal in specially designed units in the case of all other used lubricating oils.

TABLE 2.3 (continued)

5. CADMIUM AND CADMIUM COMPOUNDS (1989)

OPERATIVE SECTIONS

As from 01 January 1991:

1. Adoption of a limit value of 0.2 mg cadmium per litre discharged (monthly flow-weighted average concentration of total cadmium) for effluent discharges from industrial plants into the Mediterranean Sea before dilution in terms of Article 5 and Annex I of the Protocol, the above limit not to apply to the fertilizer industry, in which case each Mediterranean country to fix its national value pending a new decision by the Contracting Parties.

2. Use of the following procedure for the implementation of the above limit value:

   A sample representative of the discharge over a period of 24 hours will be taken. The quantity of cadmium discharged over a month must be calculated on the basis of the daily quantities of cadmium discharged. However, a simplified control procedure may be instituted in the case of industrial plants which do not discharge more than 10 kg of cadmium per year. Adoption in principle of an eventual water quality objective of 0,5 g cadmium per litre in marine waters.

3. For the purpose of progressively reaching the objective, adjustment of relevant outfall structures in such a way as to achieve maximum dilution in the mixing zone adjacent to the outfall, and monitoring sediments and biota to ensure an increase of not more than 50% above background levels in the case of new plants, and achievement of a progressive decrease towards the same objective in areas affected by existing plants.

4. Consideration, if national or local circumstances so dictate, of the imposition of limit values for concentrations of cadmium in marine organisms.

5. Encouragement of the development of substitutes and alternative technologies leading to the reduction of cadmium pollution.

TABLE 2.3 (continued)

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6. ORGANOTIN COMPOUNDS (1989)

OPERATIVE SECTIONS

As from 01 July 1991:

1. Prohibition of the use in the marine environment of preparations containing organotin compounds intended for the prevention of fouling by microorganisms, plants or animals:

   - on hulls of boats having an overall length (as defined by ISO standard No. 8666) of less than 25 m;

   - on all structures, equipment or apparatus used in mariculture.

2. This measure not to apply to any ships owned or operated by a State Party to the LBS Protocol and used only on government non-commercial service.

3. Freedom of Contracting Parties not having access to substitute products for organotin compounds by 01 July 1991 to make an exception for a period not exceeding two years, after having so informed the Secretariat.

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7. ORGANOHALOGEN COMPOUNDS (1989)

OPERATIVE SECTIONS

As from 01 January 1991:

1. The adoption of an environmental quality objective in coastal waters of 25 g l^{-1} for total DDT in terms of Article 5 and Annex I of the Protocol.

2. Use of the International Code of Conduct on the distribution and use of pesticides as adopted by the FAO Conference in 1985.

3. Promotion of monitoring programmes wherever possible for:

   - the establishment of trends and baseline concentrations for organohalogen compounds;

   - the detection of "hot-spot" areas.

TABLE 2.3 (continued)

8. ORGANOPHOSPHORUS COMPOUNDS (1991)

OPERATIVE SECTIONS

1. The promotion of measures to reduce inputs into the marine environment and to facilitate the progressive elimination by the year 2005 of organophosphorus compounds hazardous to human health and the environment.

   Such measures should, *inter alia*, include:

   (I) the promotion of integrated peat management in agriculture;

   (II) taking account of the FAO International Code of Conduct on the Distribution and Use of Pesticides in International Trade as well as the UNEP London Guidelines for the Exchange of Information on Chemicals in International Trade and its Prior Informed Consent procedure;

   (III) the financial and technical support of extension and educational services to train farmers in integrated pest management, whereby non-chemical methods of controlling pests are to be emphasized;

   (iv) the support of farm-based research and the long-term training in safe and efficient use of pesticides and environmentally sound management of pest control practices in agriculture.

2. Taking the following immediate actions:

   (I) monitor the presence of organophosphorus compounds in "hot-spot" areas and, if concentration levels so warrant, take the necessary measures for the reduction of pollution;

   (ii) ensure that products containing organophosphorus compounds shall not be used in their territory unless they have been authorised, and unless it has been proved that there is:

   - no direct effect on human and animal health, and
   - no unacceptable impact on the environment.

TABLE 2.3 (continued)

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9. PERSISTENT SYNTHETIC MATERIALS (1991)

OPERATIVE SECTIONS

1. Ratification of Annex V to the MARPOL 73/78 Convention, and installation of the necessary facilities for reception of garbage from vessels at all ports, anchorages and marinas, so that the provisions of Annex V for special areas apply to the Mediterranean as soon as possible.

2. The carrying out of reconnaissance surveys, following the guidelines described in the 1989 IOC/FAO/UNEP report, on coasts, where necessary, and coastal waters of the Mediterranean, especially those of the South, for which no data exist and where industrial development and urbanization are still relatively low, to determine the level and nature of the litter, the litter sources, marine or land-based, in an effort to formulate the proper strategy required to control litter contamination. Monitoring should be repeated every 2 to 3 years to assess any changes.

3. The design and implementation of educational programmes, mainly for youngsters but also to increase general public awareness and participation, aimed at the prevention of littering beaches and coastal waters, as well as open seas and river beds.

4. Encouragement of the use of biodegradable synthetic materials, and promotion of research on the development of such materials.

5. Promotion and encouragement of national and local authorities to carry out beach cleaning operations.

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10. RADIOACTIVE SUBSTANCES (1991)

OPERATIVE SECTIONS

1. Pertinent recommendations by competent international organizations concerning emissions of radionuclides will be respected.

2. ICRP (International Council for Radiation Protection) and human health basic principles for radiation protection of man will be used as the basis for controlling emissions of radionuclides from land-based national nuclear installations into the Mediterranean marine environment.

TABLE 2.3 (continued)

11. CARCINOGENIC, TERATOGENIC AND MUTAGENIC SUBSTANCES (1991)

OPERATIVE SECTIONS

1. Promotion of measures to reduce inputs into the marine environment and to facilitate the progressive elimination by the year 2005 of substances having proven carcinogenic, teratogenic and/or mutagenic properties in or through the marine environment, such measures to include, *inter alia*, the acquisition of more data to fill the still unidentified gaps in knowledge regarding both the actual status of specific substances as carcinogens, teratogens or mutagens, and the fate of such substances in the marine environment.

2. As an immediate action, monitoring of the presence of appropriate substances in seawater, sediments and seafood in "hot-spot" areas and, if concentration levels so warrant, take the necessary measures to reduce pollution or to minimize human health hazards arising from consumption of contaminated seafood.

PART 3

THE GENERAL ENVIRONMENTAL FRAMEWORK FOR WASTE DISCHARGE AUTHORIZATION

3.1 It is important to emphasize that the issue of authorizations for the discharge of liquid wastes into the marine environment forms part of a waste management programme which, in turn, is only one component of environmental quality management. As such, it must be consistent with the overall programme's other components (OECD, 1985). For instance, if legislation, development of criteria and standards, and enforcement procedures are not clear and unambiguous to both the body responsible for waste discharge and regulatory agency, the whole process of issue of authorizations will be difficult, if not impossible, of performance.

Environmental quality management

3.2 The inter-relationships between the components of environmental quality management are shown in Figure 3.1. The management components may be characterised as follows:

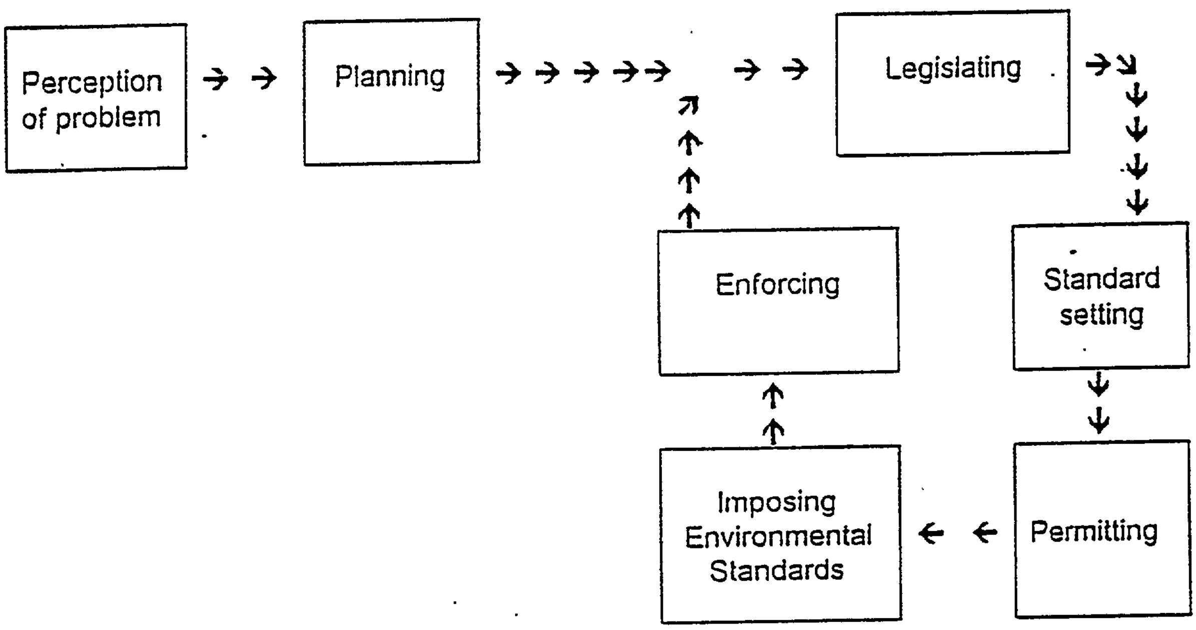
- perception of an environmental quality problem;
- data collection, analysis, and development of strategies to provide a solution to environmental problems;
- legislation and regulatory procedures;
- development and promulgation of standards;
- issue of permits and authorizations;
- application of environmental instruments to induce initial compliance;
- enforcement of permit conditions against non-complying activities.

3.3. From each component of the environmental quality management cycle, there should be feedback to previous components of the cycle. Thus, data developed on problems encountered in issue of permits, reflecting ambiguities in legislation and its enforcement, should become inputs into the next round of the environmental quality management cycle. It is also important to emphasize that all levels of government are involved in, and carry out, activities with regard to environmental quality management. One of the main requirements within the whole process, which affects the issue of waste discharge authorizations, is the allocation of management tasks among the various levels of government.

FIGURE 3.1

THE ENVIRONMENTAL QUALITY MANAGEMENT CYCLE

(adapted from OECD, 1985)



3.4 In most countries, when environmental policies at national level were first formulated in the late 1960s or early 1970s, little experience was available to provide adequate and well-tested policy instruments. Environmental policy as such was a new concept at national level, the most urgent issues were addressed on a case-by-case basis, and the search for comprehensive and long-term planning. improved effectiveness and economic efficiency with respect to environmental quality management was introduced only gradually.

Environmental policy

3.5 There is some ambiguity in the use of the term "environmental policy", and clarification of the term is essential before analysis of the measures aimed at improving its enforcement. It would appear that the "policy" of many governments has been to maintain, or to attempt to achieve and then maintain, ambient environmental quality, which may be measured or defined. In fact, many government decisions which have been designated as "policies" are, in fact, instruments, measures or actions designed to achieve indicated ambient environmental quality goals by inducing waste discharges to take appropriate action. For example, a decision to provide grants to municipalities to cover some portion of the capital costs of establishing sewage treatment plants is an environmental instrument imposed on activities (in this case, the discharge of wastes by municipalities) in order to achieve an ambient environmental quality objective. Similarly, loans for construction of facilities, cost-sharing for implementation of certain measures to reduce sediment discharges, prohibition of the use of particular pesticides, industrial revenue bonds to provide funds for installation of pollution control machinery and equipment all represent environmental instruments designed to induce activities towards the achievement of ambient environmental quality goals. They all have, however, been referred to at various times by the term "environmental policy", as have been decisions to impose secondary treatment on municipal sewage.

3.6 On the basis if the above, one might consider that there are two levels of policy. The primary or basic level relates to the adoption by a country of ambient environmental quality objectives, *e.g.* the achievement of a desired quality of surface waters defined as acceptable for fishing or bathing. The second level is represented by such decisions as the imposition of discharge limits on point sources of pollution or the implementation of optimal management practices on non-point sources.

Control strategies

3.7 A marine pollution control strategy is intimately linked to waste management, and is one of the components of a general environmental policy, and is the component under which the process of controlling waste discharges through authorization falls. Marine pollution control strategies in use have been classified (UNEP, 1985a) into three broad categories:

(a) those based on marine environmental quality standards;

(b) those based on emission standards;

(c) those based on environmental planning.

3.8 Strategies based on marine quality standards relate directly to the quality of water. biota or sediments that must be maintained for a desired level of quality and intended use. Several applications of such quality-based standards exist, including most of the measures approved by Contracting Parties to the Protocol for Protection of the Mediterranean Sea against Pollution from land-based sources since 1985 (vide Part II of this document). In the implementation of this strategy, technical assessments are conducted to determine the maximum allowable inputs that will ensure that the desired levels of environmental quality are met. The assessments consider the fates and effects of various contaminants, amounts of input, and the existing natural characteristics of the relevant marine ecosystem. Numerical standards are then established to which concentrations measured in the receiving environment may be compared. They are usually more restrictive than numbers derived from the technical assessments, to allow for monitoring capabilities and safety requirements. They may apply to water, sediments, fish or their tissues, health, or community composition of organisms in the marine ecosystem. Monitoring is required to detect changes and compliance with the standards set. Changes in the items monitored, after adjustment for natural fluctuation, may signal a need to further reduce inputs and vary existing standards and controls.

3.9 Standards are set based on existing levels, which must not be exceeded. This strategy is employed in situations where the aim is to prevent any increase in prevailing specific contaminant levels. It is an interim strategy to allow time to develop a solid scientific base on which more precise quality standards may be employed for a specific use. It does not imply an existing state of the environment which is satisfactory, nor does it eliminate the need for its improvement.

3.10 Some contaminants discharged at the source are assumed to attenuate as they spread from that source. Dynamic characteristics of the receiving environment are employed to determine rate and level of dilution. Standards are derived from measured parameters taken at given distances from the discharge point. This strategy may accept short-term or local excess of a potential pollutant at the point of discharge. Application is generally used with effluents that are considered biodegradable, and avoided where scientific evidence suggests that an effluent may accumulate in a given receiving environment. On the other hand, loading allocations impose priority of control on the larger sources in consideration of the most cost-effective solution. Allowable discharges are measured in terms of the total allowable for an entire receiving environment regardless of a specific site quality. Application is suited to relatively self-contained receiving environments such as lagoons or semi-enclosed bodies of water. It allows flexibility of contaminant output, in that certain sources may emit more than adjacent ones as long as loading limits are not exceeded.

3.11 All these strategies may employ criteria for water, air or sediment quality, as well as criteria related to specific marine life. Receiving environment quality standards are most prevalent for uses (*e.g.* bathing, direct harvesting of fish for human consumption) where sound scientific criteria exist to determine levels of harm. Emissions of potential pollutants are usually controlled to ensure that the desired quality is achieved. If the quality needs to be upgraded, additional controls are placed on allowable emissions.

3.12 Strategies based on emission standards may be based on a general principle to control pollution, on achievable technology, on distribution of control costs, or on enforceability. They differ from strategies based on marine quality in that the standards set are not primarily determined by the level of contamination in the environment. Technology-based standards are usually applied on a sectoral basis, thus providing a means of imposing similar costs across a particular sector. Alternatively, they may be determined on a case-by-case basis. The standards will need to be reviewed periodically in the light of developing technology. Standards may be based on:

(a) **best practicable technology** (or best affordable technology), which reflects the application of demonstrable and sound treatment technology or spectrum of technologies which is affordable by the sector concerned;

(b) **best available technology**, which reflects state-of-the-art technology in use for contaminant control. In general, the standards would reflect a more stringent level of control as compared to best practicable or best affordable technology. Application is generally for the control of emissions of the most noxious substances or to protect a sensitive environment;

(c) **as low as reasonably achievable**, which is mainly applied to radionuclides, and is based on the principle of optimization. This, as defined by the International Commission on Radiological Protection, requires radiation doses to be kept to levels that are "reasonably achievable", by technological improvements and by suitable choice among alternative options. The term "reasonably achievable" takes into account both the ease with which the technology can be applied, and the balance between the benefits, in terms of dose reductions, and the social and economic costs of its application.

(d) **zero discharge:** in a situation where stringent protection of a sensitive marine environment is deemed appropriate, consideration may be given to the denial of any release of a contaminant to the environment;

(e) **uniform regional emission standards,** which are usually applied in situations where there are existing pollution problems of a similar nature, and where there is urgent need to reduce pollution. These standards do not give primary consideration to the nature of sources, their economic base, or the receiving environment.

3.13 Strategies based on environmental planning draw in part on the other strategies described above, and are often used to supplement them. Planning strategies allow an approach to the management and protection of particular environments which may involve restrictions on, or modification of, activities and sites, as well as discharges. In this context, certain activities are deemed inappropriate or inconsistent with the value or use of a particular environment, Consider should be given as to whether such activities are essential and, if so, whether they can be accommodated elsewhere or in a different manner. Use of the receiving environment is the determining factor for pollution control standards as well as the basis for regulations or guidelines affecting other activities. For example, if the desire is to develop or maintain a shellfish harvest (a socio-economic decision), quality standards and uses are developed with this in mind. The application may result from a perceived threat to an established economic base or cultural value, or a conscious effort to change the existing use of a receiving environment.

3.14 The strategy also involves environmental assessment of activities. The siting of any activity significantly affecting the marine environment is subject to a comprehensive analysis and assessment of the ecological characteristics of the receiving environment, the direct and indirect potential effects and/or impacts of the activity on the environment and, as appropriate, the direct and indirect effects and/or impacts on the environment of any reasonable alternative to the activity. A strategy based on environmental planning involves regional planning, in which plans are drawn up for particular regions, taking into account socio-economic and ecological factors, which are then used as a basis for development. as well as coastal zone management, through which the strategy employs planning capabilities to make best use of the coastal zone. This is not use or- source-specific, but area-specific. Potential activities are assessed as components of a coastal zone. Planning is based on regional socio-economic and ecological considerations. Zoning and other land-use restrictions or modifications are major regulatory tools. Many states use regional planning authorities or councils, which are given the task of managing overall resource planning within a particular coastal area. The strategy also acknowledges that a large proportion of pollution enters the marine environment through watercourses. It does not necessarily account for inputs via the atmosphere, although air management areas have also been employed for control purposes. Through consideration of socio-economic and environmental factors utilising a drainage system as the boundary limit, the desired uses and levels of quality that can be attained for any given marine water body are determined. Pollution *via* watercourses is controlled through regulation of point and diffuse sources of such pollution within the given watershed.

3.15 A strategy based on environmental planning also involves the identification of unique or pristine areas, rare or fragile ecosystems, critical habitats, and the habitats of depleted or endangered species and other forms of marine life. Those areas to be protected or preserved from pollution, including that from land-based sources, are selected on the basis of a comprehensive evaluation of factors, including conservational, ecological, recreational, aesthetic and scientific values.

3.16 The question of issue of authorizations for the discharge of liquid wastes into the marine environment will therefore depend very much on the particular control strategy employed. The recent modifications to the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources, including the list of activities which now form part of Annex I, together with the progressive emphasis being placed on coastal zone management within the framework of the Mediterranean Action Plan, form ample evidence to the effect that a control strategy based on environmental planning is being adopted at overall regional level, with the expectation that individual countries will follow this strategy at national level.

Issue of authorizations

3.17 Once the decision has been made to impose discharge limits and the relative standards set, the question arises as to how to achieve compliance with such limits. The solution involves (a) the range of environmental instruments available to induce initial compliance, and (b) the range of enforcement procedures to maintain compliance, and to restore it if necessary. The range of environmental instruments includes permits, charges, loans, cost-sharing, land-use zoning, technical advice and publicity.

Actors in the authorization process

3.18 Multiple actors are involved in each component of environmental quality management, including the issue of waste discharge authorizations. The most efficient involvement of the various actors in the authorization component will be achieved if the relevant actors are also involved in the previous components of the environmental quality management cycle. An illustrative list of actors and their role is as follows:

Public agencies, as regulatory bodies at all levels of government, including local authorities, with both general and specialised jurisdiction, whose role consists in:

- development and enactment of legislation;
- setting of standards and development of guidelines;
- issue of permits and carrying out inspections;
- monitoring discharges and checking on compliance with standards, monitoring ambient environmental quality, and checking of data provided by dischargers;
- imposition of sanctions for non-compliance;
- development of cooperative agreements with public and private dischargers;
- assistance in environmental audits;
- publication of performances (good and bad) of discharge activities, maintenance of, and provision of access to, information on discharge activities;

- development and operation of a compliance response system;

- promotion of cleaner process technologies.

Courts:

- determination of whether or not discharge activities have been in compliance with statutory limits;

- determination of whether or not standards are fair and/or reasonable;

- determination of whether or not the regulatory agency has performed its designated functions;

- imposition of judicial sanctions.

The **private sector**, including those involved in industrial, tourist, agricultural, forest products and other institutional activities, Public agencies which are also pollutant dischargers would fall under this category insofar as their relevant activities are concerned. This sector is sometimes involved in:

- the legislatory process;

- setting of standards and development of guidelines;

- self-monitoring of the quality of input raw materials and of effluent discharges;

- development of cooperative agreements with regulatory bodies performing environmental audits.

Trade associations:

- presentation of testimony in the legislatory process and in standard-setting proceedings;

- performance of research in pollution control and process modification technology;

- participation in the development of guidelines for environmental audits.

Insurance companies:

- requiring environmental audits as a condition of providing insurance coverage;

- establishment of various standards of operation by activities prior to provision of insurance coverage.

Public interest groups, *e.g.* environmental groups:

- influence on legislation;

- influence on issue of authorizations;

- participation in joint groups with private activities and public bodies in development of standards and monitoring procedures;

- access to courts against private and public polluting activities, as well as against public regulatory agencies

International organizations:

- provision of guidelines and expert advice;

- provision of financial assistance.

3.19 With the exception of governmental regulatory agencies and (depending on the particular provisions of the legislation concerned) the courts of law, the specific roles played by each of the above-mentioned organizations and bodies will depend very much on the particular national legal and administrative set-up adopted.

Critical conditions for authorization

3.20 An authorization strategy should contain the following elements:

- specification of major objectives and courses of action:

- provision of authorization mechanisms - legal procedures and regulations;

- specification of the substances of concern, *e.g.* conventional pollutants, toxic substances, hazardous materials;

- specification of (a) the types of discharge of concern, *e.g.* continuous discharges, accidental spills, and (b) activities from which zero discharges are desired;

- specification of the time-scales of concern, *e.g.* short-term episodes, seasonal, long-term conditions:

- allocation of tasks among governmental agencies and levels of government.

3.21 Because the effects of discharges will not always be the same, the authorization strategy should contain a delineation of the target groups on which action should be concentrated. The targeting classification could be based on such factors as the size and complexity of the activity, the nature of the pollutants discharged, the geographical area in terms of human population density and the sensitivity of natural ecosystems, the period of the year in which meteorological conditions are at their worst, and the type of the industry or activity in terms of age, single or multi-product and ownership.

3.22 The existence of public support is essential in any environmental strategy. In this context, comprehensive information and educational programmes are of great help in achieving such support.

3.23 The achievement of continued compliance with established environmental norms requires the availability of technology to reduce discharges and to measure discharge content, input raw material quality, product content and ambient environmental quality. The critical considerations with respect to end-of-line technology are availability and performance, including the proportion of time in which the equipment is actually operating. Technology for measuring pollutants relates to in-stock monitoring of discharges, monitoring of proxy variables where monitoring of direct discharges is not possible, and monitoring the content of raw material inputs. In the case of non-point sources, such as run-off from agricultural operations, direct measurement of discharges is obviously impossible. Criteria and standards have been expressed and imposed in terms of "best management practices".

3.24 With the proliferation of environmental quality management and natural resources programmes, there is increasing concern that such programmes are not properly integrated with other government programmes. There are various types of programme integration, including:

- integration of pollution control programmes. This type is reflected in the cross-media approach;
- integration of the various health regulatory programmes, such as those controlling environmental pollution, food safety, consumer products, pesticide use, etc.;
- coordination with community and regional development plans and other related industrial siting programmes;
- integration of programmes regulating industry and commerce;
- integration of agricultural policies and practices.

3.25 All types of integration can be achieved in a number of ways, including (a) the integration of responsible departments within an agency, (b) to organize *ad hoc* efforts between departments or agencies, (c) the establishment of a mutual review process whereby proposals by one department or agency is reviewed by others, (d) an arrangement whereby agencies or departments refer proposals to others on matters considered relevant to the latter, and (e) the establishment of special councils or committees independent of any existing agency or department. These bodies would have the responsibility of reviewing or overseeing the actions of individual departments or agencies to ensure that adequate coordination is being effected, and that there are no serious gaps or inconsistencies among the various programmes.

Enforcement

3.26 Enforcement of established norms is one of the critical components of environmental quality management, and is always capable of improvement at various levels. One major bottleneck, at least in a number of countries, is the lack of resources allocated to enforcement, in particular the lack of inspectorate staff. Most of the suggestions presented below are aimed at improving enforcement without increasing its cost to any significant extent. There are a number of International organizations which can assist in the enforcement process by providing expert advice and financial assistance, particularly during the establishment phase.

3.27 Enforcement can be improved by development of a number of courses of action, including (a) improvements in the action process itself, (b) improvements in the modalities for the issue of permits and authorizations, (c) enhancement of monitoring programmes, (d) the development of cooperative agreements, (e) the strengthening of controls and sanctions, (f) the devising of incentive measures, (g) enhancing information and publicity, and (g) increasing the capacity of the relevant agency or agencies. These courses of action would not necessarily apply *in toto* to all countries, besides which each government would be expected to set its own priorities.

PART 4

NATIONAL LEGAL AND TECHNICAL REQUIREMENTS FOR WASTE DISCHARGE AUTHORIZATION

4.1 As explained in the preceding section, control of discharges of municipal and industrial wastes into the marine environment would normally be expected to form an integral part of a more general national environmental protection policy. The details of such policies would necessarily be expected to vary from country to country. Irrespective of the particular overall policy adopted, there are a number of basic national requirements for authorizing municipal and industrial waste discharges in compliance with the provisions of the Protocol for the protection of the Mediterranean Sea against Pollution from Land-based Sources. Such requirements are both legal and technical in nature.

Legal requirements

4.2 Authorizations for discharge of liquid wastes into the marine environment have to be issued under the powers of national legislation, which would be expected to reflect the provisions of the Protocol in order to satisfy the country's international commitments, as well as to cater for national requirements. In this regard, it should be remembered that the joint measures agreed on by Contracting Parties, which are reflected in criteria and standards, are normally the essential minimum on which a general consensus can be reached among more than twenty countries in varying stages of socio-economic development. It does not necessarily follow that these are adequate for the situation in any individual country, which is perfectly free to impose stricter measures than those jointly agreed on by Contracting Parties to the Convention and the Protocol, either at overall level, or in designated areas, if specific national or local conditions so require. The first requirement, therefore, is the enactment of a national legal instrument, either *ad hoc*, or as a subsidiary to more general environmental protection legislation, regulating the discharge into the marine environment of any waste by making such discharge subject to the issue of an official authorization or permit from the appropriate national authorities, which the legislation will have to designate.

4.3 The same legal instrument, the operative sections of which would be the prohibition of any discharge of wastes directly or indirectly into the marine environment unless such discharge is specifically authorized by designated national authorities, would also have to specify the conditions under which waste discharges will be authorized or otherwise. It would therefore have to contain a list of pollutants and their acceptable concentrations (and, where appropriate, amounts) in waste discharges. This list would .have to include the substances listed in Annex I to the Protocol, and make provision for the inclusion of any other substance warranting similar treatment. It would normally constitute an annex or schedule to the relative law or regulation, and provision would normally be made for this and similar annexes to be amended and/or updated by procedures simpler and more practicable than those involved in alteration or amendment of the actual text of the legislation itself. The factors influencing the issue of authorizations (which are contained in Annex II to the Protocol) would normally be integrated within the law or regulation in the form of a further annex.

4.4 In many cities and towns, small to medium-sized industries (and possibly even large ones) discharge their wastes into the municipal sewage network. As a result, the effluent will be of the mixed type as opposed to the domestic. Unless as many as possible of these industrial pollution sources are neutralised by imposing pretreatment prior to discharge into the municipal sewage network, the effluent would require a variably higher degree of treatment than would be normal for domestic sewage effluent in order to conform with expected statutory requirements for acceptability for discharge into the marine environment, particularly as regards overall pollution load. This factor will have to be taken into consideration in the formulation of national legislation regulating waste discharges. The preferred policy is normally that of enforcing pretreatment of industrial wastes in order to ensure that they comply with stipulated standards (which would again normally cover both concentration and amount, as the former can easily be modified by dilution) prior to discharge into public sewers. Such a policy also solves the problem of cost-sharing to a considerable extent, as the pretreatment process at source will obviously be at the expense of the individual polluter. Standards for this specific purpose, *i.e.* for discharge of industrial effluents into public sewers, would be expected, in the case of each pollutant, to be generally based on those stipulated for direct discharge into the marine environment, but would take a number of aspects, such as overall pollution loads, and pollutant types (particularly those capable of damage to sewer pipes) into consideration. Regulations controlling the discharge of industrial effluents into municipal sewage systems could either be integrated with, or issued separately from, those controlling direct discharges. Both could be enacted within the general framework of environmental, water or seawater protection or pollution control legislation.

4.5 Countries in which municipal wastewater is partially re-used for agricultural irrigation or other purposes will require different standards (and a higher degree of treatment) for such re-use, depending on the particular use the final treated effluent is put to, than is the case with discharge into the marine environment. The requirements for treated wastewater re-use are outside the scope of this document, and in cases where all the wastewater from any particular treatment plant is re-used, this would be a completely separate issue dealt with by other legislation, though possibly coming within the framework of an overall water resources management strategy. When however, the final treated effluent from any municipal sewage treatment plant is partially re-used and partially discharged into the sea, possibly depending on the particular season of the year, the legislation should provide for the different requirements of the two operations.

4.6 Planning, development and enforcement of legislation will require the availability of the necessary technical and administrative infrastructure at all stages, including the preliminary planning stage, since national problems and requirements have first to be studied. The enactment of a legal instrument practically repeating *verbatim* the provisions of the Protocol and prohibiting the discharge of wastes containing listed substances in concentrations above the limits jointly agreed on by Contracting Parties could perhaps be considered as satisfying international obligations. However, the extent to which enforcement of such a law would constitute a remedy to a country's coastal marine pollution problems is a completely different matter. While taking the regional measures agreed on by Contracting Parties to the Protocol as a necessary working basis, national marine pollution control legislation has to be geared to meet a country's specific requirements, which have to be studied prior to formulation of remedial measures. At a more practical working level, national and local studies during the planning stage are essential (a) to define the extent of the problem posed by substances listed in Annex I to the Protocol, as well as by other substances not listed therein, and (b) to enable the factors governing the issue of discharge authorizations, as listed in Annex II to the Protocol, to be properly taken into account during the eventual authorization process.

4.7 In summary, legislation aimed at controlling the discharge of municipal and industrial wastes into the marine environment (directly through coastal outfalls, or indirectly through river outfalls) and industrial wastes into municipal sewage systems, through a system of authorization should, *inter alia*, cover the following:

(a) prohibition of all waste discharges into the marine environment or into a river, unless specifically and individually authorised by a competent national authority, which must also be formally designated in the legislation;

(b) prohibition of all industrial waste discharges into municipal sewerage systems, again unless specifically and individually authorised by a competent national authority, (which would normally be the same as that designated in (a) above);

(c) definition of the conditions under which authorization may be granted in each case, including type, amount and composition of waste and, in the case of direct discharge into the sea or a river, discharge site, route of disposal and treatment;

(d) duration of the authorization period, and the conditions attached to renewal;

(e) definition of occurrences, such as process alterations, invalidating existing authorizations, and the conditions attached to new applications;

(f) a list of quality standards for directly discharged effluents, with the provision that conformity with concentration limits alone would not necessarily imply acceptance and authorization, particularly in the case of industrial pollutants where both the individual plant and global area amounts, together with the discharge site(s) have to be taken into consideration;

(g) a list of quality standards for industrial effluents discharged into municipal sewers;

(h) provisions for dealing with pollutants not specifically listed, and for regular updating and amendment of both lists and standards;

(I) provision for inspection of appropriate establishments (industrial plants, municipal treatment plants, etc.) to ensure compliance with the conditions of authorization;

(j) provision for monitoring of raw and treated effluents, industrial processes as appropriate, and sensitive marine areas, defining the organization responsible for (not necessarily actually performing) such monitoring.

(k) provisions for interdepartmental liaison and cooperation at formal level, where different responsibilities are allocated to more than one authority.

(l) provisions dealing with charges, fees and penalties.

4.8 Unless already specified in appropriate covering legislation, the usual legal provisions concerning right of appeal, etc. should also be covered. The incorporation of a list of standards for sensitive marine areas (seawater and seafood quality standards) would normally be expected to form part of other environmental or public health legislation. Provision would have to be made in waste discharge regulations to ensure conformity with such other legislation as part of the discharge authorization process.

Baseline surveys

4.9 The basic requirement will be to determine the extent of the problem.. As a first step, a comprehensive survey of pollutants from land-based sources being discharged into the sea will have to be carried out. Such a survey should cover both direct and indirect discharges, and include the amounts and composition of the wastes both at the points of discharge into the sea and, in the case of industrial wastes discharged into municipal sewers, at source (*i.e.* on discharge from the premises of each particular industry). Apart from the compilation of a pollution source inventory, which is essential to the eventual authorization process, this exercise should also gather all information available on the pathways of pollutants between their origin (*i.e.* at source) and their eventual entry into the sea. This information should include data on sewage systems, outfall structures, and treatment plants (if any). The survey, if properly carried out, will provide all the necessary information on the origin, type and amount of pollutants generated, and the mode of their eventual discharge into the marine environment.

4.10 Concurrently, a survey of sensitive areas in the coastal marine environment should be carried out. Such areas should include bathing beaches, shellfish grounds, and inshore fishing areas. The water and, wherever applicable, the fish or shellfish, in such areas should be analysed to determine pollutant concentrations. Bathing areas would normally be analysed for microbiological contamination, fish for industrial pollutant levels, and shellfish for both. Marine parks and nature reserves should also be surveyed, particularly if they are sited in the vicinity of discharge sites. In these cases, the whole ecosystem would have to be studied to determine pollution effects. Data obtained from the first-mentioned survey (para 4.9) will provide a very good indication of what pollutants to look for when analysing seawater, fish and shellfish and, in the case of marine ecosystems, appropriate fauna and flora.

4.11 Correlation of the data obtained from the two surveys described in paras 4.9 and 4.10 will establish the relationship between cause and effect, by the identification of links between sources, discharging outfalls and their effluents' composition on the one hand, and the state of the water and biota in affected areas on the other hand. At a practical level, the end-result will enable the authorities concerned to determine the extent of the problem, on the basis of which remedial measures, in the form of control of the content and composition of waste discharges through authorization can then be worked out.

4.12 The two studies outlined above will require the availability of trained personnel in order to enable the organization concerned to:

(a) carry out the survey of land-based sources of pollution, including:

- compilation of an inventory of pollution sources;
- acquisition of information on pathways between initial discharge from the source and entry into the marine environment, *i.e.* sewage systems, treatment plants, outfall structures, etc.;
- analysis of effluents at all appropriate stages, *i.e.* at source (in the case of industries discharging into public sewers). prior to treatment, and on entry into the marine environment.

(b) carry out the survey on the state of pollution of the coastal marine environment, including:

- analysis of the microbiological and chemical content of seawater in sensitive areas, as well as in control areas to determine background levels;

- analysis of the microbiological and/or chemical content of seafood (normally chemical analysis in the case of fish, and both microbiological and chemical analysis in the case of shellfish);

- studies on selected ecosystems to determine pollutant effects;

(c) interpret the results of both surveys, and determine national and local legal, technical and administrative requirements necessary to achieve satisfactory control;

(d) prepare the relative legislation on control of pollutant discharges through the authorization process, including the appropriate annexes containing acceptable standards for the various pollutants in effluents.

4.13 The latest survey of land-based pollutants in the Mediterranean was commenced by the World Health Organization in 1989, on the basis of country information in the form of replies to detailed questionnaires. Owing to poor country response, this survey has not yet been completed. It should be stressed that the principal aim of the survey was to collect as much material as possible in order to enable an overall regional picture to be drawn. To save time and reduce local expenditure,, countries were informed that they were only required to collect such information as was already available, and leave the appropriate parts of the questionnaires (particularly those dealing with the chemical content of effluents) blank where no data were available. While this approach was justified by prevailing circumstances, considering the scope of the regional survey, it is simply not enough to cover national data requirements for the scope of controlling pollution through appropriate legislation. Analytical data on effluent content, as described in the last sub-paragraph of 4.10 (a) above are absolutely essential.

4.14 The information and data collected in the two surveys described in paragraphs 4.7 and 4.8 above will mainly serve to determine the contents of the annexes to the legal instrument prepared, i.e. the pollutants to be controlled, and their acceptable amounts and/or concentrations in effluents for any discharge to be authorized. The text of the law or regulation can be prepared without such detailed information. In view of the time and effort required to complete the surveys, and the necessity of commencing control measures as early as possible, it would probably be advisable to enact the legislation and enforce it through "temporary" annexes prepared on the basis of existing information, both national and otherwise, until revised annexes which more comprehensively reflect both the situation and the measures necessary to control it have been prepared on the basis of the surveys. It should be realised that this would only be an interim measure, and that detailed information and data would have to be available for the design of any treatment plants and submarine outfalls which would eventually have to be installed to enable compliance with standards. The design of such establishments on the basis of inadequate or incomplete data would raise problems, and involve expense, if more complete data, when eventually acquired, demonstrate the need for modification. It should be borne in mind that collection of analytical data through monitoring will be the main factor on which enforcement of any standards, whether temporary or permanent, is based, so such work will have to commence immediately the legislation enters into force.

Technical and administrative requirements for enforcement

4.15 The critical conditions for enforcement have already been outlined in Part 3 of this document. The executive functions of coastal pollution control based on restriction of waste discharges through the authorization process is shown diagrammatically in Figure 4.1, and the procedure for control of discharges by environmental quality objectives based on water use in Figure 4.2. In practice, the national authority responsible for the process of authorizing waste discharges into the marine environment would have to consider all the factors listed in Annex II to the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources, both prior to and, as appropriate, following authorization, in order to ensure continuous compliance. In brief, the following main tasks will have to be performed:

(a) Prior to authorization of any discharges, in order to ensure that effluents and affected marine areas comply with stipulated quality standards:

- to inspect all municipal outfall systems discharging into the sea, determine, in each case, the volume and composition of the effluent with respect to prescribed standards for each listed pollutant, and impose any necessary measure, including treatment, to ensure compliance;

- to inspect all industries and appropriate commercial premises discharging their wastes into the municipal sewage system, determine, in each case, the industrial production process, the composition of the effluents concerned together with the concentration and amounts of listed pollutants contained therein, and impose appropriate treatment at source prior to such discharge;

- to inspect all industries discharging their wastes directly into the coastal marine environment, or into a river, determine, in each case, the industrial production process, the composition of the effluents concerned together with the concentration and amounts of listed pollutants, and to impose adequate treatment where necessary to ensure compliance;

- to approve, or prescribe, in the case of industries, methods for the disposal of wastes, whether originating from the industrial process itself or resulting from the treatment performed, which cannot be discharged directly or indirectly into the marine environment;

- to inspect all discharge sites, both municipal and industrial, and determine the state of seawater, edible seafood and ecosystems in affected areas (particularly coastal recreational beaches, aquaculture and natural shellfish grounds, and marine parks and nature reserves, with respect to seawater and/or seafood quality standards, and to impose discharge modifications, including the construction of submarine outfalls, wherever necessary;

FIGURE 4.1

THE EXECUTIVE FUNCTIONS OF COASTAL POLLUTION CONTROL

(from UNEP/WHO, 1985)

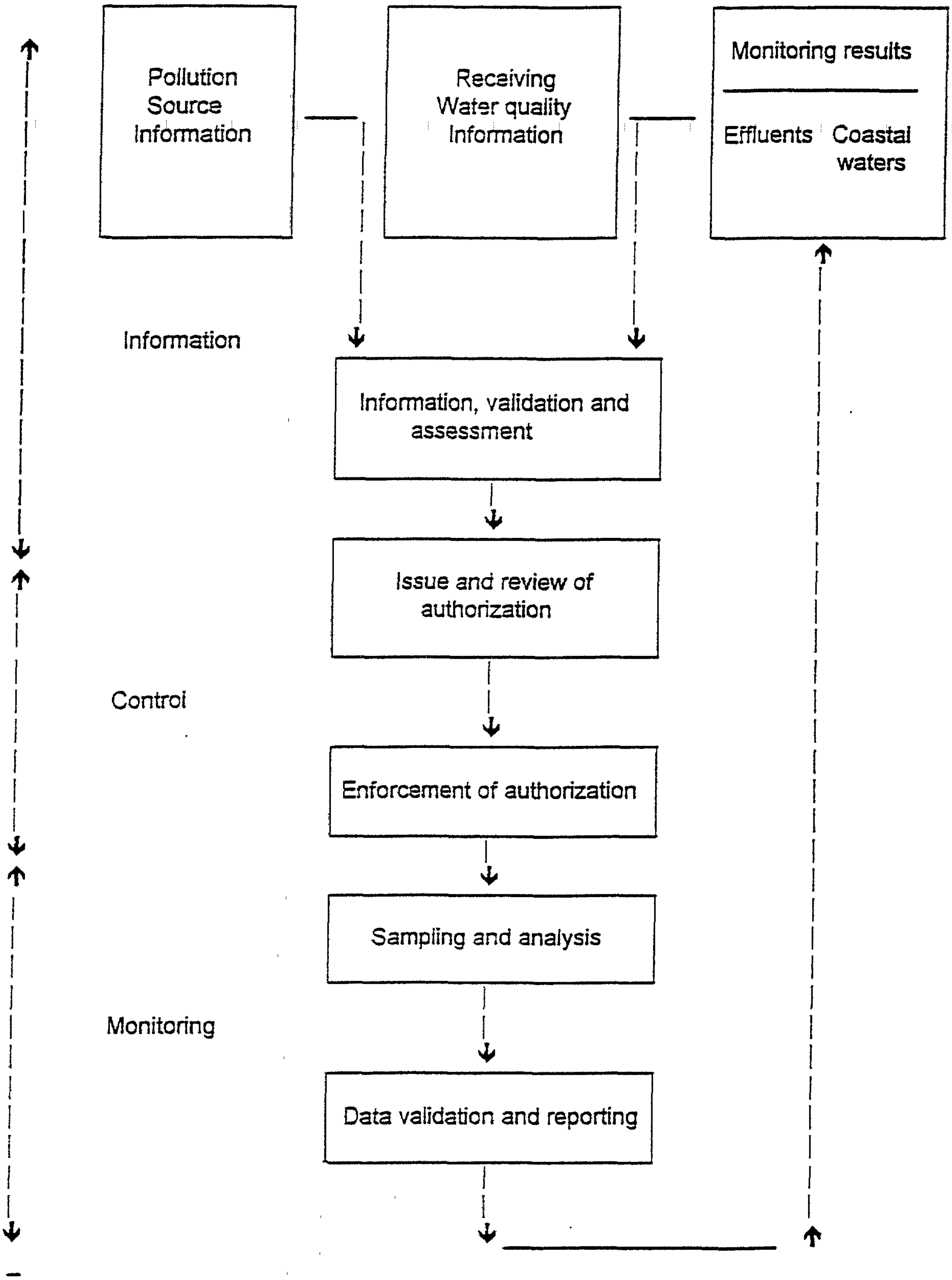
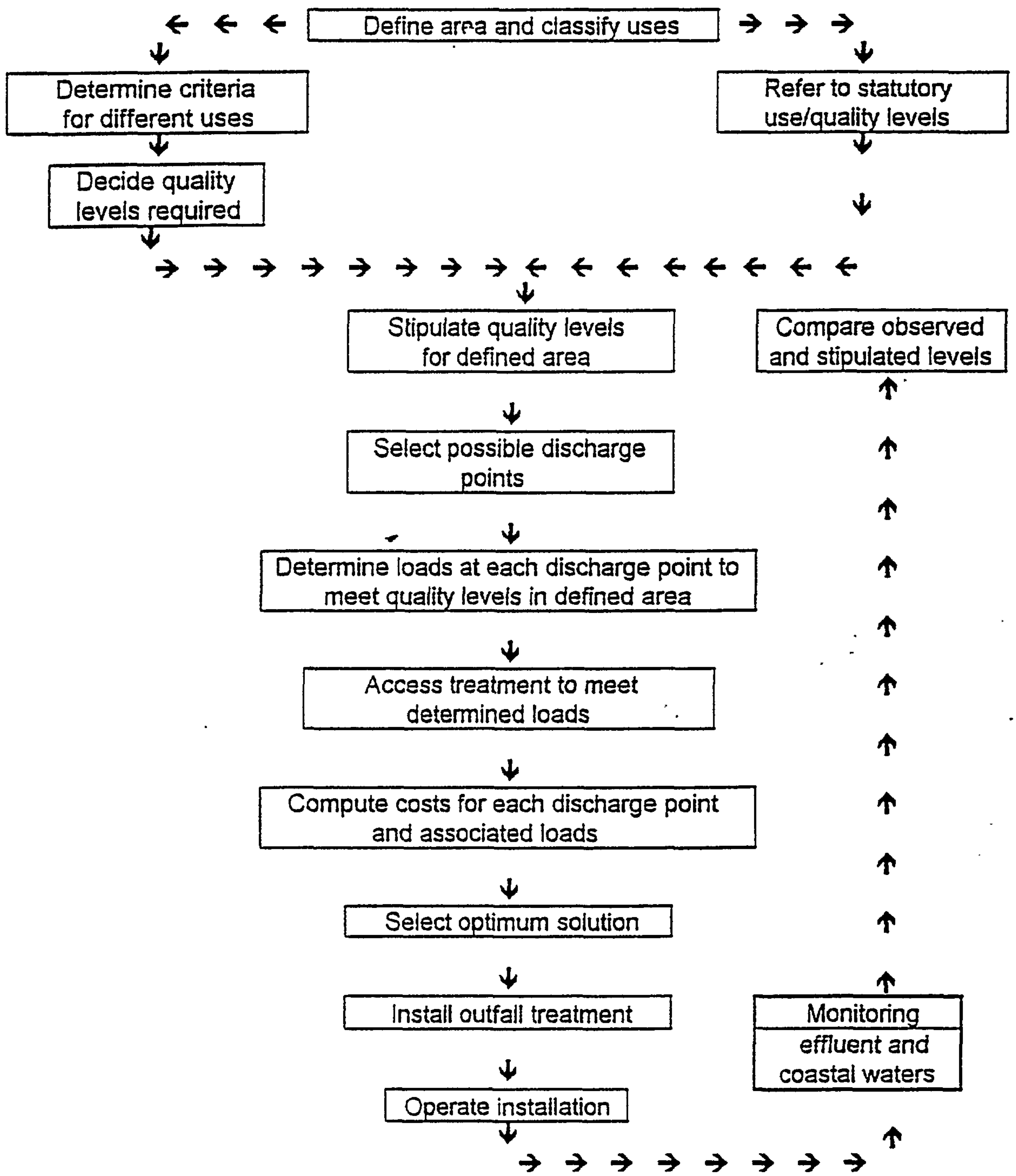


FIGURE 4.2

PROCEDURES FOR CONTROL OF DISCHARGES BY ENVIRONMENTAL QUALITY OBJECTIVES BASED ON WATER USE

(from UNEP/WHO, 1985)



(b) As a routine measure, following authorization, in order to assess he effectiveness of prescribed measures, and ensure continued compliance with stipulated quality standards:

- to monitor the performance of municipal sewage treatment plants through analysis of the incoming crude effluent and the final treated effluent discharged;

- to inspect, at appropriately-determined intervals, all industrial and commercial establishments authorised to discharge wastes into the marine environment or into municipal sewage systems, to ensure that measures prescribed as a condition for authorization, including both treatment and waste disposal, are being carried out;

- to perform the appropriate tasks listed in (a) above for new industries applying for authorization, and for already-authorized industries whose authorization to discharge wastes has to be reviewed due to expansion or to modifications in the industrial process resulting in alterations in the amount and composition of their wastes;

- to regularly monitor sensitive areas to ensure that they continue to meet quality standards;

- to take appropriate action when effluent or seawater/seafood quality standards are not met.

4.16 The above tasks will obviously require a trained inspectorate staff with professional analytical and ecological backup. Depending on the actual overall environmental organization in any particular country, and the division of responsibilities therein, the analytical and ecological aspects may be performed by government departments or bodies other than that actually responsible for discharge authorizations, in which case the importance of complete liaison and coordination must again be stressed. Routine industrial effluent analysis would normally be the responsibility of each individual industry. Such analyses, however, should be regularly controlled by the authorising organization, either through its own chemical and microbiological laboratories, or by reference to other designated government laboratories, as appropriate.

PART 5

WASTEWATER TREATMENT STRATEGIES

5.1 The authorization of wastewater discharges, whether municipal or industrial, will normally be dependent on appropriate treatment, in order to ensure compliance with emission standards or environmental quality objectives. Wastewater collection, treatment and disposal should therefore be designed to ensure such compliance. The same authority may be responsible for both the issue of discharge authorizations, and for the design and operation of municipal sewage treatment plants. If not, there should be continuous liaison between the various authorities involved right from the planning stage.

5.2 The design of treatment plants for municipal wastewater should form an integral part of a coherent master plan which all expanding communities require, in order to be able to coordinate all developmental activities, including the planning and provision of roads, housing and water supply, in addition to the collection and disposal of wastewater and storm water, and facilitate the rational expansion of all these services. (UN/ECE, 1984; UNEP, 1988). When these services are planned in an integrated manner, expenditure can be kept to a minimum. For example, if land-use plans reserve low-lying land close to receiving waters or irrigable land for wastewater treatment facilities, expensive long pipelines and pumping stations will not be required.

5.3 Although municipal sewage and sewage effluents are generally characterised by non-specific parameters, such as biochemical oxygen demand (BOD) and total suspended solids (TSS), such effluents usually contain several specific water pollutants. A number of these are mainly products of household use, such as metal brighteners and perborates, and will therefore be found predominantly in domestic sewage. Others result from industrial use and manufacture, and will therefore appear in mixed sewage as a result of discharge from workshops, factories and other establishments into the municipal sewage system. Knowledge of the nature of these specific pollutants, the amount discharged, their concentration in municipal sewage, their effects on the various unit processes of sewage treatment and, in turn, the effectiveness of such processes to destroy them or remove them from the flow, is important in controlling their environmental effects. This is particularly applicable to those pollutants originating in households and small-sized industrial and commercial establishments, where control over their discharge is practically impossible.

5.4 The main parameters to be determined in urban wastewater ((WHO/UNEP, 1982) are the following:

- suspended solids
- floating matter (grease)
- Biochemical oxygen demand (BOD)
- Chemical oxygen demand (COD)
- microorganisms
- dissolved oxygen
- nutrients (nitrogen and phosphorus)
- heavy metals
- thermal discharges

The quantitative removal of the above parameters is always aimed at, in order to avoid deterioration of seawater quality. The average composition of urban wastewater (USEPA,

1977) is given in Table 5.1. The composition of urban wastewater in a Mediterranean country (UNEP, 1993c) is given in Table 5.2.

5.5 In addition to the parameters listed in the preceding paragraph, industrial wastewaters also contain a number of toxic substances, including heavy metals and organic compounds, the composition of the waste depending on the particular type of industry.

Wastewater collection

5.6 Municipal or domestic wastewaters have to be channelled directly without retention in order to avoid serious operational problems such as anaerobic effluents. Financial incentives could be used to ensure that all households are connected to the system. As previously stated in this section, domestic wastewaters from urbanized areas will be expected to contain a variable amount of waste originating from industries situated within the urban complex. Industrial wastewaters normally contain hazardous elements which are difficult to eliminate, and their presence in urban effluents may hinder the operation of conventional domestic wastewater treatment processes. There is no obligation to accept such industrial wastes in their untreated form, and many countries have introduced legislation which requires that such wastes are pre-treated at source prior to discharge into municipal sewage systems. The question of industrial wastes should be tackled on a case-by-case basis and, in general, only those which do not affect (a) the ultimate quality of treatment, (b) the use or disposal of sludge, and (c) the treatment installation itself should be accepted.

5.7 Consideration of acceptance or otherwise of industrial wastes for discharge into a municipal sewage system should normally be entrusted to qualified experts. In addition to administrative provisions defining the various responsibilities, acceptance of such effluents would normally be subject to various technical provisions that may include:

- pretreatment, separation of various effluent streams;

- where necessary, modified circuits, recycling, modifications to manufacturing process;

- control devices for the flow and quality of the effluent, enabling identification of the origin and nature of pollutants reaching the sewage network.

TABLE 5.1

AVERAGE COMPOSITION OF URBAN WASTEWATER*

(from USEPA, 1977)

Parameter	Range (mg/l)
Solids, total	700 - 1000
Solids, dissolved, total	400 - 700
" " mineral	250 - 450
" " organic	150 - 250
Solids, suspended, total	180 - 300
" " mineral	40 - 70
" " organic	140 - 230
Solids, settleable, total	150 - 180
" " mineral	40 - 50
" " organic	110 - 130
Biochemical oxygen demand, 20^{0}C, 5-day carbonaceous (BOD_5)	160 - 280
" " " " ultimate carbonaceous	240 - 420
" " " " ultimate nitrogenous	80 - 140
Total organic demand (TOD)	400 - 500
Chemical oxygen demand (COD)	550 - 700
Total organic carbon (TOC)	200 - 250
Total nitrogen (as N)	40 - 50
Organic nitrogen	15 - 20
Free ammonia	25 - 30
Nitrites	0 - 0
Nitrates	0 - 0
Total phosphorus (as P)	10 - 15
Organic phosphorus	3 - 4
Inorganic phosphorus	7 - 11
Chlorides	50 - 60
Alkalinity (as $CaCO_3$)	100 - 125
Grease	90 - 110

* based on the following assumptions: Wastewater - 200 litres/person/day
BOD_5 - 56 grams/person/day

TABLE 5.2

AVERAGE COMPOSITION OF URBAN WASTEWATER IN A MEDITERRANEAN COUNTRY

(from UNEP, 1993c)

Parameter	Units	No of Monthly Data	Average		
			Summer 5-11	Winter 12-4	Annual Average
Suspended Solids 105	mg/l	28-31	414	410	412
Suspended Solids 550	mg/l	4-11	40	33	37
pH	-	28-31	7.25	7.06	7.17
Alkalinity, as $CaCO_3$	mg/l	7-15	429	404	418
BOD	mg/l	6-19	401	406	403
BOD f	mg/l	5-15	170	185	176
COD	mg/l	24-31	843	870	854
COD f	mg/l	10-22	299	326	311
TOC	mg/l	0-1	185	157	173
Ammonia, as N	mg/l	6-18	39.6	37.5	38.7
Kjeldahl Nitrogen	mg/l	20-27	66	65	66
Kjeldahl Nitrogen f	mg/l	3-9	49	47	48
Phosphorus	mg/l	4-12	12.8	13.1	12.9
Phosphate, as P	mg/l	3-8	9.3	9.7	9.5
Dissolved Solids 105	mg/l	3-7	1,205	1,115	1,167
Electrical Conductivity	μmhos/cm	26-31	1,939	1,835	1,896
Hadrness, as $CaCO_3$	mg/l	1-3	350	340	346
Calcium	mg/l	1-3	74	74	74
Magnesium	mg/l	1-3	39.9	37.8	39.1
Chloride	mg/l	26-31	334	294	317
Sulphate	mg/l	0-1	73	83	77
Fluoride	mg/l	0-1	0.5	8.0	4.3
Detergents	mg/l	2-6	10.5	10.0	10.3
Phenol	mg/l	1-4	282	343	307
Mineral Oils	mg/l	2-6	8.9	8.2	8.6
Fats	mg/l	2-6	102	90	97

5.8 Discharge regulations, instructions and canalization rules or prescriptions for discharge of industrial effluents into combined treatment plants may specify standard values, parameters and discharge criteria. These may be set at a national level for certain effluents which could impair the construction and operation of the sewerage system or the sewage works, and/or render the treatment of sewage costly or almost impossible. If the quality of the industrial effluent does not comply with the stipulated values, in-process measures or pre-treatment has to be applied. This includes neutralization or removal of heavy metals, toxic compounds, grease and fats and other hydrocarbons, as well as decomposition of emulsions. Typical industrial sectors which come under such regulations are metal finishing, metal mining, petroleum refining, chemical industries, textile industries, as well as pulp and paper. Some regulations make exceptions for food processing industries, laundries, or sugar refineries.

5.9 There is a difficulty in selecting between separate or combined systems for municipal wastewater and storm water. A combination of the two may be the best way to protect the environment. If poorly designed, either system (*i.e.* separate or combined) may lead to considerable disadvantage and to pollution. The combined system has the disadvantage of over-diluting the effluent with rainwater and, during a heavy storm, of discharging large amounts of mixed and untreated effluent and rainwater into streams, as a result of storm water overflows. The separate system also leads to considerable pollution if untreated rainwater is discharged into streams. A good solution may be to have a separate system where the rainwater can be treated by a simple technique, such as lagooning. Mixed solutions, combining the two systems according to local conditions, can give good results if they are designed with a view to minimizing environmental pollution. This is not necessarily the logical option of the engineer or the contractor. The installation of a combined storm run-off and municipal wastewater collection system, making use of one large conduit rather than two smaller ones, represents a false economy and may generate adverse environmental effects.

5.10 Combined wastewater/storm water carriage systems should be avoided (UNEP, 1988) for the following reasons:

- larger volumes of water are collected, thus making greater treatment capacity necessary;

- combined sewers are rarely designed to carry the peak run-off discharge of high-intensity tropical storms. There is therefore a danger that the excess flow - a mixture of storm water and municipal effluent - may overflow into streets and generate unsanitary conditions. Water bodies may also be polluted by the overflow of untreated wastes;

- in dry periods, when wastewater discharges make up the entire combined sewer flow, water movement is sluggish. Solids may then be deposited and corrosive chemicals generated;

- combined sewage systems require larger diameter pipes of expensive high-quality materials. By installing separate systems, the large-diameter pipes conveying storm waters may be constructed from cheaper materials, while the high-grade piping required for sewage can be of a smaller diameter;

- if combined sewers are used, catch basins must be installed at each storm water inlet to intercept grit and to prevent the escape of unpleasant odours. This expense can be avoided if separate carriage systems are installed.

5.11 In developing countries, where resources may be limited, the safe collection of municipal wastewater represents a priority, while storm water drainage can be considered less urgent, and may be accommodated by a surface drainage ditch system until resources for storm water collection become available.

Size of treatment installations

5.12 From the viewpoint of water quality management, central or regional installations for wastewater treatment may be given priority, as larger plants generally yield better purification performance and more uniform effluent quality (UN/ECE, 1984). In short, they may be operated more effectively. The advantages and disadvantages of a large central or regional treatment plant are listed below in general and indicative terms.

5.13 The advantages of large plants are the following:

(a) planning and construction costs are lower for a single large-scale plant than for two or more smaller individual installations;

(b) operation costs are lower according to economies of scale, as more waste is being treated at a lower rate per unit of total volume;

(c) the mixing of a variety of wastes may be beneficial: wastewater from manufacturing industries and that from municipal sewage may compensate in flow-rate and quality;

(d) higher treatment efficiency and better uniformity of effluent are possible in terms of both quantity and quality;

(e) lower energy requirements with the application of anaerobic sludge digestion (energy self-supplying systems) are possible;

(f) better handling of sludge and more efficient control over its disposal are possible;

(g) treatment plant operators are generally better qualified, since salaries associated with management of large treatment plants are higher than those for small "domestic-type" plants, and better-trained people are attracted. This factor contributes to better control and more efficient maintenance;

(h) the number of operational staff required overall for one large plant is less than would be the case for two or more smaller plants.

5.14 The disadvantages of large plants are the following:

(a) construction and operational costs can be substantially increased, because of long sewerage networks and the installation of more pumping stations;

(b) disruptions of a centralised facility impinge on effluent quality and flows over a wider geographical area, as compared with a smaller, more localized, plant;

(c) one single large plant concentrates effluent at one spot in the receiving waters, which may be more critical in terms of the recipient's assimilative capacity, whereas the self-purification capacity of a whole river stretch, for example, is not utilised as it is with numerous small dispersed treatment plants;

(d) there is increased difficulty in allocating respective costs to users;

(e) there is significantly higher vulnerability in cases of failure, breakdown, and accidents in the treatment process;

(f) financing is more complex;

(g) there have to be increased provisions for security measures, spare capacity and control programmes, in order to avoid or reduce damage to the receiving waters.

5.15 The area and the number of inhabitants served by each treatment installation depends on both administrative and technical considerations. From an administrative standpoint, size depends on the existing territorial structures and the possibility or otherwise of regrouping local communities for the purpose of wastewater treatment. From a technical standpoint, in the case of a collective treatment system, the actual size of the installation is important. It should not be too small, in order to avoid operational problems, particularly where staff qualifications are concerned, as well as relatively high costs per inhabitant. On the other hand, it should not be too extensive, in order to avoid:

(a) overlong transport times, leading to anaerobic conditions, fermentation and attendant disadvantages, such as offensive smells, plant deterioration, problems during the start-up period in biological treatment after the tourist season with high peaks of efficient loads;

(b) too great an impact on the receiving coastal waters owing to the relatively large final discharge volume.

5.16 As each individual case would be different, a careful census of future users of the load has to be made, in order to avoid over- or under-estimations of such load. The relevant procedural steps for the estimation of liquid effluents from domestic sources (WHO, 1982) are illustrated in figure 5.1.

Treatment plant conception

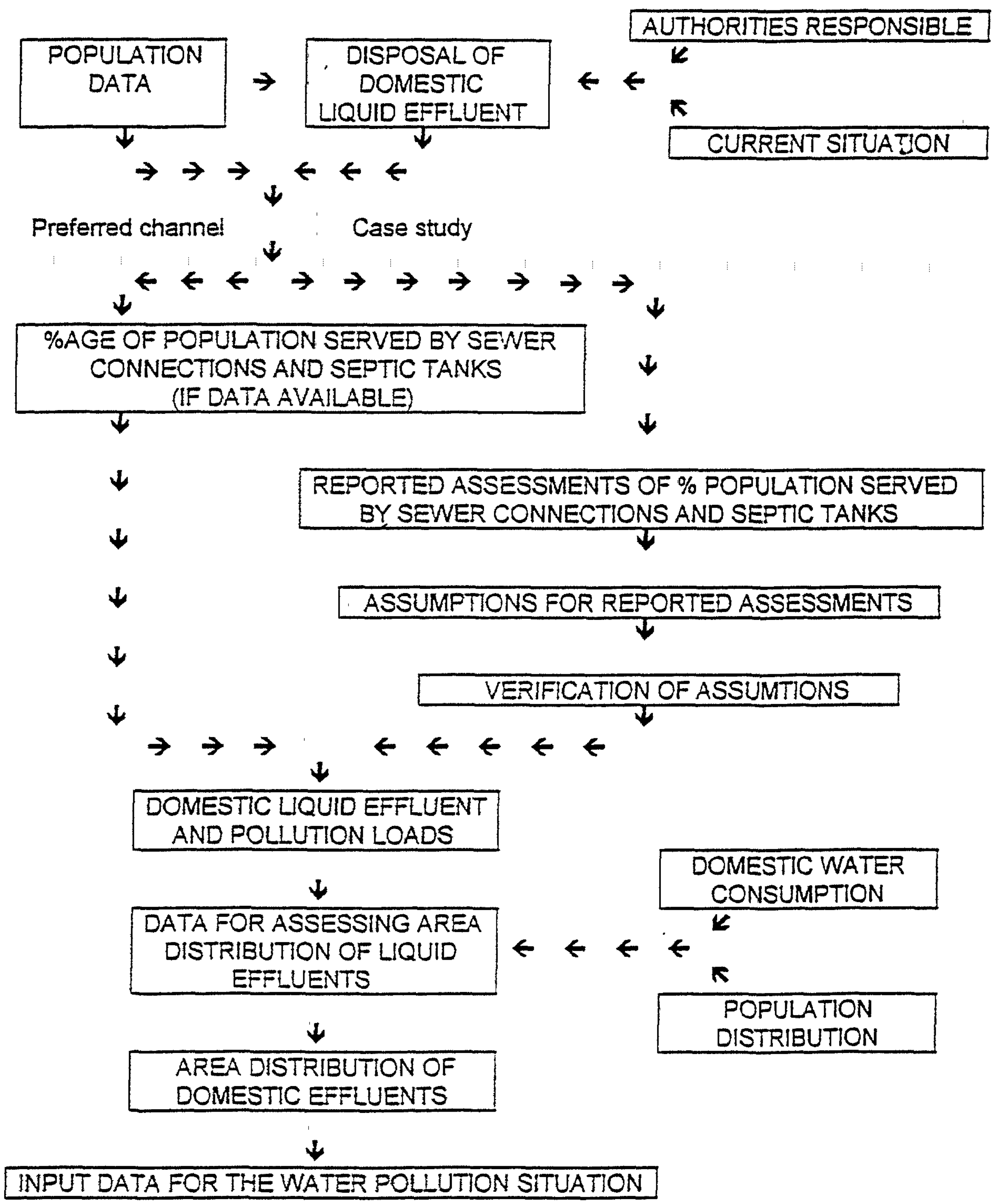
5.17 It has been recommended (UN/ECE, 1984) that the best solution for treating municipal wastewaters would be to use simple, reliable processes (various forms of lagooning, fixed cultures, etc.). particularly for small installations where it is rarely possible to obtain highly-qualified staff, and that it would also be advantageous to slightly relax discharge requirements so that simple techniques can be used which will continue to be reliable, even in the case of operational shortcomings. While this processes mentioned may be considered suitable for certain situations where the immediate requirement is some form of temporary palliative measure to improve conditions until such time as more efficient techniques can be used, it is very doubtful whether they could be considered applicable in general terms to the situation in the Mediterranean basin, where countries have already agreed on common measures equivalent to current international standards.

5.18 In very general terms, however, as long as the stipulated requirements can be met, it would be advisable to plan for relatively simple conventional installations, even if, in theory, the treatment they provide is of a lower standard than that obtainable from more sophisticated plants, particularly where a few hours breakdown would result in environmental damage. This is due to the fact that it is not the theoretical optimum efficiency of a plant that counts, but its overall efficiency 24 hours a day, 365 days a year. The actual year-long integrated efficiency is possibly much lower than the theoretical efficiency, especially where sophisticated processes are concerned, and reliability is therefore a particularly important factor. It should also be noted that the efficiency of a treatment system depends on the total daily amount of pollution (or pollution load) removed from the effluent. Efficiency will obviously be much greater if the effluent is concentrated (*i.e.* with the given pollution load for the population concerned, but with minimum dilution).

FIGURE 5.1

ESTIMATION OF LIQUID EFFLUENTS FROM DOMESTIC SOURCES

(From WHO, 1982)



5.19 The pollution content of effluent treated, or about to be treated, should always be expressed in terms of pollution load, rather than pollution concentration, since the latter parameter can easily be falsified by dilution. This is also particularly important when considering pretreatment of industrial effluents prior to discharge into municipal sewerage systems. A dual sewerage system (separating rainwater from wastewater) will result in a less diluted effluent, and therefore more efficient purification of the treated effluent in terms of total pollution load removed. However, it will often be necessary to provide a minimum treatment for the pollution content of urban run-off. The problem of treatment plants in tourist areas, subject to extensive and often sudden variations in the effluent load could be tackled either by combining such effluent with that of a community whose population fluctuates less, or, where the site allows, and technical considerations permit, by adopting extensive treatment sequences such as lagooning, or by resorting to physico-chemical treatment in the case of small plants used for short durations. Inevitably, however, such variations increase costs, particularly where physico-chemical systems are concerned. The options will obviously depend on the quality of the wastewater or run-off water in terms of pollution load, and the desired quality of the treated effluent.

5.20 The following considerations govern the choice of wastewater treatment technology (UNEP, 1988):

- characteristics of raw wastewater
- range of acceptable disposal options
- statutory discharge standards
- climatic conditions
- availability of land
- availability of appropriately trained personnel
- simplicity of design, construction, operation and maintenance
- energy requirements
- availability of construction materials and mechanical equipment
- availability of funds
- flexibility of plant capacity *vis-à-vis* projected needs
- the availability of backup systems.

5.21 The above, as in the case of the UN/ECE 1984 recommendations, are primarily aimed at situations in a number of developing countries where no wastewater treatment was practised, and where the basic need was for immediate measures to provide temporary remedial measures, necessarily based on then current resource-availability, to ameliorate the position to the extent possible. The applicability of some of these considerations to the Mediterranean situation, and more specifically, to compliance with the terms of the Protocol for the Protection of the Mediterranean Sea against pollution from land-based sources, should therefore be viewed in this light. Specific factors affecting the choice of treatment process are given in Table 5.3.

TABLE 5.3

FACTORS AFFECTING CHOICE OF TREATMENT PROCESS

(adapted from UN/EYE, 1984 and HMO, 1979)

Design target	Contributory factor to be considered
Minimum installation cost	- Land requirements: area and depth - Size and simplicity of civil, mechanical and electrical engineering required - Number of aeration devices and their means of operation - cost of structures and equipment
Minimum operating cost	- Aerator efficiency, including driving arrangements where applicable - Effects of detergents on oxygen transfer - Maintenance requirements: reliability, durability (*e.g.* materials of construction), accessibility - Effects of climatic conditions - Feasibility of automation
Minimum side effects	- Impact on other treatment processes (*e.g.* preliminary treatment required) - Secondary sludge production: its settling and dewatering characteristics - No floc disintegration: peripheral velocity of mechanical aerator 9 m/s - Adequate circulation velocity to prevent deposition, preferably 0.3 m/s - Detergent foam production and ease of suppression - Spray drift - Noise - Odours and aerosols
Adaptability	- Ease of increasing treatment capability - Effects of fluctuations in volume and/or load - Ease of automation or modifying pattern of operation - Effects of power failure on subsequent aeration efficiency - Effects of site subsidence on air distribution or aerator operation

Financing and cost

5.22 The sharing of contributions between users should be as equitable as possible, and both capital investment and running cost accounts should be open and straightforward. Financial resources should be used on a priority basis, preference being given to the largest plants and those that can effectively protect the water on a basin scale. Since inadequate mechanisms for financing installation, operation and maintenance are often a major cause of problems, this aspect requires special attention. Rates charged to the various users should take into account the pollution load, *i.e.* the amount of pollution produced, in terms of such factors as quality, harmfulness, toxicity or difficulty of elimination. Industrial pollutants are harder to treat than household pollutants but, because only a limited amount of financial data on them are generally available, they are often underestimated. In the case of medium to large industries discharging their effluents into the sewerage network, pretreatment prior to discharge would be expected to be at the cost of the industry. There might be a problem with small-scale industrial operations where pretreatment may not be possible for some reason or other.

5.23 In most Mediterranean countries, wastewater treatment plants represent one of the major investments in the environment sector. The cost of the initial capital outlay for a plant is less than that for operation and maintenance. In line with financial resources, this fact must be taken into account, and at least as much attention should be paid to the machinery for financing operation and maintenance as to the construction outlay. The technical and financial resources available for operation and maintenance must be settled during the initial planning stages of the project, and the project authority should provide a firm undertaking on this point before starting construction, Regulations should provide for the enforcement of these commitments.

5.24 Considerable differences do appear in the cost comparison of some treatment technologies for different plant sizes. Construction costs per cubic metre for plants equipped with the common high-rate activated sludge process may be approximately 50% lower for medium-sized treatment plants as compared to small-sized ones. Costs are approximately 30% less for large-sized plants as compared to medium-sized ones. Similar reductions appear in operation and maintenance costs (UN/EYE, 1984).

Conventional sewage treatment processes and their efficiency

5.25 There are essentially five separate stages in the conventional treatment of large volumes of municipal sewage to a high standard of final effluent. Fewer stages may be employed where the highest standard of effluent is not required or when, because of the small volume of sewage, simplicity is essential (OECD, 1982).

5.26 The five stages of treatment (UN/EYE, 1984a, 1984b; HMO, 1979), which are outlined in Table 5.4, comprise:

(a) preliminary treatment designed to remove coarse solids and grit which might otherwise interfere with the satisfactory operation of subsequent treatment units;

(b) primary treatment to remove that fraction of the suspended organic matter which will settle readily under gravity;

(c) secondary treatment by biological processes to oxidise or remove by adsorption the fraction of organic matter which is present in solution and which does not separate as sludge during primary treatment;

(d) tertiary treatment to remove specific materials and the small proportion of secondary sludge solids (humus or activated sludge) which is present in the effluent from the settlement stage of secondary treatment;

(e) disinfection to reduce the number of bacteria and viruses in the final effluent discharged to surface waters. The objective is to safeguard water supplies and those using the water for recreational activities.

TABLE 5.4

CATEGORIES OF TREATMENT METHODS

(after OECD, 1984)

Category	Treatment method	Pollutants removed	Purpose	BOD_5 removal
Preliminary	Screening Comminution Grease removal Grit removal	Coarse solids	Discharge into open sea, Protection of following units of treatment plant	10%
Primary	Sedimentation Coagulation Flocculation	Suspended solids	Discharge of less amounts of settling material	30%
Secondary (biological)	Aeration Final sedimentation	Total solids BOD_5	Reduction of organic load	95%
Tertiary	Activated carbon Ammonia stripping Ion exchange, etc.	Nutrients (P, N) Heavy metals	"Polishing" of secondary treated effluents	-
Disinfection	Chlorination Ozone	Microbiological load	Removal of bacteria	-

Preliminary treatment

5.27 There is a diversity of practice in the sequence of preliminary treatment processes followed, but this has had little or no bearing on the extent to which specific pollutants are affected. The unit processes employed include:

(a) screening through hand- or mechanically-raked bar screens and, less often, through rotating-drum screens;

(b) screening and disintegration, using comminutors or barminutors;

(c) grit removal in constant-velocity grit channels or in detritus tanks of various designs.

5.28 It is unlikely that any of these processes would significantly influence the concentration of any specific pollutants originating from domestic or industrial sources unless the pollutants in question are in the form of very coarse particles or fibres, or consist of oily or fatty matter which would separate as a different phase at the water surface.

5.29 Preliminary treatment involves the removal of coarse solids through screening and grit removal. Screening of wastewater is considered necessary to prevent clogging in the subsequent treatment stages. In exceptional cases, screening may be the only form of treatment before discharge into coastal waters.

Primary treatment

5.30 Primary treatment at a conventional plant consists in passing the sewage through horizontal-flow, radial-flow or upward-flow sedimentation tanks affording from 2 to about 6 hours detention to the dry-weather flow of sewage. Such sedimentation removes up to 40-60% of the matter present in suspension and typically 25-40% of the biochemical oxygen demand (BOD) from the crude sewage as sludge. Primary treatment can also remove coliform bacteria by up to one order of magnitude. Virus removal is in the range of 20-30%. Sedimentation is accomplished in ponds or in sedimentation tanks.

5.31 The performance of the primary settlement stage of sewage treatment may be improved by a variety of processes, including pre-aeration, mechanical flocculation and chemical treatment. Pretreatment by aeration can assist in the removal of specific water pollutants by stripping volatile constituents out of the sewage, but only at the expense of increasing atmospheric contamination. Mechanical flocculation is unlikely to affect the concentration of a specific pollutant except insofar as it might increase the percentage of suspended matter removed from sewage. Chemical treatment, however, can be employed to increase the percentage removal of a specific water pollutant, for instance, the addition of an excess of lime ($Ca(OH)_2$) to sewage.

5.32 In some small plants, the primary treatment of sewage is carried out in "septic tanks". These are simple sedimentation tanks designed to provide a relatively long (3 hour) period of retention of the sewage in anaerobic conditions, and permit storage of the settled sludge under conditions which allow it to undergo anaerobic decomposition without interfering with the functioning of the sedimentation stage. The quantity of sludge requiring disposal is thus reduced. The performance of a septic tank in removing specific pollutants will differ from that of conventional sedimentation tanks since the quantity of sludge is smaller, and therefore its ability to remove specific pollutants by absorption is not so great. Some metals are precipitated as their sulphides, but there is also the possibility that anaerobic decomposition of organic matter leading to the production of fatty acids could result in a significant proportion of toxic metals being solubilised as organometal complexes. Certain specific pollutants, particularly the chlorinated hydrocarbon solvents, are inhibitory to anaerobic digestion, and interfere with the functioning of the process.

Secondary (biological) treatment

5.33 The biological processes employed in the secondary stages of sewage treatment are essentially similar to those which occur naturally in soil and water. The principal difference is that an environment is provided which promotes the growth of a large population of aerobic bacteria under favourable conditions, so that biological oxidation occurs more rapidly than in the natural environment. The principal processes are:

(i) biological filtration, in which bacterial growth occurs on the surface of an inert supporting medium;

(ii) the activated-sludge process, in which the organisms are suspended in the water undergoing treatment, and are subsequently separated in sedimentation and recycled.

5.34 These principal processes may be used separately or in combination, and there are variants which differ with respect to the quantity of organic matter applied to a unit of plant in unit time. The variants of the biological filtration process are generally known as conventional-rate and high-rate processes. Variants of the activated-sludge process are known as extended aeration, and conventional and high-rate activated-sludge processes. Secondary treatment can provide BOD removal in the range of 35-95%, and can remove 95-99% of coliform bacteria, although removal of viruses is not as efficient. It can take place in stabilization ponds, activated sludge process plants, trickling filters, etc.

5.35 For an organic substance to be destroyed by biological oxidation during secondary biological treatment of sewage, the following conditions must apply:

(a) the temperature and pH value of the sewage must be within a suitable range;

(b) growth-rate of bacteria under the conditions provided must exceed a specific rate of sludge wastage. This implies that no substance should reach inhibitory concentrations and that, where potentially biodegradable inhibitory substances are present, a suitable form of treatment process, such as "compete mixing" activated sludge, must be employed;.

(c) an adequate concentration of inorganic nutrients (nitrogen, phosphorus or potassium) must be present. A suitable rate of BOD:N:P is 100:5:1;

(d) adequate time must be allowed for proliferation of the necessary bacteria;

(e) the substance must be constantly present at a stable concentration;

(f) the intensity of aeration must be sufficient to supply the necessary dissolved oxygen.

Tertiary treatment

5.36 Tertiary treatment methods "polish" effluents from secondary treatment plants prior to discharge into receiving waters or re-use. Tertiary treatment can be designed to remove materials such as phosphorus or nitrogen, or other specific wastewater constituents, as well as providing further BOD removal and pathogen die-off. Tertiary treatment processes include coagulation and sedimentation, electrodialysis, filtration adsorption, etc and the use of saturation-type ponds. The use of processes designed to remove the last traces of humus or activated solids from suspension also brings about further removal of specific pollutants, insofar as these are associated with suspended matter from the secondary stage of sewage treatment.

5.37 Chemical treatment of the effluent mainly after primary treatment, for example with lime or with the salt of a polyvalent metal such as iron or aluminium, can assist in removal of organic solids (including bacteria) and is known to be effective in reducing the concentration of phosphate and a number of other ions. Advanced wastewater treatment (AWT) is used to classify systems capable of reducing specific constituents to levels normally achieved by a well-operated activated sludge plant. Typical performance data for advanced wastewater treatment ((UN/EYE, 1984b) are given in Table 5.5. The number of stages required, and the processes used, depend not only on the type of waste to be treated, but also on the effluent quality necessary to protect the environment adequately. Additional processes and procedures may be required to remove unconventional contaminants, including toxic chemicals.

TABLE 5.5

TYPICAL PERFORMANCE DATA FOR ADVANCED WASTEWATER TREATMENT (AWT) AND ACTIVATED SLUDGE SYSTEMS (ASS)

(from UN / EYE, 1984b)

Parameter	Effluent quality in mg/l	
	AWT	ASS
BOD_5	5	15
Suspended solids	5	16
Phosphorus (as P)	1	3 - 11
Total Nitrogen (as N)	5	10 - 20

Sludge treatment

5.38 Treatment plants are "sludge factories". This is a product which becomes rapidly cumbersome to handle, and a rational use must be found for it. If a solution is not found for the sludge problem, the treatment plant's performance can be seriously compromised, and serious environmental difficulties may result. It is important for the planner to have clearly in mind, from the start, the solution for each individual situation. Disposal of the sludge is likely to be a decisive factor in the design of the treatment plant. The residues obtained from the process must also be treated. Such processes as digestion, dewatering, vacuum filtration, incineration, air drying or other physical/chemical processes are generally used for stabilization, usually with ultimate disposal of the waste on land.

5.39Strategies which consist in the elimination of household sludge as a useless waste product almost invariably result in the mere transfer of pollution, for instance, by incineration (which not only wastes energy, but also creates a considerable amount of air pollution) or disposal in refuse dumps (which leads to pollution of groundwater or surface water). Strategies providing for the rational re-use of such materials (*e.g.* for agricultural compost) constitute a much more acceptable and lasting solution.

5.40 Sludge digestion and biogas generation have several important advantages, including the production of a significant amount of energy, the stabilization of sludge (in small volumes),making it easier to use. Disposal and re-use options include:

- ponds and lagoons
- sanitary landfills
- application of sludge to agricultural land
- land reclamation
- composting of organic sludges
- incineration

5.41 For a number of reasons, particularly in relation to ultimate re-use of sludge, industrial effluents containing toxic substances should be excluded. Rational management of sludge can transform a primarily negative output (from the economic, environmental and energy viewpoints) into a clearly positive one. A "market" for this material should be organised at the appropriate level, and economic instruments could help to facilitate its sale.

Balance between treatment processes

5.42 The balance between primary, secondary and further treatment of sewage varies because of very different economic conditions and environmental requirements. Countries where ambient temperatures are high tend to reduce or eliminate primary settlement and pass comminuted crude sewage directly to an activated sludge type of treatment system. Various combinations of biological and physico-chemical unit processes (UNEP/ PAP-RAC/ CEFIGRE) are shown in Table 5.6. In dividing conventional sewage treatment into the stages described above, sedimentation to separate activated sludge for recycling, or to remove humus solids from the final effluent, is considered as an integral part of secondary biological treatment of sewage. Primary settlement and the sedimentation associated with secondary treatment both give rise to sludges which usually must receive treatment by physical, chemical or biological processes, singly or in combination before their final disposal.

5.43 Based on post-project evaluations to assess both the purification efficiency of various treatment processes and the related constructional and operational costs of municipal wastewater treatment plants, the following may be concluded:

(a) for effective reduction of oxygen-consuming substances (up to 55%), only a few processes have proved their capability, such as:
  - low-rate trickling filtration
  - activated sludge system-extended aeration
  - oxidation ditch and combined biological/chemical treatment
  - additional sand filtration (up to 98%)

TABLE 5.6

VARIOUS COMBINATIONS OF BIOLOGICAL AND PHYSICOCHEMICAL UNIT PROCESSES

(after UNEP / PAP-RAC / CEFIGRE, 1988)

Raw water concentration	Typical concentration in mg/ℓ				First unit		Second unit		Third unit	
	soluble	colloidal	solid	total	unit process	Typical out concentration (mg/ℓ)	unit process	Typical out concentration (mg/ℓ)	unit process	Typical out concentration (mg/ℓ)
Suspended solids	-	-	200	200	Sedimentation	80 -100	Activ. Sludge	10 - 30	Filtration	3 - 7
					Coag/sed.	10 - 30	Activ. Sludge	10 - 30	Filtration	3 - 7
					Coag/sed.	10 - 30	Filtration	3 - 7		
					Act. Sludge	10 - 30	Filtration	3 - 7		
BOD_5 (carbonaceous)	80	40	80	200	Sedimentation	130 - 150	Activ. Sludge	10 - 30	Filtration	1 - 3
					Coag/sed.	80 - 100	Activ. Sludge	10 - 30	Filtration	1 - 3
					Coag/sed.	80 - 100	Filtration	80 - 90	Adsorption	5 - 15*
					Act. Sludge	10 - 30	Filtration	1 - 3	Adsorption	0 - 2
COD	160	80	160	400	Sedimentation	50 - 100	Activ. Sludge	50 - 100	Filtration	40 - 60
					Coag/sed.	50 - 100	Activ. Sludge	50 - 100	Filtration	40 - 60
					Coag/sed.	160 - 180	Filtration	100 - 160	Adsorption	20 - 30
					Act. Sludge	50 - 100	Filtration	40 - 60	Adsorption	5 - 10
Phosphorus	9	-	1	10	Coag/sed.	2 - 5	Filtration	0 - 1	Filtration	0 - 2
					Coag/sed.	2 - 5	Activ. Sludge	1 - 5	Filtration	0 - 2

* no credit shown for removal by biological activity

(b) removal of total suspended solids can be achieved by:
- low-rate trickling filtration
- extended aeration
- chemical treatment
- sand filtration

Treatment of industrial wastewaters

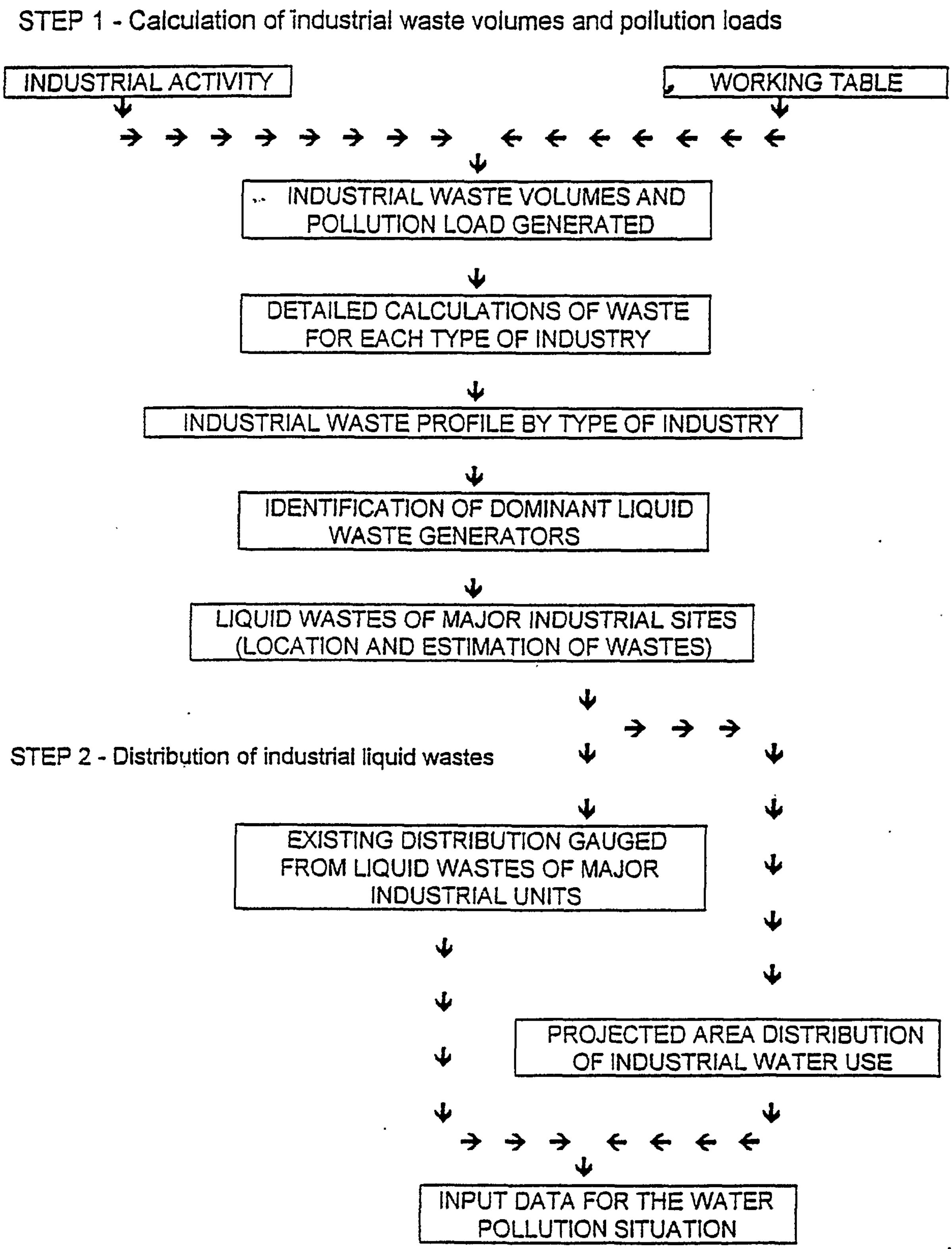
5.44 A detailed description of the treatment process for industrial wastewaters is beyond the scope of the present document. The procedural steps for the estimation of liquid effluents from industry (WHO, 1982) are given in Figure 5.2. The subject is treated further in Section 6 of this document, which describes and explains the factors to be taken into account in the issue of authorizations, in accordance with the provisions of Annex II to the Protocol. Detailed descriptions of the various treatment processes for substances listed in Annexes I and II to the original 1980 Protocol (now combined in Annex I to the new version) are available (WHO/UNEP, 1994b).

5.45 In the case of industries discharging their wastes into the municipal sewage network, as many of these as possible (certainly all the large and medium-sized ones, as well as the optimum practical proportion of the smaller ones) should be subjected to pretreatment at source before such discharge, and their sludge disposed of under stipulated conditions on land. . The resultant raw effluent entering the treatment plant should be sufficiently free from industrial pollutants so as to ensure a final treated effluent of satisfactory quality The actual amounts of "trace" pollutants, however, should be checked as even though their concentration would be expected to fall well within prescribed concentration limits, problems might arise if industrial wastes containing the same pollutants, are being discharged from other outlets in the vicinity.

FIGURE 5.2

ESTIMATION OF LIQUID EFFLUENTS FROM INDUSTRY

(From WHO, 1982)



PART 6

FACTORS GOVERNING THE ISSUE OF WASTE DISCHARGE AUTHORIZATION

6.1 As already stated in Section 2 of this document, under the terms of Article 6 of the Protocol for the Protection of the Mediterranean Sea against Pollution from land-based sources, point source discharges to the Protocol Area and releases into water or air which reach and may affect the Mediterranean Sea Area shall be strictly subject to authorization or regulation by the competent authorities of the Parties, taking into account the provisions of Annex II to the Protocol. This annex (reproduced in Table 2.2) lists the following main groups of factors of which particular account should be taken in the process of issuing authorizations for the discharge of wastes containing substances referred to in Article 6 of the Protocol:

(a) characteristics and composition of the waste;

(b) characteristics of waste constituents with respect to their harmfulness;

(c) characteristics of the discharge site and the receiving marine environment;

(d) availability of waste technologies;

(e) potential impairment of marine ecosystems and seawater uses.

Characteristics and composition of the waste

6.2 The following factors have to be considered under this heading:

(a) type and size of waste source (*e.g.* industrial process);

(b) type of waste (origin, average composition);

(c) form of waste (solid, liquid, sludge, slurry);

(d) total amount (volume discharged, *e.g.* per year);

(e) discharge pattern (continuous, intermittent, seasonally variable, etc.);

(f) concentrations with respect to categories of substances listed in Annex I, and other substances as appropriate;

(g) physical, chemical and biochemical properties of the waste.

6.3 The first requirement is obviously to acquire all the possible information about the waste itself, as this will provide the basis for authorization or otherwise when correlated with the other factors listed in Annex II to the Protocol. When more than one outfall is discharging into the same coastal area, and authorization has to be given for each outfall on a separate basis, each discharge has to be considered not only individually, but also within the framework of the total amount of wastes being discharged from all points into the marine area in question. In view of the fact that particular attention must be paid to wastes originating from the activities listed in Annex I to the Protocol (Table 2.1), the origin of the waste assumes importance.

6.4 The **type and size of the waste source** (*i.e.* the industrial plant or complex itself) and the industrial process will provide *a priori* information on the type and amount of pollutants expected, which will be valuable when deciding on any treatment required or, if appropriate, what form of alternative processes would be available if the problem could best be solved by recourse to low-waste technology.

6.5 The **type of waste and its average composition** (i.e. what substances are present in it, and in what concentrations) must be comprehensively known, as well as any treatment it may be undergoing. In this context, it is important to know **all** the constituents of the waste, and the proportions in which they occur, not only the substances listed in Annex I to the Protocol or in any annex to national legislation. The **form of the waste** (*i.e.* whether it is a solid, liquid, sludge or slurry) is essential to decide on disposal methods, which might have to be on land. Apart from the **total amount of the waste**, as expressed in terms of volume per year, the **discharge pattern**, i.e. whether the discharge is continuous, intermittent, or only seasonal, should also be noted, as this will affect the ability of the receiving marine environment to contain it or otherwise.

6.6 One major factor to consider will be the **concentrations in the waste of substances listed in annex 1 to the Protocol**, which will presumably be reflected in the appropriate national legislation, and the compliance or otherwise of such concentrations with statutory limits and standards. This should be seen along with the total amount, since concentrations can be modified by dilution.

6.7 The **physical, chemical and biochemical properties of the waste** will have to be known, as these will affect its dispersal, transport and fate in the marine environment, either as a result of its intrinsic properties, or through inter-reaction with marine organisms or with the natural components of seawater.

6.8 Extensive documentary material is available in the literature regarding the types of wastes associated with specific industries. Reference is suggested, *inter alia*, to the WHO/UNEP 1982 publication "Waste discharge into the marine environment; Principles and guidelines for the Mediterranean Action Plan" (WHO/UNEP, 1982, and to the more recent 1994 guidelines for the treatment of effluents prior to discharge into the Mediterranean Sea (WHO/UNEP, 1994b). In both publications, the constituents of wastes originating from specific industries, are described, with particular reference to substances listed in the former Annexes I and II to the original protocol, now combined in Annex I in the new version. This. however, will only provide basic information on what to expect - actual data, both qualitative and quantitative, have to be collected from each industry. When considering industries discharging their wastes into municipal sewers, composition of the waste, apart from concentrations and amounts of listed substances, assumes importance from the point of view of any possible damage, through corrosion or otherwise, to the sewerage system itself, as well as to materials such as grease which could cause blockages.

Characteristics of waste constituents with respect to their harmfulness

6.9 The following factors have to be considered under this heading:

(a) persistence (physical, chemical, biological) in the marine environment;

(b) toxicity and other harmful effects;

(c) accumulation in biological materials or sediments;

(d) biochemical transformation producing harmful compounds;

(e) adverse effects on the oxygen content and balance;

(f) susceptibility to physical, chemical and biochemical changes and interaction in the aquatic environment with other sea water constituents which may produce harmful biological or other effects on any of the uses listed in Section E below.

6.10 **Persistence in the marine environment** of a given substance strongly depends on the characteristics of both the substance and the receiving environment. The significance of persistence is directly related to that of degradability of a substance, even although the relative definitions express varying concepts. Certain substances may be removed from the marine environment or rendered harmless by chemical transformation into naturally-occurring substances. Some of the removal processes involved are photolysis and photo-oxidation, biodegradation and metabolization, sedimentation and sediment burial, transfer into the atmosphere, etc. Other substances, particularly some of the synthetically-produced organic chemicals may not be readily removed from the environment, and thus become a potential threat in view of their persistence. The definition of danger level is in relation to the ecological structure of the zone, to the type of trophic chain which exists there, and to the exploitation which man makes of this chain in the given area.(WHO/UNEP, 1982).

6.11 The **toxicological properties** of a contaminant form its most significant characteristic. The traditional method of determining the toxicity of any particular substance to marine fauna and flora is based on the LC_{50}, which is the concentration of the substance in seawater lethal to 50% of exposed test organisms in a given time. In the literature, the results given by toxicity tests show a great variation. This is explained by several reasons, including the use of various species with different physiology, and variation in the conditions under which the tests are carried out. The developmental stage of test organisms also affects the results, and fry and larvae often show a much higher sensitivity than adult specimens. The LC_{50} is determined by bioassays and, thus defined, has many conceptual limitations and is ill-suited to be used as a gauge of the toxicity of the water in models of dispersion of the receiving waters (WHO/UNEP, 1982). The conceptual limits are due to the fact that a test on every single species, especially those not belonging to the community concerned with the discharge, does not permit evaluation of acute limits and limits of chronic tolerability for the other species, or of the effects on the structure of the biological community and on its capacity to adapt and evolve.

6.12 Apart from mortality, the presence of pollutants in seawater produces several types of sub-lethal effects in marine plants and animals, and recent trends in pollution monitoring use a variety of sub-lethal effects as indicators. One approach, used in the USA, is to establish the Maximum acceptable toxicant concentration (Mount and Stephen, 1967), which is experimentally determined as that concentration which allows for the full life-cycle (from egg to egg) of target organisms, usually fish, to be completed successfully. Another way to identify a non-dangerous concentration is the No observed effect level (NOEL) approach, which is used where a few consistent data are available, including some long-term exposures, but where full toxicity information is lacking (UNEP, 1985a). Other approaches have been recorded (UNEP, 1985a), including factors which may be required to take account of different patterns of response by organisms so as to provide additional safety.

6.13 When more than one chemical substance is present in a water body (which is generally the case), possible interactions have to be taken into account, in the event that more than additive effects (synergism) or less than additive effects (antagonism) can occur. However, in the vast majority of cases for which data exist, the response is simply additive. In this context, it is still a matter of debate among scientists whether or not the effects of concentrations below the non-observed effect level are additive. Obviously, in all cases where the acceptable levels have been defined without sufficient information, it is recommended as advisable to consider concentrations to be additive in their effect.

6.14 A few metals, radionuclides, and some organic substances are selectively retained in the living tissues of organisms, where they may cause direct effects, or may be transferred *via* the food-chain to other organisms. As marine organisms absorb or digest several times their own weight in the form of food during their life-span, the concentration of such substances in the tissues, particularly in filter-feeders and in organisms occupying a high place in the food-chain, will be several times that prevailing in the ambient seawater. The phenomenon is termed **bioaccumulation**, and in its study, it is important to define the concentration factor regarding the accumulation and transfer of a substance. The concentration factor is defined as the ratio of the concentration in the organism to the concentration in an equal amount of water. .In the case of bioaccumulative substances, control of the concentration in water may not be the best means to protect the ecosystem or any of its components, including man. In these cases, the concentration in the tissues should be measured and used to derive control measures. For example, the level of mercury in aquatic organisms has been used in the United Kingdom to arrive at a maximum allowable discharge of mercury to coastal waters (Preston & Portmann, 1981). A second example of indirect protection of fish-eating birds against the effects of accumulative chemicals is the definition of an acceptable level of induced enzyme activity (*e.g.* acetylcholinesterase and mixed function oxidases) in bird liver. Tainting of seafood by phenols can also be used as an early warning of pollution from petrochemical complexes. Therefore, the bioconcentration factor (BCF) can be used as an instrument of control (UNEP, 1985a).

6.15 Wastes discharged into the environment undergo various **transformations.** Physical, chemical, and especially biological agents will interact with the various components of the waste and change the original composition of the organic matter by altering the physicochemical form of elements, through incorporation of substances into living matter, and by adsorption onto particles and sediments. A number of biochemical transformations may occur as a result of which the intermediate or end compounds produced will be more toxic than the original.

6.16 Discharge of any biodegradable organic waste into the marine environment will have an **effect on the oxygen balance** due to exertion of immediate oxygen demand and biochemical oxygen demand (BOD). The main sources of such wastes are municipal wastes and industrial wastes, particularly the food and beverage industries, breweries and distilleries, paper industries, tanneries, refineries and petrochemical industries, canneries, sugar refineries, as well as meat packing and processing and fishmeal production (WHO/UNEP, 1982). The effect of land-based point source discharges of biodegradable organic wastes on the oxygen balance of the open sea will be limited to the immediately surrounding area of the point of discharge. This is because of the enormous dilution rate in the open sea. However, the effects of oxygen depletion will be much more marked in confined areas of the sea such as estuaries, lagoons, marinas, close narrow bays and sea-enclosures. Sulphides, sulphites, and other chemical reducing agents, whether from industrial sources or from septic municipal sewage, exert an appreciable immediate oxygen demand that might cause substantial fish kills in the vicinity of discharge, particularly in sea-enclosures.

6.17 The most important factor that can seriously affect the oxygen balance in larger areas of the sea, also when a certain degree of enclosure exists which prevents free exchange of seawater with the open sea, is eutrophication. Nitrogen constitutes the main limiting factor to algal growth in the marine environment rather than phosphorus. There are a number of major sources of nitrogen that might reach the sea, including municipal wastewater, run-off, drainage water, agricultural fertilizers and wastes, and nitrogenous compounds from industrial wastes. The issue of authorizations for discharge of wastes containing nitrogen should therefore be considered in the light of nitrogen reaching the same marine area from non-point sources, such as run-off, which cannot be controlled by an authorization procedure.

Characteristics of the discharge site and receiving marine environment

6.18 The following factors have to be considered under this heading:

(a) hydrographic, meteorological, geological and topographical characteristics of the coastal area;

(b) location and type of the discharge (outfall, canal, outlet, etc.) and its relation to other areas(such as amenity areas, spawning, nursery and fishing areas, shellfish grounds) and other discharges;

(c) initial dilution achieved at the point of discharge into the receiving marine environment;

(d) dispersion characteristics such as effects of currents, tides and wind on horizontal transport and vertical mixing;

(e) receiving water characteristics with respect to physical, chemical, biological and ecological conditions in the discharge area;

(f) capacity of the receiving marine environment to receive waste discharges without undesirable effects.

6.19 Having established what substances are present in a discharged effluent, and in what concentrations and quantities, and having utilised the information to determine what quantities would be acceptable for discharge in the receiving waters, the next task is to correlate these two sets of data. This would result in an estimate of the restrictions on the discharge (to be incorporated in the conditions of authorization) in order to secure conditions acceptable to the receiving waters.

6.20 It is essential that the receiving coastal area be comprehensively studied from the **hydrographic, meteorological, geological and topographic** viewpoints. In order to determine whether a given discharge is acceptable or not, the first indication required is its geographical location. This presents no problem. It is advisable, however, that the location be established on maps of a scale sufficient to illustrate not only the local aspects, but also the general context of the problem. Therefore, for siting, use should be made of maps of the scale of 1: 100,000, 1:25,000 or even 1:10,000. Even larger scales (1:1,000 to 1:100) may be used to evidence particular connections with the sewer system, bypasses, layout of treatment plants, sampling points, etc. Obviously, one of the maps used should include bathymetric data; such maps are already available for the whole of the Mediterranean Sea, and have been accurately prepared by the hydrographic offices of the navies of several countries, both Mediterranean and other. (WHO/UNEP, 1982).

6.21 The exact **location and type** (overhead or submarine outfall, canal, etc.) of the discharge must be accurately recorded, as well as its **relation to sensitive areas and to other discharges.** For this reason all maps produced must have as much information as possible concerning urban and industrial settlements, both present and planned, river mouths and their degree of pollution, the coastal areas destined for particular uses (shellfish culture areas, recreational beaches, harbours, fishing areas, marine parks, etc.) Furthermore, all other discharges, both present and foreseen, must be reported, even if considered to be of minor importance. In this context, it may happen that the microbiological quality of a coastal area be endangered near the point of discharge even by a very small discharge (*e.g.* from a hotel), if it flows in proximity to bathing beaches. In fact, one of the difficulties which often arise in the sanitation of coastal areas consists in the purification of a number of small discharges not served by the sewer system. Obviously, for graphic reasons, discharges of minor importance may be indicated only on large-scale maps, while those of major would be shown in the smaller-scale ones. This has a certain logical justification, since discharges of minor importance, when of a similar nature, have a more limited range of action.

6.22 Discharges of wastes out to sea are normally made through an appropriate submarine outfall structure. The efficiency of already-existing structures in relation to dispersal of the effluent can be estimated by appropriate monitoring programmes with sampling stations at various intervals between the diffusers and the coastline. The point of emergence from the coast, and the length and depth of such a structure have to be accurately calculated. Guidelines for submarine outfall structures for Mediterranean small and medium-sized communities have been recently issued (WHO/UNEP, 1994a). For large cities, site-specific comprehensive *ad hoc* studies will have to be conducted.

6.23 The importance of wind data should be considered in relation to the influence it exerts on masses of seawater in producing currents. Knowledge of winds may, however, have a certain importance from the aspect of installation of treatment plants downwind of, and at a certain distance from, centres of habitation. One of the important questions of a topographic nature is that of determining the exact site at which a treatment plant is to be installed. In this context, geological information is also required from the viewpoint of treatment plant construction.

6.24 Wastewater, especially from domestic sources, is lighter than seawater. When wastewater is discharged into the sea, it tends to rise due to density differences. In highly turbulent seas, the wastewater discharged is thoroughly mixed, while in calm seas, the wastewater will rise like a plume. The eventual concentration of any particular constituent in the waste after discharge to the sea is dependent on three main phenomena. These are initial dilution, dispersion, and decay or reaction. The **initial dilution** is the dilution in the vertical direction when the wastewater rises to the surface. **Dispersion** is the dilution on the water surface as the wastewater is mixed by the waves. **Decay** is the decomposition of various components of the waste resulting from the reaction with the natural components of seawater. The physicochemical properties of seawater hasten bacterial die-off and biological degradation.

6.25 The parameters which determine jet dilution from submerged outlets are:

(a) the rate of discharge;

(b) the angle of inclination of the emergent jet;

(c) the densities of the jet fluid (the wastewater) and the receiving marine water;

(d) the depth of water over the outlet;

(e) the height to which the emerging plume rises;

(f) the jet velocity;

(g) the ambient current velocity.

6.26 In a given depth of water, the multiple port manifold or diffuser is the most satisfactory engineering technique to obtain a high initial dilution. The importance and the limits of the phenomena of initial dilution in the context of the process of sanitation of a particular marine zone results in a certain preference for standards which apply to the seawater downstream of the process of initial dilution.

6.27 The phenomenon of dispersion starts immediately after that of initial dilution. It concerns the so-called sewage field, *i.e.* the mass of water which consists of a mixture of seawater and sewage. The process of dispersion may be subdivided according to the two mechanisms concerned:

(a) the transport or movement away from the discharge point;

(b) the process of eddy diffusion, which involves the progressive dilution of the sewage field as it moves away.

6.28 It can be considered that the main importance of the phenomena of dispersion and subsequent dilution lies in the fact that they make it possible to delineate zones, according to their distance from the discharge zone, with a greater measure of protection than obtaining in the discharge zone itself. The process of transport eventually depends on the strength and direction of the marine currents in the zone in question. The exposure of a given marine zone to a discharge in a specific location may be greater or less according to whether the trend of the currents is favourable or otherwise. Among the various parameters controlling dispersion are those which take into account certain biochemical and biological phenomena which relate to the extinction of certain pollutants (bacteria) and the adsorption of others, such as nutrients. In this regard, the physico-chemical properties of seawater hasten bacterial die-off and biological degradation.

6.29 The **oceanographic and ecological characteristics of receiving sites, particularly the discharge area**, must be thoroughly studied. These characteristics will influence both the spread of the discharge and its eventual fate and effects. Particular attention should be devoted to bays and inlets.

6.30 Various terms are used to describe the extent to which the environment is able to accommodate waste without deleterious effects (UNEP, 1985). **Environmental capacity** can be considered a property of the environment, and can be defined as its ability to accommodate a particular activity or rate of activity, (*e.g.* volume of discharge per unit time, quantity of dredgings dumped per unit time, quantity of minerals extracted per unit time) without unacceptable impact. This capacity includes physical processes such as dilution, dispersion, sedimentation and evaporation, as well as other processes which lead to degradation or other ways by which an activity loses its potential for unacceptable impact. Environmental capacity will vary with the characteristics of each site, and with the type or number of discharges or activities. Use of the capacity of an environment to assimilate a waste or activity must recognise the defined capacity as an upper limit.

6.31 The calculation for the assimilative capacity is very site-specific, which calls for the development of scaled hydraulic models and computer modelling using the finite element method of solution to the dispersion equation. Modelling studies are carried out before any decision on location of major outfalls from cities and industries is taken. Detailed methods of calculating assimilative capacities are available (WHO / UNEP, 1982; UNEP, 1993a). A summary of the processes involved in the assimilation or accumulation of anthropogenic substances in the marine environment is given in Table 6.1.

Availability of waste technologies

6.32 This part of the annex stipulates that the methods of waste reduction and discharge for industrial effluents as well as domestic sewage should be selected taking into account the availability and feasibility of:

(a) alternative treatment processes;

(b) re-use or elimination methods;

(c) on-land disposal alternatives;

(d) appropriate low-waste technologies.

6.33 For domestic sewage, conventional treatment processes are considered sufficient, on the understanding that such sewage does not contain significant amounts of industrial wastes. An outline of the relative treatment steps (UN/EYE, 1984a, 1984b; HMO, 1979), which includes a number of **alternative processes**, has already been provided in Part 5 of this document.

6.34 Authorizations for discharge of industrial effluents, either directly into the sea, or into municipal sewerage systems, should specify the approved type(s) of pretreatment prior to discharge, as well as the upper limits acceptable for each particular pollutant. Present technology of industrial waste treatment includes physical, chemical and biological processes for solids separation, neutralisation, oxidation of organic materials, digestion of solids, sludge conditioning and/or incineration. It also encompasses a number of nonconventional processes such as mixed media filtration, micro-screening, break point chlorination, selective ion exchange, activated carbon absorption, reverse osmosis, ultrafiltration, and electro-flotation (Middlebrooks, 1979; UN/EYE, 1984). A comprehensive description of treatment processes for each individual pollutant listed in Annex I to the Protocol has been recently prepared (WHO/UNEP, 1994b). A summarized list of waste treatment systems, showing their uses and effectiveness, is given at Table 6.2. and a list of the main industrial pretreatment schemes (UNEP/PAP-RAC/CEFIGRE, 1988) in table 6.3.

6.35 **Wastewater reclamation** is the treatment or processing of wastewater to make it reusable, and **wastewater re-use** is the use of treated wastewater for a beneficial purpose. Wastewater re-use has varied objectives in different countries, depending on the particular requirements or interests of the locality concerned. Major objectives include the replenishing of groundwater aquifers with treated waste water to prevent salt water intrusion or restore diminishing supplies, the recovery of wastewater for industrial use, the creation of recreational facilities, and the use of wastewater for irrigation. In general, the trends and motivating factors in wastewater reclamation and re-use can be characterized as follows (Asano, 1991):

(a) water pollution abatement in receiving waters;

(b) availability of highly treated effluents for various beneficial uses;

(c) provision of long-term reliable water supplies to nearby communities;

(d) water demand and drought management in overall water resources planning;

(e) a public policy encouraging water conservation and re-use.

6.36 As a rule, reclamation and re-use is applied to municipal, as distinct from industrial, wastewaters, and a varying degree of treatment must be applied to the raw wastewater before re-use, depending on the particular way in which such re-use is planned. The applicability of reclaimed water for any particular use depends on its physical, chemical and microbiological quality. The effects of physical and chemical parameters for non-potable uses of reclaimed water are, for the most part, well understood, and criteria have been established. Health-related microbiological criteria are more difficult to quantify, as evidenced by widely varying standards and guidelines throughout the world. The categories of municipal wastewater re-use and potential constraints (Asano, 1991) are summarized in Table 6.4. Quality criteria and standards for re-used wastewater are higher than those prevailing for discharge at sea, so treatment has to be more advanced, particularly for potable or industrial re-use. However, considering the water problems prevailing in several parts of the Mediterranean, the option of re-use should be seriously considered.

6.37 **On-land disposal** of waste mainly concerns the sludge after separation. In considering on-land disposal alternatives, sludge handling and disposal can be the most difficult phase of effluent treatment and breakdown from the point of view of a satisfactory operation. A number of methods are available for sludge treatment and disposal (*vide* Part 5 of this document), but local conditions largely govern the choice of method which would be the most suitable for any particular installation. Apart from the fact that any method selected for sludge disposal on land would have to be economical, it should be environmentally safe, and not simply result in the transfer of the pollution problem from the sea to the land.

TABLE 6.1

PROCESSES INVOLVED IN THE ASSIMILATION OR ACCUMULATION OF ANTHROPOGENIC SUBSTANCES IN THE MARINE ENVIRONMENT
(from NOAA, 1984)

PROCESS	EFFECT
Passive substances (not affected by biological and chemical processes)	
Dilution	Reduction in concentration of substance by mixing with seawater
Dispersion	Horizontal or vertical spreading or scattering of substance from point of origin
Horizontal transport	Movement of substance along a horizontal plane
Vertical transport	Movement of substance along a vertical plane
Active substances (affected by biological and chemical processes)	
Flocculation and sorption by electrostatic processes	Aggregation of fine particles (including those in colloidal suspension) into flocs and adsorption of dissolved and particulate matter (organic and inorganic) on the flocs. A process that is characteristic of estuaries, where silt-laden freshwater mixes with seawater, causing sedimentation at the delta.
Precipitation and co-precipitation	Reaction of some introduced substances with constituents of seawater to form a precipitate (*e.g.* produce flocculent ferric hydroxide). Other substances may co-precipitate.
Sedimentation and scavenging	Flocs of silt and flocculent precipitates settle to the bottom by gravitation and may scavenge dissolved and suspended matter and adhere to detritus and dead organisms in the water column as they settle. Materials become fixed in bottom sediments.
Consumption and respiration by bacteria	Decomposition of matter with uptake of oxygen and release of carbon dioxide, water and nutrients.
Uptake and bioaccumulation by marine plants and animals	Removal of substances from seawater and incorporation into marine plant and animal tissues.
Biomagnification through the marine food chain	Accumulation of substances from marine organism predation at different trophic levels.
Detoxification by metabolic processes	Conversion of toxic substances to harmless compounds by biochemical action in marine organisms.
Transport by marine organisms	Vertical transport by zooplankton in diurnal migration, and horizontal transport by fish and invertebrates in feeding and spawning migrations.

TABLE 6.2

USES AND EFFECTIVENESS OF SELECTED WASTE TREATMENT SYSTEMS

(from Middlebrooks, G. E., 1979)

Treatment system	Stage	Effluent reduction
Sedimentation or gravity separation	Primary treatment or by-product recovery	Grease - 15-20% removal BOD5 - 20-30% removal SS - 30-50% removal
Dissolved air flotation (DAF)	Primary treatment or by-product recovery	Grease - 60% removal to 100/ 200 mg/l BOD5 - 30% removal SS - 30% removal
DAF with pH control and flocculants added	Primary treatment or by-product recovery	Grease - 95-99% removal BOD5 - 90% removal SS - 98% removal
Anaerobic and aerobic lagoons	Secondary treatment	BOD_5 - 95% removal
Anaerobic and aerobic + aerated lagoons	Secondary treatment	BOD_5 - up to 99% removal
Aerobic contact process	Secondary treatment	BOD_5 - 90-95% removal
Activated sludge	Secondary treatment	BOD_5 - 90-95% removal
Extended aeration	Secondary treatment	BOD_5 - 95% removal
Anaerobic lagoons and rotating biological contactor	Secondary treatment	BOD_5 - 90-95% removal
Chlorination	Finish and disinfection	-
Sand filtration	Secondary treatment Tertiary treatment	BOD_5 - to 5-10 mg/l SS - to 3-8 mg/l
Microstraining	Tertiary treatment	BOD_5 - to 10-20 mg/l SS - to 10-15 mg/l

TABLE 6.2 (continued)

Treatment system	Stage	Effluent reduction
Electrodialysis Ion exchange Ammonia stripping	Tertiary treatment Tertiary treatment Tertiary treatment	TDS - 90% removal Salt - 90% removal SS - 90-95% removal
Carbon absorption	Tertiary treatment	BOD_5 - to 98% removal as colloidal and dissolved organics
Chemical precipitation	Tertiary treatment	Phosphorus - 85-90% removal to 0.5 mg/l or less
Reverse osmosis	Tertiary treatment	Salt - to 5 mg/l TDS - to 20 mg/l

6.38 Paragraph 4 of Article 5 of the new version of the Protocol specifically states that when adopting programmes, measures and action plans, the Contracting Parties shall take into account, either individually or jointly, the best available techniques for point sources and the best environmental practices for point and diffuse sources including, where appropriate, clean production technologies. Clean production, resulting from **low-waste technology,** is a concept which, as a key feature, promotes the switching of emphasis from waste disposal to waste avoidance (Johnston, MacGarvin & Stringer, 1991). This excludes measures that simply divert or dilute polluting waste streams. A toxicity-use audit at the manufacturing stage identifies waste streams which may be eliminated directly by technical solutions and also indirectly by process or raw material substitution. A wide approach is implied embracing the whole manufacture / use / disposal cycle, and removes limitations about what can be achieved by use of economically-driven end-of-pipe solutions exemplified by the best available technology approach. It implies the design of durable and re-usable products which are easily dismantled for reconditioning or for the recovery of raw material. Given the necessary regulatory and educational changes, such a philosophy promises to provide a workable framework through which far-reaching changes in industry may be effected.

6.39 The development of this framework requires that simple questions be answered for each production process concerning the waste streams generated, the quantities and hazardous components of these, fugitive losses of raw materials, and the efficiency of conversion of raw materials to final products. Losses may be of considerable economic as well as environmental significance, and there is a huge variation in waste generated by different manufacturers producing the same products.

TABLE 6.3

SOME TYPICAL INDUSTRIAL PRETREATMENT SCHEMES

(from UNEP/PAP-RAC/CEFIGRE, 1988)

Industrial waste	Flow characteristics	Normal contaminants	Typical pretreatment
Meat products	intermittent	BOD, COD, TSS, TDS, chlorine demand, colour, coliforms, oil and grease organic nitrogen	Screening, oil and grease removal, equalization
Dairy products (milk handling and milk products)	intermittent-continuous	BOD, COD, TDS, grit, chlorine demand, colour, alkalinity, turbidity, detergents, coliforms	Oil and grease removal, equalization and neutralization
Malt beverages and distilled spirits	intermittent-continuous	BOD, COD, TSS, grit, acidity, alkalinity	Grit removal, separation of coarse solids, equalization, neutralization.
Wine and brandy	intermittent-continuous	BOD, COD, TSS, grit, nutrient deficiency	Grit removal, separation of coarse solids, equalization, neutralization
Soft drinks bottling	intermittent-continuous	Grit, alkalinity	Grit removal and neutralization
Wool	intermittent-continuous	BOD, COD, TSS, TDS, grit, chlorine demand, alkalinity, detergents, colour, heavy metals, phosphorus	Coarse solid separation, oil and grease removal, chemical precipitation, equalizations, neutralization.
Cotton and synthetics	intermittent-continuous	BOD, COD, TSS, TDS, chlorine demand, colour, alkalinity, detergents, heavy metals, phosphorus	Coarse solid separation, chemical precipitation of heavy metals and colour equalization, neutralization.

TABLE 6.3 (continued)

Industrial waste	Flow characteristics	Normal contaminants	Typical pretreatment
Chrome tanning and finishing	intermittent	BOD, COD, TSS, TDS, grit acidity/alkalinity, heavy metals, oil and grease.	Grit removal, equalization, chemical precipitation, solids separation, neutralization.
Vegetable tanning	intermittent	BOD, COD, TSS, TDS, grit, oil and grease, acidity/alkalinity	Coarse solid separation, grit removal, equaliz-ation, neutralization
Petroleum refining	continuous	BOD, COD, TSS, grit, heavy metals, oil and grease, phenols, sulphides	Oil separation, equal-ization, chemical coagulation, dissolved air flotation.
Metal finishing	intermittent-continuous	TDS, cyanide, ammonia, hexavalent chromium, heavy metals, acidity/alkalinity	equalization, neutraliz-ation, cyanide removal, chromium reduction, chemical precipitation, solids separation.
Fruit and veget-able products	intermittent	BOD, COD, TSS, TDS, grit, colour, detergents, acidity/alkalinity	Grit removal, coarse solids separation neutralization
Pulp and paper	continuous (mechanical pulping)	BOD, COD, TSS, TDS, chlorine demand, heavy metals, acidity, coliforms	Grit removal, coarse solids separation, neutralization.
Chemical pulping (unbleached)	continuous	BOD, COD, TSS, TDS, grit, heavy metals, colour, coliforms	Grit removal, coarse solid separation, neutralization.
Chemical pulping (bleached)	continuous	BOD, COD, TSS, TDS, grit, chlorine demand, acidity, heavy metals, colour, coliforms.	Grit removal, coarse solids separation, neutralization.

TABLE 6.4

CATEGORIES OF MUNICIPAL WASTEWATER RE-USE AND POTENTIAL CONSTRAINTS

(From Asano, 1991)

Re-use categories	Potential constraints
Agricultural and/or landscape irrigation	Effect of water quality, particularly salts, on soils and crops
	Public health concerns related to pathogens
	Surface and groundwater pollution, if not well managed
	Marketability of crops and public acceptance
Industrial re-use	Reclaimed wastewater constituents related to scaling, corrosion, biological growth and fouling
	Public Health concerns, particularly aerosol transmission of organics, and pathogens in cooling water and various process waters
Groundwater recharge	Trace organics in reclaimed wastewater and their toxicological effects
	Total dissolved solids, metals and pathogens in reclaimed wastewater
Recreational and environmental uses	Public health concerns due to bacteria and viruses
	Eutrophication due to nitrogen and phosphorus
	Aesthetics, including odour
Non-potable urban uses	Public health concerns about pathògen transmission by aerosols
	Effects of water quality on scaling, corrosion, biological growth and fouling
	Potential cross-connections with potable water systems
Potable re-use	Trace organics in reclaimed water and their toxicological effects
	Aesthetics and public acceptance
	Public health concerns about pathogen transmission

6.40 Extensive documentation on low-waste technology is available. Article 7 of the Protocol provides for the preparation of guidelines on the control and progressive replacement of products, installations and industrial and other processes causing significant pollution of the marine environment. These guidelines were included in the list of activities towards the progressive implementation of the Protocol covering the period 1985-1995, but unforeseen circumstances have delayed the start of such preparations, Until such time as these guidelines are complete and appropriate programmes and measures involving the use of clean technology in industrial processes are formally adopted by Mediterranean governments in terms of Article 5 of the Protocol, consideration of this factor, *i.e.* the availability of appropriate low-waste technology, in the granting or otherwise of discharge authorizations, should be taken on the basis of prevailing national policy on this issue.

Potential impairment of marine ecosystems and sea water uses

6.41 The following factors have to be considered under this heading:

(a) Effects on human health through pollution impact on:

- edible marine organisms;
- bathing waters;
- aesthetics.

(b) Effects on marine ecosystems, in particular living resources, endangered species and critical habitats.

(c) Effects on other legitimate uses of the sea.

6.42 A significant proportion of the overall effect of marine pollution originating from land-based municipal industrial waste discharges manifest themselves directly or indirectly in **adverse effects on human health** mainly through consumption of contaminated seafood and through exposure to polluted seawater in recreational areas. Municipal sewage discharges result in microbiological contamination of recreational and shellfish areas in the vicinity, the extent depending on the amount of sewage, the point of discharge in relation to the sensitive area in question, the topography of the area, and prevailing meteorological and oceanographic conditions. One of the main requirements is therefore the existence of a set of quality standards for coastal marine recreational and shellfish areas, and *authorizations for waste discharges should only be granted where and when it is known for* certain that the discharge in question will not result in recreational and/or shellfish waters in the vicinity not complying with such standards.

6.43 When considering the pollution of **edible seafood**, shellfish areas present a significant problem. Apart from being prone to microbiological contamination from sewage discharges, shellfish also accumulate toxic chemicals entering the coastal zone through industrial waste discharges. On a joint recommendation by UNEP and WHO (UNEP/WHO, 1987) the contracting Parties formally adopted criteria for shellfish waters on a joint basis in 1987 and the operative parts of the relevant resolution, including the standards, are given in Table 2.3. It should be made clear that the standards in question, although using the actual shellfish as the indicators, constitute a criterion of water quality only, and compliance signifies that the area in question is acceptable as a growing and/or harvesting area. This compliance does not necessarily mean that the shellfish themselves are fit for human consumption. This particular aspect was assumed to be covered by appropriate public health or food legislation outside the scope of the water quality standards. Apart from this, the quality standards adopted for shellfish areas in 1987 only cover microbiological aspects, and are limited to maximum concentrations of one bacterial indicator organism. A number of Mediterranean countries have stricter standards, although many of these are also confined to microbiological quality (UNEP/WHO, 1987). Annex II to the Protocol (*vide* paragraph 6.34 above) refers clearly to effects on human health through pollution impact on edible marine organisms (not to the water in which they grow), and any authorization for discharge of municipal or industrial wastes in the vicinity of shellfish areas should only be given after assurance is secured that the amounts and concentrations of microbiological and chemical pollutants in such discharge will not render the shellfish in affected areas unacceptable for human consumption through non-compliance not only with national standards for acceptability of growing waters, but also with appropriate national public health or food legislation containing standards as to the maximum acceptable concentrations of such pollutants in the shellfish concerned.

6.44 Under conditions of eutrophication, shellfish may be contaminated by a number of algal biotoxins, which render them unfit for human consumption. Eutrophication is not normally associated with effluents discharged from point sources, but this factor should be kept in mind.

6.45 Industrial effluents, particularly those containing toxic, persistent or bioaccumulative chemicals, can render several species of fish unfit for human consumption. Particular attention should be paid to fish inhabiting the immediate coastal areas under the influence of industrial waste discharges, and discharges should not be authorized if levels of pollutants in coastal fish species would, as a result of these, be in excess of stipulated acceptable maxima. In the absence of national legislation on acceptable maximum concentrations of any particular chemical in edible fish, the national body responsible for granting discharge authorizations could withhold authorization of any specific discharge if its constituents are proven to affect the quality of coastal fish species in the vicinity to an extent incompatible with consumer safety. This can be done on the basis of the factors listed in Annex II to the Protocol, provided that such factors are incorporated in national legislation on waste discharges into the marine environment, and the authorizing body is legally bound to follow them in the granting of authorizations.

6.46 Interim criteria for **bathing waters** were adopted on a common basis by Contracting Parties to the Barcelona Convention and the Land-based Sources Protocol in 1985. These, which are, in effect, standards, are reproduced in Table 2.3. The value of these standards is at best doubtful insofar as the protection of human health is involved. Apart from the fact that the relative Resolution adopting them makes it clear that they are only an essential minimum, they only represent part of the relevant recommendations made by WHO and UNEP (UNEP/WHO, 1985a, WHO/UNEP 1994c), a number of Mediterranean countries employ considerably stricter ones (WHO/UNEP, 1995). This problem, which is only temporary in nature, pending the development and adoption of permanent Mediterranean standards for recreational waters, affects the national authorities responsible for standard-setting, as distinct from those responsible for authorizing waste discharges. In the matter of discharge authorizations, the conditions for compliance as regards effects on marine recreational areas would normally have to be in conformity with prevailing national quality standards.

6.47 It is important that seawater used for specific purposes such as bathing or shellfish growing presents an **aesthetically-pleasing** appearance. Aesthetic satisfaction can be a definite force in promoting public health and well-being, This is experienced through the senses of sight, smell, taste and touch. The assessment of what is aesthetically acceptable or objectionable is a matter of subjective opinion, and although efforts have been made to suggest quantitative standards, no authoritative standards have yet obtained general approval. Therefore, criteria concerning these aesthetic characteristics must be general and descriptive, rather than specific and numerical.

6.48 The presence of gross solids represents the most important aesthetic objection to waste discharges from short outfalls. When stranded on shore and combined with floating solids, they may constitute a health hazard. If the solids are wholly or even partially removed, aesthetic objections may be satisfied and the health hazards reduced. The breakdown of solids into finer particles causes greater exposure of sewage microorganisms to the chemical agencies of seawater and sunlight, and thus accelerates their decomposition in the sea. The presence of grease, oil, wax and fats results in the formation of a visible film on the surface of the sea in the vicinity of the discharge point. These materials, which have surface-active properties, tend to smooth out ripples and small waves, thus providing a ready indication of sewage discharge. Standards relating to solids, grease and oil would be particularly relevant if an outfall were to be located off a shore continually susceptible to onshore winds. If solids, grease and oils come into contact with fish caught by trawling, there is a risk of the catch becoming a health hazard, and hence financially devalued.

6.49 Even though a discharge might not contain any toxic components listed in Annex I to the Protocol or in corresponding national legislation, it should not be authorized if it renders bathing waters in the vicinity turbid and/or murky, if it produces an unpleasant odour, or if it renders such waters objectionable in any other way through the presence of substances mentioned in the preceding paragraph. Apart from actual or potential health hazards, such conditions in bathing waters will constitute a nuisance and detract from their aesthetic value, as a result affecting public use of the waters in question. The same holds for shellfish waters, since acceptance of produce from unpleasant-looking areas could similarly be reduced, even if such produce is considered as fit for consumption on purely microbiological grounds and taste and smell are comparatively unaffected.

6.50 The ecosystem is the basic functional unit in ecology, since it includes both organisms (biotic communities) and the abiotic or non-living components of the environment, each influencing the properties of the other, and both necessary for the maintenance of life. In its natural state, an ecosystem also constitutes a complex of interactions between all its components which maintain it in a finely-balanced condition. It is not only pollutants themselves which are **damaging to marine ecosystems**, but also the concentrations of products or the parameters of factors which, working at the biotic or abiotic component level, upset their complex interactions, either breaking these down completely, or partly altering the balance between the various components (WHO/UNEP, 1982).

6.51 Because of the different reactions exhibited by various marine organisms to the same concentration of any given polluting substance, and to the consequent alteration of the environmental factors within the ecosystem, studies aimed at establishing the degree of damage to marine ecosystems must be of a synecological (*i.e.* treating the ecosystem as a whole), rather than autecological (*i.e.* dealing with individual species separately) nature. Moreover, the synergic or additive effects of the effluent as a whole, as well as those of its individual components, should be studied in relation to the diffusion phenomena of the polluting source.

6.52 Apart from bathing, shellfish growing and harvesting, and maintenance of natural marine ecosystems, some of the more important **legitimate uses of the sea** are shipping, fishing, undersea mining, power station operation, industrial activities dependent on seawater, desalination, etc. Certain uses, such as power station operation, desalination and most forms of mariculture, require particular standards of pollution control which must be kept firmly in mind when making a choice of waste treatment and disposal methods. Settleable matter in the waste may, in the long term, interfere with shipping routes through the formation of sludge banks, and also through the blockage of cooling systems and the fouling of propellers. Certain pollutants may interfere with the cooling system in power plants which take their cooling waters from polluted marine areas. Ocean mining and extraction of chemicals from seawater may be affected by impurities, or by physical obstructions introduced by submarine outfalls.

6.53 Certain scientific purposes, such as marine parks, nature reserves and wildlife conservation (especially marine mammals and marine birds) may be critically dependent on freedom from pollution damage, and their presence may influence waste disposal policy outside their immediate vicinity. It must also be noted that cultured marine organisms are essentially captive, and cannot escape from a toxic water mass. One of the essential requirements for aquaculture is the absence of deleterious chemicals.

6.54 Outdoor recreation is on the continuous increase, and the recreational use of the coastal marine environment (including the sea shore) now includes surfing, scuba diving, sailing, and other similar activities, apart from orthodox bathing, and coastal marine recreation ranks as one of the most important form of recreation, both economically and socially. A number of these activities require an increase in the coastal marine area requiring protection from microbiological pollution, to avoid health hazards. Other activities are impaired by the presence of floating matter and the grease constituents of waste, requiring the removal of these substances before discharge.

Information required for discharge authorization

6.55 Each national authority would be expected to have its own particular format for applications for waste discharge authorizations. No model forms are therefore included in this document. Annex I provides a brief list of items on which information will be required prior to the granting or otherwise of an authorization. Part A contains a list of items on which information would normally have to be provided by the applicant. Part B contains information which the granting Authority will have to required from its own or from independent sources. Both lists are obviously based on the factors listed in Annex II to the Protocol.

ANNEX I

A. Information required by national authorities for the granting of a discharge authorization

Each national authority will have its own particular format for applications for discharge authorizations. No specific format is therefore proposed. However, the information which applicants have to provide to enable proper consideration to be given is listed below.

1. Name and address of Organization making the application.

2. Name of specific person submitting the application.

3. Type of organization.

4. Type of waste source.

5. Size of waste source.

6. Location of waste source.

7. Type of waste (municipal, industrial, mixed).

8. Average composition of waste (main constituents and average percentages over a defined period of time).

9. Form of waste (solid, liquid, sludge, slurry).

10. Total amount of waste (volume discharged per year).

11. Discharge pattern (continuous, intermittent, seasonal, etc). If intermittent, the periods during which discharge is effected must be indicated. If seasonally variable, the amounts discharged during each seasonal period must be indicated.

12. Concentrations of Annex I substances in the raw waste. This need not apply to municipal effluents from small towns containing no industries. It should however apply to
    (a) all industries
    (b) cities and towns where the municipal effluent is of the mixed type.

13. Treatment of waste at source (the type of treatment should be fully described.

14. Final concentrations of Annex I substances in the treated waste prior to discharge.

15. Type of discharge (canal, outlet, outfall, etc.) (full details on outfall structures should be provided). This would apply to discharges into a river or directly into the sea.

16. Locality of the discharge site. (maps of the area showing the exact locality of the discharge site should be provided.

B. Information which should be obtained by national authorities from their own or independent sources prior to considering applications for discharge authorizations

1. Compliance, or otherwise, of the waste with stipulated standards. If no national standards are in force, the authorities responsible for approving or rejecting the application will have to be guided either by international standards or by those in other countries where the situation is similar.

2. Characteristics of the constituents of the waste. Where standards are available, these would normally have been set in accordance with the characteristics of the element or compound in question. In cases where no standard for a specific substance is available, the results of studies on the characteristics listed in Part B of Annex II to the Protocol must be consulted.

3. Location of other discharges (existing or planned) in the same general area, as well as the constituents of such discharges.

4. Amenity and production areas (spawning areas, nurseries, fishing areas) likely to be affected both by the discharge under consideration, and by the total amount of discharges in the same area.

5. Initial dilution at the discharge point, dispersion and receiving water characteristics, and receiving water capacity, as detailed in Part C of Annex II to the Protocol.

6. If no treatment is being applied, what degree of treatment will be necessary. If treatment is being applied, but not satisfactory, whether any alternative type of treatment could be applied to improve the quality of the final effluent.

7. The possibility of alternative disposal on land. Care should be taken not to simply replace one problem by another.

8. The possibility of re-use. This, however, would necessitate treatment to a considerable higher standard, and the option is only justifiable when there is a need for water, not simply for protection of the marine environment.

PART 7

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